ISSN: 0001-5113
AADRAY

ACTA ADRIAT.,
42 (1): 89-102, 2001

UDC: 597.3 (261-15)
Original scientific paper

Observations on six elasmobranch species recorded from off the coast of Senegal (eastern tropical Atlantic)

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The authors report biological observations about six elasmobranchs species caught off the coast of Senegal and landed at craft fishery sites in the Cape Verde Peninsula (Eastern tropical Atlantic). These species are Etmopterus spinax, Oxynotus centrina, Rhincodon typus, Scyliorhinus cervigoni, Torpedo bauchotae *and* T. marmorata. *They are rather rare in the area. Nevertheless, new data allow suggesting that hydrobiological parameters do not play an important role in the reproductive biology of the viviparous species.*

Key words: elasmobranchs, reproductive biology, Senegal, Cape Verde Peninsula, eastern tropical Atlantic

INTRODUCTION

Thirty-four elasmobranch species were observed from off the Cape Verde Peninsula (Senegal, eastern tropical Atlantic) between 1993 and 1996 and described in previous papers (CAPAPÉ *et al.*, 1994, 1995, 2000, 2001). Further investigations in the same sites allowed recording other species and to collect new data, which are herein presented, discussed and contrasted.

MATERIAL AND METHODS

The observations were made on five fish-landing sites from the Cape Verde Peninsula in Senegal. These sites are plotted in the Fig. 1. Among them, Ouakam, 6 km far from Dakar, was the most frequently and regularly visited.

These observations concern six species: *Oxynotus centrina*, *Etmopterus spinax*, *Rhincodon typus*, *Scyliorhinus cervigoni*, *Torpedo bauchotae* and *T. marmorata*. For each species we give its vernacular name in English, in French and in Wolof, national language the most currently spoken by Senegalese people. The specimens observed were caught by gill-nets, only a single one by trawling.

Sharks and torpedinids were measured for total length (TL) following the methods of COMPAGNO (1984) and STEVENS and LYLE (1989). The specimens more than 10 kg were weighed on calibrated spring balances reading to the nearest 100 g. The other specimens were weighed on balances reading to the nearest g.

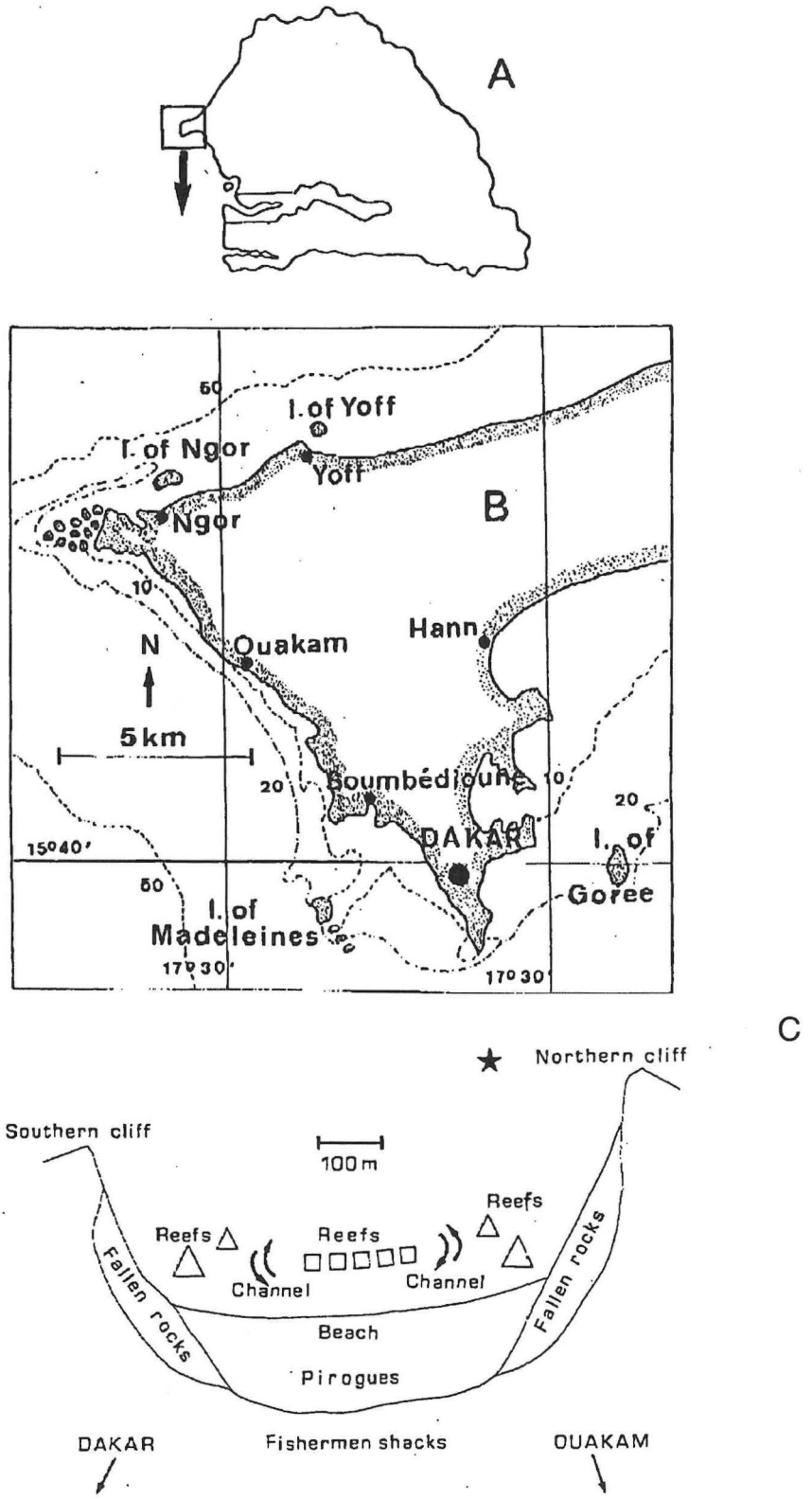

Fig. 1 A. Map of Senegal pointing out the Cape Verde Peninsula. B. Westen part of Cape Verde Peninsula (redrown from SOURIE, 1954 showing the fishing sites where the elasmobranchs were landed and observed) C. Site of Oukam (scematic, redrown from CAPAPÉ et al. *1994) pointing out the place (black star) where the While shark was captured. The curved arrows show the navigable channels throught the reefs*

In adult females, measurements also included diameter (in mm) and weight to the nearest decigrams for oocytes, eggs, embryos and fetuses. The specimens were measured to the nearest millimeter for total length (TL) following STEVENS and LYLE (1989) and weighed to the nearest gram. Measurements also included: clasper length (CL, mm) from the forward rim of the pelvic girdle to the tip of claspers according to COLLENOT (1969), the diameter and weight to the nearest decigram for oocytes, eggs, embryos and fetuses. Developing oocytes were removed from the ovaries and ova, embryos and fetuses from the uteri, then counted, measured and weighed. Fetuses were also sexed as well as embryos whenever possible.

Embryos and fetuses were only observed in *T. marmorata*. The former still had an umbilical stalk and an external vitelline vesicle (EVV). In the latter, the EVV was completely reabsorbed into an internal vitelline vesicle, a scar marking the place of the umbilical stalk.

According to STEVENS and LYLE (1989), the claspers of juvenile males are short and flexible. Males are considered to be mature when claspers are elongated and calcified.

Size of females at sexual maturity was determined from the condition of the ovaries and the morphology of the reproductive tract. Three categories of females were considered: juveniles, having small whitish ovaries with oocytes of microscopic size, membranous oviducts and inconspicuous nidamental glands; subadults with ovaries showing translucent oocytes and a differentiated genital duct; and adults having functional ovaries with yellow-yolked oocytes and a fully developed genital duct.

To emphasize embryonic development and the role of the mother during gestation, a chemical balance of development (CBD) was considered. CBD is based on the mean dry weight of fertilized eggs and fully developed fetuses. CBD can be computed as the mean dry weight of fully developed fetuses divided by the mean dry weight of fertilized eggs. Water content of 50% in ova and 75% in recently newborn pups can be taken as standard values, based on analyses in *Scyliorhinus canicula*, by MELLINGER and WRISEZ (1989). CBD is a tentative estimate in order to show the role of the female during gestation.

RESULTS

Etmopterus spinax; velvet belly; sagre noir; gaynde guedj bou nioul

Two *E. spinax* were caught from off Ouakam, in deep waters closed to the through of Kayar, at more than 100 m of depth. The first specimen, caught in September 1997, was an adult male, 380 mm TL, and weighed 186 g. The second specimen, an adult female caught in October 1998, was 420 mm TL and weighed 263 g. It contained 12 ripe oocytes with a diameter ranged from 24 to 27 mm (mean: 25.16 g; standard-deviation: 1.19) and a weight ranged from 3.3 and 3.7 g (mean: 3.52 g; standard-deviation: 0.14).

These measurements corroborated those observed in *E. spinax* from the northern coast of Tunisia (unpublished data) and the coast of Languedoc in southern France (CAPAPÉ *et al.*, 2000).

Oxynotus centrina; angular rough shark; humantin; dien mbam khoukh

Two adult females were landed at Ouakam, at the end of August 1988 and at the end of September 2000 respectively.

The first female was 680 mm TL and weighed 5065 g. Its total body weight and its eviscerated body weight were 5065 g and 4010 g respectively. The liver weighed 1004 g. The specimen contained 8 ripe oocytes in the left ovary and 3 in the right. Their diameter ranged from 40 to 42 mm (mean: 41.36 mm; standard deviation: 0.80) and weighed from 22 to 26 g (mean: 22.46 g; standard deviation: 1.40).

The second female was 685 mm TL. Its total body weight and its eviscerated body weight were 4545 g and 3080 g respectively. The liver weighed 825 g. The specimen had 5

ripe oocytes in both ovaries. Their diameter ranged from 44 to 52 mm (mean: 47.5; standard deviation: 2.87). Their weight ranged from 20.9 to 29.2 g (mean: 24.28; standard deviation: 2.83).

Three specimens were previously observed in Senegal (CAPAPÉ *et al.* 1999). They were an adult female containing fully developed fetuses and three juveniles probably born of the year. The new data are in full agreement with the previous ones.

In Senegal, females at the beginning and the end of the gestation occur at the same period of the year. Gestation could last one year in the area, but this opinion needs further investigations.

Scyliorhinus cervigoni; West African catshark; roussette Thalassa; gaynde guedj bou ndao

Two juvenile specimens, a male and a female, having 360 mm and 385 mm TL respectively and weighing 285 g and 335 g respectively were reported by fishermen, at the end of August 1997. They were caught from off Ouakam at 100 m of depth approximately. The species is considered to be rare in the area. An adult male from Kayar was also observed. It was 740 mm TL and weighed 2200 g. Unfortunately, we don't have any information about the depth of capture.

The first description of *S. cervigoni* was made by MAURIN and BONNET (1970) from specimens caught off Mauritania and Senegal. *S. cervigoni* was confused with its close related species, *S. stellaris*. The two species probably inhabit same biotops in the same marine areas.

SPRINGER (1979) also described specimens from off Guinea-Bissau, Liberia and Angola. COMPAGNO (1984) noted that *S. cervigoni* reaches 760 mm TL at a maximum, males being mature over 640 mm TL, females at less than 760 mm LT.

S. cervigoni is endemic off the western coast of Africa. Moreover, it is the first time to our knowledge that this species is recorded off the Cape Verde Peninsula.

Rhincodon typus; whale shark; requin-baleine; gaynde guedj bou mag

In June 1996, females whale shark, *Rhincodon typus* was caught by gill-nets placed some hundred meters from off Ouakam and landed alive by two pirogues at the site (Fig. 2).

Some days before its capture, native divers observed this female, 3 km off the shore of Ouakam. It is the first time that *R. typus* was captured and landed in Senegal. In July 1958, CADENAT and BLACHE (1981) observed some whale sharks moving several hours between the Island of Goree and Dakar, one of them had approximately 6-7 m TL .

We have noted some measurements, to the nearest mm following COMPAGNO (1984). Total length: 4190; mouth width: 67; eye diameter: 30; spiracle width: 33; pre-first dorsal length: 1780; height first dorsal: 490; anterior edge of first dorsal length: 168 mm; first dorsal base: 330; posterior edge of first dorsal: 360; pre-second dorsal length: 256; second dorsal height: 290; anterior edge length of the second dorsal : 430; posterior edge length of the second dorsal : 360; inferior edge length of the second dorsal: 168; pectoral length: 626; pectoral length: 626; pectoral base: 355: anterior edge length of the pectoral: 720; posterior edge length of the pectoral: 720; tail length: 1035; tail anterior edge: 1068: tail posterior edge: 1312; tail inferior edge: 530; second dorsal base: 145.

Unfortunately, we were unable to weigh the specimen. Its liver weighed 9100 g and its stomach were empty. The condition of the genital duct allowed to state that it was a juvenile female. These observations agree with COMPAGNO (1984) who noted that females between 4380 mm and 5620 mm TL were juveniles.

JOUNG *et al.* (1996), recently described a female 10.6 m TL caught from off the eastern coast of Taiwan. The specimen contained more than 300 fetuses at the end of their development, which were still enveloped in a fine capsule (CHANG *et al.*, 1997). COLMAN (1997) reviewing the biology and the ecology of the whale shark concluded: "This discovery finally con-

Fig. 2. Whale shark captured off Ouakam

firms that the species is a live-bearer, with an ovo-viviparous mode of development."

Torpedo bauchotae; rosette torpedo; torpille de Bauchot; meudj mbenjann

The original description of *T. bauchotae* was based on two specimens caught off the western coast of Africa which are deposited at the Muséum d'Histoire Naturelle (MNHN) de Paris (CADENAT *et al.*, 1978). The first specimen, holotype, was a juvenile male caught off Pointe Noire (southwestern Congo) and was referenced MNHN1967-739. The second specimen, paratype, was a juvenile female caught off the coast of Senegal (MNHN, Paris, 1969-288). Some specimens of small size are deposited in the collections of MNHN.

Table 1. Biometric and ponderal character and condition of Torpedo bauchoatae *caught from off the coast of Senegal*

Sex	L T (mm)	W (g)	Condition
male	505	2 165	adult
female	790	11 000	adult
female	590	4 408	adult
female	430	1 814	subadult

Four specimens were landed in the craft fishery site of Ouakam during May 1997 (Tables 1, 2).

Three females were observed. The smallest, 430 mm TL, was juvenile. On the opposite, the other specimens, 590 mm and 790 mm TL respectively, were adult. They exhibited an active vitellogenesis and they contained mature oocytes probably ready to be ovulated. The former had 16 oocytes, their diameter ranged from 42 to 45 mm (mean: 43.70; standard deviation: 0.09) and their weight from 20.2 to 20.60 g (mean: 20.34; standard deviation: 0.11). The latter contained 24 oocytes, their diameter ranged from 51 to 54 mm (mean: 53.08 mm; standard deviation: 1.01); their weight from 25.5 from 29.4 g (mean: 27.92 g: standard deviation: 1.44). In each female, the oocytes were more numerous in the right ovary than in the left one. Both uteri were distended and contained a clear organic liquid. This latter was excreted by the numerous and large villi covering the inner uterine wall. Consequently, the development of the oocytes and the uterine structures suggest that the females were at time of ovulation.

Moreover, the number, diameter and weight of oocytes increased with the size of specimens. In both females, the oocytes were more numerous in the right ovary than in the left one. This phenomenon was observed in the common torpedos the Tunisian coasts (QUIGNARD and CAPAPÉ, 1974) as well as by those of Senegal (CAPAPÉ *et al.*, 2000)

Table 2. Description of the ovary content of two female Torpedo bauchotae *caught from off the coast of Senegal. L= left ovary; R = right ovary*

L T (mm)	Number of oocytes	Oocyte diameter (mm)			Oocyte Weight (g)		
		range	mean	s.d.	range	mean	s.d.
590	16 (4L +12R)	42-45	43.70	0.09	20.2-20.6	20.34	0.1
790	24 (9L +15R)	51-54	53.08	1.01	25.5-29.4	27.92	1.44

T. bauchotae reaches a large size; thus confirms the opinion of DEBELIUS (1997), who wrote that the species TL is certainly over 260 mm.

Torpedo marmorata; marbled electric ray; torpille marbrée; meudj mbenjann

In all, 30 specimens were observed, among them 11 males and 19 females. They were caught between 50 and 80 m depth. The species is relatively rare in the area. The specimens

Table 3. Monthly collection of Torpedo marmorata *caught off the coast of Senegal*

Months Categories	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Total
Females									
Subadult	1	1	1	-	-	2	-	-	5
Adult	1	-	2	-	1	3	1	2	10
Total	2	1	3	-	1	5	1	2	15
Males									
Subadult	1	1	1	-	-	-	1	-	4
Adult	2	2	3	2	2	2	1	1	15
Total	3	3	4	2	2	2	2	1	19
Grand total	5	4	7	2	3	7	3	3	34

were captured from March to October. The monthly collection is summarized in Table 3. In addition, 54 embryos and 37 fully developed fetuses were observed.

Onset of sexual maturity

Males

The total length of males ranged from 195 mm to 380 mm. Five males were subadults. Their TL ranged from 240 to 260 mm.

The smallest adult male was 270 mm TL and all the specimens over this TL were adult.

Females

The total length of females ranged from 240 to 580 mm LT. Among them were distinguished 4 subadults and 15 adults. The subadults TL ranged from 240 to 370 mm. The smallest adult female was 380 mm TL. Among the adults, 8 exhibited an active vitellogenetic activity and 7 were gravid. Among the gravid females, four possessed fertilized eggs, two contained embryos at different stages of their development and two had fully developed fetuses in their uteri.

Reproduction

The observations made on the adult females are summarized in Table 4.

All the pregnant females were caught between March and October. This suggests that gestation starts in early spring and ends in autumn.

Gestation probably lasts 8 months to a minimum and the complete reproductive cycle could last one year. During this period the sea water temperature generally ranged from 22.2°C to 23° C.

Developing and ripe oocytes were more numerous in the right ovary than in the left. A similar distribution was also observed in the uteri. The right uterus always contained more eggs, embryos or fetuses than the left.

Size at birth

The total length of 37 fully developed fetuses ranged from 112 to 145 mm (mean 134.80 mm ; standard-deviation: 7.18). Their weight ranged from 33.4 g to 38.4 g (mean 36.68; standard deviation: 1.93). These data could be considered as size and weight at birth for the marbled electric ray.

Table 4. Reproductive cycle of female Torpedo marmorata *condition of ovaries und uteri during gestation*

Month	Number of females	Females size range (TL, mm)	Ovarian activity	Oocytes condition	Oocytes diameter range (mm)	Uteri content	Uteri content (TL, mm)
Mar.	1	380	vitellogenesis	developing	19-21	resting	-
Mar.	1	440	vitellogenesis	ripe	33-35	resting	-
Apr.	2	450-460	vitellogenesis	ripe	36-38	resting	-
May.	2	390-530	vitellogenesis	ripe	35-39	resting	-
May.	1	435	resting	-	-	eggs	-
Jun.	2	360-510	resting	-	-	eggs	-
Jul.	2	500-545	resting	-	-	embryos	41-45
Aug.	1	460	resting	-	-	embryos	65-68
Aug.	1	580	resting	-	-	embryos	76-84
Sep.	1	530	resting	-	-	fetuses	112-125
Oct.	1	560	resting	-	-	fetuses	120-135

Chemical balance of development

Fresh weights of 39 ripe oocytes ranged from 13.5 g to 14.8 g (mean: 14.04; standard deviation: 1.95). The average weight of fully developed fetuses was 36.68. CBD calculated for *T. marmorata* is 1.30.

Fecundity

Ovarian oocytes counted in 6 females ranged from 6 to 19 (mean 11.00, s.e.m. 4.73). However, uterine fecundity, embryos or fully developed fetuses counted in 8 specimens ranged from 8 to 20 (mean 13.37, s.e.m. 4.92).

These two types of fecundity were correlated with females TL (Table 5).

Sex ratio

Table 6 shows that sex ratio are not statistically different in the uteri contents. Among the embryos and the fully developed fetuses, females were slightly more numerous than the males, however, among the free living specimens the former are significantly more numerous than the latter.

Table 5. Ovarian fecundity (OV) and uterine fecundity (UT) versus total-length (TL, mm) relationships in adult female Torpedo marmorata

Fecundity	n	Regression	r	Range (TL, mm)
Ovarian	6	OF = 0.081 TL - 25.095	0.935	380-530
Uterine	8	OF = 0.058 TL - 15.538	0.866	360-580

Table 6. Torpedo marmorata *sex ratio for each category of specimens and for the total sample*

Category		Number of females	Number of males	Ratio (F:M)
Uterine content	Embryos	28	26	1.07 : 1
	Fetuses	20	17	1.17 : 1
	Total	48	43	1.11 :1

DISCUSSION

One hundred elasmobranch species occur in the Senegalese waters, among them 40 are actually recorded off the Cape Verde Peninsula.

The species herein presented are relatively rare and their occurrence is probably due to fortuitous events, the capture of *R. typus*, being the best instance. Nevertheless, fishermen mainly focus the species abundantly landed in the fishing sites of the Cape Verde Peninsula because they had an economic interest. They are generally used for local consumption and/or exported, as fresh products or treated into cured or dried fish products. Shark fins, named "laaf" in native Wolof language are particularly researched and exploited (GUEYE-NDIAYE, 1993; GUEYE-NDIAYE *et al.*, 1996). Sharks stocks regularly decrease off the coast of Senegal, partially explaining the massive intrusion followed by the demographic explosion of *Octopus vulgaris* in the Senegalese waters since the eighties (DIATTA *et al.*, 2001).

The decrease of elasmobranch stocks is generally observed in all marine areas, especially in northern Mediterranean, as the Adriatic Croatian shore (JARDAS, 1999) and the coast of Languedoc in southern France (CAPAPÉ *et al.*, 2000).

O. centrina and *E. spinax* are rather rare off the coast of Senegal as in other marine areas such as the eastern Atlantic and the Mediterranean (JARDAS, 1984; CAPAPÉ *et al.*, 1999; 2000). Off Senegal, *E. spinax* is generally replaced by its congener species *E. polli* according to MAURIN and BONNET (1971).

The distribution of *S. cervigoni* and *T. bauchotae* seems to be restricted off the Western coast of Africa, to our knowledge. Moreover, the specimens cited in the literature were mostly caught off Senegal.

T. bauchotae is a large torpedinid species. MELLINGER (1971) recorded an electric marbled ray that reached 630 mm TL, but he considered this record rather unusual. Among the torpedinids included in subgenus *Torpedo sensu* FRASER-BRÜNNER (1949), only *T. sinuspersici* seems to be larger. According to MICHAËL (1993), the species reaches 1000 mm TL.

The distribution of the marbled electric ray is considered to be restricted to the eastern Atlantic and the Mediterranean. The species is rare in the North Sea (MUUS and DAHLSTRÖM, 1964-1966), but it is abundantly caught in the Bay of Biscaye (BAUCHOT and PRAS, 1980). In northern Mediterranean, *T. marmorata* is captured in the Gulf of Lion (QUIGNARD *et al.*, 1962) and Adriatic Sea (JARDAS, 1984, 1996). The species is rather rare off Italy (TORTONESE, 1956) and southern Mediterranean, however it is frequently captured off the Cape Bon (northern Tunisia) according to CAPAPÉ (1979).

South from the Straits of Gibraltar, the species is common off Marocco (COLLIGNON and ALONCLE, 1972), but become rather rare from the coast of Mauritania (MAURIN and BONNET, 1970) and Senegal (CADENAT, 1950), whilst *T. torpedo* become more abundant (CAPAPÉ *et al.*, 2000).

The marbled electric ray lives from shallow coastal waters to depth over 200-300 m. Along the coasts of France, the species enters some

lagoons as the Basin of Arcachon close to the Bay of Biscaye (MELLINGER, 1971) and the Palavasian Lagoons from the coast of Languedoc (QUIGNARD *et al.*, 1984). MELLINGER (1971) noted that specimens could be captured during low tide by landing nets. Off the Cape Bon, CAPAPÉ (1979) emphasized that the species inhabits sandy and/or muddy-sandy bottoms, rarely macroalgae until 200 m depth. MAURIN and BONNET (1970) wrote that five males only were caught by trawling between 45 and 370 m depth from Cape Juby to Cape Blanc, off Mauritania.

The marbled electric ray prefers the temperate waters. In northern, as well as, in southern Atlantic the species did not exceed certain latitude. The species is considered to be rare in African marine areas.

Our data show that females were larger than males. The formers were adult from 360 mm TL and the latter from 270 mm TL. The largest male and the largest female were 380 mm TL and 580 mm TL, respectively.

These observations are in accord with MELLINGER (1971) and CAPAPÉ (1979).

In the Bay of Biscay, MELLINGER (1971) wrote that males were adult from 240 mm TL and the females between 390 and 470 mm TL. He added that the largest male and the largest female were 400 mm and 630 mm TL, respectively.

From off the northern coast of Tunisia, CAPAPÉ (1979) noted that males were adult from 280 mm TL and the females over 390-400 mm TL; the largest male and the largest female were 395 mm and 580 mm TL, respectively.

Off the Senegalese coast, the gestation approximately lasted 8 months and the parturition occurred during autumn. In the Bay of Biscay and off the northern Tunisian coast the gestation lasted from 10 to 12 months and the parturition occurred in autumn and in early winter (MELLINGER, 1971, 1974; CAPAPÉ, 1979). Off Naples, the gestation lasted from 5 to 8 months and the parturition probably occurred in autumn (LO BIANCO, 1909; RANZI, 1932; TORTONESE, 1956; CHIEFFI, 1961; BINI, 1967). It remains difficult to delineate the exact duration of the reproductive cycle of the marbled electric ray. CAPAPÉ (1979) stated that it could last more than 2 years and probably 3 years off Tunisia. According to MELLINGER (1971, 1974), this reproductive cycle could last more than one year. Off Naples and the Senegalese coast, it seemed that it did not exceed one year.

The size at birth occurred between 112 and 145 mm TL and weight at birth ranged from 34.4 to 38.4 g off the Senegalese coast. CAPAPÉ (1979) provided similar observations from Tunisian specimens. In the Bay of Biscay, MELLINGER (1971) noted that size at birth ranged from 105 to 140 mm and weight at birth from 25 g to 70 g. Off Naples, the newborn pups were between 90 and 110 mm TL and their weigh reached 30 g according to RANZI (1932).

Females from our marine area exhibited ripe oocytes from 32 to 38 mm in diameter and from 13.5 to 14.8 g in weight. In females from Tunisian waters, CAPAPÉ (1979) wrote that the diameter of ripe oocytes ranged from 35 to 40 mm and their weight from 15 to 20 g, these data agree with MELLINGER (1971; 1974). In a female caught off Naples, RANZI (1932) got eggs, which weighed 14.38 g.

Fecundity (s. l.) of the marbled electric ray ranged from 6 to 20 in the area. RANZI (1932), MELLINGER (1971) and CAPAPÉ (1979) made similar observations from specimens off Naples, Bay of Biscay and Tunisia. However, LO BIANCO (1909) found 36 embryos and 52 eggs in two females caught off Naples.

Ripe oocytes, eggs, embryos and fully developed fetuses were generally more numerous in the right side than in the left one whatever the marine area.

According to our observations, the three torpedinids were mainly captured in spring and in summer, among them adults were more numerous than juveniles and subadults. This is due to fact that adult, especially gravid females at the end of the gestation, approached the inshore waters to lay their brood. On the other hand, from September to December, fishermen from the site generally used specific nets to capture exclusively pelagic fishes as *Sardinella* spp., which invaded the marine area during this

period. These inshore migrations could partly explain why the common torpedos are rarely caught during the same period.

Some aspects of the reproductive biology of these three species exhibited remarkable analogies. This mainly concerne the size at first sexual maturity reached by females, which is larger than in males. Consequently, the former reached a larger maximal size than the latter. These size differences between sexes are three other instances of sexual dimorphism among elasmobranchs and especially in torpedinids (MELLINGER,1966,1971,1981,1989). These characteristics are probably related to reproductive strategies of this family. It was recently confirmed by CAPAPÉ *et al.*, (2000, 2001).

In both species, oocytes and/or eggs, embryos and fully developed fetuses were more numerous in the right than in the left side. MELLINGER (1974) and QUIGNARD and CAPAPÉ (1974) pointed out in *T. marmorata* and in *T. torpedo* an asymmetry of abdominal viscera and it results that the right genital tract is more developed that the left.

Vitellogenesis does not proceed in parallel with gestation. Moreover, the common torpedo and the marbled electric ray show a block of oocyte growth during gestation and egg capsules lacks in these species. These characters probably exist in *T. bauchotae* because they are the rule in torpedinids according to MELLINGER (1981, 1989). They were previously observed in other elasmobranch species generally belonging to the family Squalidae as *Centroscymnus* spp. (YANO and TANAKA, 1987, 1988) and *Centrophorus granulosus* (CAPAPÉ, 1985) and to the family Oxynotidae as *Oxynotus centrina* (CAPAPÉ *et al.*, 1999). Consequently, *T. torpedo* and *T. marmorata* achieve an annual reproductive cycle. CAPAPÉ (1979) stated that the reproductive cycle of marbled electric ray from the northern Tunisian coast lasted two years to a minimum and MELLINGER (1974), three years, for the specimens from the Bay of Biscay.

CBD are closely related in both *T. torpedo* and *T. marmorata*, 1.53 and 1.30 respectively. Following WOURMS (1977, 1981) and WOURMS *et al.* (1988), these two torpedinids are lecithotrophic species, but their CBD values show that the role of mother during gestation is not negligible.

Fecundity did not reach high values in the three species, but this parameter increased with the size of females. In *T. torpedo* and in *T. bauchotae*, weights of oocytes and/or eggs also increased according to the size of the female. This last phenomenon was described in the common torpedo from the Tunisian coasts (QUIGNARD and CAPAPÉ, 1974) and the coast of Senegal (CAPAPÉ *et al.*, 2000).

Among the marbled electric rays, size at sexual maturity, size at birth and maximal size did not show significative intraspecific variations according to the area if we compare specimens from off the coast of Senegal, off the northern Tunisian coast and off Naples. It is also the case for fecundity (s. l.), even if Lo BIANCO (1909) noted that *T. marmorata* could bear from 5 to 36 embryos and pointed out the unusual case of a large female containing 52 eggs in uteri.

On the contrary, a significant intraspecific variation appears between the common torpedos from the eastern Atlantic and from the Mediterranean. These variations concern the biometric characters cited above. The formers are larger than the latter for both sex and category of specimens and they are consequently more prolific.

LELOUP and OLIVEREAU (1951) described similar phenomenon among the small spotted catshark, *Scyliorhinus canicula*, from the same areas. They concluded that these intraspecific biometric changes were under the control of environmental influences. This is probably true for oviparous species but requires confirmation for viviparous species (DODD, 1983).

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Accepted: 10 April 2001

Proučavanje šest elasmobranhija pronađenih u obalnim vodama Senegala (istočni dio tropskog Atlantika)

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SAŽETAK

Autori u radu iznose biološka zapažanja o šest elasmobranhija pronađenih u obalnim vodama Senegala i ribarskim postajama na poluotoku Cape Verde (istočni dio tropskog Atlantika). Radi se o slijedećim vrstama: *Etmopterus spinax, Oxynotus centrina, Rhincodon typus, Scyliorhinus cervigoni, Torpedo bauchotae* i *T. marmorata*. Navedene vrste su vrlo rijetke u ovom području. Ipak prema novijim podacima hidrobiološki parametri nemaju važnu ulogu u reprodukciji viviparnih vrsta.