Thalassia Salentina
Thalassia Sal. 42 (2020), 107-116
ISSN 0563-3745, e-ISSN 1591-0725

DOI 10.1285/i15910725v42p107
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CHRISTIAN CAPAPÉ[1], YOUSSOUPH DIATTA[2], ALMAMY DIABY[2],
SIHEM RAFRAFI-NOUIRA[3], CHRISTIAN REYNAUD[4]

[1]Lab. d'Ichtyologie, Université de Montpellier, case 104, 34095 Montpellier cedex 5, France
[2] Lab de Biologie marine, Institut fondamental d'Afrique noire, Univ. Cheikh Anta Diop de Dakar, BP 206, Dakar, Senegal.
[3] Univ. de Carthage, Unité de Recherches Exploitation des Milieux aquatiques, Institut Supérieur de Pêche et d'Aquaculture de Bizerte, BP 15, 7080 Menzel Jemil, Tunisia
[4] Lab. Interdisciplinaire en Didactique, Education et Formation, Univ. de Montpellier, 2 place Marcel Godechot, B.P. 4152, 34092 Montpellier cedex 5, France
email: *capape@univ-montp2.fr*

ABERRANT HERMAPHRODITISM IN STRIPED PANRAY, *ZANOBATUS SCHOENLEINII* (ZANOBATIDAE) FROM THE COAST OF SENEGAL (E-TROPICAL ATLANTIC)

SUMMARY

A case of hermaphroditism is described in the present paper from a specimen of striped panray, *Zanobatus schoenleiniii* (Müller and Henle, 1841), captured off Dakar, Senegal, eastern tropical Atlantic. It measured 295 mm for disc width (DW), 530 mm for total length (TL) and its total body weight (TBW) reached 1017 g. It exhibited a single clasper, on the left side. Internally, the left genital apparatus was female, and the right male. It was an aberrant case of hermaphroditism due to the fact that lacking of clasper generally matches with a female genital apparatus. A relationship DW *versus* TWB expressed in logarithmic co-ordinates showed that the specimen developed in the wild similarly to normal specimens. The causes of this abnormality remain obscure but the role of pollutants in the local marine area cannot be totally ruled out.

INTRODUCTION

Striped panray, *Zanobatus schoenleiniii* (Müller and Henle, 1841) is an endemic species known from the eastern tropical Atlantic, which only occurs between southern Morocco (Lloris and Rucabado, 1998), Mauritania (Maurin and Bonnet, 1970) and the Gulf of Guinea (Blache *et al.*, 1970).

Zanobatus schoenleinii is both commonly and abundantly captured by handicraft fisheries throughout the coast of Senegal (Cadenat, 1951; Séret and Opic, 1990). The species rather inhabits shallow coastal waters at low depth, not exceeding 50 m (Capapé *et al.*, 1995). In the wake of a collaboration with experienced fishermen, several *Z. schoenleinii* were collected in shallow coastal waters surrounding the touristic area of Dakar and among them occurred a specimen displaying an abnormality of pelvic fins and claspers. This specimen was delivered at the laboratory for thorough examination, and the abnormality is described and commented in the present paper.

MATERIALS AND METHODS

The hermaphrodite *Zanoabatus schoenleinii* was captured on 25 May 2019 using trammel nets at depth between 5 and 10 m on soft bottom, off Ouakam, a handicraft fishery site located at 5 km north Dakar, in Cape Verde Peninsula, geographic coordinates 14° 43′ 26′′ N and 17° 29′ 21′′ W (Fig. 1).

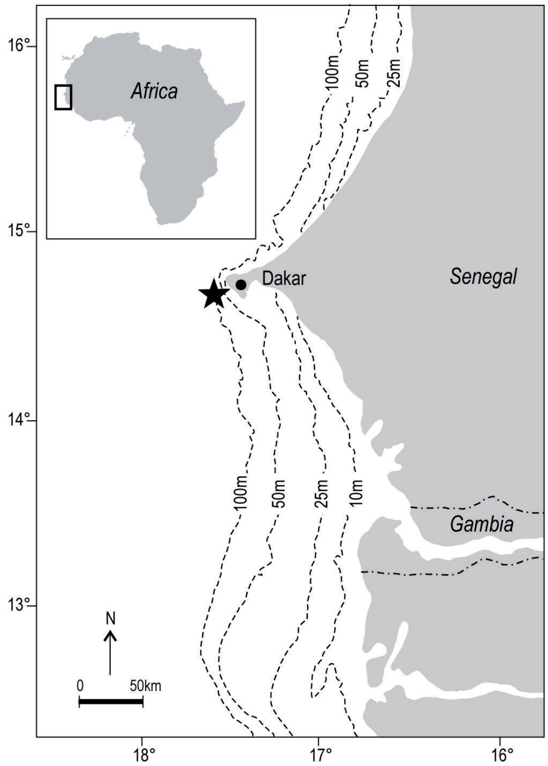

Fig. 1. Map of the Senegalese coast indicating the capture site of the hermaphrodite specimen of *Zanobatus schoenleinii* (black star).

It was captured together with 104 normal specimens which were measured to nearest mm and weighed to nearest g. They ranged between 154 and 340 mm for disc width (DW) and weighed between 104 and 1433 g for total body weight (TBW). Morphometric measurements were recorded on a normal specimen and the hermaphrodite specimen following Diatta *et al* (2013); they are presented in Table 1. Both specimens were fixed in 10% buffered formaldehyde, preserved in 75 % ethanol and deposited in the Ichthyological Collection of the Institute Supérieur d'Aquaculture et de Pêche of Bizerte (Tunisia), receiving the catalogue numbers, ISPAB-Zano-sch-07 for the normal specimen and ISPAB-Zano-sch-08 for the hermaphrodite specimen, respectively.

References	ISPAB-Zano-sch-07		ISPAB-Zano-sch-08	
Measurements	mm	% DW	mm	% DW
Total length	530	185.9	530	179.7
Disc length	254	89.1	275	93.2
Disc width	285	100.0	295	100.0
Eyeball length	18	6.3	17	5.8
Pre-orbital length	61	21.4	64	21.7
Inter-orbital length	26	9.1	29	9.8
Spiracle diameter	23	8.0	23	7.8
Interspiracular width	32	11.2	30	10.2
Pre-oral length	69	24.2	72	24.4
Mouth width	42	14.7	38	12.9
First gill-slit	9	3.2	9	3.1
Fifth gill-slit	7	2.5	8	2.7
Width between first gill-slit	88	30.9	76	25.8
Width betweenfifthgill-slit	43	15.1	41	13.9
Snout tip to mouth	76	26.7	76	25.8
Snout tip to first gill-slit	105	36.8	107	36.3
Snout tip to fifthgill-slit	140	49.1	142	48.1
Snout tip to pelvic fin	235	82.5	226	76.6
Snout tip to vent	245	86.0	241	81.7
Pectoral fin anterior margin	190	66.7	195	66.1

Pectoral fin posterior margin	164	57.5	161	54.6
Pectoral fin inner margin	12	4.2	13	4.4
Pelvic fin anterior margin	56	19.7	49	16.6
Pelvic fin posterior margin	57	20.0	56	19.0
Pelvic fin inner margin	12	4.2	18	6.1
Clasper length	57	20.0	53	18.0
Tail length	267	93.7	270	91.5
Snout tip to first dorsal	364	127.7	354	120.0
Snout tip to second dorsal	418	146.7	417	141.4
Snout tip to birth of caudal dorsal	470	164.9	473	160.3
First dorsal anterior edge	43	15.1	47	15.9
First dorsal inner edge	11	3.9	12	4.1
Second dorsal anterior edge	52	18.3	50	17.0
Second dorsal posterior edge	28	9.8	35	11.9
Second dorsal inner edge	14	4.9	12	4.1
Interdorsal distance	26	9.1	39	13.2
Second dorsal-caudal birth	30	10.5	32	10.85
Total body weight (gram)	1104		1017	

Table 1. Morphometric measurements (in mm, and as % DW), total body weight recorded in the hermaphrodite specimen of *Zanobatus schoenleinii* (ISPAB-Zano-sch-08) and comparison with a normal specimen (ISPAB-Zano-sch-07) from the coast of Senegal.

However, a sub-sample including 51 normal specimens and the abnormal specimen was used in order to obtain a more visible view, allowing to clearly distinguish the latter specimen from the normal specimens. These ranged between 250 and 300 mm DW and weighed between 104 and 1433 g TBW. The relation between DW and TBW was used as a complement following Froese *et al.* (2011), including all specimens, normal and abnormal to show if this latter is able to develop in the wild as normal specimens. This relationship size (DW) *versus* total body weight (TWB) is TBW = aDW^b, and was converted into its linear regression, expressed in decimal logarithmic coordinates and correlations were assessed by least-squares regression. as: log TBW = log a + b log DW: Significance of constant b differences was assessed to the hypothesis of isometric growth if $b = 3$, positive allometry if $b > 3$, negative isometry if $b < 3$ (Pauly, 1983). These two latter tests were performed by using logistic model STAT VIEW 5.0.

RESULTS AND DISCUSSION

The hermaphrodite specimen of *Zanobatus schoenleinii* measured 295 mm DW, 530 mm for total length (TL) and its TBW reached 1017 g. It exhibited a single clasper, on the left side, no clasper was visible on the right side (Fig. 2). The left clasper was entirely formed with all components (see radiography Fig. 2C), a little larger than the left pelvic fin but slightly flexible, its morphology was characteristic of sub-adult male (Capapé *et al.*, 1995). However, the specimen wasidentified as *Z. schoenleinii* from the combination of the following morphological characters:

- disc sub-circular, wider than long;
- snout blunt, angle nearly 120° in front;
- nostrils narrow, anterior valves united across the internarial space;
- mouth straight;
- teeth small;
- spiracles large without folds;
- dorsal and caudal fins small and rounded covered by a rigid skin, unlike and minute scales;
- a medial row of thorns in disk and tail, and three rows arranged in arc of circle on each shoulder;
- back brown with dark cross bands with white spots between toward the pectoral edges.

Such description is in total agreement with Garman (1913), Cadenat (1951), (Blache *et al.* (1970) and Séret and Opic (1990).

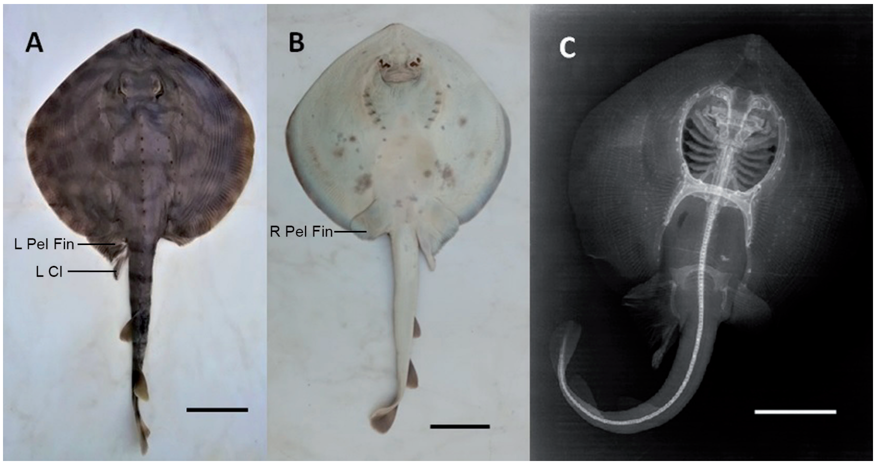

Fig. 2. Hermaphrodite specimen of *Zanobatus schoenleinii*. A. Dorsal surface. B. Ventral surface. C. Radiography. Scale bar = 80 mm.. L Pel Fin: left pelvic fin, L Cl: left clasper, R Pel Fin: right pelvic fin.

The dissection of the abdominal cavity allowed to distinguish a left side morphologically different from the right side (Fig. 3). The left side exhibited a complete female genital tract, which comprised an oviducal gland rather rounded, an oviduct and an uterus both rudimentary and poorly developed. The ovary is well developed but no ovocytes were visible, such aspect being characteristic of a juvenile organ. The right side showed a complete male genital tract, including a Leydig's gland poorly developed and a membranous spermiduct slightly convoluted. The testicle is well developed, displaying externally visible spermatocysts, but no sperm was observed in the duct. The morphology of each genital apparatus is consistent with a juvenile female on the left side and a juvenile male on the right side. Capapé *et al.* (1995) noted that in all *Z. schoenleinii* females, the genital apparatus female is single and always located on the left side, such pattern could explain the occurrence of a female genital apparatus on this side in the hermaphrodite specimen. Conversely, *Z. schoenleinii* males display a genital apparatus on both sides, left and right, and consistent with the presence of a male genital apparatus on the right side of the studied specimen. However, in this present hermaphrodite specimen, a male clasper and a genital female apparatus were observed on the left side. Similar patterns were were described by Ehemann and Gonzàlez-Gonzàlez (2018) in the chola guitarfish

Fig. 3. Ventral view of the abdominal cavity of the hermaphrodite specimen of *Zanobatus schoenleinii*. LS: left side, with Ov, ovary; OG, oviducal gland; Ovd, oviduct; Ut, uterus. RS: right side with T, testis; LG Leydig's gland; S, spermiduct. Scale bar = 40 mm.

Pseudobatos percellens (Walbaum, 1792) from the Caribbean Sea. Such pattern remains contradictory and questionable, due to the fact that in some hermaphrodite elasmobranch species, the lacking of clasper matches with female genital apparatus. Some main instances were found by QUIGNARD and CAPAPÉ (1972) in the brown ray *Raja miraletus* Linnaeus, 1758 from the Tunisian waters, CAPAPÉ and DESOUTTER (1979), in the banded eagle ray *Aetomylæus nichofii* (Bloch and Schneider, 1801) from the coast of Pakistan and RIBEIRO-PRADO *et al.* (2009), in the pelagic stingray *Pteroplatytrygon violacea* (Bonaparte, 1832) from the Brazilian coast. Conversely, functional and well developed claspers, were observed on each side by CAPAPÉ and ZAHND (1974) and CAPAPÉ (1974), respectively in hermaphrodite specimens of the smallspotted cat shark, *Scyliorhinus canicula* (Linnaeus, 1758) and the marbled electric ray, *Torpedo marmorata* Risso, 1810, caught off the Tunisian coast. On the other hand, poorly developed and small-sized claspers were described by CAPAPÉ *et al.* (2012) and RAFRAFI-NOUIRA *et al.* (2017), respectively in hermaphrodite specimens of the Tortonese's stingray *Dasyatis tortonesei*, Capapé 1975 and the common eagle ray *Myliobatis aquila* (Linnaeus, 1758), collected in the Tunisian waters. Additionally, CAPAPÉ *et al.* (2019) recorded from the Algerian coast, a specimen of the blackmouth catshark *Galeus melastomus* Rafinesque, 1810 exhibiting a minute clasper on the right side and a developed clasper on the left side.

The relationship DW *vs* TBW calculated from a sample of *Zanoabatus schoenleinii* including the hermaphrodite specimen is: log TBW = -6.98 + 4.08 * log DW; r = 0.95; n = 51 (Fig. 4). This relationship clearly indicates that the hermaphrodite specimen develops together and similarly with the normal specimens. Therefore, it cannot be ruled out that this hermaphrodite specimen could reach sexual maturity and be able to assume the functions of both the male and the female. Additionally, following ATZ (2005) and IGLÉSIAS (2005), it

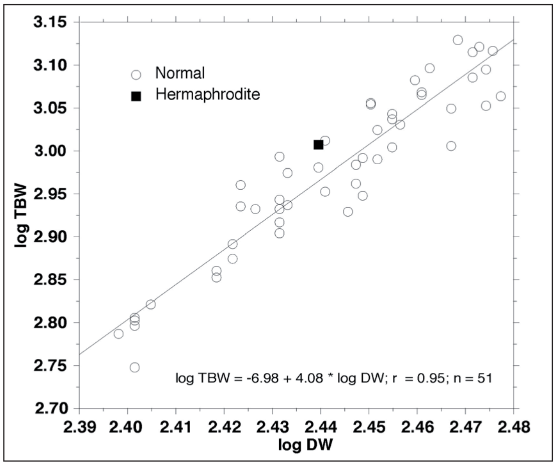

Fig. 4. Relationship total body mass (TBM) *versus* disc width (DW) expressed in logarithmic co-ordinates for normal and hermaphrodite specimens of *Zanobatus schoenleinii* collected from the coast of Senegal.

could be considered as a normal or true hermaphrodite, different from abnormal of pseudo hermaphrodite (see Irvine *et al*., 2002). However, if hermaphroditism is a normal condition in the reproduction of the longhead catshark, *Apristurus longicaphalus* Nakaya, 1975, it is not the case for batoid species, which do not display such similar pattern. The causes of hermaphroditism in elasmobranchs species still remain unclear, and could be various and different. Following Rafrafi *et al.* (2017) they may involve genetic and endogenous factors. The role of unfavourable environmental conditions cannot be totally ruled out according to Diop *et al.* (2012) and Bonnin *et al.* (2016) who noted that the coast of Senegal**,** especially around the touristic area of Dakar is facing to pollutants which are increasing in the wild since some decades. However, nowadays, their real impact on the local biodiversity needs to be assessed.

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