Arquivos de Ciências do Mar

MORPHOLOGICAL ABNORMALITIES IN SKATES AND RAYS (CHONDRICHTHYES) FROM OFF SOUTHEASTERN BRAZIL

Anomalias morfológicas em raias (Chondrichthyes) da região Sul do Brasil

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ABSTRACT

In this paper, the authors report morphological abnormalities observed in six species of skates and rays from off southeastern Brazil, between 2005 and 2008 as follows: the rio skate, Rioraja agassizi *(Müller and Henle, 1841); the spotback skate,* Atlantoraja castelnaui *(Ribeiro, 1907); the eyespot skate,* A. cyclophora *(Regan, 1903); the pelagic stingray,* Pteroplatytrygon violacea *(Bonaparte, 1832); the roughtail stingray,* Dasyatis hypostigma *(Santos and Carvalho, 2004); and the shortnose guitarfish,* Zapteryx brevirostris *(Müller and Henle, 1841). The abnormalities observed included pectoral fins non-adherent to the head; incomplete pectoral fin, anophthalmia, and presence of a single clasper. The percentage of abnormal specimens ranged from 0.1 to 1.3. Potential causes of the abnormalities probably occurred during embryonic development, for instance pectoral fins had failed to fuse together in front of the head in early development. Additionally, unfavorable environmental conditions cannot be excluded, such as the role of chemical pollutants playing a role in embryonic development of skates in egg cases.*

Key words: *Chondrichthyes, skates, rays, abnormalities, embryonic development, pollution, southeastern Brazil*

RESUMO

No presente trabalho foram reportadas anomalias morfológicas observadas em seis espécies de raias capturadas no sudeste brasileiro, entre 2005 e 2008 como segue: raias-emplastro, Rioraja agassizi *(Müller e Henle, 1841),* Atlantoraja castelnaui *(Ribeiro, 1907),* A. cyclophora *(Regan, 1903); raia-preta,* Pteroplatytrygon violacea *(Bonaparte, 1832); raia-prego,* Dasyatis hypostigma *(Santos and Carvalho, 2004); e raia-viola,* Zapteryx brevirostris *(Müller e Henle, 1841). As anomalias observadas incluíram nadadeiras peitorais não aderidas à cabeça, anoftalmia e presença de um só clasper. A porcentagem de anomalias variou entre 0,1 e 1,3. As causas potenciais das anomalias ocorrem provavelmente durante o desenvolvimento embrionário, as nadadeiras peitorais não conseguiram se fundir à região frontal da cabeça. Provavelmente também as condições ambientais desfavoráveis tais como os poluentes químicos, podem ser também consideradas, pois exercem importante influencia no desenvolvimento dos embriões nas cápsulas ovígeras.*

Palavras-chaves: *Chondrichthyes, raias, anomalias, desenvolvimento embrionário, poluição, Sudeste do Brasil.*

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INTRODUCTION

Abnormalities were listed in fish species by Dawson (1964, 1966, 1971) and Dawson & Heal (1971); they concern colour (full or partial albinism), the genital apparatus (total, semi or pseudo hermaphrodism) and morphological deformities (teratological cases, also called 'monstrosities' by authors). It appears that the latter were more frequently recorded in osteichthyan species than in chondrichthyan species, probably because of the low commercial interest that characterize the latter for several years and also because of the difficulty in obtaining a significant number of specimens to detect such abnormalities (Hoenig & Walsh, 1983). Moreover, chondrichthyans (846 species) are qualitatively less represented than osteichthyan (more than 50,000 species) were recorded throughout the world to date (Lecointre & Le Guyader, 2001; Compagno, 2005) and they represent only a minor group in terms of catches, in 1997 for instance, they accounted for only 0.65% of total world catches and 0.85% of total world captures (Vannuccini, 1988), even if off Brazil some sharks such as blue shark, *Prionace glauca* (Linnaeus, 1758) are mainly targeted (Amorim *et al*., 1998).

Atypical characteristics were listed in sharks by Barrull *et al.* (2002), Saïdi *et al.* (2005) and Mancini *et al*. (2006); they generally concerned fins, skeleton, chondrocranium and vertebral column in both embryos and free-swimming specimens. In this paper, we present abnormalities recorded in the following skates and rays species collected off the Brazilian coast: the rio skate, *Rioraja agassizi* (Müller & Henle, 1841); the spotback, skate *Atlantoraja castelnaui* (Ribeiro, 1907); the eyespot skate, *A. cyclophora* (Regan, 1903); the pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832); the roughtail stingray, *Dasyatis hypostigma* (Santos & Carvalho, 2004); and the shortnose guitarfish, *Zapteryx brevirostris* (Müller & Henle, 1841). Our findings are compared with similar previously observed in other marine areas.

MATERIAL AND METHODS

Specimens of *Atlantoraja castelnaui, A. cyclophora, A. platana, Rioraja agassizi,* were monthly collected in fishing commercial landings at Guarujá, São Paulo State, Brazil, between March, 2005 and April, 2006. Samples were collected in the area located between 23°37'S and 27°40'S, at depths between 10 and 146 m, with muddy bottoms. These specimens were discarded after sampling and photographing.

Specimens of *Pteroplatytrygon violacea* were obtained from the longliner commercial fleet operating in the southern and southeastern Brazil, in the area between 20º S and 33º S, 38º W and 50º W, at depths between 30 and 80 m, from August, 2006 to March, 2008 (adult male: NUPEC 2143; adult female: 2144; embryo: 2145).

An abnormal *Dasyatis hypostigma* was obtained as fisherman donation and it was caught 40 meters deep, on muddy bottoms, by pair troll fishery off "Laje de Santos", Santos, during August 2007 (NUPEC 2142).

An abnormal *Zapteryx brevirostris* was provided also by a fisherman; the specimen was caught at depths of 20 m, with muddy bottoms, by pair troll fishery off Santos at 24º14'50"S and 46º06'84"W, during October 2006 (NUPEC 1733).

The terminology and dimensions follows Last and Stevens (1994): total length (TL) and disc width (DW) measured to the nearest mm. In skates, size was expressed as TL and DW and in rays, as TL. The abnormal *P. violacea* were submitted to radiographies of 7.5 MHz of transduction, following methodology stated by Stetter (2004) and read following Romer & Parsons (1985), Heupel *et al.* (1999) and Mancini *et al.* (2006).

RESULTS

Atlantoraja castelnaui and *A. cyclophora*

A total number of 107 specimens of *A. castelnaui* were collected. In May 2005, a single abnormal sub-adult specimen was captured. Total length and DW of the specimen were 875 and 610 mm respectively (Figure 1-A). The abnormality consisted of an incomplete fusion of the left pectoral fin with the head, resulting in gap or cleft between the pectoral fin and rostrum. Percentage of abnormalities was 0.9 (Table I).

In all, 770 *A. cyclophora* were collected. The same abnormality described for *A. castelnaui* was observed on a single specimen of *A. cyclophora*, though the gap was deeper in this case (Figure 1-B) and also located on the left body side. This specimen was caught in October 2005, and had TL and DW of 494 and 355 mm respectively. Percentage of abnormalities was 0.1 (Table I).

Rioraja agassizi

A total of 1,023 specimens were collected. The percentage of abnormalities was 0.5 (Table I). In two specimens incomplete fusion of the pectoral fin with the head was noted. The first one was an adult female caught in April 2005, with DW of 344 mm

(Figure 1-C). In this specimen a gap or cleft between the right pectoral fin and rostrum was observed. The second specimen exhibited an abnormality between rostrum and pectoral fin; it was a sub-adult female also caught in April, 2005, having a TL of 444 mm and a DW of 302 mm (Figure 1-D).

The third abnormal specimen was a 435 mm TL sub-adult female with an important part of the left pectoral fin missing (Figure 1-E).

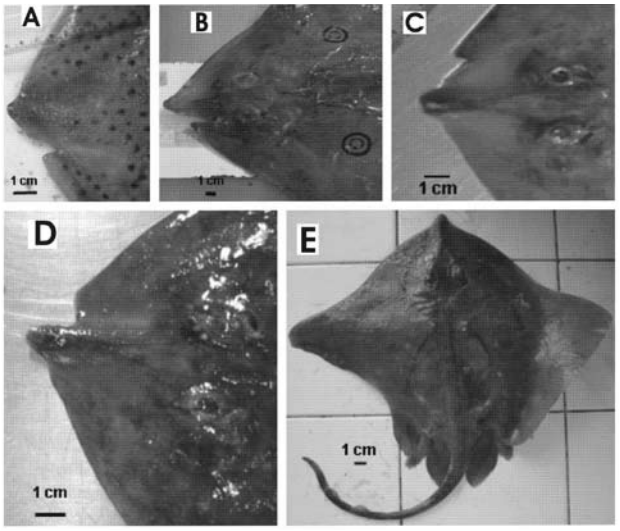

Figure 1 - Rostral abnormalities in: A - *Atlantoraja castelnaui*; B - *A. cyclophora* ; C, D - *Rioraja agassizi* ; and E - incomplete pectoral fin in *R. agassizi*.

Table I - Species recorded in the present study with abnormalities: total catch number recorded (when availabe), number of abnormal specimens and percentage of abnormalities.

Species	Specimens		
	collected	abnormal	% of abnormal
Atlantotaja castelnaui	107	1	0.9
Atlantoraja cyclophora	770	1	0.1
Rioraja agassizi	1023	5	0.5
Pteroplatytrygon violacea	223	3	1.3
Dasyatis hypostigma	?	1	?
Zapteryx brevirostris	?	1	?

Dasyatis hypostigma

According to fishermen this specimen was found close the "Laje de Santos", about 20 miles off Santos City, São Paulo State. It was a free-swimming young male, measuring 20 mm DW caught in October, 2007. There is no record of it TL. The abnormality observed consisted of completely cleft pectoral fins, having these fins a fringe-like appearance (Figure 2-A). Number of clefts was 6 on the left and 5 on the right pectoral fin. Percentage of abnormalities is unknown (Table I).

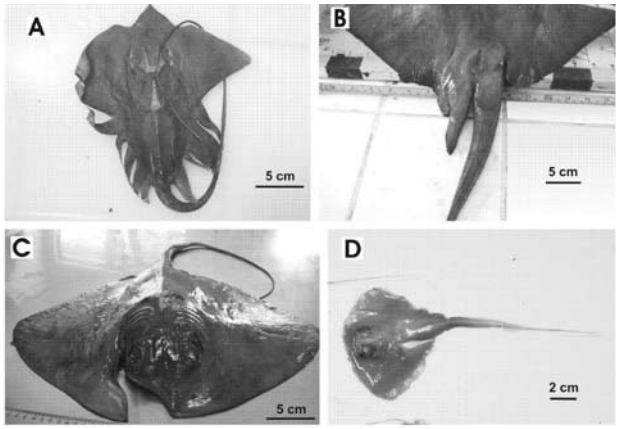

Figure 2 - Abnormal specimens in: A - *Dasyatis hypostigma*; B - mature male of *Pteroplatytrygon* violacea with the left clasper missing; C - mature female of P. violacea with the rostral abnormality and D: developing abnormal embryo of P. violacea.

Pteroplatytrygon violacea

A total of 223 specimens were collected. Percentage of abnormalities was 1.3 (Table I). In June, 2007, a mature male specimen 450 mm DW and 960 mm TL was captured. In this specimen the left clasper and the left pelvic fin were absent. Lack of right clasper suggests a probable case of hermaphrodism or semi hermaphrodism, the specimen will be thoroughly studied in a further paper (Figure 2-B).

The second specimen was a mature female, with 475 mm TW and 1080 mm TL captured in September, 2007 (Figure 2-C). This female presented a deep incomplete fusion of the pectoral fin with the head and the embryo with the pelvic waist.

The third specimen was 80 mm DW and 175 mm TL male embryo (Figure 2- D), captured in March, 2008. The yolk sac in this specimen had been already consumed. The specimen showed an incomplete fusion of the left pectoral fin and the body and also an asymmetry regarding the pectoral fins.

Zapteryx brevirostris

The female guitarfish, *Zapteryx brevirostris* measuring 216 mm DW was donated in October, 2006 by a fisherman and caught inshore of Santos Bay, at depths of 20 m, by pair trawling. This specimen was anophthalmic (Figure 3). Percentage of abnormalities is unknown (Table I).

DISCUSSION

In Table II, we have summarized reports of abnormalities observed in skates and rays in different marine areas. It appears that pectoral fins non-adherent to head were the most frequently recorded. This abnormality is due to fact that the

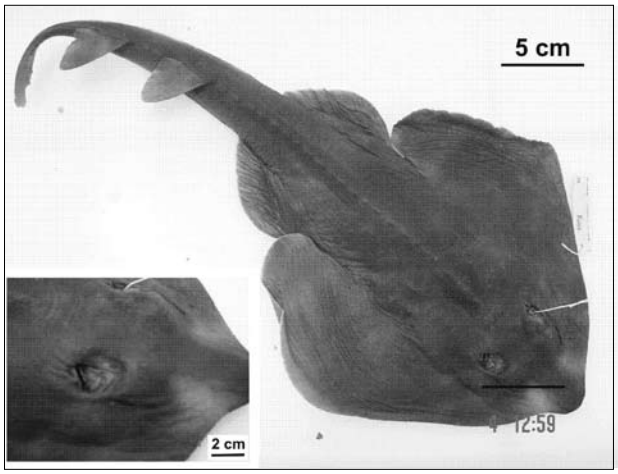

Figure 3 - Anophthalmic specimen of *Zapteryx brevirostris*; left: complete specimen; right: detail of the rostral area, showing the complete absence of eyes

pectoral fins had failed to fuse together in front of the head in early development (Bigelow & Schroeder, 1953). Moreover, Thorson *et al* (1983) described embryonic development in two freshwater stingrays *Potamotrygon constellata* (Vaillant, 1880) and *P. motoro* (Müller & Henle, 1841): in early embryo the stingray's pectoral fins begin separate, then fuse in medium embryos and finally form the complete disc in near term embryo. Basing of these atypical characteristics Day (1880-1884) described a separate species, *Ceraptoptera ehrenbergi* from an abnormal longtail butterfly ray *Gymnura poecilura* (Shaw, 1804). Pectoral non-adherent to the head were frequently observed in skates (see Table I), according to Gudger (1933), at about 35 cases were reported in literature between 1810 and 1932. Further, other cases were also reported, but a bit less in rays than in skates (Tortonese, 1956; Dawson, 1964, 1966, 1971; Dawson & Heal, 1971), in agreement with records included in Table II. Additionally, to our knowledge, anophthalmy in an elasmobranch species was firstly observed in the bluntnose stingray, *Dasyatis hypostigma* (Santos & Carvalho, 2004) captured off Rio de Janeiro by Gomes *et al.* (1991), who noted that such abnormality occurred during development of optic peduncle. The second record was described in this paper in *Zapteryx brevirostris.*

Table II - Different kinds of abnormalities recorded in batoids (by family and species) in the present study and elsewhere by other authors.

Family	Species	Abnormaity	Reproductive mode	Capture site	Authors
Rhinobatidae	*Rhynchobatus djiddensis*	Pectoral non adherent to the head	Viviparous	Indian waters	Luther (1961)
Rhinobatidae	*Zapteryx brevirostris*	anophtalmy	Viviparous	Off southern Brazil	This study
Torpedinidae	*Torpedo marmorata*	Pectoral non adherent to the head	Viviparous	Adriatic Sea	ValIe (1931)
Torpedinidae	*Torpedo marmorata*	Pectoral non adherent to the head	Viviparous	Adriatic Sea	Jardas and Homen (1977)
Torpedinidae	*Torpedo torpedo*	Surnumerary dorsal fin	Viviparous	Northern Tunisian waters	Ben Brahim and Capapé (1997)
Rajidae	*A.tlantoraja castelnaui*	Pectoral non adherent to the head	Oviparous	Off southern Brazil	This study
Rajidae	*A. cyclophora*	Pectoral non adherent to the head	Oviparous	Off southern Brazil	This study
Rajidae	*A. platana*	Pectoral non adherent to the head	Oviparous	Off southern Brazil	This study
Rajidae	*Raja asterias*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Moreau (1881)
Rajidae	*R. asterias*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Bureau (1890)
Rajidae	*R. asterias*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Pellegrin (1900)
Rajidae	*R. asterias*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Jugeat (1921)
Rajidae	*R. asterias*	Pectoral non adherent to the head	oviparous	Off Atlantic coast of France	Jugeat (1926)
Rajidae	*R. brachyura*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Legendre (1935)
Rajidae	*R. clavata*	Pectoral non adherent to the head	Oviparous	Off coast of Scotland	Williamson (1909)
Rajidae	*R. clavata*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Vaillant (1908)

Rajidae	*R. clavata*	Pectoral non adherent to the head	Oviparous	Off coast of Scotland	Williamson (1909)
Rajidae	*R. clavata*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Legendre (1936)
Rajidae	*R. clavata*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Du Buit (1964)
Rajidae	*R. clavata*	Pectoral non adherent to the head	Oviparous	Adriatic Sea	Jardas and Homen (1977)
Rajidae	*R. miraletus*	Pectoral non adherent to the head	Oviparous	Northern Adriatic	Jardas and Morovic (1973)
Rajidae	*R. radiata*	Pectoral non adherent to the head	Oviparous	Off Atlantic coast of France	Letaconnoux (1949)
Rajidae	*R. radiata*	Pectoral non adherent to the head, deformed and incomplete mouth; eyes covered with skin, vestigial snout	Oviparous	Sea of Cortez	Escobar-Sánchez *et al.* (2008)
Rajidae	*R. radula*	Pectoral non adherent to the head	Oviparous	Off coast of Tunisia	Capapé and Pantoustier (1975)
Rajidae	*R. richardsoni*	Incomplete snout	Oviparous	Off Atlantic coast of Spain	Forster (1967)
Rajidae	*Rioraja agassizi*	Pectoral non adherent to the head, incomplete pectoral	Oviparous	Off southern Brazil	Casarini *et al*., (1996)
Rajidae	*R. agassizi*	Pectoral non adherent to the head, incomplete pectoral	Oviparous	Off southern Brazil	This study
Rajidae	*Rostroraja alba*	Pectoral non adherent to the head	Oviparous	Adriatic Sea	D'Ancona (1933)
Rajidae	*R. alba*	Pectoral non adherent to the head	Oviparous	Adriatic Sea	Anisits (1912)
Dasyatidae	*Dasyatis brevis*	Pectoral non adherent to the head, lack of part of rostrum	Viviparous	Off coast of Chile	Lamilla *et al.* (1995)
Dasyatidae	*Dasyatis hypostigma*	Cleft pectoral	Viviparous	Off southern Brazil	This study
Dasyatidae	*Dasyatis gutatta*	anophtalmy	Viviparous	Off coast of Brazil	Gomes *et al*.. (1991)
Dasyatidae	*Himantura jenkinsii*	Incomplete pectoral	Viviparous	Southeastern coast of India	Ramaiyan and Sivakumar (1988)
Dasyatidae	*H. uarnak*	Pectoral non adherent to the head	Viviparous	Southeastern coast of India	Nair and Chellam (1971)
Dasyatidae	*H. uarnak*	Pectoral non adherent to the head	Viviparous	Off coast of Syria	unpublished data
Dasyatidae	*Pteroplatytrygon violacea*	Pectoral non adherent to the head	Viviparous	Off southern Brazil	This study
Gymnuridae	*Gymnura poecilura*	Pectoral non adherent to the head	Viviparous	Indian waters	Bennett (1964)
Gymnuridae	*Gymnura poecilura*	Pectoral non adherent to the head	Viviparous	Indian waters	Easrawan (1967)
Potamotrygonidae	*Potamotrygon motoro*	Pectoral non adherent to the head	Viviparous	Tocantins River, Brazil	Rosa *et al.* (1996)
Potamotrygonidae	*Potamotrygon motoro*	Pectoral non adherent to the head	Viviparous	Captivity	Oldfield (2005)

Unfavourable environmental conditions probably play a role in occurrence of abnormalities (see Table II), such as large exposure to pollutants. It could explain why they are more observed in oviparous species than in viviparous species. In the former, embryos develop in egg cases directly deposited in waters, while in the latter, embryos are protected during development by mother's uteri. For instance, Casarini *et al.* (1996), reported that of 192 *R. agassizi* collected off Santos, 11 were abnormal, the percentage of 5.7 was considerably higher than herein recorded (Table I). The most common abnormality in these specimens was rostral abnormality, though in some specimens the lack of one pelvic or dorsal fins and left eye was also observed. For these authors, those abnormalities could be the result of the exposure to chemically contaminated sites, as high values of heavy metal concentrations in Santos Bay show have been noted, as Cu, Zn, Hg and Cd (Boldrini & Pereira, 1987; Tommasi, 1985).

Comparing to literature, the abnormalities percentage was low (0.1 to 0.9) for the coastal *Rioraja*

agassizi, Atlantoraja castelnaui, A. cyclophora and *A. platana*. Similar patterns were observed for *Pteropatytrygon violacea* (1.3%) was low. Until 2008 the percentage (5.7%) of abnormalities for *Rioraja agassizi* presented by Casarini *et al.* (1996), collected off Santos was the highest register of occurrence found in literature. Due to the lack of other studies to establish comparisons, further researches could be done.

According to Bensam (1965), embryonic deformities could be caused by intrauterine pressure exerted by other embryos. However, Bonfil (1989) discarded this hypothesis as embryos of a given litter would be exposed to the same space and growth conditions and for this author, the origin of pre-natal abnormalities would be related to mutation or other developmental irregularities.

Rosa *et al.* (1996) describe an abnormal freshwater stingray *Potamotrygon motoro* where both pectoral fins were anteriorly detached from the head, their anterior tips barely reaching the level of the rostrum. For Radcuffe (1928 *apud* Rosa *et al*., 1996) this malformation could be caused by a disturb in the initial stages of ontogeny known as "shark stage", where the embryo still have the fins separated from the head, resembling a shark embryo. According to Rosa *et al.* (*op. cit*) the fact that adult rays with this kind of abnormality occur alive and in seemingly good condition means that this deformity would not interfere in the biological activities, mainly feeding.

CONCLUSION

The abnormalities occurred in different body parts, but in rostral would be the most commonly for many skates and rays. Nevertheless they do not hinder their development, as such deformities were observed mostly in adults. The percentage of abnormalities estimated is not representative of the real number because in all cases samples came from fisheries, where the total captured is uncertain. In order to obtain a more accurate percentage, samples from scientific surveys should be considered.

In future studies, it is highly recommended to preserve abnormal specimens in order to perform further analysis on the deformities and it causes, such as radiography and dissection. It remains difficult to assess the causes of the abnormalities in such a few specimens as the recorded in the present study. However, we believe that the observations presented inhere may be the base of future research on this unexplored area.

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