

ON THE OCCURRENCE OF SEVENGILL AND SIXGILL SHARKS (HEXANCHIFORMES: HEXANCHIDAE) OFF CEARÁ STATE, BRAZIL, WESTERN EQUATORIAL ATLANTIC

Sobre a ocorrência dos tubarões-de-sete-guelras e de seis-guelras (*Hexanchiformes: Hexanchidae*) no Estado do Ceará, Brasil, Atlântico Equatorial Ocidental

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ABSTRACT

This study reports the first occurrence of Hexanchiformes sharks off Ceará State, Brazil. Captures of sharks of this order were recorded during research cruises and surveillance of landings from small-scale and commercial fisheries, making up thirteen individuals out of a total of 1,937. The sampling effort covered an area corresponding with the continental shelf and upper slope, in depths from 10 to 350 meters. These are the first data gathered on the occurrence of sharks in the mesopelagic zone of Ceará State. This study extends the known distribution range of hexanchiformes in Brazil. The observed depth stratification pattern of hexanchiform shark occurrences off Ceará State underscores the need for thorough deep-sea research surveys in order to obtain a more complete assessment of the region's elasmobranch fauna.

Key words: *Hexanchiformes, Heptranchias, Hexanchus, first record, Ceará State*

RESUMO

O presente estudo teve como objetivo registrar a primeira ocorrência de tubarões da ordem Hexanchiformes ao largo da costa do Estado do Ceará. As capturas de hexanquiiformes foram registradas durante cruzeiros de pesquisa e monitoramento de desembarques da pesca artesanal e industrial, constando de 13 espécimes de um total de 1.937 tubarões. O esforço de amostragem cobriu a plataforma continental e talude ao largo do Ceará, em profundidades variando de 10 a 350 m. Estes são os primeiros dados sobre a ocorrência de tubarões abrangendo a zona mesopelágica da região. O presente estudo amplia a faixa de distribuição conhecida de hexanchiformes no Brasil. O padrão observado de estratificação de profundidade de ocorrência de hexanquiiformes ao largo do Ceará enfatiza a necessidade de pesquisas em águas profundas que permitirão um conhecimento mais completo da fauna de elasmobrânquios dessa região.

Palavras-chaves: *Hexanchiformes, Heptranchias, Hexanchus, primeiro registro, Ceará.*

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INTRODUCTION

The order Hexanchiformes consists of two families: Chlamydoselachidae and Hexanchidae. The former includes one described species and at least one undescribed species. The latter includes three genera and four described species. Hexanchiform sharks are characterized by the presence of six or seven paired gill slits, a single dorsal fin, and one anal fin. Most hexanchiform species are distributed worldwide, although patchily. In tropical regions, these sharks usually occur in deep waters (Compagno *et al.*, 2005).

Three Hexanchidae species occur in southern Brazil, two of which namely *Heptranchias perlo* and *Hexanchus griseus*, have also been recorded in northeastern Brazil (Rincón & Lessa, 1998). However, none of them has been reported off Ceará State (Gadig *et al.*, 2000). *H. perlo* reaches total lengths up to 140 cm (Compagno *et al.*, 2005) and occurs in Brazilian waters between 100 and 320 m depths (Soto, 1999). The northernmost occurrence of *H. perlo* in Brazil is off Sergipe State (Meneses *et al.*, 2005), approximately, 10° 55' S; 37° 00' W.

Hexanchus griseus reaches total lengths up to 500 cm (Compagno *et al.*, 2005) and occurs in Brazilian waters between 300 and 540 m depths (Soto, 1999). The northernmost occurrence of *H. griseus* in Brazil is off Rio Grande do Norte State (Lessa *et al.*, 1999), approximately, 5° 30' S; 35° 15' W. *H. griseus* is also

known to occur off Fernando de Noronha Island (Moreira-Júnior, 1993).

This study is part of a program to describe Elasmobranchii fauna from Ceará State, Brazil, conducted by the *Grupo de Estudo de Elasmobrânquios do Ceará (ELACE)* and reports the first occurrence of hexanchiform sharks, *Heptranchias perlo* and *Hexanchus griseus* in this region.

MATERIAL AND METHODS

Captures of hexanchiform sharks off Ceará State were recorded during research cruises and fisheries landings. Small-scale fisheries using hook-and-line and gillnets sampled a depth range from 10 to 70 m (primarily down to 50 m on the continental shelf) at the Mucuripe Embayment, Fortaleza. Landings were monitored weekly from September, 2006 to August, 2007. Commercial fisheries using longlines ranged from a 44 - 200 m depth (primarily down to 100 m on the continental slope) off the state's coastline. Sixteen landings were monitored from November, 2004 to July, 2006. Finally, two research cruises using longlines were conducted. The March 2006 cruise covered a depth range of 100 to 230 m off Fortaleza (research cruise II). The March 2005 cruise fished at depths ranging from 200 to 350 m on the continental slope off Itarema (research cruise I) - see Figure 1.

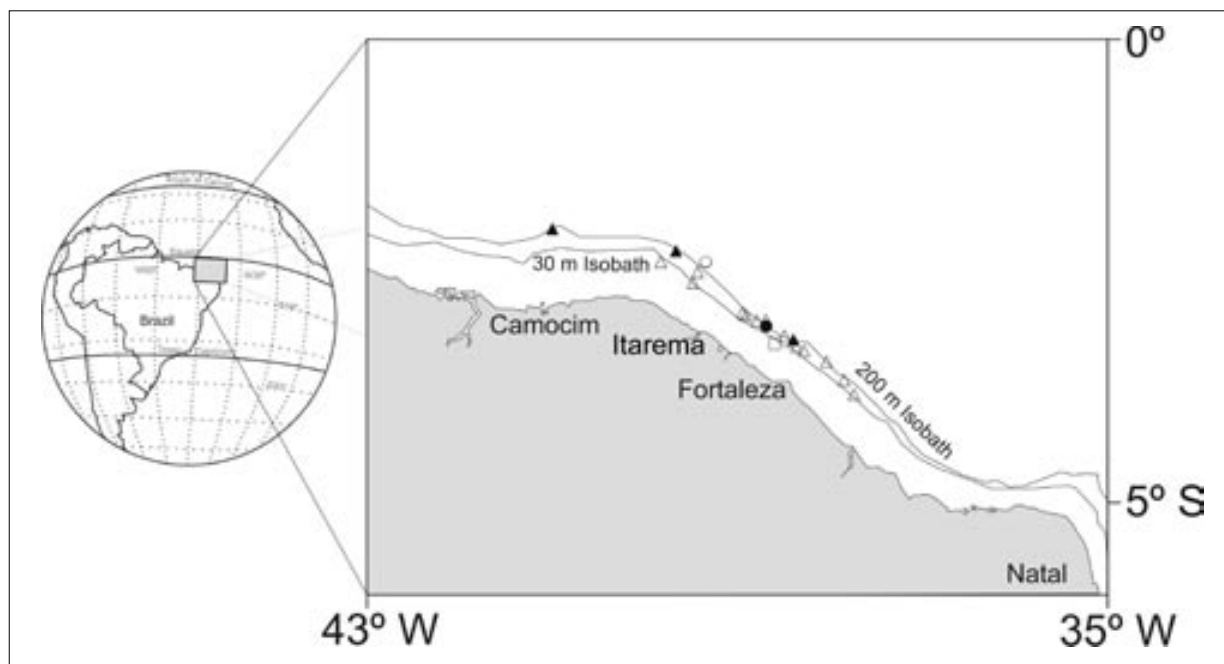


Figure 1 - Sampling points off Ceará State, Northeastern Brazil. Geometric symbols indicate central point of sampling activity. Black and white symbols denote capture and absence of hexanchiform sharks, respectively. □ = small-scale fisheries in Mucuripe Embayment, Fortaleza; ▲, △ = commercial fisheries along the state's coastline; ●, ○ = research cruises.

Hexanchiform sharks were identified using papers by Compagno (1984), Gadig (2001) and Compagno *et al.* (2005). Capture location and depth were recorded for each specimen. When possible, specimens were photographed and morphometric and reproductive data were recorded. Morphometric measurements followed Compagno (1984). Sexual maturation was determined through visual inspection of male and female reproductive organs. Fecundity values were calculated using total counts of ovules (ovarian fecundity) and embryos (uterine fecundity).

RESULTS

Of the 1,937 sharks captured off the Ceará State during this study, thirteen were hexanchiforms or 0.67% of the total shark catch. Data provided by sampling landings show that no hexanchiforms were found in the 10 - 70 m depth range, exploited by the small-scale fishery, but seven specimens (0.5%) were caught at the 100 - 200 m depth range by the industrial fishery. Surveys of deeper waters fishing grounds, down to 350 m, was carried out through two research cruises. Research cruise I, off Itarema, yielded 37 sharks, of which six were hexanchiforms (16,2%), at depths from 100 to 300 m, but no hexanchiform specimens were captured during research cruise II, off Fortaleza, which sampled at depths between 200 and 350 m (Table I).

Table I - Data on the catch and frequency of occurrence of hexanchiform sharks by sampling location and depth off Ceará State.

Activity	Study Area	Depth (m)	Hexanchiform	All sharks	% Hexanchiform
Small-scale fisheries	Mucuripe Embayment	10 - 70	0	512	0,0
Industrial fisheries	Continental shelf	44 - 200	7	1,311	0.5
Research cruise I	Off Itarema	200 - 350	0	77	0.0
Research cruise II	Off Fortaleza	100 - 300	6	37	16.2

Heptranchias perlo - A total of 12 specimens of *H. perlo* were captured, six of which during research cruise II off Fortaleza, in depths from 120 to 234 m, averaging 180 m (Figure 1, see black circle). Specimens' total length ranged from 101.5 to 115.5 cm (107.2 cm average). Of these six specimens, at least five were pregnant females (gender was not recorded for one specimen). For the four females in which embryos were already developed, fecundity values were 23, 19, 22, and 16 (20 embryos average per individual).

Commercial longline fisheries captured the other six *H. perlo* specimens in two different areas, both between the outer continental shelf and continental slope (100 - 200m depth range). In March, 2005 an adult female with a total length of 107 cm was caught off Fortaleza. Ovarian fecundity was 15 and 13 ovules for the left and right ovary, respectively. Finally, five specimens were caught off Itarema in October, 2005 (Figure 1, see black triangles). Information on sex and maturity were limited to gender of two specimens, which were males.

Hexanchus griseus - In February 2006, one male *H. griseus* specimen with 179.2 cm in total length was captured by the commercial longline fishery off Camocim (Figure 1, see black triangle), at 140 m depth. This specimen was a juvenile, with no signs of maturation.

DISCUSSION

Geographic distribution

Sharks of the order Hexanchiformes have been known to occur off southern, southeastern and northeastern Brazil (Lessa *et al.* 1999; Soto 1999). However, in the most recent elasmobranch fauna checklist for Ceará State (Gadig *et al.*, 2000), their occurrence had not yet been reported. Our study provides the first evidence of this group's presence in this region. The sampling area consisted of the continental shelf and slope along the state, with depths ranging from 10 to 350 m. This is the first

account of the elasmobranch fauna to include the mesopelagic zone off Ceará. This study extends the known distribution range of hexanchiformes in Brazil.

By recording the presence of hexanchiform sharks off Ceará State based on reliable specimen identification, capture locations, and frequency of occurrence data, this study helps to clear up the confusion and misinterpretations regarding the presence or absence of the sixgill and sevengill sharks in that region. Rincón & Lessa (1998) provided preliminary data on the capture of elasmobranchs in deep waters along northeastern Brazil (from Ceará to northern Bahia States), where both sixgill and sevengill sharks were recorded, but no specific capture locality was provided. However, in a review of the distribution of hexanchiform sharks in the southwestern Atlantic, Soto (1999) cited Rincón &

Lessa (1998) to indicate a continuous distribution of *H. perlo* and *H. griseus* from Ceará State to northern Bahia State. Gadig *et al.* (2000), on the other hand, did not include the hexanchiform sharks in their account of Ceará's fauna.

Compagno *et al.* (2005) reported *H. perlo* as distributed over the entire Brazilian coast. Unfortunately, the specific source(s) to support their assertion were not shown. The authors of this study are unaware of records to support such distribution in the Brazilian coast.

According to Compagno *et al.* (2005), the distribution of *H. griseus* in Brazilian waters is restricted to the southern region. However, *H. griseus* is already known to occur in northeastern Brazil off the States of Pernambuco (including Fernando de Noronha) and Rio Grande do Norte (Moreira-Júnior, 1993; Rincón & Lessa, 1998; Lessa *et al.* 1999). Mesopelagic fauna of tropical regions, including Northeastern Brazil, are usually underreported, which makes it difficult to assess the distribution patterns of hexanchiform sharks.

Bathymetric distribution

Worldwide, *H. perlo* has been known to occur primarily in deep waters down to 1,000 m, but occasionally also in inshore waters (Compagno *et al.*, 2005). The capture depth of *H. perlo* in this study, namely 120 - 234 m, coincides with the range described for this species, and it also agrees with Soto's (1999) data compilation, that placed it between 100 and 320 m depth in Brazilian waters.

In the present study, the *H. griseus* specimen was captured at 140 m depth, which is perhaps one of the shallowest capture records in Brazilian waters, but it still is within the range already reported for this species globally. Soto (1999) reported the occurrence of this species in Brazil between 300 and 540 m depth. Ebert (1986) reported the occurrence of immature specimens of *H. griseus* at depths shallower than 100 m at the California Bay, in the Eastern Pacific. Compagno *et al.* (2005) reported the occurrence of *H. griseus* as usually 500 to 1,100 m, with some down to at least 1,875 m depth, but also notes that young specimens may occur in inshore cold waters. Results from depth telemetry conducted off Bermuda showed that *H. griseus* mainly occurred between 600 and 1,100 m, with greatest depth down to 1,500 m (Carey & Clark, 1995).

Reproductive observations

All the examined *H. perlo* females had total length greater than 100 cm and were adults. This agrees with the 80 cm total length at maturity proposed by Tanaka & Mizue (1977) for this

species. Furthermore, they also mentioned a peak of reproductive activity between 95 and 105 cm. This also agrees with data obtained here because all females examined were pregnant. *H. perlo* female specimens captured in southern Brazil with total lengths between 96 and 113 cm were also adults (Castro-Neto & Soto, 1997).

The two largest litter sizes for *H. perlo* in this study, 22 and 23 embryos, were higher than the maximum litter size range of 6 to 20 embryos reported for this species by Compagno *et al.* (2005). Nevertheless, the average number of embryos observed in this study, 20, was within the reported range.

The only *H. griseus* specimen examined in this study was a juvenile male with total length of approximately 180 cm. According to Compagno *et al.* (2005), *H. griseus* males mature at a total length between 309 and 330 cm. Worldwide, captures of adult specimens are rare (Springer & Walker, 1969; Ebert, 1986; Soto, 1999).

Concluding remarks

The observed depth stratification pattern of hexanchiform shark occurrences off Ceará waters underscores the need for thorough deep-sea research surveys in order to obtain a more complete assessment of the region's elasmobranch fauna. The recording of the sevengill and sixgill sharks corroborates the prediction by Gadig *et al.* (2000) of the possible occurrence of previously unrecorded elasmobranch species on demersal and bathypelagic environments off Ceará.

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