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New distributional and morphological data of two species of catsharks, genus *Scyliorhinus* Blainville, 1816 (Carcharhiniformes, Scyliorhinidae), from the western South Atlantic

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Abstract
This study provides new distributional and morphological information for two recently described species of catsharks (Carcharhiniformes, Scyliorhinidae) from Brazil. *Scyliorhinus cabofriensis* Soares, Gomes & Carvalho, 2016, originally described from off Cabo Frio, state of Rio de Janeiro (536 m depth) is recorded in deeper waters (647 m) off northern Rio de Janeiro, and *Scyliorhinus ugoi* Soares, Gadig & Gomes, 2015, previously known from the Caribbean Sea to Rio de Janeiro (depth unknown), is reported off the state of Santa Catarina, southern Brazil, at 825 m. Morphometric data are provided for all the specimens examined.

Keywords
Brazil, new records, *Scyliorhinus cabofriensis*, *Scyliorhinus ugoi*.

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Introduction

The Scyliorhinidae (Elasmobranchii, Carcharhiniformes), with 17 genera and approximately 160 species, is the most diverse family of sharks (Nelson et al. 2016; Soares and Carvalho 2019). The genus *Scyliorhinus* Blainville, 1816 comprises 16 valid species living from the intertidal zone to continental slopes, although the majority occurs in deep waters, usually below 200 m (Compagno 1984; Weigmann 2016; Soares and Carvalho 2019). Four valid species of *Scyliorhinus* have been reported in the western South Atlantic: *Scyliorhinus boa* (Goode & Bean, 1896), known from the Caribbean Sea to northeastern Brazil (Rio Grande do Norte); *Scyliorhinus haeckeli* (Miranda Ribeiro, 1907), known from southern Bahia (Brazil) to northern Argentina; *Scyliorhinus cabofriensis* Soares, Gomes & Carvalho, 2016, from Rio de Janeiro (Brazil); and *Scyliorhinus ugoi* Soares, Gadig & Gomes, 2015, from the Caribbean Sea (Barbados) to Rio de Janeiro (Brazil) (Lins-Oliveira et al. 2015; Soares et al. 2015, 2016; Soares and Carvalho 2019). *Scyliorhinus besnardi* Springer & Sadowsky 1970, traditionally recognized from the western South Atlantic, was recently synonymized with *S. haeckeli* by Soares et al. (2016). A fifth

unnamed species of *Scyliorhinus* is believed to occur on the continental slopes off southern Brazil (Rincón-Filho et al. 2017).

The morphological and/or distributional information available for *S. cabofriensis* and *S. ugoi* are those mentioned in the original descriptions (Soares et al. 2015, 2016) and in a recent taxonomic review (Soares and Carvalho 2019), which were based on 23 and 26 specimens, respectively. The aim of our study is to present new records and range extensions of *S. cabofriensis* and *S. ugoi* based on the recent examination of specimens deposited in fish collections. Additional morphological data for both species are also provided.

Methods

Specimens are deposited in Fish Collection of the Instituto de Biodiversidade e Sustentabilidade, Universidade Federal do Rio de Janeiro (NPM; Macaé, Brazil) and Laboratório de Ecossistemas Aquáticos e Pesqueiros, Universidade do Vale do Itajaí (LEAP; Itajaí, Brazil). Specimens were identified according to Soares et al. (2015, 2016) and Soares and Carvalho (2019). Measurements (Table 1) were taken with calipers to the nearest 0.1 mm, according to Compagno (2001). Radiographs of specimens were taken using a Faxitron LX-60 to aid vertebrae counts.

Results

Scyliorhinus cabofriensis Soares, Gomes & Carvalho, 2016

Figures 1–3, Table 1

New records. BRAZIL • 1 ♀ (408 mm TL); state of Rio de Janeiro, off Cabo de São Tomé; 22°21′10″S, 040° 04′23″W; 647 m depth; 3 Jan. 2011; Bruna Pagliani leg.; NPM 550 • 2 ♀ (219–384 mm TL); state of Rio de Janeiro, off Macaé; 22°46′55″S, 040°38′23″W, 387–393 m depth; 11 Apr. 2008; RV *Gyre*, Michael M. Mincarone and cruise staff leg.; bottom trawl; NPM 861 • 1 ♂ (damaged); state of Rio de Janeiro, off Macaé, 5 Jun. 2017; anonymous leg.; NPM 4519 • 1 ♂ (468 mm TL); state of Rio de Janeiro, off Quissamã; 30–60 m depth; 21 Jun. 2016; anonymous leg.; gillnet; NPM 4545.

Identification. According to Soares et al. (2016), *S. cabofriensis* can be distinguished from all western South Atlantic congeners by its color pattern composed of randomly and asymmetrically distributed black and white spots of varied sizes (but predominantly small) (vs spots predominantly within saddles and with approximate bilateral symmetry in *S. haeckelii* and *S. ugoi*); saddles not well defined and without sharp median projections (vs well-defined saddles in *S. haeckelii* and saddles with sharp median projections in *S. ugoi*); claspers with a well-developed groove on the terminal portion of the ventral terminal cartilage (vs lacking groove or an undeveloped groove in *S. haeckelii* and *S. ugoi*); envelope absent and exorhipidion poorly developed (vs envelope present and exorhipidion developed in *S. haeckelii*); and neurocranium with a proportionately broader basal plate (vs narrow basal plate in *S. haeckelii* and in *S. ugoi*). In addition, an extensive list of combination of characters is provided by Soares et al. (2016). Morphometric data of the specimens examined (except the damaged specimen NPM 4519) are provided in Table 1.

Scyliorhinus ugoi Soares, Gadig & Gomes, 2015

Figures 1, 4, Table 1

New records. BRAZIL • 1 ♀ (490 mm TL); state of Santa Catarina, off Cabo de Santa Marta; 825 m depth; 3 Mar. 2001; FV *Saga de Thor*, anonymous leg.; bottom trawl; LEAP 157.

Identification. According to Soares et al. (2016), *S. ugoi* can be distinguished from western South Atlantic congeners by its color pattern composed by spots predominantly within saddles and with approximate bilateral symmetry (vs randomly and asymmetrically distributed black and white spots of varied sizes, but predominantly small, in *S. cabofriensis*); saddles with sharp median projections (vs saddles not well defined and without sharp

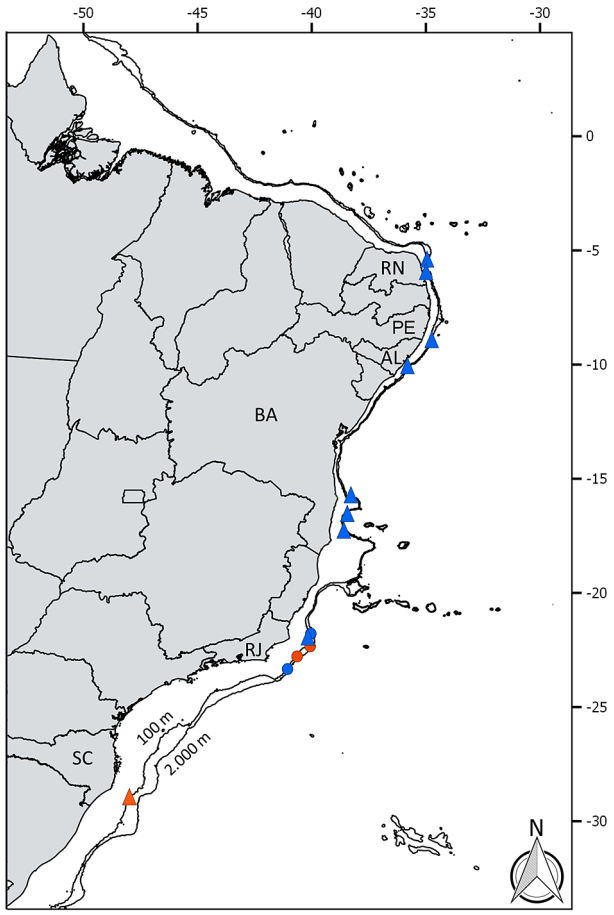

Figure 1. Records of *Scyliorhinus cabofriensis* (circles) and *S. ugoi* (triangles) along the Brazilian coast. Blue symbols are records from literature and red symbols represent new records. Selected Brazilian states: RN = Rio Grande do Norte; PE = Pernambuco; AL = Alagoas; BA = Bahia; RJ = Rio de Janeiro; SC = Santa Catarina.

Figure 2. *Scyliorhinus cabofriensis*, NPM 861 (female, 384 mm TL), collected off Macaé, RJ, Brazil. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view.

Figure 3. Ventral view of *Scyliorhinus cabofriensis*, NPM 4545 (male, 468 mm TL), collected off Quissamã, RJ, Brazil.

median projections in *S. cabofriensis* and well-defined saddles in *S. haeckelii*); clasper lacking groove or an undeveloped groove (vs claspers with a well-developed groove on the terminal portion of the ventral terminal cartilage in *S. cabofriensis*); neurocranium with a proportionately narrow basal plate (vs broader basal plate in *S. ugoi*). In addition, an extensive list of combination of characters is provided by Soares et al. (2015, 2016). Morphometric data are given in Table 1.

Discussion

Scyliorhinus cabofriensis was previously known from 23 specimens collected off northeastern Rio de Janeiro (Soares et al. 2016). All specimens were generally reported off state of Rio de Janeiro (RJ) or off Cabo Frio (type locality), without indication of coordinates and depths. The only known specimen of *S. cabofriensis* with precise collection data (MNRJ 30196) was previously recorded by Nunan and Senna (2007) as *Scyliorhinus* sp., which was collected by the RV *Thalassa* at 21° 48′29.8″S, 040°01′32.3″W, at a depth of 536 m. The current study reports on the occurrence of five additional specimens of *S. cabofriensis* between Cabo de São Tomé and Macaé, from depths of 387–647 m.

Scyliorhinus ugoi was originally described based on 10 specimens collected between the states of Rio Grande do Norte and Bahia, without mention the depth range (Soares et al. 2015). A recent taxonomic review based on 26 specimens examined, revealed that *S. ugoi* occurs from Barbados (Caribbean Sea) to Rio de Janeiro (Brazil) (Soares and Carvalho 2019). The current study extends the distribution of this species to southern Santa Catarina, Brazil, based on a single specimen bottom trawled off Cabo de Santa Marta, at 825 m depth.

In spite of the new records, both *S. cabofriensis* and *S. ugoi* probably have a wider distribution when compared with those reported herein and in the literature. At the moment, whereas the distribution of *S. ugoi* extends from Barbados (Caribbean Sea) to Santa Catarina (Brazil), records of *S. cabofriensis* are restricted to state of Rio de Janeiro, from Cabo de São Tomé to Cabo Frio.

Morphometric data of all examined specimens are given in Table 1, including 18 measurements not presented in the original descriptions of *S. cabofriensis* and *S. ugoi*, which improves the description of both species. In addition, measurements of the new specimens recorded herein increase the morphometric ranges previously known for *S. cabofriensis* and *S. ugoi*, which

Table 1. Measurements (according to Compagno 2001) for specimens of *Scyliorhinus cabofriensis* and *Scyliorhinus ugoi* examined in the current study, compared with data from the literature (ranges different from those reported in the original descriptions are indicated in bold).

Species	***Scyliorhinus cabofriensis***			***Scyliorhinus ugoi***	
Reference	**Soares et al. (2016)**	**Current study**	**Current study**	**Soares et al. (2015)**	**Current study**
Sex	Males/females	Female	Male	Males/females	Female
n	23	3	1	10	1
Total vertebrae	120–124	**118**–123	—	119–135	—
Total length mm (TL)	281–468	**219**–408	469	415–600	490
Measurements in % of TL					
Precaudal length (PRC)	76.2–79.6	76.7–77.2	78.5	74.7–76.8	75.1
Prenarial length (PRN)	–	4.6–4.7	4.1	—	—
Preoral length (POR)	4.6–5.7	4.7–5.3	**4.4**	4.3–5.6	4.3
Preorbital length (POB)	6.1–7.2	**4.8**–6.4	6.1	6.4–6.4	—
Prespiracular length (PSP)	11.0–11.2	**10.7**–11.5	10.9	10.4–10.7	—
Prebranchial length (PG1)	14.7–15.7	**15.8–16.2**	**16.7**	14.5–15.2	—
Head length (HDL)	19.7–20.8	20.1–20.2	**20.9**	19.5–20.3	—
Prepectoral length (PP1)	18.3–19.1	18.5–**19.4**	19.3	17.9–17.9	—
Prepelvic length (PP2)	40.6–42.4	**38.1–39.9**	40.9	41.0–43.4	42.9
Snout-vent length (SVL)	42.8–44.1	**40.2**–42.9	43.5	43.6–45.4	—
Preanal length (PAL)	51.8–61.7	57.6–58.1	**61.8**	59.1–64.4	—
Pre-first dorsal length (PD1)	48.9–50.6	**46.6–47.4**	**52.2**	48.4–51.2	—
Pre-second dorsal length (PD2)	—	63.8–64.0	68.9	—	—
Interdorsal space (IDS)	10.0–12.3	10.3–11.4	11.3	10.9–11.0	**10.8**
Dorsal-caudal space (DCS)	4.3–6.2	5.7–**6.7**	6.6	4.2–5.1	4.7
Pectoral pelvic space (PPS)	16.5–18.8	**16.0**–16.5	16.4	17.6–20.1	18.4
Pelvic-anal space (PAS)	10.8–14.3	11.3–11.9	**15.1**	10.5–12.8	**10.2**
Anal-caudal space (ACS)	7.2–11.5	8.1–8.8	8.6	7.4–7.6	**7.3**
Eye length (EYL)	3.6–4.4	**4.5–4.8**	4.7	3.8–4.0	**4.3**
Interorbital space (INO)	6.8–7.2	**6.7–7.3**	**6.2**	6.1–6.6	6.5
Nostril width (NOW)	—	7.1–7.9	5.8	–	2.6
Internarial space (INW)	1.8–2.7	**1.7**–2.0	1.9	1.4–2.4	2.2
Anterior nasal flap length (ANF)	—	1.9–2.1	1.0	—	1.6
Spiracle length (SPL)	—	0.6–0.9	0.7	—	0.7
Distance between spiracles (DBS)	—	8.2–8.6	7.9	—	8.6
Mouth length (MOL)	3.6–7.2	3.7–3.9	3.6	3.7–5.1	**3.3**
Mouth width (MOW)	7.4–8.2	**7.1**–7.5	**6.2**	9.0–9.7	**8.4**
Lower labial furrow length (LLA)	1.8–2.3	**1.1–1.6**	1.4	1.9–2.1	**2.2**
First gill slit height (GS1)	1.8–3.1	**1.7**–2.0	**1.5**	2.8–3.1	—
Second gill slit height (GS2)	—	1.5–1.9	1.3	—	—
Third gill slit height (GS3)	—	1.2–1.7	1.5	—	—
Fourth gill slit height (GS4)	—	1.0–1.5	1.4	—	—
Fifth gill slit height (GS5)	1.0–1.7	**0.8**–1.1	0.9	0.9–1.8	1.0
Head height (HDH)	7.2–7.5	**7.1–8.6**	8.5	5.4–6.6	**8.8**
Head width (HDW)	12.3–12.9	**10.6**–12.3	11.5	13.0–13.3	**12.8**
Trunk height (TRH)	—	8.6–10.3	8.9	9.5–12.2	**9.3**
Trunk width (TRW)	—	9.5–11.1	9.3	10.9–14.5	11.0
Tail height (TAH)	—	4.1–7.8	6.7	—	6.7
Tail width (TAW)	—	2.9–5.0	4.5	—	5.1
Caudal peduncle height (CPH)	3.6–3.6	**3.0**–3.5	3.2	3.1–3.3	**2.8**
Caudal peduncle width (CPW)	2.7–3.2	**2.2–2.3**	2.9	1.9–2.3	2.2
Pectoral length (P1L)	10.4–12.3	**12.5–13.8**	11.3	12.8–13.6	**12.6**
Pectoral anterior margin (P1A)	11.8–13.3	**13.4–14.3**	13.0	14.5–15.0	**14.4**
Pectoral base (P1B)	6.1–7.8	**5.6**–6.7	5.7	3.1–7.2	6.3
Pectoral inner margin (P1I)	6.1–6.5	**4.7**–6.2	5.3	5.9–7.1	6.5
Pectoral posterior margin (P1P)	7.4–9.1	8.3–**9.4**	**9.5**	8.7–9.0	**10.6**
Pelvic length (P2L)	10.0–11.4	**9.6–10.5**	11.4	9.0–10.5	10.2
Pelvic anterior margin (P2A)	6.1–7.2	**5.6**–6.1	6.3	6.6–7.4	6.9
Pelvic base (P2B)	6.1–6.8	6.4–**7.3**	6.7	6.4–8.9	6.7
Pelvic height (P2H)	—	2.4–3.2	4.4	—	4.4
Pelvic inner margin (P2I)	3.6–5.5	**2.8–3.1**	**5.7**	3.1–3.8	3.2
Pelvic posterior margin (P2P)	5.4–7.6	**4.7**–6.1	7.5	6.4–6.6	6.5
Clasper outer length (CLO)	3.2–4.8	—	**5.1**	3.8–4.1	—
Clasper inner length (CLI)	9.3–10.4	—	**8.2**	8.1–9.0	—

Table 1. *Continued.*

Species	*Scyliorhinus cabofriensis*			*Scyliorhinus ugoi*	
Reference	**Soares et al. (2016)**	**Current study**	**Current study**	**Soares et al. (2015)**	**Current study**
Clasper base width (CLB)	1.0–1.4	—	1.2	0.4–0.8	—
First dorsal length (D1L)	—	9.6–10.7	9.8	—	9.3
First dorsal anterior margin (D1A)	9.9–10.0	**8.9–11.6**	10.0	9.7–10.0	**10.8**
First dorsal base (D1B)	5.7–6.5	**5.4**–6.1	**6.8**	6.6–7.1	**6.5**
First dorsal height (D1H)	4.3–5.7	4.9–**5.8**	4.9	5.7–5.9	5.9
First dorsal inner margin (D1I)	2.8–4.2	3.2–3.8	3.2	3.1–3.4	**2.8**
First dorsal posterior margin (D1P)	—	4.5–7.7	4.7	—	5.9
Second dorsal length (D2L)	—	8.2–8.5	8.3	—	7.9
Second dorsal anterior margin (D2A)	7.6–8.2	7.6–**8.6**	7.8	5.0–7.6	**8.1**
Second dorsal base (D2B)	5.4–6.5	5.6–5.7	5.4	5.5–6.1	**5.3**
Second dorsal height (D2H)	3.2–3.8	**3.1–4.1**	3.5	3.8–4.7	**3.4**
Second dorsal inner margin (D2I)	2.1–2.7	2.5–**3.0**	2.8	2.6–2.9	2.6
Second dorsal posterior margin (D2P)	—	2.9–3.3	3.4	—	3.4
Anal length (ANL)	—	10.8–13.2	10.2	—	11
Anal anterior margin (ANA)	7.8–7.9	**7.7–9.2**	7.7	8.3–8.7	8.5
Anal base (ANB)	7.9–9.1	8.1–**9.8**	**7.8**	5.7–7.7	**8.5**
Anal height (ANH)	3.6–4.4	**2.8–4.8**	4.0	4.2–4.6	**4.7**
Anal inner margin (ANI)	2.1–3.4	**2.0**–2.6	3.0	2.6–2.9	2.8
Anal posterior margin (ANP)	4.3–5.5	4.3–**6.3**	4.9	5.1–5.4	**5.7**
Dorsal caudal margin (CDM)	21.6–23.0	**21.0–23.5**	21.4	23.4–25.3	24.3
Preventral caudal margin (CPV)	—	8.6–9.9	9.7	—	11.0
Postventral caudal margin (CPU)	9.6–10.5	**8.3**–9.7	**7.7**	9.4–10.7	**11.6**
Subterminal caudal margin (CST)	8.2–10.4	**4.9–6.8**	5.2	8.8–10.7	**5.7**
Terminal caudal margin (CTR)	5.0–5.3	**4.7**–5.2	4.7	5.2–5.4	**5.5**
Terminal caudal lobe (CTRL)	4.6–5.9	**6.4–8.0**	6.9	5.4–6.4	**7.3**

Figure 4. *Scyliorhinus ugoi*, LEAP 157 (female, 490 mm TL), collected off Cabo de Santa Marta, SC, Brazil. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view.

is likely to occur for species with so few specimens examined.

Among all specimens of *S. cabofriensis*, the NPM 4545 (Fig. 3) stands out by having dark spots on the ventral region of the body, a color pattern not reported in the specimens examined by Soares et al. (2016). As only 28 specimens were reported so far, the frequency in which this color pattern occurs in the population or whether this represents an anomalous coloration remain unknown.

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Authors' Contributions

SML, RCM and MMM performed the measurements, SML and LGF designed the figures. SML, LGF, and MMM wrote, revised, and corrected the manuscript.

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