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Distributional limits of the Shortnose Guitarfish, *Zapteryx brevirostris* (Rhinopristiformes: Trygonorrhinidae) - An update

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ABSTRACT

The Shortnose Guitarfish, *Zapteryx brevirostris*, is endemic to the Southwest Atlantic and its geographic range is commonly reported from Southeastern Brazil to Northern Argentina. However, range limits are imprecise or inconsistent in some cases. These inconsistencies were addressed in this study based on 1,363 specimens collected since 1865. These records were obtained from scientific collections, a systematic review of literature, and an on-board observation database. According to the data collected in this study, the known northernmost distributional limit of the species lies at the mouth of the Doce River, Northern Espírito Santo State, in Southeastern Brazil (19°S). As for the other extreme of its range, the known southernmost distribution limit refers to the Falkland Islands (Malvinas) (53°S). This represents more than 2,000 km of coastline geographic range extension — in comparison to the previous known southernmost range limit for this species. The geographical range of *Z. brevirostris* seems to follow biogeographic patterns operating at an ecosystem level in which biotic (especially in the north) and abiotic factors (especially in the south) play a role in imposing limits to its distribution range.

Keywords: Batoid, Chondrichthyes, Distribution range, Range boundaries, Southwest Atlantic Ocean

INTRODUCTION

Distributional limits of species are influenced by many factors in a complex interaction system (Brown and Lomolino, 1998, Lomolino et al., 2010). These include ecological and environmental factors, such as biotic interactions and abiotic conditions (Dobzhansky, 1950, MacArthur, 1972), as well as evolutionary responses to biotic and abiotic gradients (Hardie and Hutchings, 2010, Willi and Van Buskirk, 2019, Alexander et al., 2022). Besides being an issue of biological interest due to connecting species range to ecology and evolution, understanding species boundaries may also be crucial information considering global environmental changes (Thomas, 2010). As global temperatures fluctuate and habitats

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undergo transformations, certain species may migrate or adapt, whereas others may face higher extinction risks (Gervais et al., 2021). Furthermore, understanding the geographic range of a species and shifts on its boundaries is fundamental for conservation planning (Franklin, 2010). For instance, a well-defined geographic range may help establish priority conservation areas, appropriate monitoring of range reduction, and overlapping threats (Chan et al., 2021, Becerril-García et al., 2022). Therefore, establishing well-defined geographic range and distributional limits of species at risk of extinction can be considered a pressing issue.

Currently, one of the most threatened groups of species in the world is the Elasmobranchii, which includes sharks and rays (Díaz et al., 2019). Bycatch, overexploitation, and finning have led to population declines of dozens of species (Dulvy et al., 2014, Dent and Clarke, 2015, Charvet et al., 2021, Dulvy et al., 2021). Many elasmobranchs are characterized by slow growth, late maturity, and low fecundity, which make this group much more susceptible to threats (Dulvy et al., 2014). Among them, shark-like batoids (Rhinopristiformes) are one of the most threatened groups (Faria et al., 2013, Moore, 2017, Jabado, 2018, Dulvy et al., 2021). The genus *Zapteryx* Jordan and Gilbert, 1880 comprises three batoid species of the order Rhinopristiformes (Last et al., 2016, Weigmann, 2016). One of them, the Shortnose Guitarfish *Zapteryx brevirostris* (Müller and Henle, 1841) is endemic to the Southwest Atlantic from Southeastern Brazil to Northern Argentina (Weigmann, 2016, Gomes et al., 2019).

This trygonorrhinid batoid has a short cuneiform-shaped snout, which is the main morphological character to differ it from other guitarfishes from the Southwest Atlantic (Last et al., 2016). The only somewhat similar guitarfishes in this region include two rhinobatid species, *Pseudobatos horkelii* (Müller and Henle, 1841) and *P. percellens* (Walbaum, 1792), which differ from *Z. brevirostris* because they have an elongated snout (Bigelow and Schroeder, 1953). The Shortnose Guitarfish is commonly caught as bycatch throughout its geographic range (Costa and Chaves, 2006, Chiaramonte et al., 2011, Colonello et al., 2011, Wosnick et al., 2019). This led to a population reduction of 85% in Brazil and 25% in Uruguay in the last three generations period (Pollom et al., 2020). Consequently, this species is currently listed as Endangered (EN) by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Pollom et al., 2020). Its current conservation status suggests a trend of increased extinction risk given that in its previous IUCN Red List assessment this species was assigned to a lower threat category (Vulnerable - VU; Vooren et al., 2006).

Within the geographic range of *Z. brevirostris*, there currently exists some confusion about its distributional limits. Historically, the northernmost limit has been mentioned as the oceanic Fernando de Noronha Archipelago (Northeastern Brazil) (Batista, 1987a, 1987b, Castello, 1971, Santos et al., 2006, but not in Soto, 2001), Bahia State (Northeastern Brazil) (Bigelow and Schroeder, 1953, Menni and Stehmann, 2000), Espírito Santo State (Southeastern Brazil) (Pinheiro et al., 2015; Pollom et al., 2020), and Rio de Janeiro State (Southeastern Brazil) (Miranda-Ribeiro, 1904,1907). On the other hand, the southernmost limit has more consistently been mentioned as Mar del Plata (Argentina) in the literature (Menni and Stehmann, 2000, Wosnick and Freire, 2013, Gomes et al., 2019, Wosnick et al., 2019), although one online database (i.e., FishBase) reports one specimen collected as south as the Falkland Islands (Malvinas) (Froese and Pauly, 2022). [The Falkland Islands (Malvinas) are listed as a Non-Self-Governing Territory by the United Nations, which also recognizes the dispute concerning the sovereignty of these islands (UN, 2024).] This study reviewed the occurrence records of *Z. brevirostris* along its geographic range, focusing on its distributional limits.

METHODS

Occurrence records of *Z. brevirostris* were first compiled from two sources. Specimens deposited in scientific collections were accessed by (1) online database search made on SpeciesLink (SpeciesLink, 2022) and Global Biodiversity Information Facility-GBIF (GBIF, 2022) and (2) inquiries to curators and collection managers from museums and scientific collections (Table 1). The taxonomic identification associated with specimen records obtained from online databases was considered reliable since *Z. brevirostris* is the only species of the family in the Atlantic Ocean (Weigmann, 2016). In one case, additional information and photographs from a female specimen from the Falkland Islands (Malvinas) (ISH 591-1978, a specimen from the Zoologisches Museum, Universität Hamburg, ZMH collection) was obtained to verify the species identity and associated locality information.

Table 1. Museums and scientific collections used as source of occurrence records of the Shortnose Guitarfish, *Zapteryx brevirostris*. The left column indicates how the locality information associated with specimens were accessed. The right column shows the collections that served as source of information; codes follow Fricke and Eschmeyer (2022), Sabaj (2022), and Faria et al. (2021).

Access to specimen	Collection
Online database	**BMNH** – Natural History Museum, London, United Kingdom **CAS** – California Academy of Sciences, San Francisco, USA **CENPAT** – Centro Nacional Patagónico, Puerto Madryn, Argentina **CIUFES** – Ichthyological Collection of Universidade Federal do Espírito Santo, Vitória, Brazil **ColBIO** – Coleção Biológica “Prof. Edmundo F. Nonato” do Instituto Oceanográfico, Universidade de São Paulo, Cidade Universitária, São Paulo, Brazil **LIRP** – Laboratório de Ictiologia de Ribeirão Preto, Departamento de Biologia, Universidade de São Paulo, Ribeirão Preto, Brazil. **MBML** – Museu de Biologia Professor Mello Leitão, Instituto Nacional da Mata Atlântica, Santa Teresa, Brazil **MCP** – Museu de Ciências e Tecnologia – MCT, Pontifícia Universidade Católica do Rio Grande do Sul - PUCRS, Porto Alegre, Brazil **MCZ** – Museum of Comparative Zoology, Cambridge, USA **MHNCI** – Museu de História Natural do “Capão da Imbuia”, Curitiba, Brazil **MNHN** – Muséum national d’Histoire naturelle, Paris, France **MOVI** – Museu Oceanográfico Univali, Universidade do Vale do Itajaí, Balneário Piçarras, Brazil **MZUSP** – Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil **MZUEL** – Museu de Zoologia, Universidade Estadual de Londrina, Londrina, Brazil **MZFS** – Museu de Zoologia da Universidade Estadual de Feira de Santana, Feira de Santana, Brazil **NPM** – Núcleo em Ecologia e Desenvolvimento Sócio-Ambiental, Universidade Federal do Rio de Janeiro, Macaé, Brazil **NRM** – Naturhistoriska Riksmuseet [Swedish Museum of Natural History], Stockholm, Sweden **SMF** – Senckenberg Naturmuseum Frankfurt, Frankfurt, Germany **ZUEC** – Museu de Zoologia da Universidade Estadual de Campinas “Adão José Cardoso”, Campinas, Brazil
Direct enquiry to curator and/or collection manager	**ANSP** – The Academy of Natural Sciences of Philadelphia, Philadelphia, USA **CIDRO** – Coleção Ictiológica Dias da Rocha, Universidade Federal do Ceará, Fortaleza, Brazil **INIDEP** – Instituto Nacional de Investigaciones y Desarrollo Pesquero, Mar del Plata, Argentina **MACN** – Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina **MHNM** – Museo Nacional de Historia Natural, Montevideo, Uruguay **MNRJ** – Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil **ZMH** – Zoologisches Museum, Universität Hamburg, Hamburg, Germany **ZMB** – Museum für Naturkunde, Berlin, Germany

Another source of information of occurrence records of *Z. brevirostris* was a systematic review of literature. For this, the PICO Strategy (acronym for patient/population, intervention, comparison, and outcome) was applied to the bibliographic search, according to a previously described methodology (Richardson et al., 1995). The terms 'population' and 'intervention' were used to choose keywords (O'Dea et al., 2021). In the search, under 'population' the term searched was '*Zapteryx brevirostris*,' and, under 'intervention,' the term 'Atlantic' was applied in three languages (English, Portuguese, and Spanish). The Boolean operator AND was applied to combine the terms 'population' and 'intervention.' The term 'Atlantic' (three languages) was separated by the Boolean operator OR.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) is a set of guidelines and a structured framework for planning and conducting systematic reviews and meta-analyses in research (O'Dea et al., 2021). The PRISMA Protocol approach was used as the criteria for research article selection. Searches using the online databases Scopus, ScienceDirect, and Web of Science were carried out on May 15, 2023. Additional searches in Google Scholar using the term '*Zapteryx brevirostris'* as keyword were carried out for further information about geographic range and distributional limits of *Z. brevirostris*. Only research articles and one technical note that provided primary occurrence data of *Z. brevirostris* were included in the analysis. Conversely, articles providing only secondary or incomplete occurrence data of *Z. brevirostris* and those providing occurrence data of other *Zapteryx* species were excluded.

One last source of information was the 'On-Board Observer Program' of the Fisheries Secretariat of the Province of Chubut, Argentina. This program monitors bycatch in the *Pleoticus muelleri* (Bate, 1888) shrimp fishery. This database has been kept unpublished but was accessed by the second author of this study (N. Bovcon).

For map preparation, the geographic range of *Z. brevirostris*, geographic coordinates, and shapefiles were converted to WGS84. Then, occurrence records with inaccuracies or missing coordinates were removed from the dataset. Records without geographic coordinates but with detailed information about the sampling locality had the coordinates estimated and were included in the dataset used for map construction. Once the dataset was considered suitable, the geographic coordinates were plotted on Qgis, version 3.10.8 (QGIS, 2020).

RESULTS

Data collection resulted in 1,363 specimens of *Zapteryx brevirostris*: one from on-board observation, 257 from scientific collections, and 1,105 from the literature review (30 research articles and one technical note) from 1865 to 2022 (Table S1; Supplementary Material). These specimens were collected from 107 localities - each considered an occurrence point - from Brazil, Uruguay, and Argentina (Figure 1). The 107 occurrence points had the following sources: collection managers (n = 16), online databases (n = 80), published research articles (n = 9), on-board observation (n = 1), and a technical note (n = 1).

The search for *Z. brevirostris* on the three databases (Scopus, ScienceDirect, and Web of Science) resulted in 42 research articles that mentioned the occurrence of this species, 25 of which were excluded from this study due to duplicates and lack of precise occurrence data, which resulted in 17 research articles being considered suitable. Moreover, 13 research articles were incorporated after a complementary search (i.e., Google Scholar). Therefore, 30 research articles were effectively included in this study (references in Table 2 and as follows: Jaureguizar et al., 2003, 2004, Colonello et al., 2014, Loto et al., 2018, Alvarenga et al., 2021, Gatts et al., 2021, Karlovic et al., 2021, Lucena et al., 2021, Martins et al., 2021, Takatsuka et al., 2022). These 30 research articles reported data from each country as follows: Brazil only (n = 23); Brazil, Uruguay, and Argentina (n = 1); Argentina and Uruguay (n = 3); and Argentina only (n = 3) (Table S1). All studies included provided information on geographic range or distributional limits or information, such as sampling location and/or number of individuals.

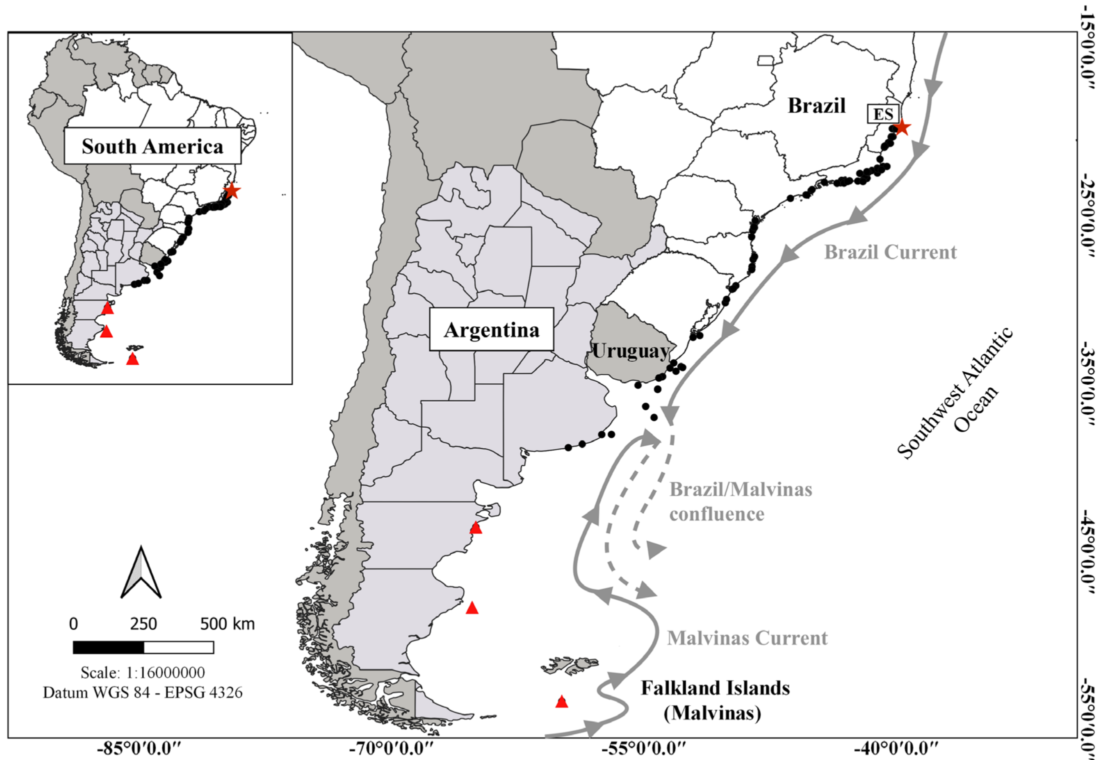

Figure 1. Dot map of the geographic range of the Shortnose Guitarfish, *Zapteryx brevirostris*. Each black dot represents a locality in which the species has been documented by either a voucher deposited in museums and scientific collections or a specimen mentioned in a scientific article. The red star represents the species northernmost occurrence: Linhares, in 2016 (voucher specimen MBML–PEIXES 120490). Red triangles represent the species southernmost occurrence: (1) upper triangle: Chubut, in 2010 (on-board observation; N. D. Bovcon, unpubl. data); (2) the triangle in between the other two: Santa Cruz Province, in 1997 (technical note; Wöhler et al., 1999) and (3) the lower triangle: south of the Falkland Islands (Malvinas), in 1978 (voucher specimen ISH 591-1978). Oceanographic currents follow Piola and Matano (2019). ES: Espírito Santo State.

Table 2. List of publications that included specific remarks on the geographic range or distributional limits associated with the Shortnose Guitarfish, *Zapteryx brevirostris*.

Geographic range or distributional limit	Source
Ilha Rasa, Rio de Janeiro Coast, Brazil	Miranda-Ribeiro (1904)
Rio de Janeiro and Bahia, Brazil	Miranda-Ribeiro (1907)
Near Bahia and near Rio de Janeiro, Brazil	Bigelow and Schroeder (1953)
Fernando de Noronha Archipelago, Brazil to Mar del Plata, Argentina	Batista (1987a, b); Castello (1971); Santos et al. (2006)
Western South Atlantic (northeast of Brazil to Argentina)	Batista (1991); Figueiredo (1977);
Bahia, Brazil to Bonaerensean District, Argentina	Menni and Stehmann (2000)
Southeastern Brazil to Mar del Plata, Argentina	Gomes et al. (2019); Wosnick and Freire (2013); Wosnick et al. (2019)
Brazil to Northern Argentina	Colonello et al. (2011)
Western South Atlantic Ocean, from South-eastern Brazil to Northern Argentina	Caltabellotta et al. (2019); Barbini et al. (2011); Pasquino et al. (2016)
Espírito Santo coast (Brazil) to Argentina	Alexandre de-Franco et al. (2012); Pinheiro et al. (2015, 2018)

The northernmost records for Z. *brevirostris* refer to three specimens captured at the mouth of the Doce River, Regência, in the Municipality of Linhares, Northern Espírito Santo State, Southeastern Brazil (19°44'57" S 39°41'51" W; MBML – PEIXES 12049). Other northernmost records of *Z. brevirostris* include an adult female from Aracruz, Espírito Santo State (19°49'49" S 40°03'09" W; CIDRO-B-38; Figure 2A) and a juvenile male from Piúma, Espírito Santo State (20°50' 58"S 40°43'56" W; CIDRO-B-39; Figure 2B).

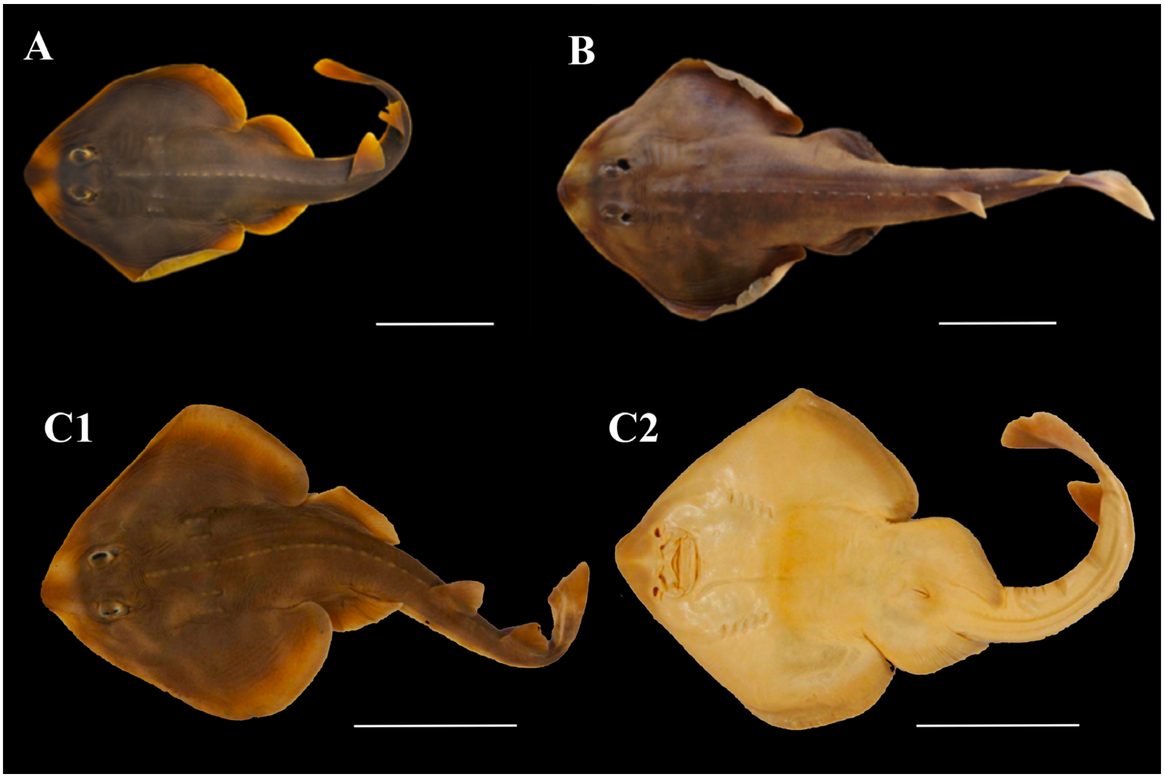

Figure 2. Three voucher specimens of the Shortnose Guitarfish, *Zapteryx brevirostris*, collected at the species distributional limits. Figure 2A: dorsal view of an adult female from Aracruz, Espírito Santo State, Southeastern Brazil (CIDRO-B-38; photo by Lilian Xavier). Figure 2B: dorsal view of a juvenile male from Piúma, Espírito Santo State, Southeastern Brazil (CIDRO-B-39; photo by Lilian Xavier). Figure 2 - C1 and Figure 2 - C2: dorsal and ventral views, respectively, from an adult female from the Falkland Islands (Malvinas) (ISH 591-1978; photos by Irina Eidus). Scale bar: 10 cm.

The southernmost records for *Z. brevirostris* were as follows: (1) one specimen captured in the coastal area of the Province of Chubut, Argentina (43°30'S 65°12'W; 34 m depth, December 26, 2010) as part of the 'On-Board Observer Program' of the Fisheries Secretariat of the Province of Chubut, which monitors bycatch in the *Pleoticus muelleri* (Bate, 1888) shrimp fishery (Bovcon, unpubl. data); (2) one specimen captured in the Province of Santa Cruz, Argentina (48°28.3'S 65°24.5'W; from 50–100 m depth isobaths) in 1997 during research campaigns for southern demersal fisheries carried out in the summer on the continental shelf of the Argentine Sea by the National Institute for Fisheries Research and Development - INIDEP (Wöhler et al., 1999); and (3) one specimen captured south of the Falkland Islands (Malvinas) (53°52'S 59°55'W; 205 m depth) as part of the Argentine Expedition 1978 (ISH 591-1978, this specimen is currently deposited at the Zoologisches Museum, Universität Hamburg; Figure 2 - C1 and C2 - Table S1).

DISCUSSION

The geographic distribution of species is often associated to patterns delimited as biogeographic provinces (Briggs, 1974). Delimiting a biogeographic province follows distinct criteria in different approaches; as a result, its limits and names fail to necessarily coincide (e.g. Spalding et al., 2007, Toonen et al., 2016). Furthermore, the distributional limits of species fail to be always restricted to a single biogeographic province (Spalding et al., 2007, Briggs and Bowen, 2012). This seems to be the case regarding the distribution of *Zapteryx brevirostris*, which can be associated with various provinces: (a) Indian (Indias Occidentales), Temperate Western South Atlantic (Argentina), and Magellanic (Magallánica) (*sensu* Lopez, 1963, Menni and Stehmann, 2000, Menni et al., 2010, Cousseu et al., 2019); (b) also Brazilian, Argentinian, Southern Argentina, and Falkland Islands (*sensu* Floeter et al., 2008, Briggs and Bowen, 2012, Toonen et al., 2016); (c) and Tropical Southwestern Atlantic, Warm Temperate Southwestern Atlantic, and Magellanic (*sensu* Spalding et al., 2007). Regardless of which approach is followed, in all cases, this species crosses different biogeographical limits and its distribution range comprises at least three biogeographical provinces.

Zapteryx brevirostris uses multiple marine habitats (Barbini et al., 2011), including estuaries (Wosnick and Freire, 2013), which may favor its dispersion from its core distribution area. Therefore, as for any organism, biotic and abiotic factors will play a role in imposing its distribution range limits. The distribution of this species appears to follow biogeographic patterns operating at an ecosystem level. In the northern limit, biotic factors such as species higher diversity seem to affect *Z. brevirostris* distribution, whereas, in the southern border, abiotic factors such as water temperature seem to play a role in imposing its limits.

Northernmost range limit

Previous reports of *Z. brevirostris* further north than Espírito Santo State should be viewed with caution. The mention of Ilha Rasa for the Fernando de Noronha Archipelago (Castello, 1971; followed by Batista, 1987a, 1987b and Santos et al., 2006, but not in Soto, 2001) is doubtful and should be disregarded. This mistake is possibly due to a misinterpretation of Miranda-Ribeiro's (1904) records of *Z. brevirostris* for Ilha Rasa, Guanabara Bay, Rio de Janeiro State. Mentions of *Z. brevirostris* for the coastal region of Bahia State (Northeastern Brazil) lack support of museum specimens or detailed locality records. Miranda-Ribeiro (1907) mentioned Bahia State as part of this species habitat despite the absence of locality data. Other subsequent studies (Bigelow and Schroeder, 1953, Figueiredo, 1977, Batista, 1991) based their accounts on Miranda-Ribeiro (1907). This study found no additional evidence of *Z. brevirostris* for Bahia State. Nonetheless, Bahia and Espírito Santo States have been considered a part of an ecotone area that enables the occurrence of fauna from different subdivisions of the Brazilian Biogeographic Province (Cord et al., 2022, Anderson et al., 2023). Moreover, the distribution of a species is dynamic and influenced by environmental factors associated with its life history, migration patterns, colonization, and even local extinction (Brown and Lomolino, 1998, Luiz et al., 2012). It is possible that migrants of *Z. brevirostris* once reached southern Bahia State but fluctuations occurred temporally and the presence of this species currently remains uncertain.

Oceanographic features possibly play an important role on the northernmost range limit of *Z. brevirostris*. The South Equatorial Current bifurcates in Northeastern Brazil from 10°S to 15°S, generating the Brazil Current, which influences conditions in Southeastern Brazil (Peterson and Stramma, 1991, Piola and Matano, 2019). The Brazil Current, along with upwellings from the south, generates a transition zone of tropical and subtropical waters in Espírito Santo State (Schmid et al., 1995, Floeter et al., 2001, 2007). Moreover, freshwater discharge from the São Francisco River (Pinheiro et al., 2018) and the Abrolhos Archipelago, which is characterized as a topographic barrier to the Brazil Current (Schmid et al., 1995), possibly influence oceanographic conditions to the north of Espírito Santo along the southeast shelf. It is already known that variations in environmental conditions strongly affect reef fish species occurrence in the area (Pinheiro et al., 2018). These environmental features have established Espírito Santo State as the northernmost range limit for some species (Floeter et al., 2001, Barroso et al., 2016, Pinheiro et al., 2018). Besides *Z. brevirostris* (Pinheiro et al., 2015), examples of other elasmobranches that have Espírito Santo State as their northern range limit include the Brazilian Guitarfish, *P. horkelii*, the Groovebelly Stingray, *Dasyatis hypostigma* Santos and Carvalho, 2004, and the Angular Angel Shark, *Squatina guggenheim* Marini, 1936 (Last et al., 2016, Pinheiro et al., 2015, 2018).

The northernmost range limit of *Z. brevirostris* is in a tropical area and may also be affected by biotic factors. In the tropics, biotic conditions may be drivers capable of limiting the abundance and distribution of species (Dobzhansky, 1950, MacArthur et al., 1972). Commonly, these areas have a higher species richness (Brown and Lomolino, 1998), which might be the case for the northern range limit of *Z. brevirostris* since other authors (Pinheiro et al., 2018) have suggested a relatively high reef fish species richness.

Southernmost range limit

The southernmost range limit of *Z. brevirostris* is most often set as the continental shelf off Mar del Plata, in northeastern coast of Argentina (Castello, 1971, Last et al., 2016, Menni and Stehmann, 2000, Santos et al., 2006, Gomes et al., 2019). However, records further south in Argentina have also been mentioned, such as Puerto Quequén (Tamini et al., 2006, Chiaramonte et al., 2011, Barbini and Cousseau, 2015; see also MACN-Ict 9664) and the Gulf of San Matias (Pollom et al., 2020). The three occurrence records highlighted in this study [Chubut Province, Santa Cruz Province, and the Falkland Islands (Malvinas)] further extend the known distribution range for *Z. brevirostris* (more than 2,000 km further south than the Gulf of San Matias).

These occurrence records, reaching the Central Coast of Patagonia, may be facilitated by the Brazil Current, which could have its greatest influence in the region during summer months (Boschi, 1989, Caille and Maldonado, 1993). Accordingly, the records for Chubut and Santa Cruz provinces both refer to warm months (December and February, respectively). In this region, several other species from temperate warm waters have been recorded at higher latitudes during summer months (e.g., the Dusky Grouper, *Epinephelus marginatus*, Irigoyen et al., 2005; the Silver Porgy, *Diplodus argenteus*, Galvan et al., 2005; the Namorado Sandperch, *Pseudopercis numida*, Venerus et al., 2007; the Spotback Skate, *Atlantoraja castelnaui*, the Eyespot Skate, *Atlantoraja cyclophora*, the Atlantic Moonfish, *Selene setapinnis*, the Cochero, *Dules auriga*, the Argentine Goatfish, *Mullus argentinae*, the Brazilian Codling, *Urophycis brasiliensis*, the Red Porgy, *Pagrus pagrus* and the Largehead Hairtail, *Trichiurus lepturus*, Góngora et al., 2009, Bovcon et al., 2011; the Snowy Grouper, *Hyporthodus niveatus*, Trobbiani et al., 2014; the Tope, *Galeorhinus galeus*, Chiaramonte et al., 2016; the Striped Smoothhound, *Mustelus fasciatus*, and the Shortnose Eagle Ray, *Myliobatis ridens*, Chiaramonte et al., 2023).

In turn, the record of *Z. brevirostris* in the Falklands Islands (Malvinas) suggests a physiological plasticity for the species given the low water temperature in the region (4 to 10° C, influenced by cold waters from the Malvinas Current - Piola and Matano, 2019). Possibly, factors other than water temperature, such as salinity, depth, and bottom substrate type, further allow the occurrence of this species in the region. For instance, *Z. brevirostris* is intimately related to ocean floors that are flat and composed of sand, mud, and gravel (Barbini et al., 2011). All these conditions are present in the Patagonian Continental Shelf of Argentina, in which the Falklands Islands (Malvinas) are located (Violante et al., 2014).

Overall, biotic factors may influence the distribution of a species, affecting its range limit on one side (usually at low latitudes), whereas abiotic conditions might be the limiting factors on the other extreme of its range (usually at high latitudes) (Dobzhansky, 1950, Brown and Lomolino, 1998, MacArthur et al., 1972, Paquette and Hargreaves, 2021). This seems to apply to *Z. brevirostris*, which may have its southernmost range limit affected by abiotic factors. This area is influenced by the Malvinas Current and the Brazil/Malvinas confluence (Piola and Matano, 2019). Environmental conditions such as bottom type, decreasing water temperature, increasing salinity, dissolved oxygen, and latitude affect the spatial distribution of many other species in this region (Menni et al., 2010, Barbini et al., 2011, Lucifora et al., 2012). Water temperature influences the geographical distribution of fish (Menni et al., 2010, Sunday et al., 2012, Rutterford et al., 2023). Water temperature (which is related to latitude) and depth are the abiotic factors that most influence (working as ecological drivers) the geographic distribution of Chondrichthyes in the Southwest Atlantic (Menni et al., 2010). For instance, influence of water temperature may even result in the splitting of the Chola Guitarfish, *Pseudobatos percellens*, into distinct genetic lineages (Cruz et al., 2023).

It is unknown if *Z. brevirostris* has established a population at its southernmost limit or if its presence in the region is due to occasional migrants. In fact, it is unclear if *Z. brevirostris* completes its life cycle throughout its entire geographic distribution range. Movements of Chondrichthyes further south of their distribution are mostly considered to be occasional or seasonal in the Southwestern Atlantic (Menni et al., 2010). This may explain a relatively sparser occurrence of *Z. brevirostris* at its southernmost limit when compared to its northernmost limit.

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L.G.X.: Conceptualization; Investigation; Data Curation; Methodology; Writing – original draft; Writing – review & editing.

N.D.B.; T.H.B.: Investigation; Methodology; Writing – review & editing.

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REFERENCES

Alexander, J. M., Atwater, D. Z., Colautti, R. I. & Argreaves, A. L. 2022. Effects of species interactions on the potential for evolution at species' range limits. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 377, 20210020. DOI: http://doi.org/10.1098/rstb.2021.0020

Alexandre de-Franco, B., Mendonça, F. F., Oliveira, C. & Foresti, F. 2012. Illegal trade of the Guitarfish *Rhinobatos horkelii* on the coasts of central and southern Brazil: genetic identification to aid conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 22(2), 272–276. DOI: https://doi.org/10.1002/aqc.2229

Alvarenga, M., Solé-Cava, A. M. & Henning, F. 2021. What's in a name? Phylogenetic species identification reveals extensive trade of endangered guitarfishes and sharks. *Biological Conservation,* 257, 109119. DOI: https://doi.org/10.1016/j.biocon.2021.109119

Anderson, A. B., Pinheiro, H. T., Batista, M. B., Francini-Filho, R. B., Gomes, L. E. O., Bernardino, A. F., Horta, P. & Joyeux, J. C. 2023. Biogeographic patterns of marine fishes associated with rhodolith beds in the Southwestern Atlantic reveal an ecotone of biodiversity. *Biodiversity and Conservation*, 32, 821–837. DOI: https://doi.org/10.1007/s10531-022-02528-0

Barbini, S. A. & Cousseau, M. B. 2015. Lista de peces cartilaginosos (tiburones, rayas y quimeras, Chondrichthyes) almacenados en la Colección Ictiológica del Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP). *Historia Natural*, 5(1), 5–19.

Barbini, S. A., Lucifora, L. O. & Hozbor, N. M. 2011. Feeding habits and habitat selectivity of the shortnose guitarfish, *Zapteryx brevirostris* (Chondrichthyes, Rhinobatidae), off north Argentina and Uruguay. *Marine Biology Research*, 7(4), 365–377. DOI: https://doi.org/10.1080/17451000.2010.515229

Barroso, C. X., Lotufo, T. M. D. C. & Matthews-Cascon, H. 2016. Biogeography of Brazilian prosobranch gastropods and their Atlantic relationships. *Journal of Biogeography*, 43(12), 2477–2488. DOI: https://doi.org/10.1111/jbi.12821

Batista, V. S. 1987a. Desenvolvimento sexual de *Zapteryx brevirostris* (Müller & Henle 1841), no litoral do Rio de Janeiro, Brasil. *Revista Brasileira de Biologia*, 47, 301–307.

Batista, V. S. 1987b. Length-weight relationship of the little guitarfish, *Zapteryx brevirostris* (Chondrichthyes: Rhinobatidae), from Itaipu inlet, Rio de Janeiro, Brazil. *Copeia*, 1987(3), 787–789. DOI: https://doi.org/10.2307/1445676

Batista, V. S. 1991. Aspectos quantitativos da fecundidade e do desenvolvimento embrionário da arraia *Zapteryx brevirostris* Müller & Henle 1841 (Chondrichthyes: Rhinobatidae) da Enseada de Itaipu, Niterói, Rio de Janeiro. *Revista Brasileira de Biologia*, 51, 495–501.

Becerril-García, E. E., Arauz, R., Arellano-Martínez, M., Bonfil, R., Ayala-Bocos, A., Castillo-Géniz, J. L., Carrera-Fernández, M., Charvet, P., Chiaramonte, G., Cisneros-Montemayor, A. M., Concha, F., Espinoza, M., Ehemann, N. R., Estupiñán-Montaño, C., Fuentes, K., Galván-Magaña, F., Grahams, R., Hacohen-Domené, A., Hazin, F., Hernández, S., Hoyos-Padilla, E. M., Ketchum, J. T., Kingma, I., Méndez, O., Oddone, M. C., Pérez-Jiménez, J. C., Petatán-Ramírez, D., Polo-Silva, C., Rangel, B., Salinas-De-León, P., Santana-Morales, O., Zanella, I., Vélez-Zuazo, X. & Godard-Codding, C. A. G. 2022. Research priorities for the conservation of chondrichthyans in Latin America. *Biological Conservation*, 269, 109535. DOI: https://doi.org/10.1016/j.biocon.2022.109535

Bigelow, H. B. & Schroeder, W. C. 1953. *Sawfishes, guitarfishes, skates and rays*: Part two. New Haven, Yale University Press. DOI: https://doi.org/10.2307/j.ctvbcd0f3

Boschi, E. E. 1989. *Biología pesquera del langostino del litoral Patagónico de Argentina* (*Pleotius muelleri*). Mar del Plata, Ministerio de Economía.

Bovcon, N. D., Cochia, P. D., Góngora, M. E. & Gosztonyi, A. E. 2011. New records of warm- temperate water fishes in central Patagonian coastal waters (Southwestern South Atlantic Ocean). *Journal of Applied Ichthyology*, 27, 832–839. DOI: https://doi.org/10.1111/j.1439-0426.2010.01594.x

Briggs, J. C. 1974. *Marine Zoogeography*. New York, McGraw-Hill.

Briggs, J. C. & Bowen, B. W. 2012. A realignment of marine biogeographic provinces with particular reference to fish distributions. *Journal of Biogeography*, 39, 12–30. DOI: https://doi.org/10.1111/j.1365-2699.2011.02613.x

Brown, J. H. & Lomolino, M. V. 1998. *Biogeography* (2nd ed). Sunderland, Sinauer Associates Inc. Publishers.

Caille, G. & Maldonado, A. 1993. Conformación de las comunidades de peces de la Bahía Engaño y Bajo Mazaredo, Patagonia Argentina. *Actas de las Jornadas Nacionales de Ciencias del Mar*, (1991), 129-133.

Caltabellotta, F. P., Siders, Z. A., Murie, D. J., Motta, F. S., Cailliet, G. M. & Gadig, O. B. 2019. Age and growth of three endemic threatened guitarfishes *Pseudobatos horkelii*, *P. percellens* and *Zapteryx brevirostris* in the western South Atlantic Ocean. *Journal of Fish Biology*, 95(5), 1236–1248. DOI: https://doi.org/10.1111/jfb.14123

Castello, H. P. 1971. Contribución al conocimiento sistemático y biológico de *Zapteryx brevirostris* (Müller & Henle, 1841) de la costa atlántica marplatense (Chondrichthyes: Rhinobatidae). *Phisis*, 30, 619–629.

Chan, M. Y. C., Sosa-Nishizaki, O. & Pérez-Jiménez, J. C. 2021. Potential distribution of critically endangered hammerhead sharks and overlap with the small-scale fishing fleet in the southern Gulf of Mexico. *Regional Studies in Marine Science*, 46, 101900. DOI: https://doi.org/10.1016/j.rsma.2021.101900

Charvet, P., Wosnick, N. & Barreto, R. 2021. RE: Southwestern Atlantic Shortfin Makos in Troubled Waters? *Science, e-Letter*, 372, 1049.

Chiaramonte, G. E., Tamini, L. L. & Perez Comesaña, J. E. 2011. Evaluación de la supervivencia de elasmobranquios capturados por arrastreros de fondo. In: Wöhler, O. C., Cedrola, P., & Cousseau, M. B. (Eds.). 2011. *Contribuciones sobre biología, pesca y comercialización de tiburones en la Argentina: aportes para la elaboración del plan de acción nacional* (pp. 217-222). Mar del Plata: Instituto Nacional de Investigación y Desarrollo Pesquero.

Chiaramonte, G. E., Cedrola, P. V., Caille, G. M. & Gosztonyi, A. E. 2016. Upgrading the status (taxonomy, fisheries and conservation) of the school shark *Galeorhinus galeus* (Elasmobranchii: Triakidae) in Patagonian waters, South West Atlantic Ocean. *Ciencia Pesquera*, 24, 5–13.

Chiaramonte, G. E., Tamini, L. L., Pettovello, A. D. & Gosztonyi, A. E. 2023. Annotated systematic checklist of the ichthyofauna of the Ría Deseado (Patagonia, Argentina). *Revista del Museo Argentino de Ciencias Naturales*, 25(2), 207–223.

Colonello, J. C., García, M. L. & Menni, R. C. 2011. Reproductive biology of the lesser guitarfish *Zapteryx brevirostris* from the south western Atlantic Ocean. *Journal of Fish Biology*, 78(1), 287–302. DOI: https://doi.org/10.1111/j.1095-8649.2010.02864.x

Colonello, J. H., Cortés, F. & Massa, A. M. 2014. Species richness and reproductive modes of chondrichthyans in relation to temperature and fishing effort in the Southwestern Atlantic Shelf (34–54° S). *Fisheries Research,* 160, 8-17. DOI: https://doi.org/10.1016/j.fishres.2014.04.015

Cord, I., Nunes, L. T., Barroso, C. X., Freire, A. S., Gadig, O. B., Gomes, P. B., Gurgel, C. F. D., Lindner, A., Mantelatto, F. L., Targino, A. K. G. & Floeter, S. R. 2022. Brazilian marine biogeography: a multi-taxa approach for outlining sectorization. *Marine Biology*, 169(5), 1–13. DOI: https://doi.org/10.1007/s00227-022-04045-8

Costa, L. & Chaves, P. T. C. 2006. Elasmobrânquios capturados pela pesca artesanal na costa sul do Paraná e norte de Santa Catarina, Brasil. *Biota Neotropica*, 6(3). DOI: https://doi.org/10.1590/S1676-06032006000300007

Cousseau, M. B., Pequeño, G., Mabragaña, E., Lucifora, L. O., Martínez, P. & Giussi, A. 2020. The Magellanic Province and its fish fauna (South America): Several provinces or one? *Journal of Biogeography*, 47(1), 220-234. DOI: https://doi.org/10.1111/jbi.13735

Cruz, V. P., Rotundo, M. M., Charvet, P., Boza, B. R., Souza, B. C., Cerqueira, N. N. C. D., Oliveira, C., Lessa, R. & Foresti, F. 2023. Investigating an Unknown Biodiversity: Evidence of Distinct Lineages of the Endemic Chola Guitarfish *Pseudobatos percellens* Walbaum, 1792 in the Western Atlantic Ocean. *Diversity*, 15(3), 344. DOI: https://doi.org/10.3390/d15030344

Dent, F. & Clarke, S. 2015. *State of the global market for shark products*. Rome, FAO.

Díaz, S. M., Settele, J., Brondízio, E., Ngo, H., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K., Butchart, S., Chan, K.M.A., Garibaldi, L.A., Ichii, K., Liu, J., Subramanian, S., Midgley, G., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Polasky, S., Purvis, A., Razzaque, J., Reyers, B., Roy Chowdhury, R., Shin, Y., Visseren-Hamakers, I., Willis, K. & Zayas, C. (Eds.). 2019. *Global assessment report on biodiversity and ecosystem services: Summary for policy makers.* Bonn, IPBES Secretariat. DOI: https://doi.org/10.5281/zenodo.3553579

Dobzhansky, T. 1950. Evolution in the tropics. *American Scientist*, 38(2), 209–221.

Dulvy, N. K., Fowler, S. L., Musick, J. A., Cavanagh, R. D., Kyne, P. M., Harrison, L. R., Carlson, J. K., Davidson, L. N. K., Fordham, S. V., Francis, M. P., Pollock, C. M., Simpfendorfer, C. A., Burgess, G. H., Carpenter, K. E., Compagno, L. J. V., Ebert, D. A., Gibson, C., Heupel, M. R., Livingstone, S. R., Sanciangco, J. C., Stevens, J. D., Valenti, S. & White, W. T. 2014. Extinction risk and conservation of the world's sharks and rays. *eLife*, 3, e00590. DOI: https://doi.org/10.7554/eLife.00590

Dulvy, N. K., Pacoureau, N., Rigby, C. L., Pollom, R. A., Jabado, R. W., Ebert, D. A., Finucci, B., Pollock, C. M., Cheok, J., Derrick, D. H., Herman, K. B., Sherman, C. S., Vanderwright, W. J., Lawson, J. M., Walls, R. H. L., Carlson, J. K., Charvet, P., Bineesh, K. K., Fernando, D., Ralph, G. M., Matsushiba, J. H., Hilton-Taylor, C., Fordham, S. V. & Simpfendorfer, C. A. 2021. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology*, 31(21), 4773–4787. DOI: https://doi.org/10.1016/j.cub.2021.08.062

Faria, V. V., Mcdavitt, M. T. M., Charvet, P., Wiley, T., Simpfendorfer, C. & Naylor, G. J. P. 2013. Species delineation and global population structure of Critically Endangered sawfishes (Pristidae). *Zoological Journal of the Linnean Society*, 167(1), 136–164. DOI: https://doi.org/10.1111/j.1096-3642.2012.00872.x

Faria, V. V.; Xavier, L. G. & Freitas, J. E. P. 2021. Coleção Ictiológica Dias da Rocha CIDRO da Universidade Federal do Ceará: Um histórico. *In*: Siqueira, G. K., Lopes, K. K. V., Almeida, L. M., Vieira, M. J. & Rocha, S. M. (Eds.). *I Seminário Museus e Coleções da UFC - Reflexões Contemporâneas* (pp. 49-67). Fortaleza: Museu de Arte da Universidade Federal do Ceará. Available from: https://repositorio.ufc.br/ri/bitstream/riufc/58880/3/2021_liv_gksiqueira_v3.pdf Access date: 2024 Feb. 28.

Figueiredo, J. L. 1977. *Manual de peixes marinhos do sudeste do Brasil*. I. Introdução: cações, raias e quimeras. São Paulo: Museu de Zoologia da Universidade de São Paulo.

Floeter, R. S., Guimarães, R. Z. P., Rocha, L. A., Ferreira, C. E. L., Rangel, C. A. & Gasparini, J. L. 2001. Geographic variation in reef-fish assemblages along the Brazilian coast. *Global Ecology and Biogeography*, 10, 423–431. DOI: https://doi.org/10.1046/j.1466-822X.2001.00245.x

Floeter, S. R., Krohling, W., Gasparini, J. L., Ferreira, C. E. L. & Zalmon, I. R. 2007. Reef fish community structure on coastal islands of the southeastern Brazil: the influence of exposure and benthic cover. *Environmental Biology of Fishes*, 78, 147–160. DOI: https://doi.org/10.1007/s10641-006-9084-6

Floeter, S. R., Rocha, L. A., Robertson, D. R., Joyeux, J. C., Smith-Vaniz, W. F., Wirtz, P., Edwards, A. J., Barreiros J. P., Ferreira, C. E. L., Gasparini, J. L., Brito, A., Falcón, J. M., Bowen, B. W. & Bernardi, G. 2008. Atlantic reef fish biogeography and evolution. *Journal of Biogeography*, 35 (1), 22–47. DOI: https://doi.org/10.1111/j.1365-2699.2007.01790.x

Franklin, J. 2010. *Mapping species distributions: spatial inference and prediction*. New York, Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511810602

Fricke, R. & Eschmeyer W. N. 2022. *A guide to fish collections in the Catalog of Fishes database*. On-line version of 7 September 2022. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/collections.asp Access date: 2022 Sept. 26

Froese, R. & Pauly, D. 2022. *FishBase*. online version of June 2022. Available from: http://www.fishbase.org/ Access date 2022 Sept. 18

Galvan, D. E., Venerus, L. A., Irigoyen, A. J., Parma, A. M. & Gosztonyi, A. E. 2005. Extension of the distributional range of the silver porgy *Diplodus argenteus* (Valenciennes 1830) and the red porgy *Pagrus pagrus* (Linnaeus 1758) (Sparidae) in northern Patagonia, southwestern Atlantic. *Journal of Applied Ichthyology*, 21, 444–447. DOI: https://doi.org/10.1111/j.1439-0426.2005.00621.x

Gatts, P. V., Franco, M. A. L., Almeida, M. G., Rezende, C. E. De & Costa, P. A. S. 2021. Isotopic niche of coastal fish and cephalopods off the Campos Basin, southeastern Brazil. *Estuarine, Coastal and Shelf Science*, 261, 107563. DOI: https://doi.org/10.1016/j.ecss.2021.107563

GBIF (Global Biodiversity Information Facility). 2022. GBIF Occurrence download of *Zapteryx brevirostris*. DOI: https://doi.org/10.15468/dl.tpfw7m.

Gervais, C. R., Champion, C. & Pecl, G. T. 2021. Species on the move around the Australian coastline: A continental-scale review of climate-driven species redistribution in marine systems. *Global Change Biology*, 27(14), 3200–3217. DOI: https://doi.org/10.1111/gcb.15634

Gomes, U. L., Signori, C. N., Gadig, O. B. F., Santos, H. S. & Vicente, M. M. 2019. Guia para identificação de tubarões e raias do Rio de Janeiro (Chondrichthyes: Elasmobranchii e Holocephali). *Revista Nordestina de Biologia*, 27(1), 171–368. DOI: https://doi.org/10.22478/ufpb.2236-1480.2019v27n1.47122

Góngora, M. E., Bovcon, N. D. & Cochia, P. D., 2009. Ictiofauna capturada incidentalmente en la pesquería de langostino patagónico *Pleoticus muelleri* Bate, 1888. *Revista de Biología Marina y Oceanografía*, 44(3), 583–593. DOI: http://dx.doi.org/10.4067/S0718-19572009000300006

Hardie, D. C. & Hutchings, J. A. 2010. Evolutionary ecology at the extremes of species' ranges. *Environmental Reviews*, 18, 1–20. DOI: https://doi.org/10.1139/A09-014

Irigoyen, A. J., Galvan, D. E. & Venerus, L. A. 2005. Occurrence of dusky grouper *Epinephelus marginatus* (Lowe, 1834) in gulfs of northern Patagonia, Argentina. *Journal of Fish Biology*, 67, 1741–1745. DOI: https://doi.org/10.1111/j.1095-8649.2005.00866.x

Jabado, R. W. 2018. The fate of the most threatened order of elasmobranchs: Shark-like batoids (Rhinopristiformes) in the Arabian Sea and adjacent waters. *Fisheries Research*, 204, 448–457. DOI: https://doi.org/10.1016/j.fishres.2018.03.022

Jaureguizar, A. J., Menni, R., Bremec, C., Mianzan, H. & Lasta, C. 2003. Fish assemblage and environmental patterns in the Rio de la Plata estuary. *Estuarine, Coastal and Shelf Science*, 56(5-6), 921–933. DOI: https://doi:10.1016/s0272-7714(02)00288-3

Jaureguizar, A. J., Menni, R., Guerrero, R. & Lasta, C. 2004. Environmental factors structuring fish communities of the Rio de la Plata estuary. *Fisheries Research*, 66(2-3), 195–211. DOI: https://doi:10.1016/s0165-7836(03)00200-5

Karlovic, T. C., Gomes, R. R., Paiva, P. C., Babcock, E. A. & Dias, J. F. 2021. Functionality and Effectiveness of Marine Protected Areas in Southeastern Brazilian Waters for Demersal Elasmobranchs. *Frontiers in Marine Science*, 1204. DOI: https://doi.org/10.3389/fmars.2021.694846

Last, P., Naylor, G., Séret, B., White, W., De Carvalho, M. & Stehmann, M. (Eds.). 2016. *Rays of the World*. Clayton South, CSIRO publishing.

Lomolino, M. V., Riddle, B. R., Whittaker, R. & Brown, J. H. 2010. *Biogeography* (4th ed). Sunderland, Sinauer Associates Inc.

Lopez, R. B. 1963. Problemas sobre la distribución geográfica de los peces marinos sudamericanos. *Revista del Museu Argentino de Ciencias Naturales “Bernardino Rivadavia” (Hidrobiologia)*, 1(3), 111–135.

Loto, L., Monteiro-Neto, C., Martins, R. R. M. & De Almeida Tubino, R. 2018. Temporal changes of a coastal small-scale fishery system within a tropical metropolitan city. *Ocean & Coastal Management,* 153, 203–214. DOI: https://doi.org/10.1016/j.ocecoaman.2017.12.004

Lucena, M. B., Mendes, T. C., Barbosa, M. C., Cordeiro, C. A., Eggertsen, L. M. & Ferreira, C. E. 2021. Does the colors of light matter? Testing different light color in nocturnal underwater visual censuses. *Marine Environmental Research*, 166, 105261. DOI: https://doi: 10.1016/j.marenvres.2021.105261

Lucifora, L. O., García, V. B., Menni, R. C. & Worm, B. 2012. Spatial patterns in the diversity of sharks, rays, and chimaeras (Chondrichthyes) in the Southwest Atlantic. *Biodiversity and Conservation*, 21, 407–419. DOI: https://doi.org/10.1007/s10531-011-0189-7

Luiz, O. J., Madin, J. S., Robertson, D. R., Rocha, L. A., Wirtz, P. & Floeter, S. R. 2012. Ecological traits influencing range expansion across large oceanic dispersal barriers: insights from tropical Atlantic reef fishes. *Proceedings of the Royal Society B: Biological Sciences*, 279(1730), 1033–1040. DOI: https://doi.org/10.1098/rspb.2011.1525

MacArthur, R. H., Diamond, J. M. & Karr, J. R. 1972. Density compensation in island faunas. *Ecology*, 53(2), 330–342. DOI: https://doi.org/10.2307/1934090

Martins, M. F., Costa, P. G., Gadig, O. B. & Bianchini, A. 2021. Metal contamination in threatened elasmobranchs from an impacted urban coast. *Science of The Total Environment*, 757, 143803. DOI: https://doi.org/10.1016/j.scitotenv.2020.143803

Menni, R. C., Jaureguizar, A. J., Matthias F. W., Stehmann, M. F. W. & Lucifora, L. O. 2010. Marine biodiversity at the community level: zoogeography of sharks, skates, rays and chimaeras in the southwestern Atlantic. *Biodiversity and Conservation*, 19, 775–796. DOI: https://doi.org/10.1007/s10531-009-9734-z

Menni, R. C. & Stehmann, M. F. W. 2000. Distribution, environment and biology of batoid fishes off Argentina, Uruguay and Brazil. A review. *Revista del Museo Argentino de Ciencias Naturales nueva serie,* 2(1), 69–109.

Miranda-Ribeiro, A. 1904. Pescas do ‘Annie’. *A Lavoura: Boletim da Sociedade Nacional de Agricultura Brasileira*, (4-7), 1–53.

Miranda-Ribeiro, A. 1907. Fauna Brasiliense. Peixes II (Desmobranchios). *Arquivos do Museu Nacional*. 14, 131–218.

Moore, A. B. 2017. Are guitarfishes the next sawfishes? Extinction risk and an urgent call for conservation action. *Endangered Species Research*, 34, 75–88. DOI: https://doi.org/10.3354/esr00830

O’dea, R. E., Lagisz, M., Jennions, M. D., Koricheva, J., Noble, D. W., Parker, T. H., Gurevitch, J., Page, M. J., Stewart, G., Moher, D. & Nakagawa, S. 2021. Preferred reporting items for systematic reviews and meta-analyses in ecology and evolutionary biology: a PRISMA extension. *Biological Reviews*, 96(5), 1695–1722. DOI: https://doi: 10.1111/brv.12721

Paquette, A. & Hargreaves, A. L. 2021. Biotic interactions are more often important at species’ warm versus cool range edges. *Ecology Letters*, 24(11), 2427–2438. DOI: https://doi.org/10.1111/ele.13864

Pasquino, A. F., Martins, M. F. & Gadig, O. B. F. 2016. Length–weight relationship of *Rhinobatos horkelii* Müller & Henle, 1841 and *Zapteryx brevirostris* (Müller & Henle, 1841) off Brazil, southwestern Atlantic Ocean. *Journal of Applied Ichthyology*, 32(6), 1282–1283. DOI: https://doi.org/10.1111/jai.13171

Peterson, R. G. & Stramma, L. 1991. Upper-level circulation in the South Atlantic Ocean. *Progress in Oceanography*, 26, 1–73. DOI: https://doi.org/10.1016/0079-6611(91)90006-8

Pinheiro, H. T., Madureira, J. M. C., Jean-Christophe, J. & Martins, A. S. 2015. Fish diversity of a southwestern Atlantic coastal island: aspects of distribution and conservation in a marine zoogeographical boundary. *Check List*. 11(2), 1–17. DOI: https://doi.org/10.15560/11.2.1615

Pinheiro, H. T., Rocha, L. A., Macieira, R. M., Carvalho-Filho, A., Anderson, A. B., Bender, M. G., Di Dario, F., Ferreira, C. E. L., Figueiredo-Filho, J., Francini-Filho, R., Gasparini, J. L., Joyeux, J. C., Luiz, O. J., Mincarone, M. M., Moura, R. L., Nunes, J. A. C. C., Quimbayo, J. P., Rosa, R. S., Sampaio, C. L. S., Sazima, I., Simon, T., Vila-Nova, D. A. & Floeter, S. R. 2018. South-Western Atlantic reef fishes: Zoogeographical patterns and ecological drivers reveal a secondary biodiversity centre in the Atlantic Ocean. *Diversity and Distribution*, 24, 951–965. DOI: https://doi.org/10.1111/ddi.12729

Piola, A. R. & Matano, R. P. 2019. Ocean Currents: Atlantic Western Boundary—Brazil Current/Falkland (Malvinas) Current. *In*: COCHRAN, J. K., BOKUNIEWICZ, H. J., YAGER, P. L. (Eds.) *Encyclopedia of Ocean Sciences* (3th. ed; pp. 340-349). Cambridge: Academic Press. DOI: https://doi.org/10.1016/B978-0-12-409548-9.10541-X

Pollom, R., Barreto, R., Charvet, P., Chiaramonte, G.E., Cuevas, J.M., Faria, V., Herman, K., Marcante, F., Montealegre-Quijano, S., Motta, F., Paesch, L. & Rincon, G. 2020. *Zapteryx brevirostris*. The IUCN Red List of Threatened Species 2020: e.T61419A3104442. Gland: IUCN. DOI: https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T61419A3104442.en. Access date: 2022 Feb. 19.

QGIS (QGIS Geographic Information System). 2020. QGIS Association, Version 3.10.8. Available from: http://qgis.osgeo.org Access date: 2022 Aug. 30.

Richardson, W. S., Wilson, M. C., Nishikawa, J., & Hayward, R. S. 1995. The well-built clinical question: a key to evidence-based decisions. *ACP Journal Club*, 123(3), A12–A13. DOI: https://doi.org/10.7326/ACPJC-1995-123-3-A12

Rutterford, L. A., Simpson, S. D., Bogstad, B., Devine, J. A. & Genner, M. J. 2023. Sea temperature is the primary driver of recent and predicted fish community structure across Northeast Atlantic shelf seas. *Global Change Biology*, 29(9), 2510–2521. DOI: https://doi.org/10.1111/gcb.16633

Sabaj, M. H. 2022. *Codes for Natural History Collections in Ichthyology and Herpetology (online supplement)*, Version 9.0. Washington, DC, American Society of Ichthyologists and Herpetologists. Available from: https://asih.org. Access date: 2022 Aug. 30.

Santos, C., Cortellete, G. M., Araujo, K. C. B. & Spach, H. L. 2006. Estrutura populacional da raia-viola *Zapteryx brevirostris* (Chondrichthyes: Rhinobatidae), na plataforma adjacente à baía de Paranaguá, PR. *Acta Biologica Leopoldensia*, 28, 32–37.

Schmid, C., Schäfer, H., Zenk, W. & Podestá, G. 1995. The Vitória eddy and its relation to the Brazil Current. *Journal of Physical Oceanography*, 25(11), 2532–2546.

Soto, J. M. R. 2001. Peixes do Arquipélago Fernando de Noronha. *Mare Magnum,* 1(2), 147–169.

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., Halpern, B. S., Jorge, M. A., Lombana, A., Lourie, S. A., Martin, K. D., Mcmanus, E., Molnar, J., Recchia, C. A. & Robertson, J. 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience*, 57, 573–583. DOI: https://doi.org/10.1641/B570707

SPECIESLINK. 2022. Sistema de Informação Distribuído para Coleções Biológicas. Available from: https://specieslink.net/ Access 2022 Apr. 8.

Sunday, J. M., Bates, A. E. & Dulvy, N. K. 2012. Thermal tolerance and the global redistribution of animals. *Nature Climate Change*, 2(9), 686–690.

Takatsuka, V., Guedes-De-Azevedo, V., Maganhe, B. L., Camilo, L. D. O. & Gomes-Sanches, E. 2022. Occurrence of *Nerocila acuminata* (Schiödte & Meinert, 1881) (Crustacea, Cymothoidae) parasitic on the shortnose guitarfish *Zapteryx brevirostris* (Rhinobatiformes, Rhinobatidae) off Brazil. *Latin American Journal of Aquatic Research*, 50(4), 618–621.

Tamini, L. L., Chiaramonte, G. E., Perez, J. E. & Cappozzo, H. L. 2006. Batoids in a coastal trawl fishery of Argentina. *Fisheries Research*, 77(3), 326–332. DOI: https://doi.org/10.1016/j.fishres.2005.08.013

Thomas, C. D. 2010. Climate, climate change and range boundaries. *Diversity and Distributions*, 16(3), 488–495. DOI: https://doi.org/10.1111/j.1472-4642.2010.00642.x

Toonen, R. J., Bowen, B. W., Iacchei, M. & Briggs, J. C. 2016. Biogeography, Marine. *In*: Kliman, R.M. (Ed.). *Encyclopedia of Evolutionary Biology* (pp. 166–178). Oxford, Academic Press. DOI: https://doi.org/10.1016/B978-0-12-800049-6.00120-7

Trobbiani, G. A., Galván, D. E., Cuestas, M. & Irigoyen, A. 2014. Occurrence of the snowy grouper, *Hyporthodus niveatus* (Valenciennes, 1828), in Argentine waters. *Journal Applied Ichthyology*, 30, 182–184. DOI: https://doi.org/10.1111/jai.12350

UN (United Nations). 2024. *Falkland Islands* (Malvinas). New York, United Nations. Available from: https://www.un.org/dppa/decolonization/en/content/falkland-islands-malvinas#:~:text=Listing%20as%20a%20Non%2DSelf,Charter%20of%20the%20United%20Nations Access date: 2024 Feb. 28.

Venerus, L. A., Galvan, D. E., Irigoyen, A. J. & Gosztonyi, A. E. 2007. First record of the namorado sandperch, *Pseudopercis numida* Miranda-Ribeiro, 1903 (Pinguipedidae; Osteichthyes), in Argentine waters. *Journal Applied Ichthyology*, 23(2007), 110–112. DOI: https://doi.org/10.1111/j.1439-0426.2006.00800.x

Violante, R. A., Paterlini, C. M., Marcolini, S. I., Costa, I. P., Cavallotto, J. L., Laprida, C., Dragani, W., García Chapori, N., Watanabe, S., Totah, V., Rovere, E. I. & Osterrieth, M. L. 2014. The Argentine continental shelf: Morphology, sediments, processes and evolution since the Last Glacial Maximum. *In*: Chiocci F. L. & Chiva, A. R. (Eds). *Continental Shelves of the World: Their Evolution During the Last Glacio-Eustatic Cycle* (pp. 55-68). London, The Geological Society of London. DOI: https://doi.org/10.1144/M41.6

Vooren, C. M., Lamónaca, A. F., Massa, A. & Hozbor, N. 2006. *Zapteryx brevirostris*. The IUCN Red List of Threatened Species 2006: e.T61419A12478303. Galnd, IUCN DOI: http://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T61419A12478303.en

Weigmann, S. 2016. Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the word, with a focus on biogeographical diversity. *Journal of Fish Biology*, 88(3), 837–1037. DOI: https://doi.org/10.1111/jfb.12874

Willi, Y. & Van Buskirk, J. 2019. A practical guide to the study of distribution limits. *The American Naturalist*, 193(6), 773–785. DOI: https://doi.org/10.1086/703172

Wöhler, O. C., Giussi, A. R., Garcia De La Rosa, S., Sánchez, R., Hansen, J. E., Cordo, H. C., Alvarez Colombo, L., Incorvaia, S., Reta, R. & Abachián, V. 1999. *Resultados de la campaña de evaluación de peces demersales australes efectuada en el verano de 1997* (Informe 24). Mar del Plata, INIDEP.

Wosnick, N. & Freire, C. A. 2013. Some euryhalinity may be more common than expected in marine elasmobranchs: The example of the South American skate *Zapteryx brevirostris* (Elasmobranchii, Rajiformes, Rhinobatidae).

Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 166(1), 36–43. DOI: https://doi.org/10.1016/j.cbpa.2013.05.002

Wosnick, N., Awruch, C. A., Adams, K. R., Gutierre, S. M. M., Bornatowski, H., Prado, A. C. & Freire, C. A. 2019. Impacts of fisheries on elasmobranch reproduction: high rates of abortion and subsequent maternal mortality in the shortnose guitarfish. *Animal Conservation*, 22(2), 198–206. DOI: https://doi.org/10.1111/acv.12458