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TAXONOMIC IMPLICATIONS OF THE RESOURCE "BATOIDS" IN COMMERCIAL LANDINGS OF BOTTOM TRAWL FISHERIES IN SOUTHERN BRAZIL

Implicações taxonômicas do recurso "raia" nos desembarques da pesca comercial de arrasto de fundo no Sul do Brasil

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ABSTRACT

A survey conducted to study batoid species landed by the bottom trawl fishing fleet of Rio Grande, RS, Brazil, was carried out from 2001 to 2015. The objective of the study was to assess the diversity of batoids on the southern shelf of Brazil, a crucial area for the reproduction of this group. Understanding the taxonomic composition of this group is essential for conservation efforts. A total of 2,360 specimens were recorded, with 15 taxa identified to species: *Rioraja agassizii* (n = 617; 26.1%), *Sympterygia bonapartii* (20.4%), *Atlantoraja castelnaui* (14.8%), *Atlantoraja cyclophora* (12.7%), *Zapteryx brevirostris* (11.8%), *Sympterygia acuta* (4.4%), *Atlantoraja platana* (1.9%), *Dasyatis hypostigma* (1.4%), *Pseudobatos horkelii* (0.6%), *Myliobatis goodei* (0.5%), *Gymnura altavela* (0.3%), *Psammobatis extenta* (0.2%), *Psammobatis rutrum* (0.2%), *Psammobatis lentiginosa* (0.1%), and *Myliobatis freminvillei* (0.04%). Among the batoids ('raia'), there are several categories locally used by fishermen when separating the fish for processing in the industries. Skates (Rajiformes) are locally known as part of a generalized category called 'emplastro' by fishermen for commercialization. This category includes *A. cyclophora*, *A. platana*, *R. agassizii*, and juvenile *A. castelnaui*. However, it was observed that, within this fishing category, Myliobatiformes, especially smaller species, are often grouped together within 'emplastro.' Fishermen also classify 'emplastro' into 'emplastro amarelo' (yellow

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'emplastro'), corresponding to *S. acuta* and Myliobatiform pectoral fins, and 'emplastro bicudo' (long-beaked 'emplastro'), which refers to *S. acuta*. The carcasses of *A. castelnaui* are processed separately and grouped as 'emplastro pintado', 'raia pintada', 'raia marcela', or 'raia chita'. Rhinopristiformes are classified as 'raia viola' (Brazilian guitarfish), corresponding to *P. horkelii*, and 'raia banjo' (shortnose guitarfish), corresponding to *Z. brevirostris*. Females predominated (1,258; 53.3%) over males (n = 666, 28.2%), and a considerable number of immature individuals were recorded (n = 545; 23.1%). Pair trawling was the most commonly used method (82%) and was more likely to capture medium to large-sized species.

Keywords: Biodiversity, By-catch, Species conservation, Elasmobranch, Overfishing.

RESUMO

Foi realizado um levantamento das espécies desembarcadas pela frota de pesca de arrasto de fundo do Rio Grande - RS entre os anos de 2001 e 2015. As amostragens ocorreram de modo descontínuo ao longo desse período. O intuito deste estudo foi elucidar a estrutura taxonômica do recurso "raia" na plataforma sul do Brasil, uma importante área para a reprodução desse grupo. O conhecimento das espécies que compõem esse recurso é importante para a conservação. Dos 2360 exemplares amostrados, 15 taxa foram identificados no nível de espécie. As espécies mais comuns foram Rioraja agassizii *(n = 617; 26,1%),* Sympterygia bonapartii *(n= 481; 20,4%),* Atlantoraja castelnaui *(n = 349; 14,8%),* Atlantoraja cyclophora *(n = 299; 12,7%) e* Zapteryx brevirostris *(n = 279; 11,8%). Em menor frequência, foram registradas as seguintes espécies:* Sympterygia acuta *(4,4%),* Atlantoraja platana *(1,9%),* Dasyatis hypostigma *(1,4%),* Pseudobatos horkelii *(0,6%),* Myliobatis goodei *(0,5%),* Gymnura altavela *(0,3%),* Psammobatis extenta *(0,2%),* Psammobatis rutrum *(0,2%),* Psammobatis lentiginosa *(0,1%) e* Myliobatis freminvillei *(0,04%). Dentre as raias, há varias categorias usadas localmente pelos pescadores na hora de separar os peixes para processamento nas industrias. Os Rajiformes são conhecidos como parte de uma categoria generalizada chamada "emplastro" pelos pescadores para comercialização. Essa categoria inclui* A. cyclophora*,* A. platana*,* R. agassizii *e juvenis de* A. castelnaui*. No entanto, foi observado que, dentro dessa categoria de pesca, os Myliobatiformes, especialmente as espécies menores, frequentemente são agrupados dentro do "emplastro". Os pescadores também classificam o "emplastro" em "emplastro amarelo", correspondente a* S. acuta *e nadadeiras peitorais de Myliobatiformes, e "emplastro bicudo", que se refere a* S. acuta*. As carcaças de* A. castelnaui *são processadas separadamente e agrupadas como "emplastro pintado", "raia pintada", "raia marcela" ou "raia chita". Os Rhinopristiformes são classificados como "raia viola" (peixe-guitarra brasileiro), correspondente a* P. horkelii*, e* "raia banjo" (raia viola de focinho curto), *correspondente a* Z. brevirostris*. Houve um predomínio de fêmeas (1258; 53,3%) em relação aos machos (n = 666, 28,2%) assim como um número considerável de espécimes maduros (n = 545; 23,1%). A modalidade de arrasto parelha foi a mais utilizada (82%) e demonstrou ter maior propensão a capturar espécies de tamanhos médios a grandes.*

Palavras-chave: *Biodiversidade, By-catch, Conservação de espécies, Elasmobrânquios, Sobrepesca.*

INTRODUCTION

The use of bottom trawl nets in commercial fishing represents one of the most widespread sources of anthropogenic disturbances to marine habitats. Due to their low selectivity, trawl fisheries -especially those targeting a single or few species- are characterized by high discard rates, leading to significant economic losses and impacts on communities and ecosystems (Alverson et al., 1994; Hiddink et al., 2017).

Batoids are frequent and important components of both global commercial and artisanal fisheries due to their benthic and demersal habits. Although a large portion remains undocumented, it is estimated that they account for more than half of the global elasmobranch catch. They are also considered the most taxonomically challenging group of chondrichthyans, facing difficulties in phylogenetic classification and species identification (Holden, 1974; Brander, 1981; Compagno, 1990; Last et al., 2016). This group also exhibits biological traits that result in very low growth and reproductive potentials, reducing their ability to recover from the negative impacts of fishing (Holden, 1974; Pratt; Casey, 1990; Stevens et al., 2000; Dulvy & Reynolds, 2002).

A concerning aspect of local extinctions, particularly in skates, is the prolonged time it takes to detect significant population declines (Brander, 1981; Casey & Myers, 1998). This is often due to the lack of knowledge about the group's species composition, life history, and relative abundance in landings. The scarcity of species-specific data stems from limited economic interest and conservation priorities that are focused on the immediate extinction risk of elasmobranchs (Bonfil, 1994; Marris, 2007; Dulvy et al., 2014). Assessments are further limited by an exclusive focus on quantitative fishing catch trends, where batoids in fishing landings are typically classified into broad morphological categories, potentially obscuring species-specific declines. These issues emphasize the need for a reevaluation of population collapses, as the extinction risks may be greater than previously assessed (Dulvy et al., 2000; Iglésias et al., 2009).

There are over 600 known species of batoids worldwide, making them the most diverse group among Chondrichthyes (Compagno, 2001; Ebert & Compagno, 2007). Along the Brazilian coast, approximately [number missing] batoid species are recorded, with 26 species found on the continental shelf off Rio Grande do Sul, including seven migratory species. This area, known as the Southern Brazil Shelf, is an important site for reproduction and development of batoids, considered a natural nursery for these species, with a dynamic and productive system of its own characteristics (Vooren et al., 2005; Vooren & Oddone, 2019).

The objective of this study was to elucidate the taxonomic composition of batoids, in landings from the bottom trawl fleet of Rio Grande, RS, and to document the gears involved in their capture. The study also demonstrates that valuable biological (mainly reproductive) data can be obtained through careful observation of carcasses in commercial fishing landings.

MATERIAL AND METHODS

Study site

The study area was the Southern Brazil Shelf, which represents the continental shelf off southern Brazil. This area stretches from Cabo de Santa Marta (28°36’ S) in the north to Arroio do Chuí (33°45’ S) in the south (Figure 1). The Southern Brazil Shelf has a sandy beach coastline and a gentle slope extending to its outer margin, with depths of 200 m located approximately 120 to 200 km offshore. It spans approximately 750 km in length. The bottom sediment of the shelf is of terrestrial origin, predominantly sandy down to a depth of 50 m. The Southern Brazil Shelf is influenced by significant seasonal processes that transport fertile waters from different sources, promoting high primary production (Odebrecht & Castello, 2001; Vooren et al., 2005).

Visits to Fishing Landings and Data Collection

Visits to fishing outposts at the Rio Grande port to observe bottom trawl landings were conducted intermittently between 2001 and 2015 as part of the scientific project "Emplastros do Sul" (n. 086576/2011), Instituto de Oceanografia, Universidade Federal do Rio Grande, from 2011 to 2015. The term 'emplastro' refers to a category of fish that is meant to include exclusively skates, which are separated for commercial purposes. In total, 73 visits were made, with batoid landings observed on 65 occasions. The remaining eight visits occurred after 2014, following the ban on batoid landings in the state. Data collection from landings began with interviews with vessel masters to compile a spreadsheet of fishing data, including the type of trawl, geographic position of the fishing sets, fishing effort (trawling time per fishing operation), trawl depth, and the magnitude of catches for target species and specifically for batoids, expressed in tons.

Sampling and Species Identification

Generally, batoids were landed as eviscerated carcasses, often with only the pectoral fins attached to the pectoral girdle, and frequently lacking the tail, head, or rostrum (Figures 2, 3, and 4). In the case of the genera *Zapteryx* Jordan & Gilbert, 1880, and *Pseudobatos* Last, Seret & Naylor, 2016, only the caudal region, which is commercially valuable, was retained (Figure 2). Various carcass cutting methods were observed and described in this study. Species identification at the order level followed Last et al. (2016), comprising Rajiformes for skates only, Myliobatiformes for stingrays, and Rhinopristiformes for guitarfishes. Family-level identification followed Compagno (2005), and genus- and species-level identification in the field followed Menezes et al. (2003), Vooren et al. (2003), Vooren et al. (2005), and Gomes et al. (2010).

Since the samples were mostly carcasses, sex determination and morphological measurements were conducted based on evisceration patterns and specimen integrity. Morphological measurements included, when possible, disc width (DW, cm), defined as the distance between the distal ends of the pectoral fins in their natural position; total length (TL, cm), defined as the distance from the snout to the posterior end of the caudal fin; and clasper size in males.

Biological samples, such as claspers in males, uterine content in females, and maturity estimation, were taken whenever feasible. Male maturity stage was estimated based on clasper calcification and length relative to the distal end of the pelvic fin. Claspers extending beyond the pelvic fins with calcified and rigid cartilage were considered adults, those extending beyond the pelvic fins but flexible were juveniles, and claspers shorter than the pelvic fins and flexible were considered immature. In the absence of claspers, sex in Rajiformes could also be identified by the observation of alar thorns on the pectoral fins in adults or in those maturing (Oddone & Vooren, 2005). Female maturity stage was estimated based on observations of vitellogenic follicles in the ovaries, the development of the oviducal glands, and uterine eggs or embryos (Figure 5).

Since the reproductive system was not fully present or intact in most samples, individual size records were used and compared with available literature on sizes at first maturity to determine the maturity stage of each species (Table 1).

Data Analysis

Absolute and relative frequencies of taxa present in the catches were calculated for each taxon. Total length (TL), disc width (DW), and clasper size (CS), when available, were recorded in cm. The analysis of catch composition included relationships between immature and mature individuals, males and females, the lowest possible taxonomic level, and seasonal occurrence. The sex ratio was established by the quotient between the number of males and females. A Chi-square test (χ^2) for proportions with Yates' continuity correction was used to determine significant differences, with a significance level (p) of 0.05 considered.

RESULTS

Fishery Data

In the area under study, vessels operated between the isobaths of 10 and 150 m (Figure 1). A total of 65 landing events were recorded. Regarding the fishing gear used, 52 of these landings were from pair trawling, seven from single bottom trawling, one from midwater trawling, one from tangon trawling, and three from gillnetting/set-netting. Pair trawling was observed to be the most commonly used fishing gear, recorded in 81% of the fishing trips.

Specimen Identification and Biological Data

A total of 2,360 specimens of batoids were analyzed. Fifteen species, distributed across nine genera, five families, and three orders, were identified (Table I, Figs. 2, 3, and 4). Among the batoids, there are several categories locally used by fishermen when separating the fish for processing in the industries. Skates (Rajiformes) are locally known as part of a generalized category called 'emplastro' by fishermen for commercialization. This category includes *Atlantoraja cyclophora*, *A. platana*, *R. agassizii*, and juvenile *A. castelnaui*. However, it was observed that, within this fishing category, Myliobatiformes, especially smaller species, are often grouped together within 'emplastro'. Fishermen also classify 'emplastro' into 'emplastro amarelo' (yellow 'emplastro'), corresponding to *S. acuta* and Myliobatiform pectoral fins, and 'emplastro bicudo' (long-beaked 'emplastro'), which refers to *S. acuta*. The carcasses of *A. castelnaui* are processed separately and grouped as 'emplastro pintado', 'raia pintada', 'raia marcela', or 'raia chita'. Rhinopristiformes are classified as 'raia viola' (Brazilian guitarfish), corresponding to, *P. horkelii*, and 'raia banjo' (shortnose guitarfish), corresponding to *Zapteryx brevirostris*.

Regarding species frequency in the landings (Fig. 5), the most frequent were oviparous species, with *Rioraja agassizii* (n = 617; 26.1%), *Sympterygia bonapartii* (n = 481; 20.4%), *Atlantoraja castelnaui* (n = 349; 14.8%), and *Atlantoraja cyclophora* (n = 299; 12.7%). Among the viviparous species, the most frequent was *Z. brevirostris* (n = 279; 11.8%). Overall, females were more frequent in the landings ($\chi^2 = 181.539$; $p < 0.0001$). Of the 2,360 specimens, 1,258 (53.3%) were females, 666 (28.2%) were males, and in 436 (18.5%) the sex could not be determined (Table II).

Figure 1. Map of the study area on the Southern Continental Shelf of Brazil. Rio Grande, in the state of Rio Grande do Sul (Southeastern Brazil), is marked as the batoid landing site for the fishing fleet studied from 2001 to 2015. The northernmost operational limit of the fishing fleet was Cabo de Santa Marta, SC (28°36'S), while the southernmost limit was Arroio do Chuí, RS (33°45'S). The lines indicate the 20, 50, 75, 100, and 200 m isobaths.

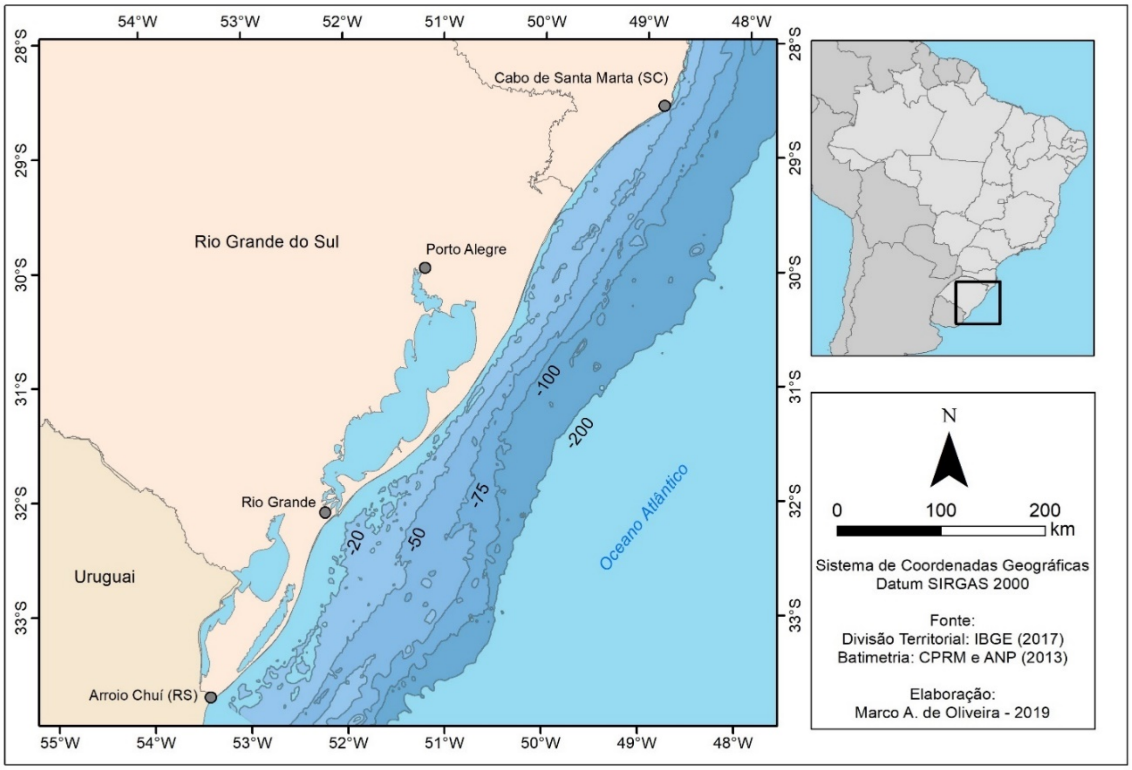


Table I – Taxonomic classification of batoid specimens sampled between 2001 and 2015 from landings of the commercial fishing fleet of Rio Grande, RS. Classification levels, species status on the IUCN Red List, absolute (AF) and relative (%) capture frequency.

Taxonomic Classification		**IUCN**	**Frequency**	
Order/ Family	**Species**	**Red List**	**AF**	**(%)**
Rajiformes				
Arhynchobatidae	*Rioraja agassizii*	VU	617	26.14
	Sympterygia sp.	-	3	0.13
	Sympterygia bonapartii	NT	481	20.38
	Sympterygia acuta	CR	103	4.36
	Atlantoraja castelnaui	CR	349	14.79
	Atlantoraja cyclophora	CR	299	12.67
	Atlantoraja platana	EN	45	1.91
	Psammobatis sp.	-	32	1.36
	Psammobatis extenta	LC	4	0.17
	Psammobatis rutrum	LC	4	0.17
	Psammobatis lentiginosa	LC	3	0.13

Myliobatiformes				
Myliobatidae	*Myliobatis* sp.	-	59	2.50
	Myliobatis goodei	VU	11	0.47
	Myliobatis freminvillei	VU	1	0.04
Dasyatidae	*Dasyatis* sp.	-	18	0.76
	Dasyatis hypostigma	EN	33	1.40
Gymnuridae	*Gymnura altavela*	EN	6	0.25
Rhinopristiformes				
Rhinobatidae	*Pseudobatos horkelii*	CR	13	0.55
	Zapteryx brevirostris	EN	279	11.82
			2,360	**100**

* LC – Least Concern, NT – Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered.

Figure 2. Representation of how eviscerated specimens from the landings of the bottom trawl commercial fishing fleet were found between 2001 and 2015 on the Southern Continental Shelf of Brazil. [a] Box containing two specimens of *Myliobatis* sp. without heads and tails. [b] Box containing several specimens of Rhinopristiformes displaying only the caudal part. [c] Box containing specimens of *Atlantoraja castelnaui*. [d] Box containing specimens of *Atlantoraja cyclophora*, *Myliobatis* sp., and *Sympterygia acuta*.

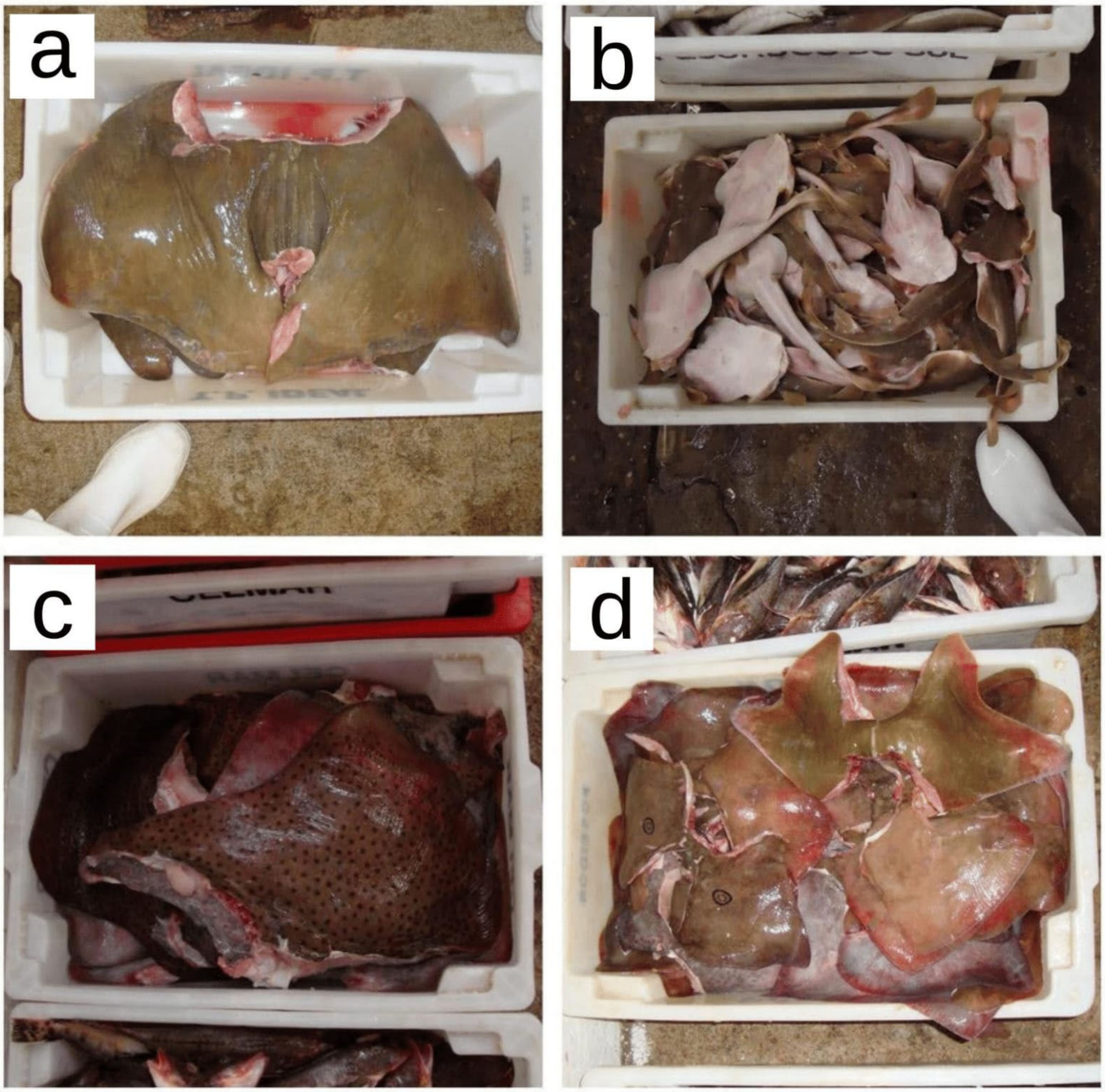


Figure 3. Patterns of evisceration found in batoid specimens from the landings of the bottom trawl commercial fishing fleet between 2001 and 2015 on the Southern Continental Shelf of Brazil. [a] *Myliobatis goodei* without the head and tail regions. [b] *Gymnura altavela* without the head and tail regions. [c] *Atlantoraja castelnaui* without the head and tail regions. [d] *Myliobatis* sp. without the head and tail regions. [e] *Atlantoraja castelnaui* without the head and tail regions. [f] *Dasyatis hypostigma* without the head and tail regions.

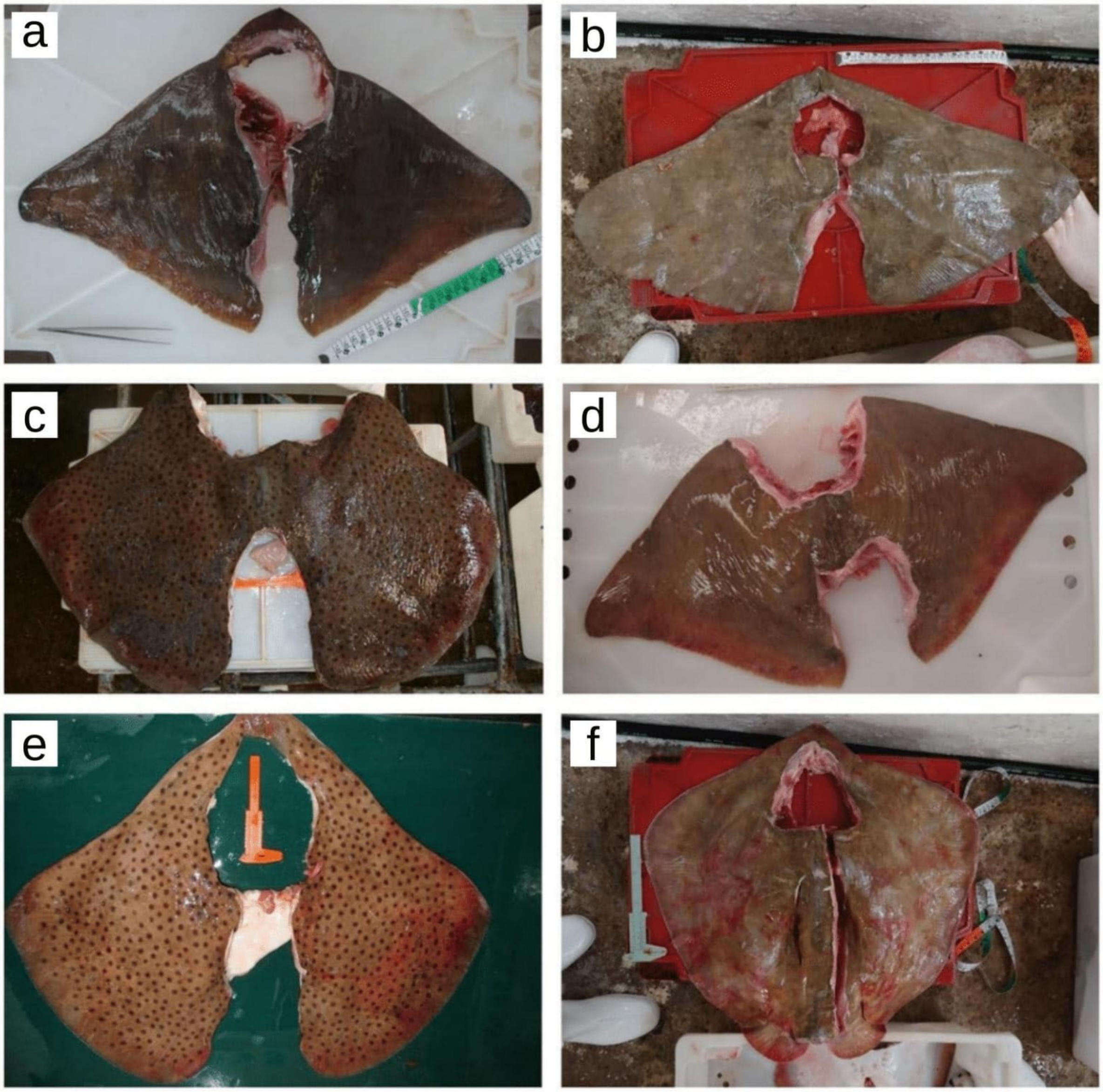


Figure 4. Patterns of evisceration found in specimens of batoids from the landings of the bottom trawl commercial fishing fleet, between the years 2001 and 2015 over the Southern Continental Shelf of Brazil. [a] *Rioraja agassizii* without the head and tail region. [b] Female *Sympterygia acuta* without the head and tail region, showing ovaries and part of the liver. [c] *Myliobatis* sp. without the head and tail region. [d] *Rioraja agassizii* without the head and tail region. [e] Immature *Zapteryx brevirostris* with only the tail region. [f] *Sympterygia bonapartii* without the head and tail region.

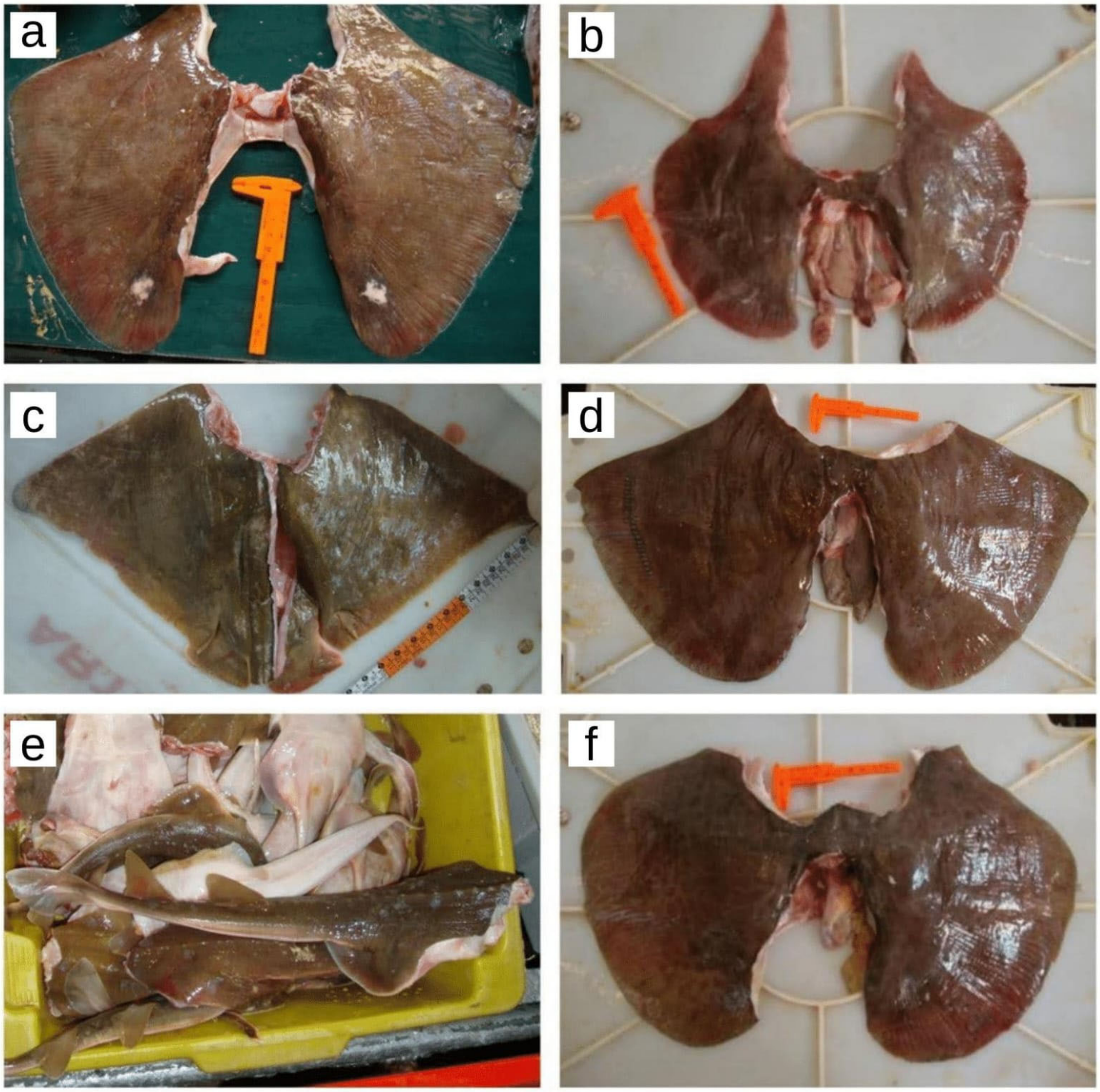
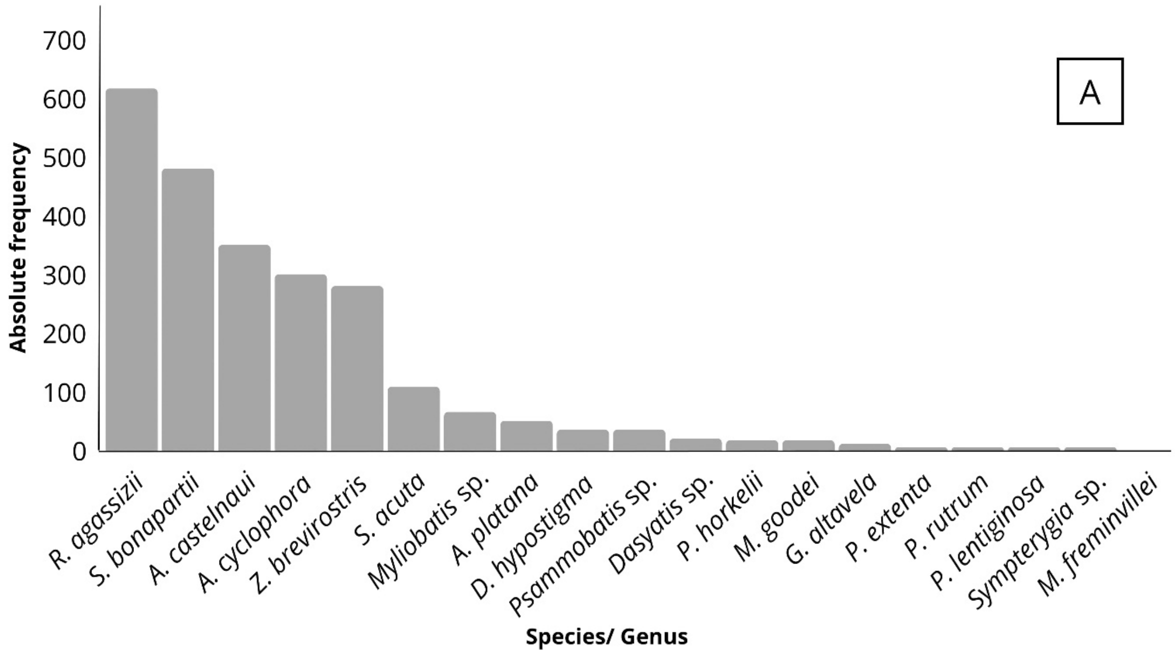


Figure 5. Absolute (A) and relative (B) frequency of the number of batoid specimens landed at the Port of Rio Grande between the sampling years of 2001 and 2015 over the Southern Continental Shelf of Brazil.



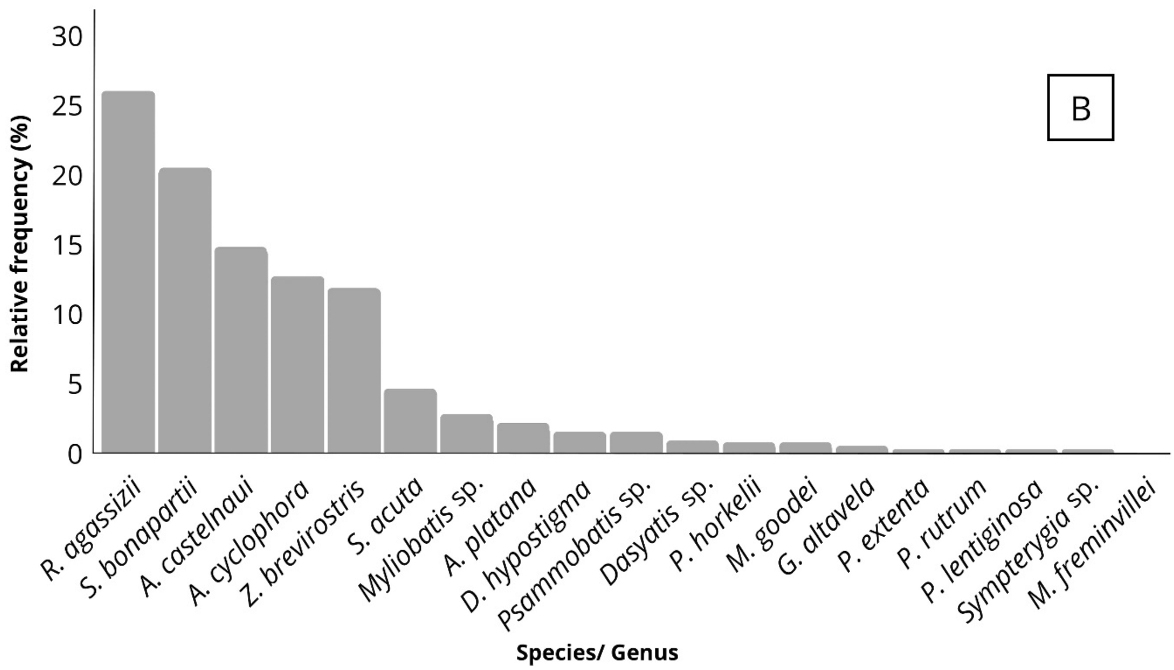


Table II - Number of female (F), male (M), and unidentified (U) individuals of batoids landed per year between 2001 and 2015, from landings of the commercial fishing fleet of Rio Grande, RS.

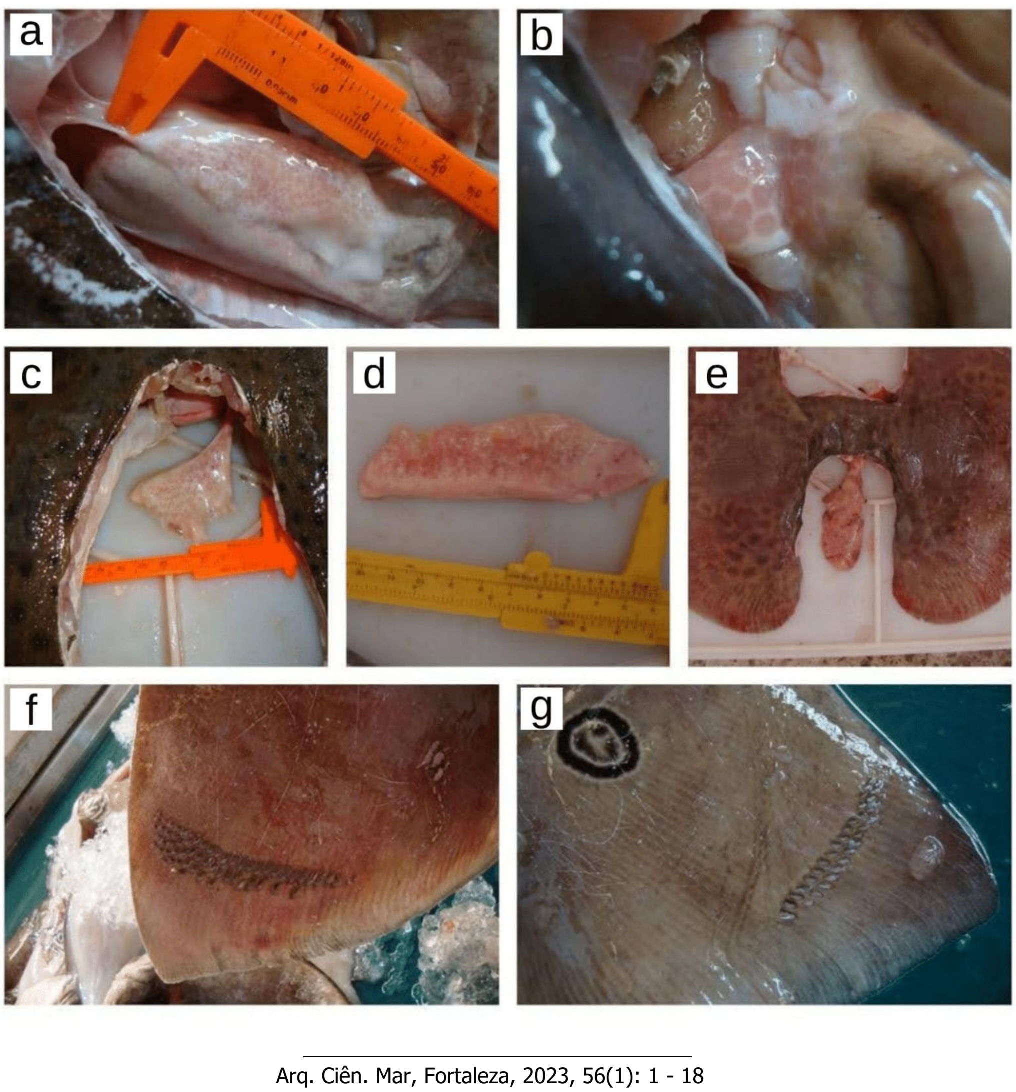
Sex	**Year**							
	2001	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
F	17	23	57	289	704	150	18	**1,258**
M	18	19	31	143	388	58	7	**666**
U	5	4	23	130	238	32	6	**436**
Total	**40**	**46**	**111**	**562**	**1,330**	**240**	**31**	**2,360**

The total frequency per estimated maturity stage, based on visual inspection of reproductive organs and structures, was 937 adults (40%), 261 immatures (11%), 239 juveniles (10%), and 923 unidentified (39%) (Table III, Fig. 6). On the other hand, when the maturity stage was indirectly estimated using the real TL or DW of the carcasses, the results were 1,569 adults (66.5%), 545 immatures (23.1%), and 246 unidentified (10.4%).

Table III - Number of batoids by maturity stage determined through visualization of reproductive organs and structures by year sampled between 2001 and 2015, from landings of the commercial fishing fleet of Rio Grande, RS.

Maturity Stage	**Year**							**Total**
	2001	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	
Adults	9	45	65	97	631	84	6	**937**
Immature	0	1	1	15	181	57	6	**261**
Juvenile	2	0	1	26	180	26	4	**239**
Unidentified	29	0	44	424	338	73	15	**923**
Total	**40**	**46**	**111**	**562**	**1,330**	**240**	**31**	**2,360**

Figure 6. Visualization of organs and structures demonstrating the maturity stage in specimens of batoids captured by the bottom trawl fishing fleet of Rio Grande, between the years 2001 and 2015 over the Southern Continental Shelf of Brazil. [a] Immature ovary, [b] testicle of an adult male, and [c] section of an immature ovary of a female *Atlantoraja castelnaui*. [d] Section through a maturing ovary showing the epigonal organ (EO) and vitellogenic follicles (VF) in white and orange surrounding an adult female *Sympterygia acuta*. [e] Part of the uterus of a female *Sympterygia bonapartii*. [f and g] Alar thorns on the dorsal fins of mature males.



DISCUSSION

Regarding the diversity found in the region, sixteen species of batoids were identified in the landings, totaling 2,360 sampled specimens. This demonstrates that the Southern Brazilian Shelf is an important area for the reproduction and growth of this group. This can be explained by the occurrence of seasonal processes that transport fertile waters from different sources, generating primary production with unique characteristics in the region, thus supporting a high abundance and biodiversity of fish (Odebrecht; Castello, 2001). The Southern Brazilian Shelf is also used by chondrichthyans as an important nursery area, harboring 85 species, 35 of which are batoids, including both resident and migratory species (Vooren et al., 2005; Vooren; Oddone, 2019). According to Gordon et al. (2016), nursery areas are ecologically important habitats, particularly when well-defined, highlighting the crucial need for knowledge about these areas in order to implement conservation management actions for resident species.

The most frequently landed species was *Rioraja agassizii*, representing 26% of the catches with a total of 617 specimens. There was a significant predominance of females over males, raising concerns about potential population decline due to the capture of abundant females. Conversely, there were few immature individuals, indicating a prevalence of adults. In terms of seasonality, the species occurred year-round. According to Wourms (1977), Rajiformes reproduce continuously throughout the year, with one or two peaks of activity. Larger peaks of females were observed in spring, summer, and winter, respectively, which agrees with Colonello et al. (2007), who suggested, based on variations in the gonadosomatic index, ovarian width, and diameter of ovarian follicles, that *R. agassizii* exhibits a partial reproductive cycle, with at least one peak occurring from spring to late summer and a second reproductive peak in winter, coinciding with capsule deposition (Cordeiro; Oddone, 2019; Gularte et al., 2023). Therefore, abrupt temperature changes may influence the reproductive activity of *R. agassizii*. Holden et al. (1971) also noted that the onset of reproductive activity and egg-laying are apparently temperature-dependent in skates. According to Cordeiro and Oddone (2019), egg capsules of *R. agassizii* are most abundant along the sealine of Cassino Beach, in Rio Grande, RS.

The second most captured species was *Sympterygia bonapartii*, with 461 specimens. There was also a predominance of females over males and a significant occurrence of immature individuals, warranting attention for species monitoring. The species occurred year-round, with abrupt peaks observed in December (spring/summer), primarily featuring females, and a more even distribution in autumn with lower presence in winter, showing a balanced ratio of males to females. According to Queiroz (1986) and Vooren (1998), *S. bonapartii* appears to exhibit winter migrant patterns, with a resident population and another migrating from Argentinean and Uruguayan waters during winter.

There were 349 specimens of *Atlantoraja castelnaui* recorded, and the sex ratio was 1:1. However, there was a high number of immature individuals, possibly due to the species' relatively large size, reaching maturity at approximately 1 m in length, which makes it difficult for trawl nets to distinguish between mature and immature individuals. Considering that females in the genus *Atlantoraja* undergo an extended immature phase before maturing abruptly after a short juvenile phase, there is significant concern regarding the extraction of this species at this stage (Oddone; Vooren, 2005). This species also proved to be the most commercially valuable during landing visits in the sampled years, likely due to its size. Seasonally, the species showed peaks in abundance during autumn and winter, with a higher frequency of females, and less so in summer and spring, reflecting the species' sexual cycle and preference for colder waters. The large body size in females appears to be an investment favoring reproduction; however, larger-bodied species are associated with higher mortality rates compared to smaller-bodied species (Dulvy; Reynolds, 2002). The large body size, combined with late maturity in *A. castelnaui*, makes this species one of the most concerning in the region from a conservation point of view. As an oviparous species, the extinction risk is expected to be offset by high fecundity, as oviparity provides a higher fecundity rate compared to viviparous species (Oddone; Amorim, 2007; Oddone et al., 2008; Colonello et al., 2012). However, the species is listed as "Endangered" (EN) by the IUCN, documenting severely fragmented populations as of the latest update in 2004. These factors require further studies to fully understand the current status of the species.

Another species of *Atlantoraja*, with significant capture incidence, was *Atlantoraja cyclophora*, with 299 specimens recorded. There was a predominance of females over males and a relatively low incidence of immature individuals compared to adults. Seasonally, the species was more frequent in autumn and spring, with a decline in winter and summer, indicating a preference for waters with moderate temperatures for reproduction. Four occurrences of egg-bearing females were noted in April, June, and August. Oddone and Vooren (2005) observed that ovarian resting periods in *A. cyclophora* occur at the individual level in winter and summer, without a defined temporal pattern. They also suggested that the species may follow either an annual reproductive cycle without peaks, or an annual cycle with at least one peak in spring or autumn.

Among Rhinopristiformes, *Zapteryx brevirostris* was the most abundant in the catches, representing 11.8% of the specimens, with a total of 279 samples. This group is known to exhibit slow growth, late maturity, and low fecundity, making it particularly vulnerable compared to other oviparous batoids, highlighting concerns over the abundance of catches for this species (Dulvy et al., 2000; Dulvy; Reynolds, 2002). The sex ratio for this species was even, with a significant number of juveniles captured, particularly among males. Considering that the carcasses of this species were mostly represented by just the caudal fin, making total length inference impossible in most cases, the number of immature and juvenile individuals — especially among females — may have been even higher. In relation to seasonality, the species was more frequent in winter, summer, and autumn, with a decline in spring. These observations corroborate those of Colonello et al. (2011), who recorded that the reproductive season of the species occurs in the winter months, which could reflect a strategy to avoid predation and interspecific competition.

Other Rajiformes occurred less frequently, such as *Sympterygia acuta*, with 103 specimens, and *Atlantoraja platana* in smaller numbers, with 45 specimens. *Sympterygia acuta* showed no predominance of females over males, resulting in equal ratios, and demonstrated a significant occurrence of immature individuals among the captures. The population of *S. acuta* has declined in recent years due to industrial fishing, particularly on the continental shelf of Rio Grande do Sul, likely because of the capture of many immature individuals (Gomes et al., 2010). *Atlantoraja platana*, on the other hand, showed a predominance of females over males, with no significant incidence of immature individuals. This species has a relatively large body size, which may explain its low capture incidence.

All other species occurred at low frequencies. For the genus *Psammobatis*, for instance, 43 specimens were recorded, with only eight individuals identified to species level. This is due to the species' similar morphology, which makes it challenging to properly identify them to the species level in the field. The low incidence of *Psammobatis*, despite being highly associated with fishing zones, may be related to their small body size and the fact that these species were mostly discarded before landing due to their lack of commercial interest based on size (Braccini; Chiaramonte, 2002).

Viviparous species such as *Gymnura altavela*, *Dasyatis hypostigma*, *Pseudobatos horkelii*, and the genus *Myliobatis*, represented by *M. goodei* and *M. freminvillei*, occurred less frequently. This could be explained by lower population rates of viviparous species due to their lower fecundity compared to oviparous species. Viviparity offers advantages, such as protection and constant physiological conditions for the embryo, as well as lower metabolic costs for the mother due to direct nutrient transfer, but it also makes these individuals more vulnerable to fishing exploitation (Vooren, 1992; Wourms, 1977). *Pseudobatos horkelii*, once abundant on the Southern Brazilian Shelf during the 1980s, has undergone significant declines over the decades. In the current study, this species appeared in catches with low frequency, reflecting the ongoing population decrease. This decline is consistent with the findings of Vooren et al. (2005), who reported an 85% reduction in the species' population due to commercial fishing in the region. These results highlight the importance of environmental laws and conservation practices to prevent the extirpation of batoid populations in the study area. Despite this, it remains uncertain whether the species' decline has stabilized, which requires further studies and fish monitoring over time.

Overall, skates predominated over viviparous species, indicating strategies and morphologies that enhance survival, especially among smaller species. Regarding the sizes captured by pair trawl fishing nets, medium (40 to 60 cm disc width) to large sizes (60 to 100 cm disc width) predominated. Vooren (1998) classified *Sympterygia*, *Atlantoraja*, and *Rioraja* as "constantly present" with respect to the temporal distribution of these genera on the Southern Shelf, a classification supported by this study. This predominance over viviparous species is relative, due to the inherently lower population rates of Myliobatiformes, resulting from their greater reproductive investment. However, most viviparous rays lack conservation status data. For instance, only *G. altavela* and *Z. brevirostris* are assessed by the IUCN as Vulnerable (VU), highlighting limited knowledge about the impacts of fishing on these species. Considering that medium to large-sized species appear more vulnerable to the prevalent fishing methods in the region, this issue becomes even more relevant.

It is suggested that the abundance of viviparous species may overlap with these populations through competitive release once viviparous species are captured, or even among oviparous species, where the abundance of medium-sized species such as *R. agassizii* and *S. bonapartii* may overshadow larger species like *A. castelnaui* and *A. platana*, as reported by Dulvy et al. (2000). In this study, it was observed that under the fishing category 'raia' (general term than includes all the local skates and rays orders) 15 batoid taxa are actually being masked. A similar issue was reported by Iglésias et al. (2009) regarding trends in batoid fishing statistics in France. Moreover, this paper demoastrated the importance of accurate taxonomic classification of batoids during landings for conversation purpuses, especially because the categories established by fishermen do not have taxonomic value.

Ordinance MMA No. 445, dated December 17, 2014, which came into effect in 2014, banned the landing of batoids throughout the state of Rio Grande do Sul due to the high fishing pressure in the state, causing concerning declines in elasmobranch populations. However, for conservation purposes, the prohibition on landing batoids does not prevent their capture. To avoid landing, batoids are discarded at sea, and at the time of discarding (even for species with higher survival rates than bony fish), most of these specimens are already dead or injured. To date, there is no information on the mortality rate of batoids caught by fishing gear and subsequently returned to the sea. For these reasons, the only way to protect these species would be to ban high-impact bottom trawling or take effective actions such as limiting the trawling area, which has been discussed in the state under Law No. 15,223, dated September 5, 2018, expanding the prohibition area for fishing from three to twelve nautical miles off the coast.

According to Vooren et al. (2005), the Southern Shelf is an important unit for environmental management due to its unique characteristics and its role as a natural nursery for many species, especially the elasmobranchs that inhabit it, and should therefore be properly preserved.

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