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Fisher Ethnotaxonomy for Elasmobranchs Captured Along the Brazilian Amazon Coast

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Abstract The diversity of popular names used in fish nomenclature off the Brazilian coast makes it difficult to identify species, and many names have their origins in Indigenous languages, mainly Tupi-Guarani. This study sought to understand and update the list of the most popular names and assess some ethnotaxonomic patterns employed by artisanal fishers from the Brazilian Amazon Coast in naming elasmobranchs. Interviews with 314 fishermen from 17 coastal municipalities were carried out employing a semi-structured form, banners, and photographic records of local elasmobranch species, addressing characteristics applied to species identification. A total of 130 ethnospecies were identified (113 names in Portuguese and 17 of Tupi-Guarani origin) for the identification of 22 and 18 species of sharks and rays, respectively. The highest degree of homonyms occurs interspecifically for the Dasyatidae, Mobulidae, Pristidae, Urotrygonidae, Carcharhinidae, Sphyrnidae and Triakidae families. *Sphyrna tiburo* and *Hypanus guttatus* comprised the taxa with the highest diversity of common names. Morphological characteristics such as shape, colors, texture, and size of certain body parts are the ethnotaxonomic patterns most applied in shark and ray identification. We conclude that the use of common names for elasmofauna facilitates communication between fishers and that the scientific approach to this local ecological knowledge is fundamental for the management and sustainability of fisheries in the long term.

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Introduction

Traditional communities inhabiting coastal Brazilian regions attribute a great diversity of popular names to marine fish and other nature elements (Barbosa-Filho et al. 2021; Freire and Carvalho-Filho, 2009). The diversity of names employed by fishers and fish consumers is due to multiple factors, including country size, regional disparities, colonization processes, and the complexities of Brazilian culture (Amorim 2005; Freire and Pauly 2005; Mourão and Barbosa-Filho 2018; Rodrigues 2016). Many of the popular plant and animal names in Brazil have their origins in Tupi-Guarani linguistics (Barbosa 1951). Since colonization, the Portuguese language spoken in Brazil has been marked by the Tupi linguistic trunk, which is manifested in the names of places, landscape landmarks, animals, plants, and food (Dietrich and Noll 2016a). This stems from the relations established during the colonial period between the Portuguese and Tupi-Guarani inhabiting the Brazilian coast, especially the Tupinambá people, whose loans and cultural exchanges were historically documented through linguistic contacts and the absorption of numerous Amerindian words in the Portuguese language spoken in Brazil (Dietrich 2016).

In the first half of the 16th century, Tupinambá was widely spoken in Brazilian coastal zones and

estuarine areas, as well as in some inland areas (Rodrigues 2016). Its dispersion followed the migratory flows of Indigenous people and was adopted in Jesuit missions between the 16th and 17th centuries, while other languages of Tupi origin were spoken in other regions of the country (Dietrich and Noll 2016b). However, Tupinambá fell into disuse with the genocide of Tupinambádue to epidemics and the catechization process and subsequent religious assimilation (Rodrigues 2016). From the 19th century, the term "Tupi" refers to a complex linguistic combination, comprising Tupinambá, on which most colonial languages are based on, the Brasilic language used in Jesuit missions, the language spoken in São Paulo on the Piratininga plateau—the first colonizing nucleus towards the Southeast, and the Amazonian language used in settlements of Indigenous Peoples of different ethnic origins in the Grão-Pará Jesuit missions (Dietrich 2016). "Tupi" has also been applied as a generic term since the 16th century to designate Indigenous populations along the Brazilian coast (Rodrigues 2016). With the intensified contact between the Portuguese and Brazilian Indigenous Peoples, both were learning to use each other's language, mixing, exchanging, and building a common language that has influenced the current language spoken in Brazil.

The growing need to include traditional communities and natural resources users in biodiversity management and conservation has shown traditional ecological knowledge to be a promising tool (Barbosa-Filho et al. 2021; Ferreira-Araujo et al. 2021; Giareta et al. 2021; Rodrigues et al. 2021; Silva et al. 2021). For example, ethnotaxonomy can be applied to improve and adapt management plans, as the use of inclusive language increases the chances of traditional communities understanding what is being proposed and for which species. Ethnotaxonomy translations can also fill knowledge gaps regarding target-species biology and ecology, particularly in data-poor countries such as Brazil (Ladislau et al. 2021; Mourão and Barbosa-Filho 2018). Concerning artisanal fisheries, traditional fisher knowledge is of great value, as fishing is spread out and landings are difficult to monitor. In Brazil, elasmobranch fishing is a traditional activity, with several coastal communities engaged in the capture and trade of sharks and rays (Aragão et al. 2019; Barbosa-Filho et al. 2019; Barbosa -Filho et al. 2021; Carvalho et al. 2018; Martins et al. 2018). Not entirely a subsistence activity, elasmobranch fishing guarantees the financial gain of many families under socio-economic vulnerability conditions, as well as food security in many regions of the country (Araujo et al., 2020; Dias et al. 2016; Martins et al. 2018; Nunes et al. 2005; Pinto et al. 2015; Viana and Souza 2019). The point of concern is that sharks and rays are now among the most threatened vertebrates worldwide, with population declines that seriously compromise their sustainable use (Dulvy et al. 2021; Pacoureau et al. 2021). The situation is critical in Brazil, as official fisheries statistics are absent since 2011, and legislation towards elasmobranch conservation is rarely met, mainly due to a lack of enforcement and incentive programs aiming at reducing elasmobranch catches. Moreover, the vast majority of species captured incidentally are retained and traded, posing additional pressure to elasmobranchs throughout the Brazilian Exclusive Economic Zone.

The Brazilian Amazon coast (BAC) is listed as a global conservation hotspot, mainly due to the significant number of local endemic species threatened with extinction (Dulvy et al. 2014). The region has a large artisanal fleet that captures elasmobranchs throughout the year, catching mostly juveniles and pregnant females (Almeida et al. 2000; Araujo et al. 2020; Gonçalves 2004; Lessa et al. 1999; Lessa and Silva 1992; Nunes et al. 2016). Members of fishing communities are mostly citizens suffering great social vulnerability, marginalization, and being deprived of access to basic health, education, and adequate living conditions. The management of endangered species in the Brazilian Amazon region is very challenging, and human dimensions are constantly overlooked in decision-making processes. In order to improve shark and ray management in the region, traditional communities should be not only considered in decision-making processes, but also their knowledge and demands in conservation planning. This includes access to regional ethnotaxonomy, especially considering the barriers imposed by poor access to basic education and the complexity of the language used in legal/punitive measures (e.g., list of banned species).

In this context, the present study aims to update the list of popular names of sharks and rays used by traditional communities inserted in the BAC and identify ethnotaxonomic patterns applied in the identification and classification of captured species marketed by local artisanal fleets as a way to reduce

the linguistic distance between academia, policy makers and fisheries resource users.

Material and Methods

Study Area

The data were collected along the coast of the state of Maranhão, which extends from the mouth of the Gurupi River to the mouth of the Parnaíba River, approximately 640 km in length (IMESC, 2020). This coastline comprises three Environmental Protection Areas (EPA) with 35 municipalities, an estimated population of over two million inhabitants, and is part of the BAC (IBGE, 2020; Figure 1).

The western coast comprises the Reentrâncias Maranhenses Environmental Protection Area (EPA). This area is characterized by an expressive set of islands, peninsulas, and bays, cut by rivers, streams and tidal channels filled with clay and silt that favor mangrove development (Castro et al. 2019) with high fishing resource productivity, representing a source of food and work for most coastal and riverside populations, especially low-income communities (IMESC 2020). The central part comprises the Golfão Maranhense, an estuarine complex formed by three bays, several river discharge sites and the island of Maranhão (Castro et al. 2019), as well as the Upaon Açu-Miritiba-Alto do Rio Preguiças EPA. The latter displays paramount importance concerning the region's high commercial value fishing resources, such as Acoupa weakfish *Cynoscion acoupa* (Lacepède, 1801) and Serra Spanish mackerel *Scomberomorus brasiliensis* Collette, Russo & Zavala-Camin, 1978 (IMESC 2020). The eastern coast comprises the Foz do Rio das Preguiças - Pequenos Lençóis - Adjacent Lagoon Region EPA (IMESC 2020), marked by a straight coastline, tidal terraces, fixed and mobile dunes,

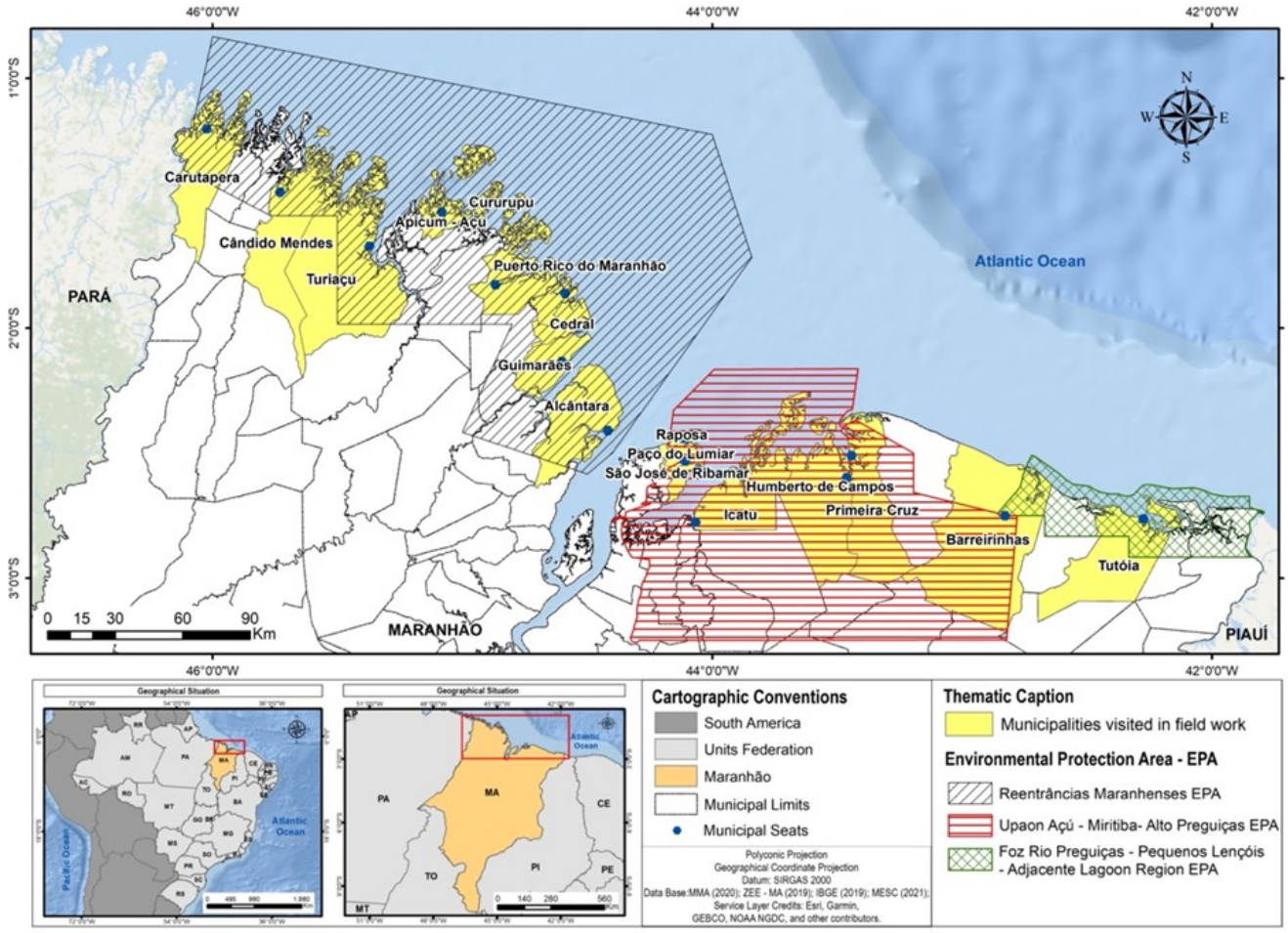

Figure 1 Delimitation of Environmental Protection Areas and the 17 municipalities that make up the study area on the coast of the state of Maranhão, located on the Brazilian Amazon Coast. Credits: Brenda S. S. Nunes, 2021.

mangroves, beaches, bays, islands, coves, and the Parnaíba River delta (El-Robrini et al. 2018; Figure 1).

Data collection and analysis

Monthly interviews were carried out with artisanal fishers from December 2019 to October 2020 in the main Alcântara, Apicum Açú, Barreirinhas, Cândido Mendes, Carutapera, Cedral, Cururupu, Guimarães, Humberto de Campos, Icatú, Paço do Lumiar, Porto Rico, Primeira Cruz, Raposa, São José de Ribamar, Turiaçú and Tutóia ports (Figure 1). The interviews took place over three days with a daily effort of eight hours at each location, when the interviewees were performing fishing gear maintenance, vessel repairs or following fish landings.

The interviews took place individually through a semi-structured form, visually stimulated by banners (Figure 2) and photographic records of local elasmobranchs (see Wosnick et al. 2019), focusing on their common names and external characteristics used for species identification. During the interviews, fishers were also asked about the species that were caught in abundance in the past and that have disappeared, species currently hardly caught at all and species not recorded for the region. The obtained information was compared with available literature (Almeida 2008; Almeida et al. 2011; Martins-Jura et al. 1987; Marceniuk et al. 2020; Nunes et al. 2005; Nunes et al. 2011; Stride et al. 1992). In addition, an additional search on local fauna records from the 17th

Figure 2 Interviews and data collection in the municipalities of Carutapera (A) - West Coast, Tutóia (B) - East Coast and Raposa (C) - Golfão Maranhense, in the state of Maranhão. Credit: Keyton K. F. Coelho, 2020.

century was carried out to understand the origins, historical records and diversity of popular names applied to elasmobranchs.

Data were quantitatively analyzed to obtain the total common names and relative frequencies (Fr) of citations for each species, as well as the total percentage of each common name cited in relation to all species identified by fishers.

Linguistic considerations

In the present study, common names were considered non-scientific nomenclature employed by fishing communities and fish consumers for the identification of morphological entities and, therefore of no official taxonomic nature. Synonymy was considered as the use of different common names applied to the same species (Minelli 1999), while homonymy was considered when at least two distinct species were associated with the same common name (Papavero 1994). Polysemy cases were associated with generalized naming conditions regarding initial species identification (e.g., "arraia" or "cação;" Martins 2015). The richness of common names was evaluated by the sum of synonyms and homonyms (Minelli 1999). The observed variation was subtle in many cases, but details were also considered as a possible variation of diachronic origin, which consists of slightly modified forms due to divergences over time (e.g., "arraia-lixa" or "raia-lixa"), or of diatopic origin, slightly different nominal forms for the same species as a result of regionalisms (e.g., "cação-junteiro", "juntão", "junteiro" or "tubarão-junteiro").

Results

A total of 314 artisanal fishers from 17 municipalities were interviewed ($\bar{x}$ 18,47 ± 8,68 fishers/ municipality), numbering a minimum of five fishers from Primeira Cruz and a maximum of 35 fishers from Cândido Mendes. All fishers were men, and most were from the state of Maranhão (90%; n = 282), mainly residing in the municipalities of Cururupu, Cândido Mendes and Turiaçú, while other fishers (10%; n = 32) were from other states, such as Ceará, Pará and Piauí. Fishers' age ranged from 20 to 83 years old ($\bar{x}$ 47 years) and time acting as fishers ranged from two to 72 years ($\bar{x}$ 30 years).

All fishers identify elasmobranchs as "leather fish," informally classifying them in the "sharks or cação family" or "ray family". A total of 14 taxonomic families were recorded (five shark and nine ray families), comprising 40 species (22 sharks and 18 rays), resulting in 130 common names and an average of 3.25 names per species (Figure 3; Table 1 and Table 2).

Ethnospecies were named in both Portuguese and Tupi-Guarani. Most common names were in Portuguese (87%; n = 113; 61 for sharks and 52 for rays) (Table 1) compared to Tupi-Guarani (13%; n = 17, nine for sharks and eight of rays) (Figure 4 and Table 2).

Both simple names (e.g., "boneta") and compound names (e.g., "tubarão-lombo-preto") are noted among the cited common names in Portuguese. Compound names usually contain the prefixes "Cação", "Tubarão", "Sacuri", "Panã", "Raia" and "Arraia" as polysemic forms for designating a group (shark or ray) or the initial name of a given species (e.g., "cação-rudela") (Table 1). For rays belonging to the Pristidae and Rhinobatidae families, the use of the term "cação" was predominant (e.g., "cação-viola" for Pseudobatos percellens and "cação-espadarte" for *Pristis pristis* and/or *Pristis pectinata*) (Table 1). Interestingly, 65% of fishers (n = 205) reported that they had never caught or seen a "cação-espadarte" (i.e., sawfish, Pristidae) (Table 1).

Common names derive from a series of morphological, ecological, behavioral, or physiological characteristics (Table 1). The fishers name, identify and classify sharks and rays mostly based on morphological attributes (56%; n = 175), such as body shape and color, body part size and texture, at 50%, 25%, 15% and 10% of citations, respectively (e.g., "sacuri-branco" for *Carcharhinus acronotus* and "raia-bicuda" for *Hypanus guttatus*). Fishers also use ecological attributes (18%; n = 57), such as the type of consumed food and habitat or type of substrate where the species is usually found (e.g., "raia-pedra", *Hypanus say*). Behavioral attributes (15%; n = 47) such as the ability to produce sounds underwater, strength, and endurance (e.g., "tubarão-boca-redonda," *Carcharhinus leucas*), and physiological attributes (11%; n = 35), such as the ability to produce electrical discharges and inoculate venom (e.g., "raia-elétrica", *Narcine brasiliensis* and "raia-de-fogo", *Urotrygon microphthalmum*), are also applied (Table 1).

Historical documents (Carvalho 1964; D'Abbeville 2008; Prazeres 1891) also indicate the description of some elasmobranchs based morphological characteristics, as in the case of

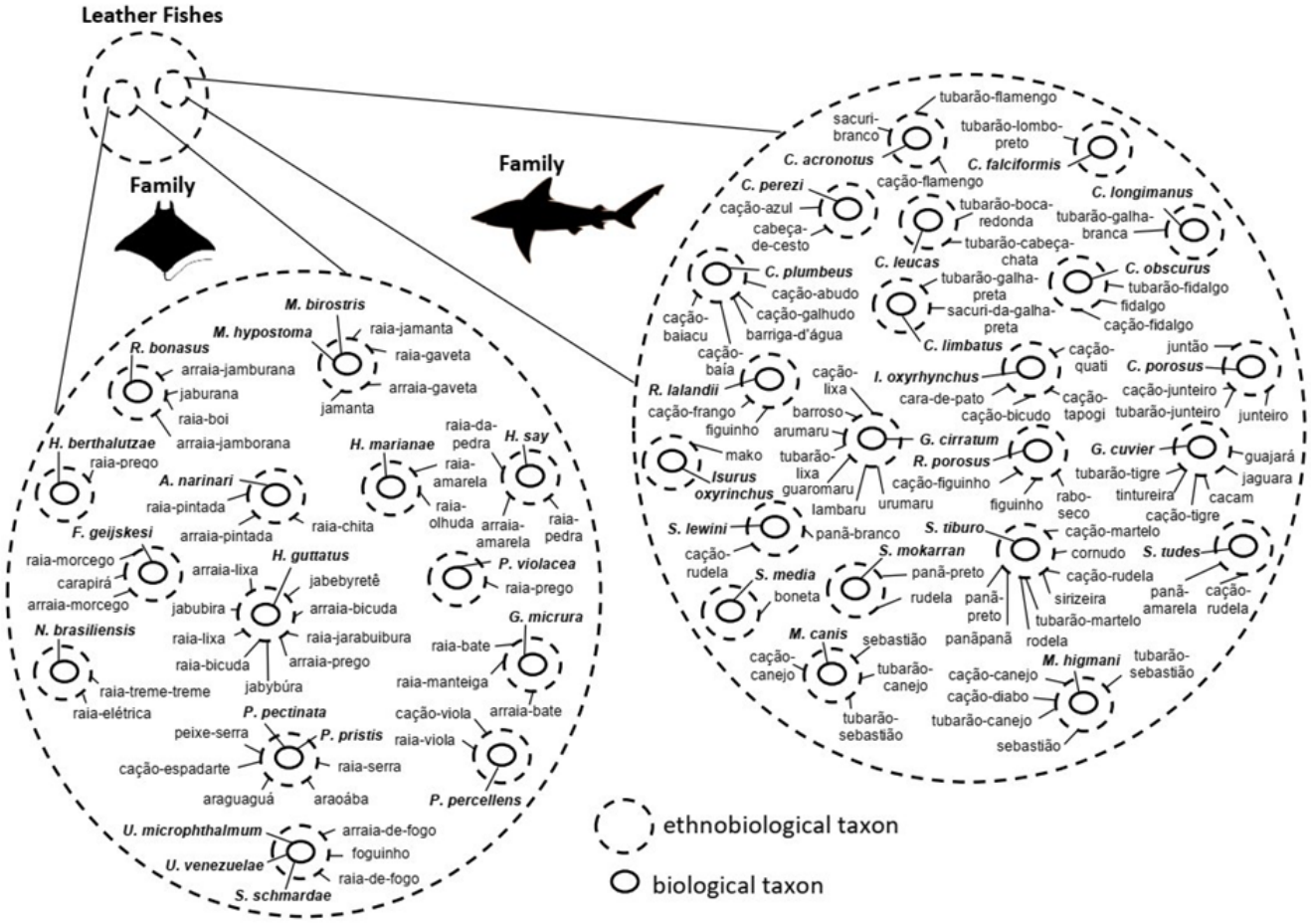

Figure 3 Hierarchical diagram of shark and ray families with their common names associated to their respective scientific names cited by artisanal fishers on the coast of the state of Maranhão, located on the Brazilian Amazon Coast. Credit: Keyton K. F. Coelho, 2021.

Galeocerdo cuvier, *Ginglymostoma cirratum*, *Sphyrna tiburo*, *Aetobatus narinari* and *Hypanus guttatus* (Table 3).

Regarding linguistic considerations, homonyms occur most frequently among species belonging to the same ray families (62%), such as Dasyatidae (*Hypanus berthalutzae* and *Pteroplatytrygon violacea*), Mobulidae (*Mobula birostris* and *Mobula hypostoma*), Pristidae (*P. pristis* and *P. pectinata*) and Urotrygonidae (*Urotrygon microphthalmum* and *Urotrygon venezuelae*) (Table 1). Homonyms between species from different families, however, are also noted, such as Potamotrygonidae (*Styracura schmardae*) and Urotrygonidae (*U. microphthalmum* and *U. venezuelae*) (Table 1). Regarding sharks, homonymy is most frequent (38%) for Carcharhinidae (*Rhizoprionodon lalandii* and *Rhizoprionodon porosus*), Sphyrnidae (*Sphyrna lewini*, *Sphyrna mokarran*, *Sphyrna tiburo* and *Sphyrna tudes*) and Triakidae (*Mustelus canis* and *Mustelus higmani*) (Table 1).

Concerning synonymy, averages of 3.18 and 3.33 names per species were identified for sharks and rays, respectively (Table 4 and Table 5). Regarding sharks, *Sphyrna tiburo* (Linnaeus, 1758) was given the greatest diversity of common names (n = 8), displaying the highest relative frequency (11.43%) and citations (6.15%) (Table 1, Table 2, and Table 4). *Carcharhinus falciformis*, *C. longimanus*, *Isurus oxyrinchus* and *Sphyrna media*, on the other hand, were all identified by a single common name throughout the entire study area (Table 1 and Table 4). For rays, *Hypanus guttatus* (Bloch & Schneider, 1801) was given the highest number of common names (n = 9), displaying the highest relative frequency (15%) and citations (6.92%)

Table 1 Families, Species and Common Names in Portuguese of the ethnospecies cited by artisanal fishers from the Brazilian Amazon Coast associated with ethnotaxonomic characteristics.

Family	Species	Common names	Ethnotaxonomic features
	Carcharhinus acronotus (Poey, 1860)	cação-flamengo, sacuri-branco or tubarão-flamengo.	"When young, this shark has a soft and very tasty meat..., it is small, when bigger it reaches up to one meter and has a black dot on the tip of its nose" (Morphological ethnotaxonomy – body size and head color).
	Carcharhinus falciformis (Müller & Henle, 1839)	tubarão-lombo-preto.	- - - - -
			"This shark snores a lot under the boat, it makes a lot of noise" (Behavioral Ethnotaxonomy).
			"It has a lot of strength and is too angry..., it takes a long time to die in the fishing net, it is very resistant" (Behavioral and physiological ethnotaxonomy).
	Carcharhinus leucas (Müller & Henle, 1839)	tubarão-cabeça-chata or tubarão-boca-redonda.	"This animal's head is flattened to the tip of its nose and its mouth is huge" (Morphological ethnotaxonomy – head shape).
	Carcharhinus limbatus (Müller & Henle, 1839)	sacuri-da-galha-preta or tubarão-da-galha-preta.	- - - - -
	Carcharhinus longimanus (Poey, 1861)	tubarão-galha-branca.	- - - - -
	Carcharhinus obscurus (Lesueur, 1818)	cação-fidalgo, fidalgo or tubarão-fidalgo.	- - - - -
	Carcharhinus perezi (Poey, 1876)	cabeça-de-cesto or cação-azul.	- - - - -
	Carcharhinus plumbeus (Nardo, 1827)	cação-abudo, barriga-d'água, cação-baía, cação-galhudo or cação -baiacu.	- - - - -
	Carcharhinus porosus (Ranzani, 1839)	cação-junteiro, juntão, junteiro or tubarão-junteiro.	- - - - -
	Galeocerdo cuvier (Péron & Lesueur, 1822)	cação-tigre, tintureira or tubarão-tigre.	"This shark is easy to identify because it has spots on its body" (Morphological ethnotaxonomy – body color).
	Isogomphodon oxyrhynchus (Müller & Henle, 1839)	cara-de-pato, cação-bicudo, cação-quati or cação-tapogi.	"This shark has a head that thins and flattens up to the nose" (Morphological ethnotaxonomy – head shape).
Carcharhinidae	*Rhizoprionodon lalandii* (Müller & Henle, 1839)	cação-frango or figuinho.	- - - - -

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Family	Species	Common names	Ethnotaxonomic features
Carcharhinidae	*Rhizoprionodon porosus* (Poey, 1861)	cação-figuinho, figuinho or rabo-seco.	- - - - -
Ginglymostomatidae	*Ginglymostoma cirratum* (Bonnaterre, 1788)	barroso, cação-lixa or tubarão-lixa.	"Where there is mud, you can throw a net, because this shark likes muddy environments" (Ecological Ethnotaxonomy – Habitat). "The skin of this shark is like sandpaper" (Morphological ethnotaxonomy – body texture).
Lamnidae	*Isurus oxyrinchus* Rafinesque, 1810	mako	- - - - -
Sphyrnidae	*Sphyrna lewini* (Griffith & Smith, 1834)	cação-rudela or panã-branco.	"This panã (shark) is easy to find when we are out there, it lives in the high seas" (Ethnotaxonomy ecological – habitat).
	Sphyrna media Springer, 1940	boneta.	- - - - -
	Sphyrna mokarran (Rüppell, 1837)	panã-preto or rudela.	- - - - -
	Sphyrna tiburo (Linnaeus, 1758)	cação-martelo, cação-rudela, cornudo, rodela, sirizeira or tubarão-martelo.	- - - - -
	Sphyrna tudes (Valenciennes, 1822)	cação-rudela or panã-amarela.	"This shark has a hammer-shaped head and is yellow on the underside of its head" (Morphological ethnotaxonomy – head shape and color).
Triakidae	*Mustelus canis* (Mitchill, 1815)	cação-canejo, sebastião, tubarão-canejo or tubarão-sebastião.	- - - - -
	Mustelus higmani Springer & Lowe, 1963	cação-canejo, cação-diabo, sebastião, tubarão-canejo or tubarão-sebastião.	- - - - -
Aetobatidae	*Aetobatus narinari* (Euphrasen, 1790)	arraia-pintada, raia-pintada or raia-chita.	"This stingray is called a spotted stingray because its entire top body has white spots and it is easy to know when it is this species" (Morphological ethnotaxonomy – body color). "When it's sururu time, this ray shoals into the mouth of the river to eat this shellfish" (Behavioral and ecological ethnotaxonomy).

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Family	Species	Common names	Ethnotaxonomic features
	Fontitrygon geijskesi (Boeseman, 1948)	arraia-morcego, raia-morcego or carapirá.	"This ray has very large fins, even more so when you consider the big ones" (Morphological ethnotaxonomy – body size and shape).
	Hypanus berthalutzae Petean, Naylor & Lima 2020	raia-prego.	- - - - -
			"The sea of Maranhão was made for this ray, just cast a net from end to end of this coast and you catch this fish, there are too many" (Ecological ethnotaxonomy - habitat).
	Hypanus guttatus (Bloch & Schneider, 1801)	arraia-bicuda, arraia-prego, arraia-lixa, raia-lixa or raia-bicuda.	"Its skin is like sandpaper, even more so when you consider the big ones... you can even scrape the hull of the boat" (Morphological ethnotaxonomy – body texture).
	Hypanus marianae (Gomes, Rosa & Gadig, 2000)	raia-amarela or raia-olhuda	"This ray is called this because it has very large eyes that sticks out of its head" (Morphological ethnotaxonomy – shape of the eyes on the head).
	Hypanus say (Lesueur, 1817)	arraia-amarela, raia-da-pedra or raia-pedra.	"This stingray likes stony bottoms, that's why it's called the stone ray" (Ecological Ethnotaxonomy – Habitat).
Dasyatidae	*Pteroplatytrygon violacea* (Bonaparte, 1832)	raia-prego	- - - - -
Gymnuridae	*Gymnura micrura* (Bloch & Schneider,	arraia-baté, raia-baté or raia-manteiga.	"This stingray is yellow on the underside of its body; it really looks like butter" (Morphological
			"This ray has some white spots near the head, the other manta rays don't" (Morphological ethnotaxonomy – body color).
	Mobula birostris (Walbaum, 1792)	arraia-gaveta, raia-gaveta, raia-jamanta or jamanta.	"We know that this ray is in the water when it is above the water hitting its big fins or when it gets caught in the net; in that case, it drags the boat for many meters; it's a loss, we have to cut the nets and lose everything" (Morphological ethnotaxonomy – body size and shape).
Mobulidae	*Mobula hypostoma* (Bancroft, 1831)	arraia-gaveta, raia-gaveta, raia-jamanta or jamanta.	- - - - -
Myliobatidae	*Rhinoptera bonasus* (Mitchill, 1815)	arraia-jamburana, arraia-jamborana, jaburana or raia-boi.	"This ray has a head similar to that of an ox, even the eyes look very much like an ox's" (Morphological ethnotaxonomy – head shape).
Narcinidae	*Narcine brasiliensis* (Olfers, 1831)	raia-elétrica or raia-treme-treme.	"I want to get away from this animal, fish from hell, it gives a huge shock, and it hurts" (Physiological ethnotaxonomy – act of shocking).

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Family	Species	Common names	Ethnotaxonomic features
			"This fish is easy to identify because of the katana sword, but they have not appeared in these waters for a long time" (Morphological ethnotaxonomy – body shape).
			"I only hear about this animal, but I've never seen it, I want to see it... my father caught a lot in the past" (Common citation).
			"About three years ago, one appeared here at half a meter in size, which caused a lot of confusion because many people did not know this animal, including an old fisher who had never seen it" (Report of a fisher in the municipality of Cedral-MA).
	Pristis pristis (Linnaeus, 1758)	cação-espadarte, raia-serra or peixe-serra.	"There is a beach called Espadarte Beach, because we used to go there just to kill these animals years ago, often just to get the katana to sell" (Report of a fisherman over 80 years old from the municipality of Barreirinhas- BAD).
Pristidae	*Pristis pectinata* (Latham, 1794)	cação-espadarte, raia-serra or peixe-serra.	
Potamotrygonidae	*Styracura schmardae* (Werner 1904)	arraia-de-fogo, foguinho or raia-de-fogo.	"Another animal that I want to stay away from, it even walks in the mud and runs after us to hurt you with its sting" (Behavioral Ethnotaxonomy).
Rhinobatidae	*Pseudobatos percellens* (Walbaum, 1792)	cação-viola or raia-viola.	"This ray has a body like a guitar" (Morphological ethnotaxonomy – body shape).
	Urotrygon microphthalmum Delsman, 1941	arraia-de-fogo, foguinho or raia-de-fogo.	"The sting of this stingray hurts so much, even more when we are removing the nets, then it takes advantage of it" (Physiological Ethnotaxonomy).
Urotrygonidae	*Urotrygon venezuelae* Schultz, 1949	arraia-de-fogo, foguinho or raia-de-fogo.	- - - - -

(Table 1, Table 2 and Table 5). Interestingly, *P. violacea* and *H. berthalutzae* were both recognized by the same common name ("raia-prego") (Table 1 and Table 5).

Discussion

The richness of common names (n = 130) in Portuguese or in Tupi-Guarani used by artisanal fishers does not necessarily correspond to the number of biological shark or ray species, since these common names are usually associated with polysemy, homonyms, or synonyms cases when naming ethnospecies.

The polysemy observed in the studied area is high and is generally applied when fishers generically identify fish as "Cação", "Panã", "Raia" or "Arraia" or classify them in the "shark" or "ray" family. These denominations do not correctly define biological species but may reveal the biological diversity that exists in the region. In the northeastern coast of Brazil, generic or polytypic taxa are usually associated with the high species richness observed in some localities (Barbosa-Filho et al. 2021; Previero et al. 2013) or categories of greater economic or sociocultural importance in local fishing communities (Mourão and Montenegro 2006; Pinto et al. 2015; Silvano and Begossi 2012). This was verified in the present study, given the high richness of elasmobranch species in the study area and the relevance of

Table 2 Families, Species and Common Names in Tupi-Guarani of the ethnospecies cited by artisanal fishers from the Brazilian Amazon Coast associated and their respective meanings.

Family	Species	Common names	Meaning
Carcharhinidae	*Galeocerdo cuvier* (Péron & Lesueur, 1822)	cacam, jaguara or guajará.	Big fish, huge size.
Ginglymostomatidae	*Ginglymostoma cirratum* (Bonnaterre, 1788)	arumaru, guaromaru, lambaru or urumaru.	- - - - -
Sphyrnidae	*Sphyrna tiburo* (Linnaeus, 1758)	panãpanã or panã.	- - - - -
Dasyatidae	*Hypanus guttatus* (Bloch & Schneider, 1801)	jabubira, jabebyretê, jabybúra or raia-jarabuibura.	Swollen, lumpy or blistered skin.
Pristidae	*Pristis pristis* (Linnaeus, 1758)	araguaguá or araoába.	- - - - -
	Pristis pectinata (Latham, 1794)	araguaguá or araoába.	- - - - -

marine fish as a source of subsistence and income on the coast of Maranhão.

Homonyms are more frequent in rays (62%), mainly due to the phenotypic similarity usually observed between different species belonging to the same family. An example of this are the manta rays *M. birostris* and *M. hypostoma*, which are locally identified as "arraia-gaveta", "raia-gaveta", "raia-jamanta" or simply "jamanta". Concerning sharks, although a lower homonym frequency is observed (38%), a high morphological similarity between different species is also noted, such as between *M. canis* and *M. higmani* known as "cação-canejo", "Sebastião", "tubarão-canejo" or "tubarão-Sebastião", as well as between *R. lalandii* and *R. porosus* identified by "figuinho," in addition to "cação-frango" and "cação rabo-seco," respectively. This same morphological similarity pattern was observed by Carvalho et al. (2018) when studying the ethnotaxonomy of sharks in the state of Rio Grande do Norte, Brazil, where R. lalandii and R. porosus have also been recognized as "cação-frango" and "cação rabo-seco". This perception and recognition of biological groupings by humans is based on similarities and differences shared between organisms, but the skills required to recognize this variability must be developed (Barbosa-Filho et al. 2021).

The synonymy observed in sharks, with an average of 3.18 common names per species, was lower than that observed by Barbosa-Filho et al. (2021) regarding the ethnotaxonomy of sharks by fishers in the municipalities of Ilhéus, Una and Canavieiras, in the state of Bahia, Brazil, which averaged 4.8 common names per species. These authors indicated 13 common names for *S. tiburo*, higher than for the same species in our study (n = 8). These differences in common names are often justified by geographic variations, linguistic differences, or person to person changes (Carvalho et al. 2018; Freire and Carvalho-Filho 2009; Freire and Pauly 2005; Last et al. 2016). However, when analyzing the popular knowledge of artisanal fishers concerning 22 shark species, Carvalho et al. (2018) also identified an average of 3.17 common names per species. For stingrays, the highest number of common names for *H. guttatus* (n = 9; five in Portuguese and four in Tupi-Guarani) may be associated with the use of ethnotaxonomic characteristics in their identification (e.g., stingray) and their high occurrence along the study area (as reported by some fishers: "... just cast the net from one end of the coast to the other and you catch this fish"), favoring its availability and commercial value accessible to local consumers.

The national average for Brazil is of six common names for each biological species, but some fish species are known by more than 30 common names, in addition to higher-level taxonomic groups that include different families, genera, and species that are referred to by a single common name (Freire and Pauly 2005), as in the case of rays ("raia" or "arraia" in Brazilian Portuguese). For taxa displaying high synonymy, the insertion of "notes" is recommended for reviews, catalogs, and other publications, to avoid naming errors (Papavero 1994).

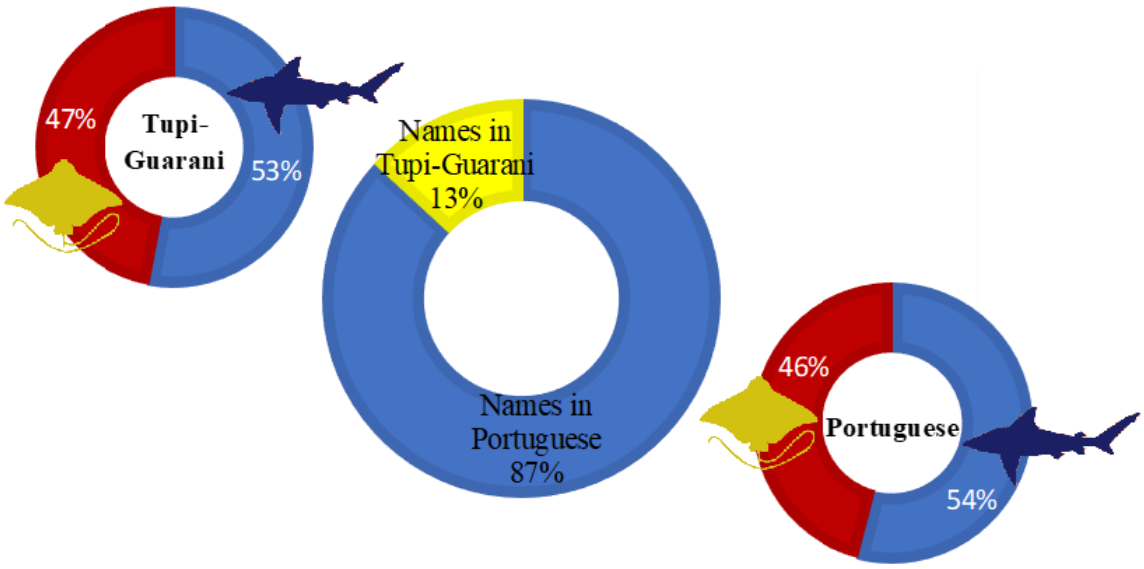

Figure 4 Percentage of common names with Portuguese and Tupi-Guarani origin applied to the identification of ethnospecies by artisanal fishers on the coast of the State of Maranhão, located on the Brazilian Amazon Coast. Credit: Keyton K. F. Coelho, 2021.

Many common fish names reflect fisher local ecological knowledge (Mourão and Barbosa-Filho 2018). All artisanal fishers who participated in this study have fishing as their main activity and demonstrate knowledge concerning the biology of the fish they often catch. This is reflected in the length of experience in the fishing profession ($\bar{x}$ 30 years), where the use of natural aquatic resources is the result of life experience and knowledge. These social actors have empirical knowledge that must be respected regarding their behavior in relation to the environment when obtaining resources (Mourão and Nordi 2002) with a wealth of information on the biology, ecology and etymology of different groups of animals (Mourão and Barbosa-Filho 2018; Silvano and Begossi 2012). This knowledge is paramount regarding the relational composition of social existence, being transmitted orally and through experience to descendants over time in the construction of identity bonds across generations (Aragão 2021; Aragão et al. 2019).

The association of ethnotaxonomic characteristics favors the existence of many common names in Portuguese (87%) for shark and ray identification. Morphological aspects are the most considered for naming species, highlighting the size or shape of the body, or the texture and colors of body parts, which are usually associated with a word (noun or adjective) to designate the species. An apt example is the "cação -bicudo" or "cara-de-pato" (transliteration Portuguese to English = "beaked shark" or "duckface shark", respectively). Daggernose shark *I. oxyrhynchus*, which, according to fishers, is named after the shape of its head: "This shark has a head that thins and flattens up to the beak". The Sharpsnout stingray *F. geijskesi* receives the composite name of "raia-morcego" ("bat stingray") due to the presence and span of its large fins. Barbosa and Nascimento (2008) suggest that the use of common names related to other animals, objects or actions should be composed to avoid confusion and thus, aid in informal species identification. Thus, the use of nouns and adjectives when establishing compound or derivative names is extremely important for the determination of a specific taxon (Papavero 1994).

In some cases, different morphological characteristics are considered in the complete naming of the species, as in the case of the "panã-amarelo"/ Smalleyer hammerhead ("yellow panã") *S. tudes*, in which fishers relate the shape of the head with the characteristic color of the animal: "This cação has a hammer-shaped head and is yellow on the underside

of the head and the rest of the body". In other situations, body shape can confuse fishers as to the difference between some species of rays and sharks, as verified in the statement that the "raia-viola"/ Chola guitarfish *P. percellens* and the "raias-serras"/ Sawfishes *P. pristis* or *P. pectinata* are usually identified as "cação-viola" and "cações-espadartes", respectively, attributing these names due to their similarity with cações (sharks).

The color pattern is the second most applied morphological aspect in species identification, such as in the "sacuri-branco"/Blacknose shark *C. acronotus* ("with a black marking on the tip of the nose") and the Tiger shark *G. cuvier* ("with markings along the body"), or the "raia-manteiga"/Smooth butterfly ray *G. micrura* ("yellowish color on the underside of the body"), the "raia-pintada"/Whitespotted eagle ray *A. narinari* ("all the upper part of this species has white spots"), and the "manta ray"/Giant ray *M. birostris* ("with some white spots near the head"). Colors play a major role in descriptions and are important for the identification of the vast majority of plant or animal organisms (Papavero 1994). In fact, this physical feature stands out to the eye, being frequently used in the construction of popular and vernacular denominations (Martins 2015; Mourão and Barbosa-Filho 2018).

The size and texture of the body are morphological aspects evidenced in species such as the "sacuri-branco"/Blacknose shark *C. acronotus* ("...it is small, when large it reaches one meter...") and in the Longnose stingray *H. guttatus* ("its leather is sandpaper..., you can even scrape the hull of the boat"). Names in Tupi-Guarani also reveal the same

Table 3 Families and species identified in Maranhão waters in the 17th century (historical documents).

Family	Species	Morphological description
Carcharhinidae	*Galeocerdo cuvier* (Péron & Lesueur, 1822)	"A dangerous fish of the sea", it only serves to do harm, especially to shipwrecked people and bathers, comparable to the jaguar, and can reach six meters or more in length; we only use the liver for the oil... (Carvalho 1964).
Ginglymostomatidae	*Ginglymostoma cirratum* (Bonnaterre, 1788)	Body short, subcylindrical, somewhat tapered and long in the posterior region. An obtuse, rather small muzzle is noted, as well as the eyes, which are located in the upper third of the head. Size ranging between 1 and 4 meters weighing over 150 kilos... (Carvalho 1964).
Sphyrnidae	*Sphyrna tiburo* (Linnaeus, 1758)	This fish has a semicircular cephalic contour and the nostrils are close to the eyes, very characteristic for having a small, flattened and spatulate head (Carvalho 1964).
Aetobatidae	*Aetobatus narinari* (Euphrasen, 1790)	Flatfish similar to stingrays. It is six feet long by six feet wide. The tail is a fathom long, and in the center, as in the previous one, a tip, but longer, about a foot long, and equally dangerous. This fish is all spotted white and black (D'Abbeville 2008).
Dasyatidae	*Hypanus guttatus* (Bloch & Schneider, 1801)	The young are entirely smooth; adults have a series of spines along the midline of the body, up to the caudal dart; some over the shoulder, with a rough upper body (Carvalho 1964). Another flatfish, similar to the stingray, but much larger. It is two fathoms long by two fathoms wide and a foot thick. It has a tail an arm and a half long, in the center of which there is a point, in the shape of a dart, much larger than a finger, and whose wound is very dangerous, to the point that it is often necessary to cut off the offended part (D. 'Abbeville 2008).

Table 4 List of shark species with the number of synonyms, relative frequency (Fr%) and percentage of citations by artisanal fishers from the Brazilian Amazon Coast.

Nº	Shark	Common names	Fr%	% Citations
1	*Sphyrna tiburo* (Linnaeus, 1758)	8	11.43	6.15
2	*Ginglymostoma cirratum* (Bonnaterre, 1788)	7	10.00	5.38
3	*Galeocerdo cuvier* (Péron & Lesueur, 1822)	6	8.57	4.62
4	*Carcharhinus plumbeus* (Nardo, 1827)	5	7.14	3.85
5	*Mustelus higmani* Springer & Lowe, 1963	5	7.14	3.85
6	*Isogomphodon oxyrhynchus* (Müller & Henle, 1839)	4	5.71	3.08
7	*Mustelus canis* (Mitchill, 1815)	4	5.71	3.08
8	*Carcharhinus porosus* (Ranzani, 1839)	4	5.71	3.08
9	*Carcharhinus acronotus* (Poey, 1860)	3	4.29	2.31
10	*Carcharhinus obscurus* (Lesueur, 1818)	3	4.29	2.31
11	*Rhizoprionodon porosus* (Poey, 1861)	3	4.29	2.31
12	*Carcharhinus leucas* (Müller & Henle, 1839)	2	2.86	1.54
13	*Carcharhinus perezi* (Poey, 1876)	2	2.86	1.54
14	*Rhizoprionodon lalandii* (Müller & Henle, 1839)	2	2.86	1.54
15	*Sphyrna lewini* (Griffith & Smith, 1834)	2	2.86	1.54
16	*Sphyrna mokarran* (Rüppell, 1837)	2	2.86	1.54
17	*Sphyrna tudes* (Valenciennes, 1822)	2	2.86	1.54
18	*Carcharhinus limbatus* (Müller & Henle, 1839)	2	2.86	1.54
19	*Carcharhinus falciformis* (Müller & Henle, 1839)	1	1.43	0.77
20	*Carcharhinus longimanus* (Poey, 1861)	1	1.43	0.77
21	*Isurus oxyrinchus* Rafinesque, 1810	1	1.43	0.77
22	*Sphyrna media* Springer, 1940	1	1.43	0.77
TOTAL		**70**	**100.00**	

aspects, such as "jaguara," "cacam" or "guajará" ("large fish, of enormous size," referring to the Tiger shark *G. cuvier*) or "jabubira," "jabebyretê," "jabybúra" or "ray-jarabuibura" ("swelled, lumpy or blistered skin," referring to the stingray *H. guttatus*). However, these and other names in the Tupi-Guarani language used to identify sharks and rays, such as "arumaru," "guaromaru," "lambaru" or "urumaru" (*G. cirratum*), "panãpanã" or "panã" (*S. tiburo*) and "araguaguá" or "araoába" (*P. pristis* and *P. pectinata*) are no longer used by fishers in the region. These names are generally used by fishers aged between 50 and 80 years due to contact with older fisher generations (e.g., parents and grandparents). A loss of cultural values through applied names is verified, due to the lack of interest of young people in fishing. For Pinto et al. (2015), this lack of interest occurs due to the lack of investment in storing, processing, and marketing fish, in addition to low values and the search for new employment opportunities.

Morphological characteristics were also widely applied in early descriptions of the local aquatic fauna in colonial periods, as observed for the "tubarão-lixa"/Nurse shark *G. cirratum* ("...the hide of this dogfish is like sandpaper" or "...obtuse snout, somewhat small, the same is noted for the eyes, located in the upper third of the head..."), the hammerhead shark/Bonnethead *S. tiburo* ("... semicircular cephalic contour and the nostrils are close to the eyes..."), the spotted ray/Whitespotted eagle ray *A. narinari* ("...this fish is all spotted white and black") and the "raia-bicuda"/Longnose stingray (beaked ray) *H. guttatus* ("...the adults have a series of spines on the midline of the body, to the tail dart...").

The ecological criteria used by fishers reveal much of the habitat of some species, such as Nurse shark *G. cirratum* ("it likes muddy environments"), the "panã-branco"/Scalloped hammerhead *S. lewini* ("it is found out there, in high seas") and the "raia-pedra"/ Bluntnose stingray ("rock ray") *H. say* ("its likes stony

bottoms"). The behavioral and physiological criteria reported by fishers indicate certain peculiar characteristics of some species, as observed for the "tubarão-boca-redonda"/Bull shark ("roundmouth shark") *C. leucas*, which emits sounds, making a lot of noise under the boat and is highly resistant when caught, even tearing nets or breaking longlines, the "electric ray"/Brazilian electric ray *N. brasiliensis*, capable of producing painful electrical discharges that leave fisher body parts numb for long periods of time, and the "raias-de-fogo" ("fire rays") Chupare stingray *S. schmardae* and Smalleyed round stingray *U. microphthalmum* that can leave irreparable injuries when piercing the human legs, arms or hands with their stingers (see Carvalho et al. 2019; Dias et al. 2016 and Junior et al. 2013).

These ethnotaxonomic fish identification patterns are also reported in other ethnobiological studies (Mourão and Barbosa-Filho 2018; Mourão and Nordi 2002, 2003; Pinto et al. 2016), but morphological criteria are generally the most employed in elasmobranch identification and naming (Barbosa-Filho et al. 2021; Carvalho et al. 2018; Pinto et al. 2016).

All the ethnospecies mentioned by the interviewed fishers match those mentioned in the preexisting literature (Almeida 2006; Almeida 2008; Araujo and Gonçalves 2006; Almeida et al. 2011; Barbosa 1951; Carvalho 1964; D'Abbeville 2008; Fortes and Galvão 2006; ICMBIO 2018; Marceniuk et al. 2020; Martins-Jura et al. 1987; Nunes and Santos 2006; Nunes et al. 2005; Nunes et al. 2011; Papavero et al. 2000; Silva and Paz 2006; Spix and Martius 1829; Stride et al. 1992), with the exception of the "raia-morcego"/Sharpsnout stingray *F. geijskesi*, which was also identified by the name "Carapirá" in the municipality of Carutapera. However, some fisher reports (65%; n = 205) indicate that they had never caught or seen a *P. pristis* or *P. pectinata* specimen throughout their years of fishing experience (e.g., "I only hear about this animal, but I've never seen it, I'd like to see it..."). The few reports (34.72%) concerning species of Pristidae function as historical records of the distribution of their populations, indicating occurrence and capture sites of these animals, since the information is brought by the oldest fishers in the region and indicate a long time since the last time these animals were seen ("...but it has been a long

Table 5 List of ray species with the number of synonyms, relative frequency (Fr%) and percentage of citations by artisanal fishers from the Brazilian Amazon Coast.

Nº	Ray	Common names	Fr%	% Citations
1	*Hypanus guttatus* (Bloch & Schneider, 1801)	9	15.00	6.92
2	*Pristis pristis* (Linnaeus, 1758)	5	8.33	3.85
3	*Pristis pectinata* (Latham, 1794)	5	8.33	3.85
4	*Mobula birostris* (Walbaum, 1792)	4	6.67	3.08
5	*Mobula hypostoma* (Bancroft, 1831)	4	6.67	3.08
6	*Rhinoptera bonasus* (Mitchill, 1815)	4	6.67	3.08
7	*Fontitrygon geijskesi* (Boeseman, 1948)	3	5.00	2.31
8	*Hypanus say* (Lesueur, 1817)	3	5.00	2.31
9	*Gymnura micrura* (Bloch & Schneider, 1801)	3	5.00	2.31
10	*Urotrygon microphthalmum* Delsman, 1941	3	5.00	2.31
11	*Urotrygon venezuelae* Schultz, 1949	3	5.00	2.31
12	*Aetobatus narinari* (Euphrasen, 1790)	3	5.00	2.31
13	*Styracura schmardae* (Werner 1904)	3	5.00	2.31
14	*Hypanus marianae* (Gomes, Rosa & Gadig, 2000)	2	3.33	1.54
15	*Narcine brasiliensis* (Olfers, 1831)	2	3.33	1.54
16	*Pseudobatos percellens* (Walbaum, 1792)	2	3.33	1.54
17	*Pteroplatytrygon violacea* (Bonaparte, 1832)	1	1.67	0.77
18	*Hypanus berthalutzae* Petean, Naylor & Lima 2020	1	1.67	0.77
TOTAL		**60**	**100.00**	

time since they appears in these waters"; "About three years ago one appeared here, half a meter in size..."). Fishers from Batoque Beach in the state of Ceará, northeastern Brazil, reported that the sawfish *P. pristis* has not been observed in the region for over 40 years (Pinto et al. 2015). In general, fisher reports indicate how much these species have been suffering population declines over the years. Feitosa et al. (2017) recorded 23 sawfish catches in the region Maranhão Amazon coast between 1984 and 2016 and demonstrated that the degradation of these species' habitat through mangrove deforestation, pollution and strong artisanal fishing pressures are the main factors responsible for the observed declines.

The high diversity of common names used in Brazil to designate fish species is a challenge for adequate collection of fish landing data (Freire and Pauly 2003). In this sense, the designation of a certain species by several popular names, as well as the use of the same epithet to refer to different species, makes it difficult to record species-specific fish in existing landing monitoring systems, a fact that limits the possibilities for assessing the impact of fisheries on fishery resource populations (Freire and Pauly 2005). For example, the ethnocategory "cação" is used to designate a multitude of scientific species from different shark families, and this category is usually used in regional fisheries monitoring systems in Brazil to group all locally caught shark species (Freire and Pauly 2005; Barbosa-Filho et al. 2021). Such a procedure is not very useful in terms of fisheries management, as it makes a basic assessment of the population dynamics of the different fishing resources exploited over time unfeasible (Freire and Pauly, 2003), a fact that strongly restricts the possibilities of the Brazilian State to adequately manage the fishing for elasmobranchs.

It is verified that, in Brazil, it is usual to group the fishing landings of elasmobranchs under the generic categories "cações" and "arraias" in several official documents such as evaluations of landings carried out by the public authorities, as well as in research reports and scientific articles (Barbosa-Filho et al. 2021; Medeiros et al. 2022). It is possible that the challenges inherent in the taxonomic identification of elasmobranch species, the fact that sharks are normally landed eviscerated and headless, and the possible negligence of researchers and fisheries managers in carrying out a thorough job of identifying the landed elasmobranch species, culminate for this scenario. Given this context, for a more adequate management of the elasmobranch fishery in the country, it is essential to link academic knowledge from scientists and fisheries managers with those related to the ethnotaxonomy developed by fishermen for the construction of a landing data collection system more judicious and fruitful, that is, that seek to carry out the species-specific identification of the captured animals.

Conclusion

The diversity of common names used to identify different shark and ray species from the Brazilian Amazon Coast is a consequence of the high miscegenation rates that took place between Indigenous and settler populations during the colonization process. This linguistic richness is easily observed by homonyms and synonyms that reflect a series of ethnotaxonomic characteristics employed for species identification. The use of these common names facilitates traditional fishing community communication with consumers and civil society. On the other hand, this is one of the main difficulties regarding correct species identification. Thus, constant updates concerning common names should take place, in order to standardize species nomenclature in the region. Finally, fisher knowledge regarding shark and ray names can contribute to basic information on elasmobranchs captured throughout the coast of Maranhão and species-specific recognition in fishing landing monitoring systems, generating subsidies for the development of conservation and management plans for these fishery resources.

Author contributions section

KKFC and JLSN, conceived and planned the study; KKFC, GR, MLVBF, NW, AROPN and JLSN reviewed and analyzed the data; KKFC, GR, AMB, MLVBF, NW, RMSB, AROPN and JLSN wrote the paper.

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Declarations

Permissions: This research followed the guidelines set by the Declaration of Helsinki and Tokyo for humans and was approved by the Human Ethics Committee of the Federal University of Maranhão (UFMA - nº 3717163 - CAAE 25628919.9.0000.5087), Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA; SISBIO - nº 60306-1) and the State Secretariat for the Environment and Natural Resources (Superintendence of Biodiversity and Protected Areas; SEMA-MA - nº 00397/2019). All interviewees signed a Free and Informed Consent Term (FICT).

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Conflicts of Interest: None declared.

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