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Ethnotaxonomy of Sharks by Expert Fishers from South Bahia, Brazil: Implications for Fisheries Management and Conservation

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ABSTRACT

Historically, Brazilian fisheries management has not considered the knowledge of fish taxonomy from within fishing communities. This study points out processes of recognition, classification and nomenclature of sharks achieved by fishermen from South Bahia, Brazil. Data were obtained through semi-structured interviews visually stimulated by exhibiting images of 30 species of elasmobranch fishes. Regionally, elasmobranch species are inserted into the folk taxon called "leather fishes" and in a category known as *"cação"* (shark) family. In addition to hierarchical classification, the fishermen organize shark species by adopting an ethnodimorphic and sequential model based on ethnoontogeny. Ethnodiagnostic characteristics are mainly related to the morphology, ecology and even physiology of a species. A total of 144 epithets is recorded, with a mean value of 4.8 ethnospecies for each scientific correspondent. Richness of vernacular names impedes species-specific information gathering regarding shark landings if fisher knowledge is not considered and applied in the improvement of fisheries data. Thus, this study encourages the employment of fishermen as parataxonomists in order to assist in the identification of sharks to specific levels. This study further emphasizes the potential of using ethnotaxonomic knowledge of fishing communities in initiatives related to participative management of shark fisheries in developing countries.

Keywords: Elasmobranch Fishes; Fisheries Statistics; Folk Taxonomy; Parataxonomists.

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SIGNIFICANCE STATEMENT

The manuscript describes the ethnotaxonomic knowledge of traditional fishermen of southern Bahia with respect to sharks. The study area is part of a region considered a hotspot of elasmobranch fish biodiversity. The main contribution of the manuscript is to demonstrate the ability of traditional fishermen to identify shark species in catches, which represents a great challenge even for scientists. In Brazil, as in other developing countries, fishing landing statistics usually do not report shark catches at the specific level, a situation that limits the potential for their proper management and conservation. The use of fishermen's knowledge can facilitate the identification of these fish at a specific level at landings. In this way, we emphasize the potential of including fishers as parataxonomists in fishery landing systems, a fact that, in addition to generating work and income for them, may contribute to strengthen partnership relationships with scientists.

INTRODUCTION

Human beings classify things into groups by their similarities and differences (Raven et al. 1971; Mishler and Donoghue 1982). Taxonomies are a result of the scientific classification of organisms. Folk taxonomy is a system of the vernacular nomenclature that diverges from scientific taxonomy as it reflects the experience, goals and values of people. Moreover, it works as a convenient tool in obtaining information about the natural world, displaying ways in which people observe the environmental components, and their perception and comprehension of nature as a whole (Ellen 1993; Atran 1998; Gould 2001; Beaudreau et al. 2011). Folk taxonomy is considered a hierarchical metaphor that includes notions associated to category, level and contrast, and additionally serves as a guide to decode the natural world and involves the mental processes when compared to those of modern Science (Maffi 1999; Medin and Atran 2004).

Naming of live animals in folk taxonomy is a process that confers contextual significance to objective continuities and discontinuities in nature. It is essentially similar in every language and it is based on a small number of nomenclatural principles (Berlim et al. 1973). Atran (1990) states that knowing the vocabulary of a certain local population is the first step for accessing information related to a variety of cognitive domains that comprise the human mind. It also represents an indirect approach to the formation and diffusion of concepts related to the studied context (Atran 1990). Conklin (1962) was one of the pioneers to prove the existence of similar taxonomic structures among many traditional human groups, opening means to investigate the existence of universal biological taxonomic structures.

Berlin (1973) established three main areas of study in folk taxonomy: classification (related to principles of organization of organisms), nomenclature (related to principles of linguistics employed for naming folk classes), and identification (related to the study of relationships between characteristics of individuals and classification). According to this author, ethnobiological classifications consider the principle of universality between different cultures in which there are regularities for the classification and nomenclature of plants and animals among traditional populations. Some ethnobiological principles of classification and nomenclature were suggested by Berlin (1973) to identify similarities among cognitive systems in various societies. Berlin (1992) established six hierarchical categories (king, life form, intermediate, generic, specific and varietal), according to the existence of a basic plan of nature in which human beings of any area of the world would be similarly affected by the remarkable aspects of the morphology of plants and animals.

Studies of folk taxonomy in fishing communities began during the 1960s (e.g. Morril 1967). Freire and Carvalho-Filho (2009) pointed out that richness of epithets employed for naming reef fishes is a result of the Brazilian cultural diversity, with a mean value of 7.2 names per species when examining vernacular names of 547 local species. Miscegenation between indigenous, African and white populations assigned ethnographic and linguistic richness to the fisheries culture in Bahia State, Brazil (Ott 1944). The Brazilian Federal Government considers the south region of Bahia State as a priority area for conservation of coastal and marine biodiversity (MMA 2002), as it bears the most extensive coral formation in the South Atlantic Ocean and it provides habitat to almost 300 fish species (Dutra et al. 2005). Previero et al. (2013) pinpointed this region as a hotspot for common fish names and designated it as a Tower of Babel to highlight the challenges of fishery monitoring in the region. These authors noticed that the category of the generic common name "cação" (shark) contained the highest number of specific epithets. Phenotypic similarity is intrinsic within 500 valid species of sharks (Compagno 2005), which disrupts worldwide monitoring of fish landings to species level. Estimation of population sizes of landed species is challenging. This is especially evident in the artisanal fisheries where landing logbooks or observer sheets are not available aboard fishing vessels. In Brazil, for instance, shark landing data are provided at the categories of class and order in more than 90% of the available monitoring landing systems (Fischer et al. 2012), even though

the country is considered a shark biodiversity hotspot (Lucifora et al. 2011). Thus, fishery scientists and decision-making specialists have the challenge of suggesting alternatives to reverse this obstacle for management and conservation purposes of the group along the Brazilian coast.

Informalities and non-existence of historical series of capture data from small-scale fishery landings make it unfeasible to accomplish satisfactory inferences about the population dynamics of species (Castello et al. 2007). These inferences are essential to support initiatives related to fisheries management (Sparre and Venema 1997). It is necessary to access as many sources of information as possible, including those provided by fishing communities (Costello et al. 2012). These communities bear valuable knowledge about the ecology and biology of exploited resources and they may collaborate directly to the development of public actions for fisheries management (Yaeger et al. 2017). Furthermore, their participation in decision-making processes as social actors contributes to the political and social empowerment of the fishing community in the engagement of the human and labor rights, and improvement of life quality. Even though ethnobiological knowledge of fishing communities has not been historically considered in the development of actions for fisheries management, several studies on ethnobiological knowledge of shark species have been conducted in recent years (e.g. Bizzarro et al. 2009; Powers et al. 2013; Barbosa-Filho et al. 2014; Barbosa-Filho et al. 2017; Humber et al., 2017). This study aimed to detect how recognition, classification and nomenclature of shark species are undertaken in the fishing communities from Bahia State, Brazil, in order to contribute to the management and conservation of elasmobranch fishes. The results indicate the potential to include ethnotaxonomic knowledge in the development of initiatives for sustainable fisheries of sharks on a broad scale.

MATERIAL AND METHODS

Sampling sites

Data collection was carried out in the municipalities of Ilhéus, Una and Canavieiras in Bahia State, which together comprise 164 km of the Brazilian coast. In this region, the continental shelf varies in extension, becoming broader in a north-south direction (Nascimento et al. 2007). Two main areas are defined here: the first area is situated North of Ilhéus municipality with its continental shelf comprising 11 km width; a second area located South of Ilhéus has the continental shelf width of 100 km near the Royal Charlotte Bank off the Canavieiras municipality (Nascimento et al. 2007). This variation facilitates the capture of many coastal, oceanic and shelf-associated shark species by the local fishermen.

There are at least 20 fishing communities in the study area. Ponta do Ramo, Mamoã beach, Ponta da Tulha, Barra do Itaípe, São Miguel, Prainha, Pontal, Cururupe, Olivença, Jairí beach and Acuípe communities are situated in Ilhéus municipality. Lençóis beach, Esperança farm, Pedras de Una, and Comandatuba Island are located in Una municipality. Puxim da Praia, Barra Velha, downtown area, Porto do Areal and Atalaia village belong to Canavieiras municipality. Fishermen with experience in shark fisheries are found in 13 fishing communities as illustrated in Figure 1.

Semi-structured interviews were conducted during February and October 2012 using a standardized survey questionnaire, according to Albuquerque et al. (2014). A total of 65 fishermen were interviewed, corresponding to 38 individuals in Canavieiras, two in Una, and 25 in Ilhéus. All interviews were recorded using a digital audio recorder, totaling 70.4 hours. Ethnobiological and ethnotaxonomic knowledge of shark species and ethnoecology of local fisheries were covered in the interviews.

Sampling is according to the checklist-interview method of Medeiros et al. (2014), showing pictures (Additional files) of target species to stimulate interviews. Printed images of 30 shark species were numbered in order to organize them sequentially according to phenotypic similarities and facilitate comparisons. The following questions were asked for each species:

1. Is this fish a shark?
2. What is the name of this species?
3. Why does the species have this name?.

Images illustrating the main diagnostic features of a species were preferably chosen when possible. Correspondence of common and vernacular names employed by the fishing community was verified with those available in the related literature (e.g. Brandão 1964; Figueiredo 1977; Queiróz and Rebouças 1995; Lessa and Nóbrega, 2000; Szpilman 2004; Freire and Carvalho-Filho 2009).

Images were taken from Fishbase (Froese and Pauly, 2006) and other resources that allow unlimited usage of intellectual property for scientific proposes. Preliminary interviews included 21 shark species indicated in Queiróz and Rebouças (1995) as occurring along Bahia coast. Four species additionally recorded in this area by Olavo et al. (2005) and Nunan and Senna (2007) were also included in the analysis. Three species of stingrays (Order Myliobatiformes) recognized in the study area as types of "cações" (sharks) were also included. Two species of sharks (*Galeorhinus galeus* (Linnaeus, 1758) and *Carcharias taurus*

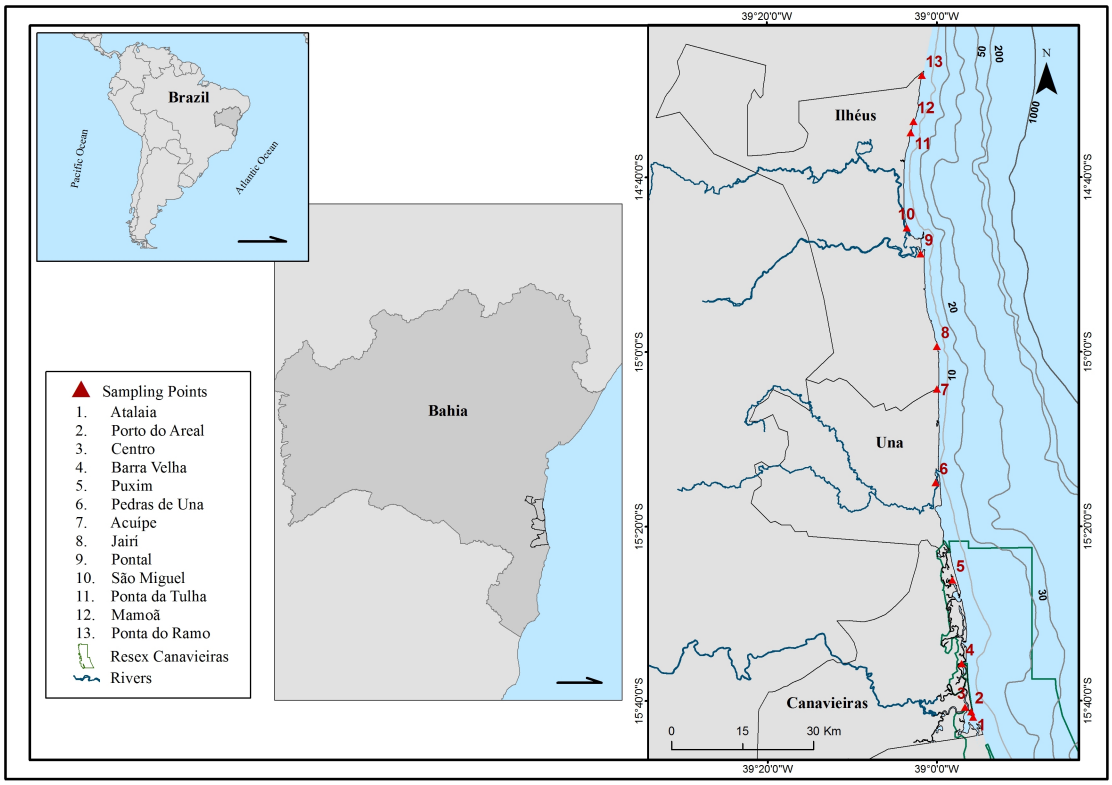

Figure 1. Map of Bahia State, Brazil, showing the fishing communities between Ilhéus and Canavieiras from which data were obtained.

(Rafinesque, 1810)) that not occur in the Brazilian Northeast region were selected to be, although they were included in analysis to serve as a control for testing species recognition by the local fishers.

The research followed the guidelines of the Declaration of Helsinki and Tokyo for humans, was approved by the Ethic Committee for Research with Human Beings of the Universidade Estadual de Santa Cruz (CAAE 01244412.3.0000.5526) and the informed consent was obtained.

Data analyses

Data were analyzed through principles of nomenclature and classification provided in Berlin (1992). A quantitative approach was applied through analysis of relative frequency of common names to designate each target species, to evaluate the ethnotaxonomic knowledge of the fishing communities. Principal common names are conventionally defined herein as those whose frequency corresponds to 15% ($n = 10$) of the interviews due to lack of consensus among interviewees for common names applied to different shark species. Constraints are generally related to (a) natural similarity among many species of sharks shown during collecting data, (b) excessive number of species included in the analysis, (c) historical and intermittent variation of common names applied to designate the same species among the adjacent fishing communities from Bahia State (Ott 1944), and (d) difficulty in recognizing species through a single picture.

RESULTS

Sharks are identified, named, and classified in detail in the fishing communities. According to the used classification system, sharks are inserted into the ethno-semantic domain called *"Peixes"* (Fishes). Marine fishes are sub-classified into two major folk taxa, according to the structure of tegument: *"peixes de escamas"* (scaled fishes) and "peixes de couro" (leather fishes). Sharks are inserted into the second group in a category known regionally as *"cação"* (shark) family.

Despite grouping sharks into a single major intermediate taxon called *"família dos cações"* in the ethnoclassification of the fishing communities, it was possible to verify the formation of sub-classifications from the ethno-biological level through morphological characteristics of the species. In Ilhéus, 10.8% ($n = 7$) of the fishermen reported the existence of *"família dos panã"* (hammerhead family) and *"família dos bico-doce"* (beak-like head family). The first subgroup comprises sharks of the genus *Sphyrna* whose

species have a head representing a *"chapéu"* (hat) or that show *"cabeça em forma de chapéu"* (hat-shaped head). The second sub-group comprises sharks of the family Carcharhinidae whose species exhibit head as a *"bico"* (pointed head), which is a classic shape frequently associated with this group of fishes.

"Família dos cações" (shark family) is a diverse group comprising 144 specific epithets in total with a mean value of 4.8 common names for each scientific correspondent. The lexeme *"cação"* accompanies the ethno-specific name, for instance, *"cação-gata"* or *"cação-viola"* for referring to specific folk. However, it is standard to employ the masculine definite article *"o"* (the) before the specific epithet even when it is a feminine noun in Portuguese such as *"o gata"* or *"o viola"*.

"Família dos cações" has 22 folk species when considering a minimum of 15% ($n = 10$) frequency of citations for a target species as principal common name. A list of target species of sharks, ethno-specific principal names, and number and frequency of principal common names are provided in Table 1. The sequence of species in Table 1 corresponds to the sequence of photographs shown to the interviewees.

Galeorhinus galeus and *Carcharias taurus* were not recognized by the fishermen. A model of ethnobiological classification for *"Família dos cações"* is proposed herein by applying Venn's diagram (Figure 2).

Besides hierarchical classification of sharks, the fishing communities group them by adopting a sequential model based on ethno-ontogeny and ethno-dimorphism. Different specific epithets were employed to designate the same species when considering various stages in the life cycle of these fishes. For instance, adult *Carcharhinus leucas* is known as *"cação-sucurupóia"* and neonates as *"cação-sucurupóia-galha-preta"*. Nomenclatural variation was also verified in a more general perspective, with different names being applied to sharks according to their life stage regardless of species. Thus, subsequent classification based on life cycle stage is observed for elasmobranch fishes, including *"lambinga"*, *"caçonete"*, *"cação"* and *"tubarão"*. For 36.0% ($n = 24$) of the interviewees, neonates are known as *"lambingas"* and have *"imbigo aberto"* which means an open umbilical cleft. *"Caçonetes"* are juvenile sharks for 63.1% ($n = 41$) of the fishermen. "Late juveniles are *"caçonete"*, right?" says R., 60 years old. *"Caçonete"* is used by 29.2% ($n = 19$) of the fishermen for adult specimens of species that reach five kg of maximum weight. Local fishing communities also often employ *"cação"* or *"cação grande"* (big shark) for specimens weighing more than 500 kg. The term *"tubarão"* (shark) is applied when a fisherman tells a story reported in the media showing sharks interacting with humans, or when a local community refers to large size specimens that are caught by the fishermen.

Elasmobranch fishes are also classified according to ethno-dimorphic characteristic. Fishermen can make sexual distinction among specimens by the presence or lack of *"esporões"* (claspers). "Two *"esporão"* are present in *"cação"* while *"caçoa"* is "flat", says M. 43 years old. *"Caçoa"* is employed to designate female specimens using the ethno-dimorphic criteria for this lexeme.

Interviewees considered 15 criteria for naming different folk species of sharks (Table 2). However, it was noticed that these criteria are much more detailed than those shown in the photographs. For instance, the epithet *"cação-de-choque"* refers to the particular physiological characteristic of *Narcine brasiliensis*, a species that produces electrical discharges. These results reveal that conspicuous characteristics that are considered for terminology in the fishing communities often addressed a few or at least a single species. Thus, these particular characters were not initially considered as criteria for naming ethnospecies.

Difficulties in monitoring shark landings at species-specific level are revealed in the control system of fish landing of the Fishermen and Aquaculture Community Z-34 in Ilhéus, which is the only control system available among the three studied cities. Members of this Community emphasized some duty limitations in the identification process based on catch data for landing logbooks (e.g. caught species, weight and price). For example, overworked employees that have other job duties in the community make identification of sharks using limited and inadequate equipment, and thus it contributes towards reducing their ability to make accurate identification of species. These limitations, along with intrinsic phenotypic similarity among shark species in the region, contribute to the exclusive assignment of the epithet *"cação"* to designate all landed species.

DISCUSSION

Ethno-taxonomic degree of identification, classification and nomenclature of sharks in fishing communities of South Bahia, Brazil, is related to a variety of locally employed models for species classification. According to the principles of hierarchical classification proposed by Berlin (1992), the ethno-semantic domain "Fishes" corresponds to the ethno-taxonomic Life Form level in the model of classification of these fishing communities and "scale fishes" and "leather fishes" are domains that coincide to the ethno-taxonomic Intermediate level. *"Família dos cações"* represents the Generic level, according to Berlin (1992). Individuals may use classification systems that are overlapping and independent from one another in certain hu-

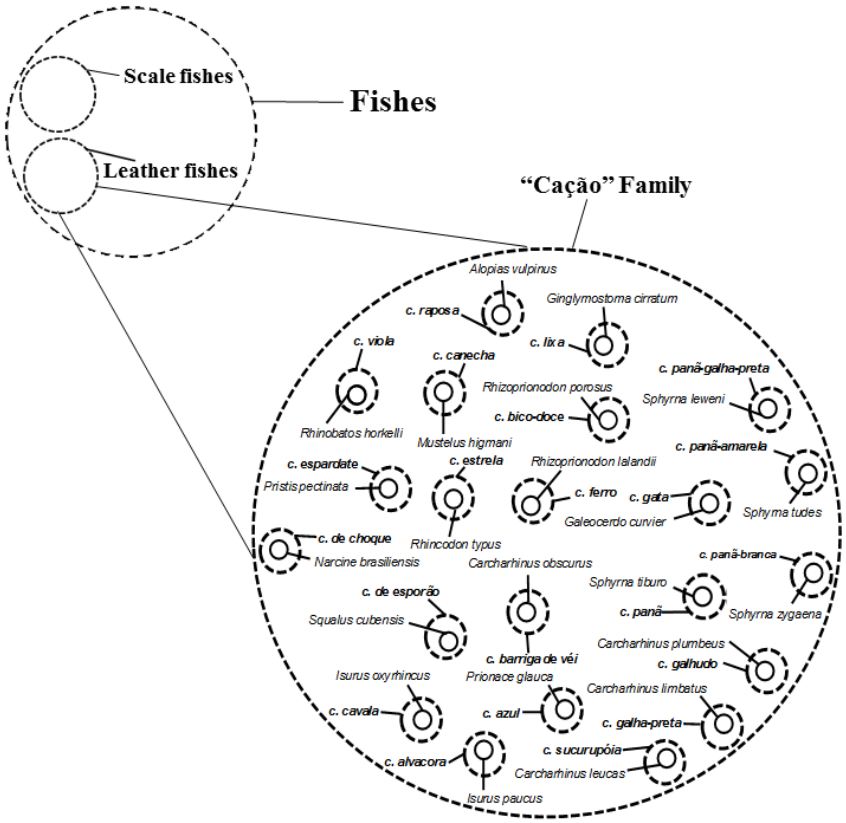

Figure 2. Diagram representing the hierarchical categories in the ethno-biological classification of *"Família dos cações"*, according to the fishing communities from South Bahia, Brazil.

man cultures. These ethno-biological classifications are called multidimensional classifications. Individuals use different taxonomic criteria at the stage of categorizing biotic elements of the ecosystem in this classification (Santos-Fita and Costa-Neto 2009), which explains why some fishermen consider subcategories in the *"família dos cações"*, including: *"família dos panã"* and *"família dos bico-doce"*. Morphological criteria (e.g. head shape) were used for subdivision in this case.

The generic taxon *"cação"* is polytypic and reveals high diversity. Mourão and Nordi (2002) stated that the occurrence of polytypic taxa might be related to the biological diversity in some regions. Mourão and Montenegro (2006) emphasized that generic and polytypic taxa represent categories with more economic, cultural and psychological importance within specific groups. The abundance of specifics within the generic *"cação"* indicates the great socio-cultural relevance of sharks in the local fishing communities. Comparative analysis of the folk and scientific classification systems revealed that the generic *"cação"* shows the correspondence called sub differentiation of type 2. A single generic folk taxon refers to two or more species from more than one scientific genus in this correspondence (Berlin 1973). However, Seixas and Begossi (2001) reported that the generic *"cação"* includes scientific species from more than one family for the coast of São Paulo State, and these authors further highlighted the rarity of this situation.

A high degree of polysemy and synonymy is observed in the studied area, which occurs when different common names are applied to the same specific folk within the studied group. A mean value of 4.8 common names per shark species is observed, representing a value higher than that observed in Previero et al. (2013) for Corumbau Marine Extractive Reserve in South Bahia, Brazil, with a mean value of 4.0 common names per species. A mean value of 6.0 common names per species of Brazilian marine fishes was indicated in Freire and Pauly (2005), who supported that the richness of these names is related to the commercial interest of certain species. Another contributing factor to the high number of synonyms within the generic *"família dos cações"* is the variation of common names applied for a single shark species among different fishing communities and cities.

Implementation of a sequential model based on ethno-ontogeny of fishes was verified in many studies related to the Brazilian artisanal fishermen (Mar-

Table 1. List of folk species of "cações" (sharks) cited in the fishing communities from South Bahia, Brazil ($n = 65$).

Family	Taxonomic identification	Ethnospecies ($\geq 15\%$)	%Citations	N Ethno-names
Alopiidae	*Alopias vulpinus*	cação-raposa	15.4	5
Carcharhinidae	*Carcharhinus acronotus*	–	-	6
	Carcharhinus falciformis	–	-	8
	Carcharhinus leucas	cação-sucurupóia	24.6	9
	Carcharhinus limbatus	cação-galha-preta	93.8	3
	Carcharhinus longimanus	–	-	6
	Carcharhinus obscurus	cação-barriga-de-véi	15.4	8
	Carcharhinus porosus	–	-	14
	Charcharhinus plumbeus	cação-galhudo	15.4	10
	Galeocerdo cuvier	cação-gata	43.1	10
	Negaprion bevirostris	–	-	15
	Prionace glauca	cação-azul	46.1	12
	Rhizoprionodon lalandii	cação-ferro	30.8	7
	Rhizoprionodon porosus	cação bico-doce	29.2	8
	Sphyrna lewini	cação-panã-galha-preta	43.1	10
	Sphyrna tiburo	cação-panã	55.4	13
	Sphyrna tudes	cação-panã-amarela	50.8	11
	Sphyrna zygaena	cação-panã-branca	27.7	11
Dalatiidae	*Isistius brasiliensis*	–	-	6
Ginglymostomatidae	*Ginglymostoma cirratum*	cação-lixa	90.8	2
Lamnidae	*Isurus oxyrinchus*	cação-cavala	30.8	5
	Isurus paucus	cação-alvacora	47.7	7
Narcinidae	*Narcine brasiliensis*	cação-de-choque	26.2	11
Odontaspididae	*Carcharias taurus*	–	-	5
Pristidae	*Pristis pectinata*	cação-espardate	67.7	6
Rhincodontidae	*Rhincodon typus*	cação-estrela	52.3	10
Rhinobatidae	*Pseudobatos percellens*	cação-viola	100	1
Squalidae	*Squalus cubensis*	cação-de-esporão	46.1	6
Triakidae	*Galeorhinus galeus*	–	-	7
	Mustelus higmani	cação-canecha	32.3	10

ques 1991; Mourão and Nordi 2002). Adult specimens of *Carcharhinus leucas* are designated as *"cação-sucurupóia"* while juveniles are known as *"cação-sucurupóia-galha-preta"* due to ontogenetic variation in coloration. Juvenile *Carcharhinus leucas* shows dark dorsal fins, a pattern not observed in adults (Szpilman 2004). Differentiation between males and females within fishing communities is relevant for conservation purposes when female specimens of sharks are still alive during capture. The release of live females of threatened species comprises an essential requirement for elasmobranch conservation (Vooren and Klippel 2005).

According to Marques (1991), implementation of a variety of models of biological classification aims to arrange nature, and demonstrates a strong capacity of patterning. Mourão and Montenegro (2006) underline that a sequential system of ethnobiological classification does not deprive the Berlinean hierarchical model (Berlin 1992) as the criteria related to fish size are simply semantic and comprise an universal basis among fishing communities. Perception and recognition of biological assemblages by human beings are based on shared similarities and differences among organisms in the academic and ethno-biological classifications. Thus, the development of skills for recognition of such variability is required.

Brazil is considered a hotspot with regards to the diversity of common names employed to identify local fish species (Freire and Pauly 2003). Despite interesting cultural and linguistic aspects, such nomenclatural diversity has a negative influence on the collection of national data from fish landings, as many captured species are not accurately registered (Freire and Pauly 2003). Inadequate understanding of both popular and scientific knowledge undermines the assessment of the local fishing impact on populations of commercially important fishes (Freire and Pauly 2005). The lexeme "cação" is third in the number of homonyms and has been employed to designate 20 scientific species of five different shark families (Carcharhinidae, Lamnidae, Sphyrnidae, Squalidae, and Triakidae) (Freire and Pauly 2005). This situation restricts possible monitoring of captured species in Brazil (Freire and

Table 2. List of classification criteria for different folk species employed by the fishermen ($n = 65$) from South Bahia, Brazil. A.f.: absolute frequency; R.f.: Relative frequency.

Criteria	A. f.	R. f. (%)	Example
Coloration	44	67.7	cação azul; cação panã-amarela; cação gata
Head shape	29	44.6	cação martelo; cação bico-doce
Fin coloration	27	41.5	cação galha-preta; cação panã-galha-preta
Body shape	24	36.9	cação viola; cação sucurupóia
Skin surface	8	12.3	cação lixa
Fin shape	8	12.3	-
Caudal fin shape	5	7.7	cação raposa; cação rabo-seco
Size	5	7.7	cação baleia
Eye length	5	7.7	-
Fin length	5	7.7	cação galhudo; cação ôreudo
Collecting site	5	7.7	cação de mangue; cação boca de barra
Eye color	5	7.7	-
Flesh color	4	6.2	-
Teeth absence	2	3.1	cação boca de véa
Behavior	2	3.1	cação sombreiro

Pauly 2003).

To improve the collection of data at species-specific level from fish landings of exploited species in the Fishing Community Z-34 in Ilhéus, technical and financial support from public fishing organizations is necessary. Moreover, implementation of new monitoring systems of artisanal fish landings in the studied region is imperative. Trained local specialists are efficient para-taxonomists, according to Santos-Fita and Costa-Neto (2007), as they assist with efforts related to the evaluation and documentation of biological diversity. Begossi et al. (2008) emphasized that interaction between taxonomic studies and fisheries management is critical, and they further encouraged the

Table 3. Ethical perspective related to the classification criteria for different folk species in the fishing communities from South Bahia, Brazil.

	Ethno-diagnostic characteristics
External characters	
Morphology	- shape of specimen and specific body parts (e.g. head, caudal fin); - total length of specimen and specific body parts (e.g. head, fins, eye); - presence of "esporões" (claspers); - thickness of skin; - body coloration or color of specific body parts, such as "costas" (dorsum), "barriga" (belly), "abas" (fins), and eyes; - pattern of spots
Inner characters	- presence/absence of teeth; - flesh color
Physiology	- ability to produce an electrical discharge ("cação que dá choque"); - flesh consistency after capture
Ecology	- spatial distribution in water column; - hydrographic distribution of species

inclusion of fishermen as para-taxonomists or para-ecologists in order to propagate local conservation efforts. In the regional scenario, the employment of experienced fishermen as para-taxonomists is encouraged, using didactic identification guides of species of fishes. The fishing communities would hence be responsible for identifying elasmobranch fishes to species level.

In fact, the restriction on monitoring species-specific shark catches can be observed around the world, especially in developing countries (Bornatowski et al. 2014). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) recognizes that the lack of taxonomists to identify the landed shark species is a challenge to the conservation of these fish and points to the need to develop friendly guides directed at non-experts and identification training for those involved in the fishery production chain (CITES 2014). The development and application of such lists have already been carried out in several regions of the world (Bonfil and Abdallah 2004; FAO 2014; FAO 2016). In addition, public training experiences have already been conducted to identify sharks. For example, several countries in the Indian Ocean, recognizing that the dificulty identifying elasmobranch species with catch restrictions, limits the possibilities of management and conservation of the group, requested FAO to carry out actions for training of fishery professionals and monitoring of shark fisheries (Bodiguel et al. 2017). Thus, between 2014 and 2016, three workshops were held in Mauritius, Seychelles and Reunion, where 150 professionals were trained in the taxonomic recognition and biological data collection of elasmobranch species captured in that region (Bodiguel et al. 2017).

Fisheries statistics depict a problematic scenario associated to the inclusion of some shark species in the official list of Brazilian aquatic threatened species, available in Portaria MMA No 445, 2014. Eight species examined in the present study are included in this list. *Carcharhinus longimanus* and *Rhicodon typus* are listed as Vulnerable. *Carcharhinus obscurus* is considered Endangered, and *Carcharias taurus, Galeorhinus galeus, Sphyrna lewini, Sphyrna tudes* and *Sphyrna zygaena* are listed as Critically Endangered. Any analysis associating the nomenclature of sharks from fishing communities and local fishery statistics is of great importance for management purposes or restrictions related to the exploited species. Contributions from fishing communities will be invaluable and appreciated in initiatives of this kind.

CONCLUSION

Fisher knowledge is refined and consistent with scientific knowledge. Under an ethno-taxonomic perspective, sharks are identified, classified and named in detail, although a variety of models of classification are employed. Richness of names to designate different folk species may hinder collection of species-specific information about shark landings in the region if this knowledge is not properly applied for the improvement of catch data. The name "cação" is used in the control system of fisheries landings by the Fishing and Aquaculture Community Z-34 in Ilhéus, as well as in previous Brazilian programs of fishery statistics. These results support that the identification of species is insufficient, indicating that the insertion of the ethno-taxonomic knowledge is a means to improve the fishery statistics. Thus, it will further contribute to promoting conservation actions in a more participative manner for those shark species caught in developing countries.

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DATA AVAILABILITY

The data used to support the findings of this research is available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The author has no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the idea: MLVBF, EMCN
Data analysis: MLVBF, MR
Wrote the first draft of the manuscript: MLVBF
Wrote the Final versions of the manuscript: MLVBF, MR, JSM, RSR, RRNA, EMCN
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