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Size matters: identity of culturally important herrings in northeastern Brazil

Thais Ferreira-Araújo[1,2,*]; Priscila Fabiana Macedo Lopes[3] and Sergio Maia Queiroz Lima[1]

ABSTRACT

Fishery statistics are mainly made by recording the popular fish names, which is later translated into scientific identification. However, these names often either refer to a species group and/or vary along their distribution, increasing identification uncertainty. Species that have cultural value for traditional communities are known as culturally important species (CIS). Herein, we assessed Fishers' Ecological Knowledge to investigate small-silvery herrings (*ginga*) used as part of a traditional dish "ginga com tapioca", that is recognized as a cultural heritage in the Brazilian northeastern. Through 103 interviews conducted in six communities in three states, we determined that *ginga*, although a name known elsewhere, is only traded as such in the metropolitan area of Natal. In this region, *ginga* is caught with drift net and deemed profitable by fishers. We identified both over- and under-differentiation, with *ginga* recognized by fishers as five, and sold as three main species, namely *Opisthonema oglinum, Harengula* sp., and *Lile piquiting*. The larger specimens of two of those species (*O. oglinum* and *Harengula* sp.) were also traded as sardines. We found that most individuals sold as *ginga* were juveniles, which might impact the recruitment of some fish species. Due to its unique cultural relevance to the local community of Natal, *ginga* could be considered a CIS, which could aid future management or conservation measures.

Keywords: Ethnozoology; Clupeiformes; Folk Taxonomy; Ginga; Southwestern Atlantic.

1 Laboratório de Ictiologia Sistemática e Evolutiva (LISE), Departamento de Botânica e Zoologia, Universidade Federal do Rio Grande do Norte, Natal, RN, 59078-970, Brazil.
2 Programa de Pós-Graduação em Sistemática e Evolução (PPGSE), Universidade Federal do Rio Grande do Norte.
3 Fishing Ecology, Management and Economics (FEME), Departamento de Ecologia, Universidade Federal do Rio Grande do Norte, Natal, RN, 59078-970, Brazil.
* Corresponding author ✉. E-mail address: TFP (thaisfpa94@gmail.com)), PFML (pmaccord@gmail.com), SMQL (smaialima@gmail.com)

SIGNIFICANCE STATEMENT

In this manuscript, we investigated the ethnoichthyology and taxonomy of *ginga* regarding its composition, exploitation size range, and the geographic range of this popular name. *Ginga* comprises multiple species of small herrings used as the main ingredient of a widely popular and traditional cassava dish in Natal, on the northeastern coast of Brazil: "ginga com tapioca". Despite its cultural and fishing relevance, previous to this study, the fish species caught and sold as *ginga* or the geographic distribution of this common name were unknown. By unveiling this basic, but relevant information, our results can help support the accuracy of fisheries statistics and eventually the implementation of management measures by environmental agencies.

INTRODUCTION

Overfishing is one of the leading causes of declining marine fish stocks worldwide (Coleman and Williams 2002; Diamond 1984; Pauly et al. 2003). Yet, many overexploited species lack basic information, such as taxonomic identification (Carvalho and Hauser 1995; Ward et al. 2005), without which proper management can be compromised. One source of taxonomic uncertainty in fisheries regards the common names, which are often used in fisheries statistics, and their corresponding species (Freire and Pauly 2005).

The study of how traditional communities identify, label, and classify organisms is known as ethnotaxonomy or folk taxonomy (Berlin 1973). Understanding this knowledge is particularly important for organisms that are exploited under a popular name by local communities (Johannes 1998; Johannes et al. 1999). Additionally, ethnotaxonomy can provide guidance for conservation efforts, as fishers' Local Ecological Knowledge (LEK) can provide valuable insight into the diversity of species from locations lacking scientific knowledge (Begossi et al. 2008). Fishers' LEK assessment is an alternative to correctly associate common names to scientific species (Begossi et al. 2016; Freire and Pauly 2005; Seixas and Begossi 2001).

The richness of biological species does not necessarily correspond to an equivalent number of popular names. A popular name may correspond to more than one species, which is known as under-differentiation in the ethnotaxonomy literature (Berlin 1973; Seixas and Begossi 2001). One such example is the fish known as *pititinga* in Bahia state, northeast of Brazil, which includes several morphologically similar species of freshwater characiforms (Rodrigues et al. 2016). The opposite is also possible, when people assign different names to distinct life phases of a given species, resulting in over-differentiation (Berlin 1973). The blue runner *Caranx crysos* (Mitchill, 1815), for instance, is known in parts of Brazil as *manequinho, carapau*, or *xerelete*, depending on their life stage or size (Seixas and Begossi 2001). These inaccuracies seem most evident for small, abundant, silvery, and relatively cheaper fishery resources (Freire and Pauly 2005; Previero et al. 2013; Seixas and Begossi 2001), such as herrings, which may harbor several taxa under the same denomination.

Herrings are widely exploited worldwide for human consumption, fishmeal and fish oil, and as baitfish (Munroe and Nizinski 2003; Whitehead 1985). Although they tend to form large schools, have high fecundity and early maturity (Kindsvater et al. 2016), some species have been overexploited in the Atlantic and Pacific oceans (Clark 1976; Cushing 1992; Dickey-Collas et al. 2010; Jablonski 2007). Recently, Verba et al. (2020) assessed the exploitation status of fish species in the Brazilian Exclusive Economic Zone and among the six clupeid species analyzed, three are overexploited, one is fully exploited, and another has collapsed. This is worrisome because these fish are the main food source of several animals, including dolphins, sharks, marine birds, and commercially important fish species, such as tunas (Santos et al. 2014; Silvano and Begossi 2012, 2010). Thus, herrings, as forage and low trophic level fish, have a key importance in sustaining marine ecosystems by conveying production from plankton to larger predators (Pikitch et al. 2014; Smith et al. 2011).

In some places, herrings' cultural value goes beyond their socio-economic importance, such as sardines in Portugal (Braga et al. 2017; Instituto Nacional de Estatística 2012; Teixeira et al. 2016) and in Brazil (Braga et al. 2018; Coelho-Souza et al. 2012; Lessa et al. 2004). Species that have a high relevance for human culture can be considered "culturally important species" (CIS), which is a broader term compared to "cultural keystone species" (CKS) (Freitas et al. 2020). While CKS are organisms whose existence are crucial to the survival and identity of human cultures (Cristancho and Vining 2004; Garibaldi and Turner 2004), the CIS are those that have significant importance in a culture, but are not necessarily essential for its survival (Freitas et al. 2020). Nonetheless, the decline or overexploitation of CIS may negatively affect the subsistence and practices of traditional communities (Freitas et al. 2020).

In northeastern Brazil, in addition to the popular name *sardinha* (sardine), *ginga* is used for small herrings, but it is not clear whether it comprises juveniles of a single species (over-differentiation, if the adults receive a different name, as *sardinha*) or individuals of multiple species (under-differentiation). *Ginga* is part of what may be one of the most important traditional local dishes, the "ginga com tapioca" (small fried fish inside a cassava flour pancake). This dish was declared an intangible cultural heritage in Rio Grande do Norte state (RN) due to its cultural and touristic value (Rio Grande do Norte 2019). In the days prior to the existence of the local dish (created between 1950-1960), these small fry fish used to be discarded by fishers (Dantas 2015; Lima et al. 2016). To date, no ichthyological study has been conducted to identify which species are actually traded as *ginga*. The only information available suggests that *ginga* are mainly sardines (clupeids), but it can also include anchovies *Anchoviella lepidentostole* (Fowler, 1911) (Dantas 2015).

The trade of herrings under the name *ginga* precludes a better knowledge of multiple aspects relevant for fisheries management, including an accurate taxonomic identification of the species being caught, the quantities being harvested, and the stages of their

life cycle being preferentially targeted. This information would not only support future management, but also help in the effort made in recent years to reconstruct historical information on fisheries catch around the world, including Brazil (Freire and Oliveira 2007). Therefore, this study aimed to combine the identification of the geographical distribution of the popular name *ginga*, the perception of fishers about what species they identify as *ginga*, and the sampling of individuals in fish markets sold as *ginga*. Additionally, this study also provided information on artisanal fishing of herrings regarding gears, sale values, sizes being harvested, and purposes of the fishing. The hypotheses here were that *ginga* comprehends juveniles of more than one species, and that this name ia restricted to RN.

MATERIAL AND METHODS

Samplings

Interviews and fish sampling were conducted at six fish landing sites on the northeast coast of Brazil in three states: Rio Grande do Norte (samplings in Macau, Natal, and Baía Formosa municipalities, in the north, east and south parts of the state, respectively), Paraíba (Cabedelo), and Pernambuco (Recife and Fernando de Noronha, the latter an oceanic island) (Figure 1a). Although *ginga* is a cultural heritage of Rio Grande do Norte, we included two neighboring states (Paraíba and Pernambuco) to assess the geographical range of this popular name. In each site, we searched for traditional fishing communities and local fish markets to conduct the interviews and purchase fish.

We acquired fish specimens from Natal, Macau, and Cabedelo to assess which species were being caught and sold as *ginga* and/or *sardinha*. We did not purchase fish in Baía Formosa, Recife, and Fernando de Noronha because there were no *ginga* or *sardinha* being sold at the time of the sampling. A few specimens of *Harengula* sp. (locally called *sardinha*) were donated by fishers in Fernando de Noronha, where this species is used as bait, and rarely sold (Lopes et al. 2017) (deposited at UFRN, under the vouchers UFRN5645 and UFRN5646).

Even though we acquired *sardinha* in other localities, our analyses regarding fish composition and size are restricted to fishes bought in Natal, since it was the only sampling site where fish under the name of *ginga* was being sold. Specifically, we visited the fish markets of Natal on four different occasions (May, October, and December of 2018, and March of 2019). In each of these visits, we bought 0.5 kg of small silvery herrings, fresh or frozen, being sold either as *ginga* or *sardinha*. Although there are other popular names in the region for small herrings, as *arenque* and *manjuba*, these could not be bought separately because they are not commercially valuable species.

Individuals sold as *ginga* and *sardinha* were identified to species level, whenever possible, using the "Manual de Peixes Marinhos do Sudeste do Brasil: Teleostei 1" (Figueiredo and Menezes 1978) and the FAO Species Catalogue Vol. 7 Clupeoid fishes of the world (Whitehead 1985). Vouchers were deposited in the ichthyological collection of the Federal University of Rio Grande do Norte (UFRN). Samplings were conducted under the permits SISBIO nº 67671-1 and 30532-1. All interviews and fish samplings were conducted from March 2018 to July 2019.

Interviews and questionnaire

Prior to the interviews, we briefly explained the purpose of our study and asked if the fisher would like to participate. Those who accepted signed an informed consent form. The approaching procedure followed the recommendations of the Research Ethics Committee of the Universidade Federal do Rio Grande do Norte (CAAE 09901318.1.0000.5537). We tried to interview all fishers that were present at that moment we were in the fish markets and fishers' colonies. In addition, we followed fishers' indication of other fishers to be interviewed in these places. Most localities were visited more than once, except for Cabedelo, Recife, and Fernando de Noronha. In Natal, we interviewed fishers in the Redinha beach, which is the main locality for fishing *ginga* and just next to the public market of Redinha, a local and touristic site, better known for the making and commerce of "ginga com tapioca" (Lima et al. 2016).

The semi-structured questionnaire was elaborated in two sections (Add File 1). The first consisted of an identification board with photos of nine species of adults of small silvery forage fishes, one per species, so that the fisher would provide the popular name of each fish they recognized (Add File 2). The photographs corresponded to: *Opisthonema oglinum* (Lesueur, 1818), *Harengula* sp., *Sardinella brasiliensis* (Steindachner, 1879), and *Lile piquitinga* (Schreiner, Miranda & Ribeiro, 1903) of the Clupeidae family, *Lycengraulis grossidens* (Spix & Agassiz, 1829), *Cetengraulis edentulus* (Cuvier, 1829), and *Anchoviella lepidentostole* of the Engraulidae family, *Atherinella brasiliensis* (Quoy & Gaimard, 1825) of the Atherinopsidae family, and *Mugil* sp. of the Mugilidae family (sensu Fricke et al. 2019). These species, known to occur in the Brazilian northeastern coast, were selected based on their characteristics, specifically being small-sized, having a metallic silver body, and presenting schooling behavior (Nóbrega et al. 2015). All pictures were of adult individuals.

The second section of the questionnaire consisted of questions about fishing gear, purpose, and sale value of each popular name. For fishing gear, we used five category types: cast net, bottom drift net, surface drift net, hook and line, and beach seine. Regarding the purpose of fishing, the fisher could choose more than one of the four categories: fishing for his own use, which included fishing for subsistence and/or to use the fish as bait, and fishing for sale, which included sale for consumption and/or bait. At last, the fisher would choose how worthy that fishing was, taking into account their effort to catch that fish and how much they would make for it, if sold: very worthy, worthy, unworthy, and very unworthy. This questionnaire was conducted at all the six localities to check for divergence or convergence of popular names for these commercial herring species, and which species are sold as *ginga*.

Data analysis

To determine the geographic range of the name *ginga*, we analyzed the ethnoichthyological data and searched for which localities fishers recognized any of the species shown in the questionnaire as *ginga*. For its taxonomic range and composition, we considered the fisher's LEK data, meaning whether fishers, in each locality, said to know *ginga* and were able to identify it out of the pictures provided. We then compared the LEK's results to the species sold as *ginga* to check whether there is an agreement between what is recognized and what is sold. The distribution map was created using software QGIS 3.10.2 (QGIS Development Team 2020).

To establish if *ginga* comprised individuals being sold below the size at sexual maturity, we calculated the mean and median of the standard length (SL), from the tip of upper jaw or snout to the end of hypural plate (Miller and Lea 1972). We measured the most representative species of *ginga* that were also sold as *sardinha* and compared them to the ones taken from *sardinha* individuals acquired at the same sites. We then calculated the frequency distribution of fish size, by separating the size classes into 10 mm each. The size at first sexual maturity of the main species identified as *ginga* were determined according to the literature (Martinez and Houde 1975; Trindade-Santos and Freire 2015). Additionally, a Wilcoxon rank sum test was performed to verify whether the SL means of *ginga* and *sardinha* were significantly different. All analyses and graphs were done using the software R (R Development Core Team 2019).

RESULTS

Fishers' knowledge

A total of 103 interviews were conducted during the survey with the fishers at six localities (35 in Macau, 23 in Natal, 25 in Baía Formosa, four in Cabedelo, seven in Recife, and nine in Fernando de Noronha) (Figure 1). Except for one woman in Cabedelo, all fishers were men. These fishers were on average 50.4 ± 12.1 years old and had been fishing for 34.7 ± 14.1 years. About half (49%) of the fishers were born in the same place where they currently live and fish.

In the identification stage of the interview, fishers cited over 30 popular names for the nine species presented. The most cited were *sardinha* (sardine), *arenque* (herring), *ginga*, and *manjuba* (anchovy), respectively. The name *ginga* was cited in Natal, Macau, and Fernando de Noronha (20.3%). However, in Macau and Fernando de Noronha, despite its recognition, fishers stated that this fish only occurs in Natal. The name *sardinha* was cited by all fishers at all localities, and *arenque* was the second most cited common name (79.6%), followed by *manjuba* (25.2%) (Add File 3).

According to the fishers' identifications, we were able to assess the species comprising the popular name *ginga*, the focus of this study, but also the species identified as *sardinha*, *arenque*, and *manjuba* (Figure 1b). For the fishers, *ginga* was mainly composed of *Harengula* sp. (HAR) (44%), followed by *Anchoviella lepidentostole* (ANC) (24.8%), *Lile piquitinga* (LIL) (16%), and *Opisthonema oglinum* (OPI) (12%), all clupeids, except for the engraulid ANC. *Sardinha* was mainly composed by OPI (25%) and HAR (24.4%), and, to a lesser extent, *Sardinella brasiliensis* (SAR) (18.9%), *Cetengraulis edentulus* (CET) (15.9%), and LIL (9.3%) all belonging to Clupeidae, except CET that belongs to Engraulidae. Fish identified as *arenque* were mainly composed by *Lycengraulis grossidens* (LYC) (36.7%), followed by ANC (22.2%), CET (13.4%), SAR (9.3%), and *Atherinella brasiliensis* (ATH) (9.3%). LYC, ANC, and CET belong to Engraulidae, SAR to Clupeidae, and ATH to Atherinopsidae (Atheriniformes). Lastly, *manjuba* was composed of ANC (48.2%), SAR (13.8%), ATH (20.6%), and HAR (6.9%).

The fishing aspects of *ginga*, *sardinha*, *arenque*, and *manjuba* were assembled based on the fishers' answers (Figure 2). For *ginga*, its fishing characteristics were: caught with surface drift net (47%), a financially worthy catch (72.2%), and being caught mainly to be sold for human consumption (38.2%). *Sardinha* had the same characteristics: surface drift net (47.4%) gear, a worthy catch (50%), and sold for consumption

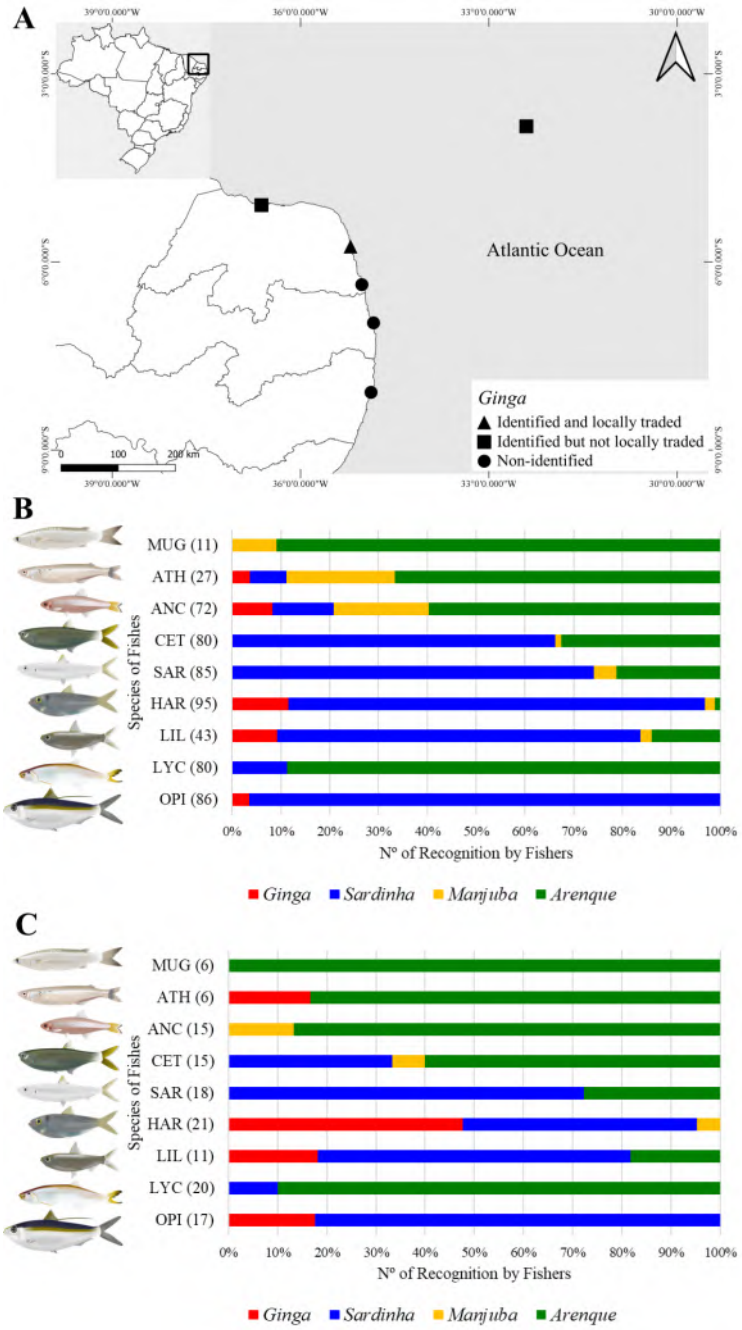

Figure 1. Map of sampling localities and graphs of fishers' LEK. A. Sites of interviews and fish specimens, sites in different shapes show where the popular name *ginga* was cited by fishers and where it was regularly traded; B. Common names assigned by fishers from northeastern Brazil (n = 103) according to photo plates; C. Common names assigned by fishers from Natal (n = 23) according to photo plates. The values on the x axis correspond to how many times the species was recognized as that common name, the total value for each is in parentheses. OPI = *Opisthonema oglinum*; LYC = *Lycengraulis grossidens*; LIL = *Lile piquitinga*; HAR = *Harengula* sp.; SAR = *Sardinella brasiliensis*; CET = *Cetengraulis edentulus*; ANC = *Anchoviella lepidentostole*; ATH = *Atherinella brasiliensis*; MUG = *Mugil* sp.

(33.6%). *arenque* and *manjuba*, on the other hand, were said to be caught mainly with beach seine (38.5% and 38.7%, respectively), being very unworthy (48%) or unworthy (50%) financially, respectively, and being

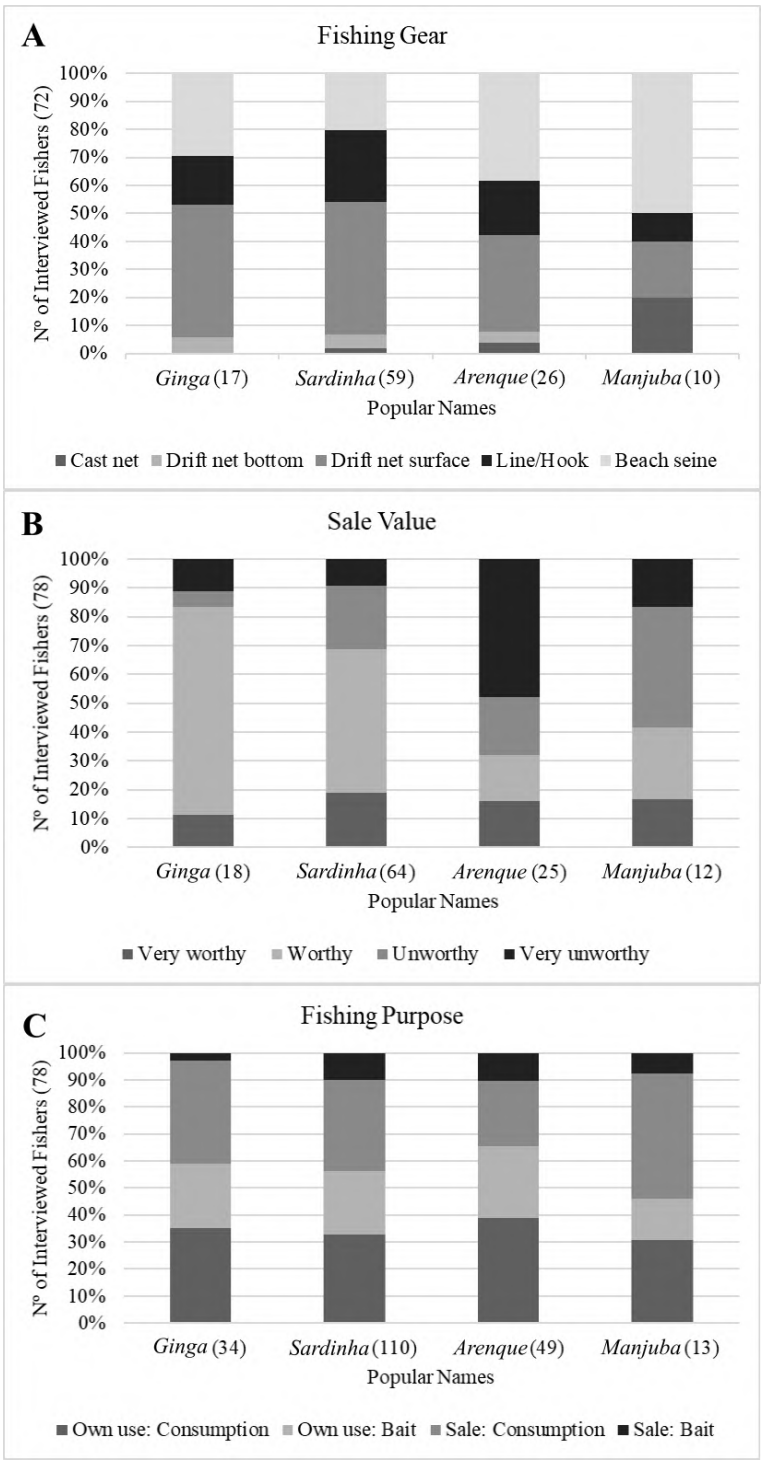

Figure 2. Fishing characteristics of herring fishes by their common names according to fishers from the northeastern coast of Brazil. Values between parentheses on y and x axes corresponds to total number of fishers that answered about that fishing characteristic and total number of answers for each popular name, respectively. A. Fishing gears used for fish popular names; fishers could indicate more than one gear. B. Sale value for each fish. C. Fishing purposes for each fish; fishers could indicate more than one purpose.

used for the fishers' subsistence (38.7% and 46.1%).

Size matters

Although we acquired fish specimens from four localities (Natal, Macau, Cabedelo, and Fernando de

Noronha) (Table 1), only in Natal we found both *ginga* and *sardinha* being sold; the other three places only sold (or caught as bait) *sardinha*. In Natal, we bought 248 individuals of *ginga* and 46 individuals of *sardinha*. Two species, *O. oglinum* and *Harengula* sp., were both sold as *ginga* and *sardinha* in Natal (Table 1).

Most specimens of ginga belonged to OPI ($n = 126, 50.8\%$), followed by HAR ($n = 51, 20.5\%$) and LIL ($n = 41, 16.5\%$), all clupeids, and a few specimens belonged to the engraulids ANC ($n = 11, 4.4\%$), LYC ($n = 9, 3.6\%$), *Anchoa* sp. (ANO) ($n = 5, 2.0\%$), and CET ($n = 4, 1.6\%$), and one individual of *Chloroscombrus chrysurus* (CLR) (0.4%) (Figure 3). Individuals sold as *sardinha* ($n = 46$) were HAR ($n = 32, 69.6\%$) and OPI ($n = 14, 30.4\%$).

Considering that the main species sold as *ginga* and *sardinha* were the same, we compared their sizes ($n = 218$) to check if the differences regarding these names were statistically significant. For HAR, the mean and median for individuals sold as *ginga* were 71.1 mm and 70.1 mm, respectively, and for the ones sold as *sardinha* were 103.7 mm and 100.1 mm, respectively. For OPI, mean and median for individuals sold as *ginga* were 78.8 mm and 79.9 mm, respectively, and for ones sold as *sardinha* were 165.4 mm and 186.6 mm, respectively. The Wilcoxon rank sum test indicated that the means of HAR and OPI sold as *ginga* and *sardinha* were significantly different, with *ginga* always smaller (Figure 4).

Most individuals of the main species sold as *ginga* were below the size at first sexual maturity, which are 78 mm of SL for *Harengula* sp. and 117 mm of SL for *Opisthonema oglinum* (Martinez and Houde 1975; Trindade-Santos and Freire 2015), ($n = 44, 91.6\%$ for *Harengula* sp.; $n = 123, 99.2\%$ for *O. oglinum*) (Figure 5). For fish sold as *sardinha*, all individuals of *Harengula* sp. ($n = 32$) were above the size at first sexual maturity and most individuals of *O. oglinum* ($n = 11, 78.5\%$) were above the size at first sexual maturity.

Among the 23 fishers interviewed in Natal, 13 fished *ginga*, most of them ($n = 10$) using some type of fishnet (beach seine, drift net or cast net) Figure 6. Additionally, few fishers stated that they used a specific type of fishnet, called *gingueira*, to catch small herrings. This fishnet has a smaller mesh size compared to the *sardinheira*, to catch sardines. Additionally, most fishers ($n = 11$) reported that they catch *ginga* to be sold, and few of them ($n = 7$) also retain a small amount for their own use.

The perception that fishers have about the species included under the popular name *ginga* is slightly different from what is actually sold in fish markets: individuals sold as *ginga* were mainly composed of *O. oglinum* ($n = 126, 50.8\%$) in markets, whereas fishers recognized ginga mainly as *Harengula* sp. ($n = 10, 62.5\%$) (Figure 1C). While four species (HAR, OPI, LIL, ATH) were indicated as ginga by fishers, at least seven (HAR, OPI, LIL, ANC, LYC, ANO, CET) were identified being sold as *ginga* in markets. In addition, fishers indicated no Engraulidae species and one Atherinopsidae species, but among the fish sold as *ginga* on markets, we identified four species of Engraulidae and no Atherinopsidae. Additionally, *ginga* seems to be a common name used exclusively in Natal's metropolitan area. Therefore, the *ginga* found in markets is the result of the artisanal fishing of juveniles of a few clupeid species that occur in coastal waters, which are captured by surface drift nets with small-sized mesh known as *gingueira*, have a medium sale value, and are mainly sold for consumption.

DISCUSSION

Small-silvery coastal fishes that form schools are identified as *ginga* by fishers in Natal, Rio Grande do Norte state. Particularly, the common name *ginga* is not associated with a specific fish species, but to the small size (about 70 mm SL) of a few fish species, most of them clupeids, but also some engraulids. This kind of correspondence is an apparent under-differentiation type II (Berlin 1973; Seixas and Begossi 2001). However, when we look at the popular names of both *ginga* and *sardinha*, we also observe an over-differentiation type I correspondence, because the same two species (*Harengula* sp. and *O. oglinum*) receive different popular names based on their size, with the smaller individuals named as *ginga* and the larger ones as *sardinha*. This interesting case, where we can observe both types of correspondence using the same popular name-species seems to be rare, yet not unique. One example is the *Caranx crysos*, which is known as an over-differentiation, but is also a case of under-differentiation correspondence for being recognized together with other species as *garajuba* in Ceará state (Pinto et al. 2013).

Most of the *ginga* traded were clupeids (82.3%), belonging majorly to three species *Opisthonema oglinum*, *Harengula* sp., and *Lile piquitinga*, although there were some engraulids as well, which supports the previous work that lacked scientific identification (Dantas 2015). The disparity between fishers' perception of the species that comprise *ginga* and what is actually sold as *ginga* may have been caused by the pictures of the fish species used in the interview. These were from adult individuals and had no size scale, whereas fishers associate *ginga* with small sized fish (juveniles). This hypothesis is supported by the fact that all smaller specimens compared to those species, such as *L. piquitinga*, were sold as *ginga*. It is also worth to note that half of the interviewed fishers were

Table 1. List of the species sold as ginga and sardinha in northeastern Brazil.

Species	Family	Name	Locality	Vouchers (UFRN)
Chloroscombrus chrysurus	Carangidae	Ginga	Natal, RN	5135
Harengula sp.	Clupeidae	Ginga	Natal, RN	5302,5309
Lile piquitinga	Clupeidae	Ginga	Natal, RN	5301
Opisthonema oglinum	Clupeidae	Ginga	Natal, RN	4790, 5134, 5308, 5547
Anchoa sp.	Engraulidae	Ginga	Natal, RN	5304
Anchoviella lepidentostole	Engraulidae	Ginga	Natal, RN	5133, 5303, 5549
Cetengraulis edentulus	Engraulidae	Ginga	Natal, RN	5305,555
Lycengraulis grossidens	Engraulidae	Ginga	Natal, RN	5132,5306
Harengula sp.	Clupeidae	Sardinha	Natal, RN	5548
Opisthonema oglinum	Clupeidae	Sardinha	Natal, RN	4791
Opisthonema oglinum	Clupeidae	Sardinha	Macau, RN	5053,5054
Lycengraulis grossidens	Engraulidae	Sardinha	Macau, RN	5055
Opisthonema oglinum	Clupeidae	Sardinha	Cabedelo, PB	4906
Harengula sp.	Clupeidae	Sardinha	Fernando de Noronha, PE	5645,5646

Legend: RN: Rio Grande do Norte state, PB: Paraíba state. PE: Pernambuco state.

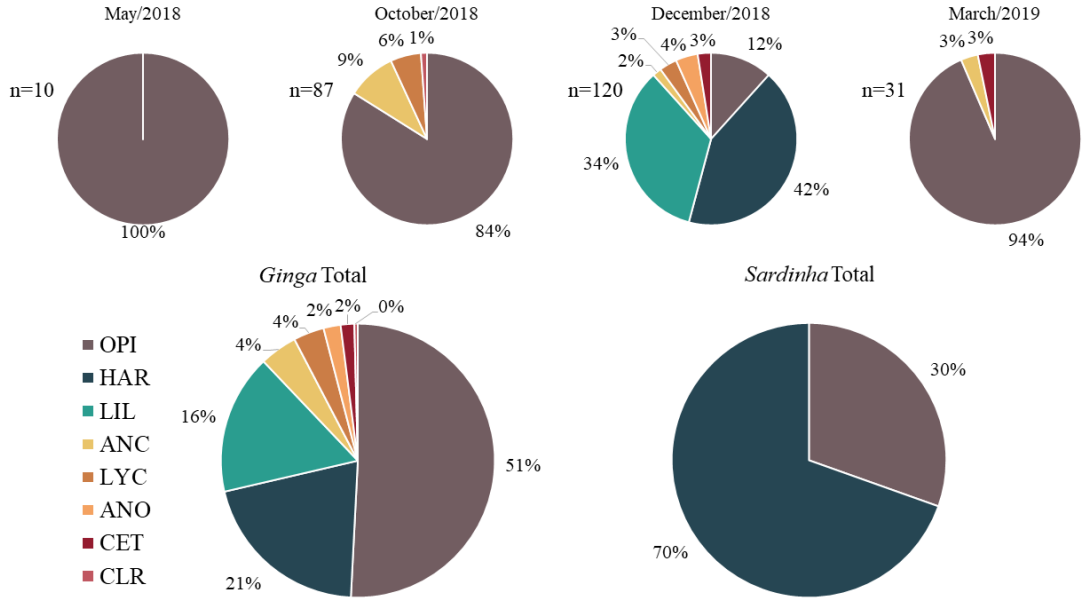

Figure 3: Species composition of fishes sold as ginga and *sardinha* in Natal, Rio Grande do Norte state. Species composition of *ginga* for each sampling and total, and of *sardinha* in total. OPI = *Opisthonema oglinum*; HAR = *Harengula* sp.; LIL = *Lile piquitinga*; ANC = *Anchoviella lepidentostole*; LYC = *Lycengraulis grossidens*; ANO = *Anchoa* sp.; CET = *Cetengraulis edentulus*; CLR = *Chloroscombrus chrysurus*.

not born in the same place where they currently fish. This might bias our results regarding the geographic distribution of the name *ginga*, since fishers that have recently moved to where they currently fish might be sharing knowledge from somewhere else. While in the past these small fish used to be discarded, the creation of a niche market in the last decades (Dantas 2015) led to a new type of directed (with the use of specific mesh size) and profitable fishing, according to the fishers. By making it popular, this market has possibly also increased the acceptance of these small fish in the local diet, as many fishers reported using *ginga* for their own consumption.

Yet, the popularization of *ginga* through a dish may also raise some concerns. Most individuals (97.1%) of *Harengula* sp. and *O. oglinum* sold as *ginga* were under the size at first sexual maturity, which could put pressure on juveniles. Catching fish that have not reached sexual maturity may decrease future catches, recruitment of fish stocks, and lead to

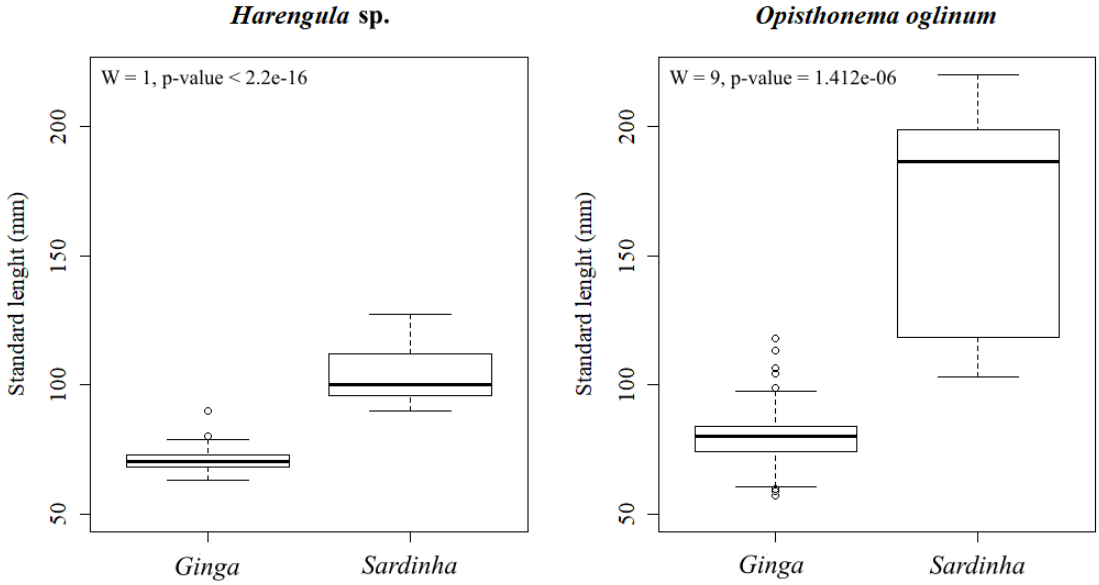

Figure 4: Boxplots of the standard length (SL) of *Harengula* sp. ($n = 80$) and *Opisthonema oglinum* ($n = 138$) sold as *ginga* and *sardinha*.

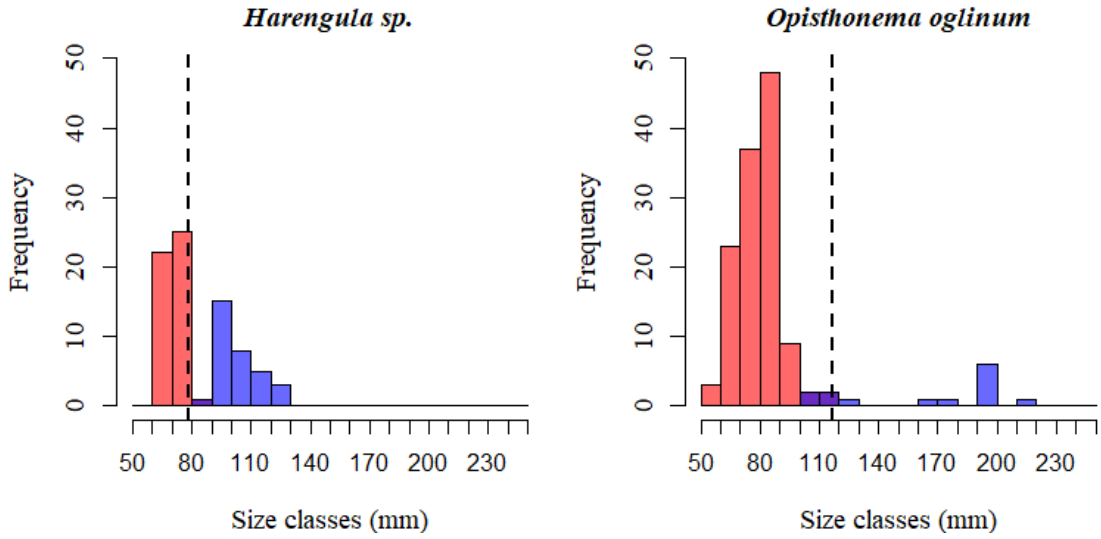

Figure 5: Frequency distribution of size of *Harengula* sp. ($n = 80$) and *Opisthonema oglinum* ($n = 138$) sold as *ginga* (light red) and *sardinha* (light blue). Dashed lines indicate the size at first sexual maturity. Purple indicates overlap between *ginga* and *sardinha*.

overexploitation (Crowder and Murawski 1998; Diamond et al. 1999; Najmudeen and Sathiadhas 2008). This can be especially problematic given that both *O. oglinum* and *Harengula* spp. (both *Harengula jaguana* Poey, 1865 and *H. clupeola)* are fully exploited and overexploited, respectively, in Brazil (Verba et al. 2020). While *O. oglinum* is mainly exploited by industrial fisheries, *Harengula* spp. is mainly exploited by small-scale fisheries (Verba et al. 2020). As clupeids are considered opportunistic strategists, their population dynamics respond quickly to changing environmental conditions and this makes them susceptible to rapid depletion when fishing pressure is intense (Kindsvater et al. 2016; King and McFarlane 2003). On the other hand, even if these concerns are valid and worth investigating further through annual or biannual stock assessments (King and McFarlane 2003), there are, at least, two counteracting factors

Figure 6: Pictures of Redinha beach, the birthplace of "ginga com tapioca", in Natal, Rio Grande do Norte state, Brazil. A. Non-motorized boats used by some fishers to catch *ginga*. B. Interview session with local fishers. C. *Ginga* being sold in a styrofoam box, it is possible to identify clupeids and engraulids among the fish. D. Fisher showing a fish specimen that corresponds to one of the fish photos used in the questionnaire. E. *Ginga* being prepared and cleaned by a fisher. F. The dish "ginga com tapioca", small fried fish skewered inside a cassava flour pancake. Pictures by TFA.

that could minimize the risks of juvenile overexploitation. The first one is that some studies suggest that species with high juvenile mortality, which is the case of most clupeids and engraulids (Kindsvater et al. 2016; King and McFarlane 2003), can have some fishing directed to this specific development phase with less risk to the stocks (e.g. Codling et al. 2005; Crouse et al. 1987). This fishing strategy can be successful as long as enough juveniles are left to grow and reproduce, which may not be the case if they are later intensively targeted as well. The second factor is that the fishing of *ginga*, and thus, of juveniles, is highly localized and restricted. In the remaining of the study sites, for example, there would be no concern with the targeting of juveniles. This is not to say that *ginga* should not be managed, but that this management should concern all species involved under this popular name, with specific assessments of where and how much of each development phase of these species are being extracted.

The association of these fish with the local and traditional dish "ginga com tapioca" makes *ginga* not only a food and economic resource but also a cultural asset of Natal. Even though its local notoriety was due to this association with the dish, *ginga* has reached quite a cultural and socio-economic relevance by itself. One example is the "Festival da Ginga", an entire festival dedicated to the celebration and culinary preparation of *ginga* (G1 2020). This festival happened for the first time in 2016 and its fourth and most recent edition was in February 2020 (Prefeitura do Natal 2016). Therefore, the main species (*Harengula* sp. and *O. oglinum*) associated to *ginga* could be considered CIS. CIS can play an important role in conservation and fisheries management, improving the odds of making conservation work (Freitas et al. 2020). Local communities may be more willing to participate and contribute to management measures that involve relevant organisms for them, such as CIS (Freitas et al. 2020; Noble et al. 2016). Therefore, having *ginga* as CIS could be a tool to promote local management strategies without much opposition, as it would be clearer that all parts could benefit from a niche market that delivers not only the maintenance of the local culture, but also sustainability.

CONCLUSION

Using LEK as a tool for gaining taxonomic knowledge of locally traded fish species is one way to tackle some of the most basic problems associated with fishing statistics: to actually know what is caught by fishers. Also, this source of knowledge is a valuable ally to management. Herein we identified that *ginga* is an assemblage of juveniles of different species (*O. oglinum, Harengula* sp., *L. piquitinga*, and few engraulid species), targeted exclusively in Natal, the capital of Rio Grande do Norte state. Fishing pressure on juveniles may be a threat to the maintenance

of fish stocks, which are already considered as fully exploited or overexploited, depending on the quantity caught. However, due to its local and artisanal level of exploitation, this pressure, on its own and with its current characteristics, is less likely to compromise these fish stocks. Finally, given its singular cultural importance to local communities, *ginga* could eventually be considered a CIS, which could facilitate any eventual conservation measure. Additional studies should be done to evaluate the impacts of fishing on juveniles and delimitate stocks, while *ginga* should also be promoted as a CIS to ensure the maintenance of this marine resource.

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DATA AVAILABILITY

Fish specimens are deposited in the ichthyological collection of Universidade Federal do Rio Grande do Norte. All remaining data (questionnaires, measures, etc.) used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: PFML, SMQL.
Carried out the experiment: TFA.
Carried out the data analysis: TFA.
Wrote the first draft of the manuscript: TFA.
Review and final write of the manuscript: TFA, PFML, SMQL.
Supervision: PFML, SMQL.

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Additional Files

Add File 1. Semi-structured questionnaire used during interviews with fishers to assess their knowledge about the common name of herrings and its fishing characteristics in northeastern Brazil.

Nome do entrevistador: _____ Data: _____
Cidade: _____ Comunidade: _____
Nome do pescador: _____ Naturalidade: _____
Idade: _____ Gênero: _____ Ano que começou a pescar: _____

Mostrar a prancha de ID e perguntar se o pescador conhece os peixes e por qual nome ele os conhece

- ⇨ **SE NÃO CONHECE:** Concluir entrevista.
- ⇨ **SE CONHECE:** Continue.

Qual peixe é a ginga? ❑OPI ❑LYC ❑LIL ❑HAR ❑SAR ❑CET ❑ANC ❑ATH ❑MUG ❑outro ❑não conhece

Qual peixe é a sardinha? ❑OPI ❑LYC ❑LIL ❑HAR ❑SAR ❑CET ❑ANC ❑ATH ❑MUG ❑outro ❑não conhece

Qual peixe é a manjuba? ❑OPI ❑LYC ❑LIL ❑HAR ❑SAR ❑CET ❑ANC ❑ATH ❑MUG ❑outro ❑não conhece

Qual peixe é a/o _____? ❑OPI ❑LYC ❑LIL ❑HAR ❑SAR ❑CET ❑ANC ❑ATH ❑MUG ❑outro ❑não conhece

Qual peixe é a/o _____? ❑OPI ❑LYC ❑LIL ❑HAR ❑SAR ❑CET ❑ANC ❑ATH ❑MUG ❑outro ❑não conhece

Gostaria que o senhor pensasse apenas sobre a pesca da GINGA:

Em que ano começou a pescar? _____ **Em que ano parou de pescar?** _____ *[❑ainda pesca]*

Qual tipo de pesca o senhor realiza?
Qual a quantidade normalmente pescada? _____ ❑ kg *[❑ outra unidade: _____]*
Tempo de pesca: ❑horas _____ Número de pescadores:_____
❑dias
Aparelho: ❑Rede espera: (❑Fundo❑Superfície) ❑Tarrafa ❑Rede arrasto: (❑Praia ❑Fundo) ❑Linha/Anzol ❑Outro: _____

Época do ano: ❑Jan ❑Fev ❑Mar ❑Abr ❑Mai ❑Jun ❑Jul ❑Ago ❑Set ❑Out ❑Nov ❑Dez

Qual o destino do peixe pescado: ❑Uso próprio para consumo ❑Uso próprio como isca ❑Venda para consumo ❑Venda como isca ❑Outro: _____

Para as próximas perguntas, considere a sua carreira de pesca inteira na pescaria.
Dada a sua experiência, o senhor diria que a quantidade de peixe (kg/ton):
❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe

Durante o seu tempo na pescaria, o senhor diria que o tamanho dos peixes:	❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe
Considere o custo de pescar, o tempo e esforço que leva para pescar, e o preço de venda dessa pescaria nos últimos anos em que pescou. O senhor diria que essa pescaria:	❑ Vale muito a pena ❑ Vale a pena ❑ Quase não vale a pena ❑ Com certeza não vale a pena

Gostaria que o senhor pensasse apenas sobre a pesca da SARDINHA:

Em que ano começou a pescar? _____ **Em que ano parou de pescar?** _____ *[❑ainda pesca]*

Qual tipo de pesca o senhor realiza?
Qual a quantidade normalmente pescada? _____ ❑ kg *[❑ outra unidade: _____]*
Tempo de pesca: ❑horas _____ Número de pescadores:_____
❑dias
Aparelho: ❑Rede espera: (❑Fundo❑Superfície) ❑Tarrafa ❑Rede arrasto: (❑Praia ❑Fundo)
❑Linha/Anzol ❑Outro: _____

Época do ano: ❑Jan ❑Fev ❑Mar ❑Abr ❑Mai ❑Jun ❑Jul ❑Ago ❑Set ❑Out ❑Nov ❑Dez

Qual o destino do peixe pescado: ❑Uso próprio para consumo ❑Uso próprio como isca ❑Venda para consumo ❑Venda como isca ❑Outro: _____

Para as próximas perguntas, considere a sua carreira de pesca inteira na pescaria.
Dada a sua experiência, o senhor diria que a quantidade de peixe (kg / ton):
❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe

Durante o seu tempo na pescaria, o senhor diria que o tamanho dos peixes:
- ❑ Aumentou
- ❑ Diminuiu
- ❑ Permaneceu igual
- ❑ Não sabe

Considere o custo de pescar, o tempo e esforço que leva para pescar, e o preço de venda dessa pescaria nos últimos anos em que pescou. O senhor diria que essa pescaria:
- ❑ Vale muito a pena
- ❑ Vale a pena
- ❑ Quase não vale a pena
- ❑ Com certeza não vale a pena

Gostaria que o senhor pensasse apenas sobre a pesca da MANJUBA:

Em que ano começou a pescar? _____ **Em que ano parou de pescar?** _____ *[❑ainda pesca]*

Qual tipo de pesca o senhor realiza?
Qual a quantidade normalmente pescada? _____ ❑ kg *[❑ outra unidade: _____]*
Tempo de pesca: ❑horas _____ Número de pescadores:_____
❑dias
Aparelho: ❑Rede espera: (❑Fundo❑Superfície) ❑Tarrafa ❑Rede arrasto: (❑Praia ❑Fundo)
❑Linha/Anzol ❑Outro: _____

Época do ano: ❑Jan ❑Fev ❑Mar ❑Abr ❑Mai ❑Jun ❑Jul ❑Ago ❑Set ❑Out ❑Nov ❑Dez

Qual o destino do peixe pescado: ❑Uso próprio para consumo ❑Uso próprio como isca ❑Venda para consumo ❑Venda como isca ❑Outro: _____

Para as próximas perguntas, considere a sua carreira de pesca inteira na pescaria.
Dada a sua experiência, o senhor diria que a quantidade de peixe (kg / ton):
❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe

Durante o seu tempo na pescaria, o senhor diria que o tamanho dos peixes:
- ❑ Aumentou
- ❑ Diminuiu
- ❑ Permaneceu igual

❑ Não sabe

Considere o custo de pescar, o tempo e esforço que leva para pescar, e o preço de venda dessa pescaria nos últimos anos em que pescou. O senhor diria que essa pescaria:

❑ Vale muito a pena
❑ Vale a pena
❑ Quase não vale a pena
❑ Com certeza não vale a pena

Gostaria que o senhor pensasse apenas sobre a pesca da _____:

Em que ano começou a pescar? _____ **Em que ano parou de pescar?** _____ *[❑ainda pesca]*

Qual tipo de pesca o senhor realiza?
Qual a quantidade normalmente pescada? _____ ❑ kg *[❑ outra unidade: _____]*
Tempo de pesca: ❑horas _____ Número de pescadores:_____
❑dias
Aparelho: ❑Rede espera: (❑Fundo❑Superfície) ❑Tarrafa ❑Rede arrasto: (❑Praia ❑Fundo)
❑Linha/Anzol ❑Outro: _____

Época do ano: ❑Jan ❑Fev ❑Mar ❑Abr ❑Mai ❑Jun ❑Jul ❑Ago ❑Set ❑Out ❑Nov ❑Dez

Qual o destino do peixe pescado: ❑Uso próprio para consumo ❑Uso próprio como isca ❑Venda para consumo ❑Venda como isca ❑Outro: _____

Para as próximas perguntas, considere a sua carreira de pesca inteira na pescaria.
Dada a sua experiência, o senhor diria que a quantidade de peixe (kg/ton):
❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe

Durante o seu tempo na pescaria, o senhor diria que o tamanho dos peixes:

❑ Aumentou
❑ Diminuiu
❑ Permaneceu igual
❑ Não sabe

Considere o custo de pescar, o tempo e esforço que leva para pescar, e o preço de venda dessa pescaria nos últimos anos em que pescou. O senhor diria que essa pescaria:

❑ Vale muito a pena
❑ Vale a pena
❑ Quase não vale a pena
❑ Com certeza não vale a pena

Gostaria que o senhor pensasse apenas sobre a pesca da _____:

Em que ano começou a pescar? _____ **Em que ano parou de pescar?** _____ *[❑ainda pesca]*

Qual tipo de pesca o senhor realiza?
Qual a quantidade normalmente pescada? _____ ❑ kg *[❑ outra unidade: _____]*
Tempo de pesca: ❑horas _____ Número de pescadores:_____
❑dias
Aparelho: ❑Rede espera: (❑Fundo❑Superfície) ❑Tarrafa ❑Rede arrasto: (❑Praia ❑Fundo)
❑Linha/Anzol ❑Outro: _____

Época do ano: ❑Jan ❑Fev ❑Mar ❑Abr ❑Mai ❑Jun ❑Jul ❑Ago ❑Set ❑Out ❑Nov ❑Dez

Qual o destino do peixe pescado: ❑Uso próprio para consumo ❑Uso próprio como isca ❑Venda

para consumo ❑Venda como isca ❑Outro: _____

Para as próximas perguntas, considere a sua carreira de pesca inteira na pescaria.
Dada a sua experiência, o senhor diria que a quantidade de peixe (kg/ton):
❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe

Durante o seu tempo na pescaria, o senhor diria que o tamanho dos peixes:	❑ Aumentou ❑ Diminuiu ❑ Permaneceu igual ❑ Não sabe
Considere o custo de pescar, o tempo e esforço que leva para pescar, e o preço de venda dessa pescaria nos últimos anos em que pescou. O senhor diria que essa pescaria:	❑ Vale muito a pena ❑ Vale a pena ❑ Quase não vale a pena ❑ Com certeza não vale a pena

Add File 2. Identification board with photos of nine species of small silvery forage fishes used during interviews with fishers to identify common names of each species.

Opisthonema oglinum

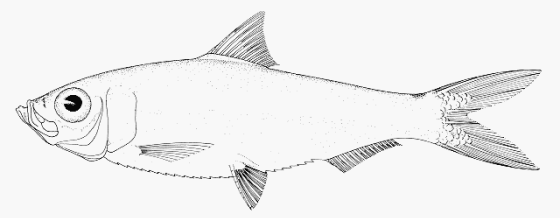
OPI

Lycengraulis grossidens

LYC

Lile piquitinga

LIL



Harengula clupeola

HAR

Sardinella brasiliensis

SAR

Cetengraulis edentulus

CET

Fonte: Vaske Jr., T.

Anchoviella lepidentostole

ANC

Atherinella brasiliensis

ATH

Mugil sp.

MUG

Add File 3. Localities of interviews and the common names of herring species that were cited by the local fishers in northeastern Brazil. % represents the percentage of fishers that cited each common name in a same locality.

Local (N of interviews)	***Ginga* (%)**	***Sardinha* (%)**	***Manjuba* (%)**	***Arenque* (%)**
Macau/RN (35)	6 (17.1%)	35 (100%)	8 (22.8%)	31 (88.5%)
Natal/RN (23)	14 (60.8%)	23 (100%)	4 (17.3%)	18 (78.2%)
BaĆa Formosa/RN (25)	0 (0%)	25 (100%)	7 (28%)	23 (92%)
Cabedelo/PB (4)	0 (0%)	4 (100%)	2 (50%)	1 (25%)
Recife/PE (7)	0 (0%)	7 (100%)	4 (57.1%)	7 (100%)
Fernando de Noronha/PE (9)	1 (11.1%)	9 (100%)	1 (11.1%)	2 (22.2%)
Total (103)	21 (20.3%)	103 (100%)	26 (25.2%)	82 (79.6%)

Legend: RN: Rio Grande do Norte state. PB: Paraíba state, PE: Pernambuco state.