Folk taxonomy of the gray mullets (Mugilidae: Mugiliformes) in a marine extractivist reserve of northern Brazil

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Fish local knowledge is important to recognize species and contribute to conservation and management strategies. Thus, our aim was to provide diagnostic information for the rapid identification of Mugilidae species in Caeté–Taperaçu Extractive Reserve in Bragança (PA) in northern Brazil. A total of 28 fishers were interviewed using semi-structured questionnaires. Most of the interviewees have lived in their resident village since birth and have been involved in artisanal fishers for at least 12 years. Eight generic folk taxa were identified, including 'tainha', which was the vernacular name most used to define the *Mugil* genus. Each scientific species had at least two folk generic taxa and one species. *Mugil curema*, *M. rubrioculus*, and *M. trichodon* were all included in the same ethnospecies, 'tainha chata'. Most of the scientific species were referred to at least once as the ethnospecies 'caica', this name was applied most often to *Mugil brevirostris*, which is the smallest species found in northern Brazil. The principal characteristics used by the fishers were morphological traits, however, some behavioral characteristics were also taken into account. These findings should contribute to the elaboration of ethnotaxonomic keys that facilitate the rapid identification of *Mugil* harvested by the region's artisanal and industrial fisheries.

Keywords: Amazon estuary, Artisanal fishery, Ethnotaxonomy, *Mugil*, Traditional knowledge.

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O conhecimento local sobre peixes é importante para reconhecer espécies e contribui para estratégias de conservação e manejo. Nosso objetivo foi fornecer informações diagnósticas para a rápida identificação das espécies de Mugilidae da região da Reserva Extrativista Marinha Caeté Taperaçu (PA), Norte do Brasil. Um total de 28 pescadores foi entrevistado por meio de questionários semiestruturados. A maioria dos entrevistados vive na sua aldeia residente desde o nascimento e está envolvida na pesca artesanal há pelo menos 12 anos. Oito táxons populares genéricos foram identificados por esses pescadores, incluindo 'tainha', que era o nome vernacular mais usado para definir o gênero *Mugil*. Cada espécie científica tinha pelo menos dois táxons genéricos populares e uma espécie. *Mugil curema*, *M. rubrioculus* e *M. trichodon* foram todos incluídos na mesma etnoespécie, 'tainha chata'. A maioria das espécies científicas foi referida pelo menos uma vez como etnoespécie 'caica', este nome foi aplicado mais frequentemente a *Mugil brevirostris*, que é a menor espécie encontrada no Norte do Brasil. As principais características utilizadas pelos pescadores foram os traços morfológicos, porém, algumas características comportamentais também foram levadas em consideração. Esses achados devem contribuir para a elaboração de chaves etnotaxonômicas que facilitem a rápida identificação de *Mugil* capturadas pela pesca artesanal e industrial da região.

Palavras-chave: Conhecimento tradicional, Estuário amazônico, Etnotaxonomia, *Mugil*, Pesca artesanal.

INTRODUCTION

The gray mullets, family Mugilidae, are pelagic fish that are often found in large shoals, and are exploited commercially in all the regions in which they occur (Menezes, 1983; Szpilman, 2000). Seven species (all members of the genus *Mugil*) are found on the coast of Brazil (Herbst, Hanazaki, 2014; Menezes *et al.*, 2015): *M. curema* Valenciennes, 1836, *M. incilis* Hancock, 1830, *M. brevirostris* Miranda Ribeiro, 1915, *M. trichodon* Poey, 1875, *M. curvidens* Valenciennes, 1836, *M. rubrioculus* Harrison, Nirchio, Oliveira, Ron & Gaviria, 2007, and *M. liza* Valenciennes, 1836.

In the northeastern extreme of the Brazilian state of Pará, *Mugil* is harvested primarily by artisanal fisheries, which use a range of different capture techniques and use these fish traditionally as a source of subsistence (Nascimento *et al.*, 2016). The captures are made by working partnerships or by members of the fishers' own families with incomes typically shared (Bentes *et al.*, 2012), and the characteristics and dynamics of the system are influenced by environmental characteristics (Maccord *et al.*, 2007; Silva *et al.*, 2012). Nascimento *et al.* (2016) verified the catches of Mugilidae between the years 2008 to 2010 where 4,755 landings from 270 vessels were recorded, accounting for a production of 358.9 tons in the Ajuruteua Peninsula, Pará.

The recognition of fish species by artisanal fishers is often based on generic empirical characteristics that are passed traditionally between generations, as well as certain behavioral traits, such as reproductive events and foraging patterns (Berlin *et al.*,

1973; Mourão, Nordi, 2002a). The recognition of species based on traditional fishers' classification can provide an essential tool for the identification of the ecological patterns (Previero *et al.*, 2013; Messias *et al.*, 2019) and the correction of fishery data that may have large catches landed (Herbst, Hanazaki, 2014; Tesfamichael *et al.*, 2014; Damasio *et al.*, 2015). Folk taxonomy, as used in the present study, is a field of ethnobiology that elucidates the principles of the classification and naming of species of organisms based on emic knowledge (Berlin, 1992).

In general, the traditional knowledge of fishing communities is rich in detail and is often consistent with scientific classifications, and is considered to be indispensable for scientific research (Atran, 1998; Clauzet *et al.*, 2005; Clauzet *et al.*, 2007; Ramires *et al.*, 2012a,b). Mourão, Nordi (2002a) found that a folk classification based on the local bioecological knowledge of fishers in northeastern Brazil was 71% consistent with the scientific taxonomy of the fish species. In 2014, Herbst, Hanazaki, registered life cycle patterns of mullets in Santa Catarina coast (Brazil) based in fishers' knowledge, thus, they found that mullets spawning occurs throughout the coast of the Santa Catarina State and they feed in lagoons and riverine systems but also out at sea during migration, adding to scientific knowledge the fishing and biological aspects, observing by fisher.

Although several recent studies have focused on the systematics and taxonomy of the mullet family Mugilidae, the identification of species or even genera is often difficult, and a number of controversies persist, which suggest the existence of cryptic species that may have been identified erroneously in some studies (Durand *et al.*, 2012; Konan *et al.*, 2014; Durand, Borsa, 2015; Xia *et al.*, 2016). The present study investigated the principal characteristics used by the artisanal fishers of the Caeté-Taperaçu Extractive Reserve in Bragança (Pará) in northern Brazil, to identify the mugilid species that occur in region, with the aim of compiling diagnostic tools for the rapid identification of these fish.

MATERIAL AND METHODS

Study location. The Ajuruteua coastal plain extends from Maiaú Point to the mouth of the Caeté River, covering an area of 1,570 km², which includes estuarine plains, coastal plateaus, and river, and part (652.7 km²) of the world's most extensive continuous mangrove domain (Souza-Filho, El-Robrine, 1996). The region has semidiurnal macrotides (amplitude > 4 m), a warm and humid climate, and mean annual precipitation of 2,000–3,000 mm. This region has one of the most productive fisheries in the Brazilian state of Pará (Seap/Prozee/Ibama, 2006; Isaac *et al.*, 2011).

The Caeté-Taperaçu Marine Extractive Reserve (RESEX) is a partially protected area located in the municipality of Bragança, northeastern Pará, Brazil. This protected area covers approximately 42,100 hectares, and is inhabited by traditional populations that obtain their livelihood primarily from artisanal fishing, and are encouraged constantly to participate in local management plans and to contribute to the development of practices and strategies that permit the systematic integration of traditional and scientific knowledge (Abdala *et al.*, 2012).

The study focused on two villages, Pescadores and Bonifácio, which are located within the Caeté-Taperaçu RESEX, on the left margin of Caeté Bay, 40 km from the town of Bragança (Pereira *et al.*, 2009) (Fig. 1). The two villages have approximately

392 permanent inhabitants, of which, 80% have no fixed income and rely on fishing for their subsistence (Pereira *et al.*, 2007; Gomes *et al.*, 2009; Monteiro *et al.*, 2009). The relevance of fishing for these communities, together with the local abundance of *Mugil*, determined the selection of this area for ethnotaxonomic research.
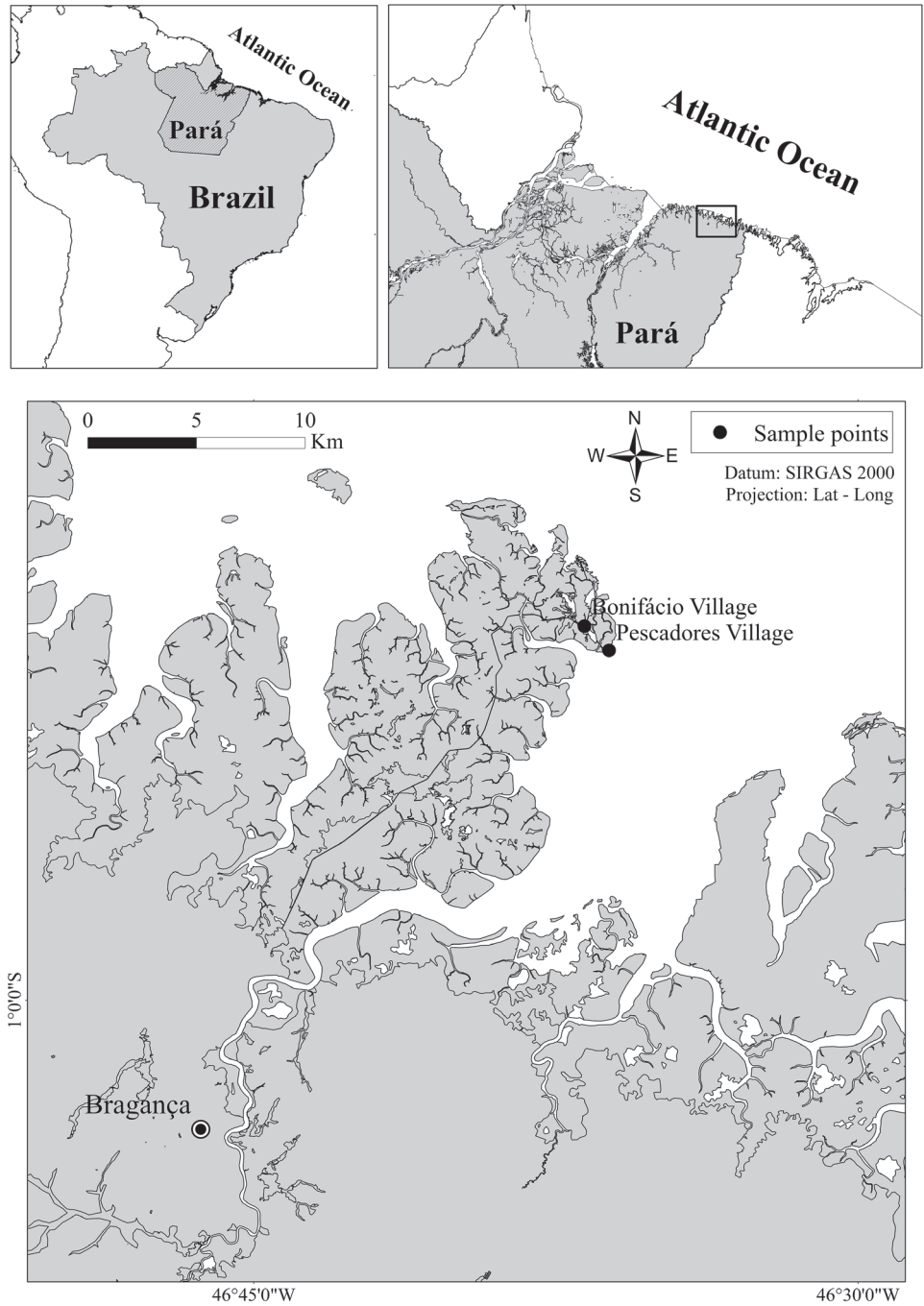
FIGURE 1 | Map of Ajuruteua Plateau, on the northern coast of Brazil, showing the two villages at which the ethnotaxonomic data on the fish of the family Mugilidae were collected in the present study.

Data collection. The data were obtained in interviews based on the application of semi-structured questionnaires (**S1**) (Albuquerque *et al*., 2010) that cover taxonomy (how they recognize the species; predominant characteristics and some behavioral aspects of the species), fishing (gear and ways of catch), and the bioecology of the local ethnospecies. Fishers of varying ages resident throughout both study villages (Pescadores and Bonifácio) were interviewed using the snowball method, which is used in non-probabilistic sampling, where each interviewee indicates the next person to be interviewed in the village, based on the assumptions of the study (Bailey, 1982; Bernard, 1995; Silvano *et al*., 2006; Albuquerque *et al*., 2010). The number of interviews is assumed to be adequate when no new information is added in subsequent interviews, that is, that the answers begin to be repeated.

During the interviews, each subject was shown a catalog of photographs of mugilid species (**S2**), always in the same order, and asked to name the body structures and indicate the principal differences among the species, identifying the ethnospecies mentioned previously. This approach facilitates the differentiation of the species by the interviewee (Begossi *et al*., 2008; Albuquerque *et al*., 2010). Although *M. margaritae* Menezes, Nirchio, Oliveira & Sicchramirez, 2015, a new mullet species from Venezuela described by Menezes *et al*. (2015), is not known to occur on the Brazilian coast, it was included in the interviews to certify its possible occurrence by the fishers.

All the interviews were applied with the prior consent of the subject, who was required to sign a free and informed consent term with the Sistema de Autorização e Informação da Biodibversidade (SISBIO). All the interviews were recorded using a portable Sony® recorder, so that specific questions could be reviewed during data processing (Mourão, Nordi, 2003). The terms used by the fishers to differentiate the ethnospecies are summarized for comparative purposes (Tab. 1). The local seasons were classified following Moraes *et al*. (2005), that is, the rainy season (known locally as the winter) lasts from December to July, while the dry season (the local summer) lasts from August to November.

Analyses. The data were analyzed qualitatively following the model proposed by Mourão, Nordi (2003), which is based on the compilation of a Venn Diagram (Hunn, 1976), which is used to compare the ethnotaxonomic arrangement with the scientific classification, and determine the proximity between the folk and scientific species of mullet (Mourão, Montenegro, 2006). A presence (1)/absence (0) matrix of the atributes used to identify the species was compiled to verify the principal characteristics used by the fishers to identify their ethnospecies.

A Redundancy Analysis (RDA) was run with a Monte Carlo permutation test (9999 permutations) to evaluate the statistical significance of the results. In the manual method, with a 5% error margin, the variables were included successively in the analysis, with the dependent variables being tested against each independent variable. The data were processed in Microsoft Excel 2010 spreadsheets and the RDA was run in CANOCO 4.54 (Software for Canonical Community Ordination) (ter Braak, Šmilauer, 2002).

TABLE 1 | Characteristics and equivalences used by fishers to describe the fish of the family Mugilidae in the Caeté-Taperaçu Marine Extractive Reserve in Bragança, northern Brazil. a: Technical characteristics, b: Equivalent characteristics according to the fishers interviewed.

Characteristic[a]	Emic equivalence in Portuguese[b]
Grows a lot, long body	Cresce mais, comprida
Short bodied	Corpo curto, menor
Narrower, more elongated body	Mais fina, mais esguia, mais esquia, mais aguda, mais longa
Rounded, fatter body	Mais larga, mais grossinha, mais redonda, mais grossa, corpo roliço, mais gorda
Big headed	Cabeça comprida, cabeça maior
Small headed	-
Broad, rounded head	Cabeça redonda, cara larga
Flat headed	Cabeça achatada
Narrow headed, beaked	Cabeça aguda, cabeça fina, cara aguda, cabeça bicuda
Small eyed	Olho miúdo, zolho miúdo
Large eyed	Olhos grandes, zolhuda
Red eyed	Olho cor de fogo
Large scales	Escama graúda
Small scales	Escama miúda
Scales close together	Escama mais junta, escama mais próxima
Back dark/blackish	Costa escura, meio preta
Stupid	-
Smart	Mais sabida
Jumps	-
Does not jump	-
Smells strongly	Cheiro bom, cheiro forte
No smell	-
Sexual dimorphism	Só macho, sempre macho, buchuda, ovada

RESULTS

Only two of the 28 fishers interviewed in the present study were woman. A majority of the interviewees (65%) have lived in their village of residence since being born, and have been involved in fishing for at least 12 years. The terminologies used to designate the body structures of *Mugil* were consensual in most cases, with no variation in the terms used to refer to the head, mouth, and scales. However, the fins were referred to as 'guias' by two interviewees, while the dorsal fin was denominated 'esporão' by three individuals (Fig. 2; Tab. 2).
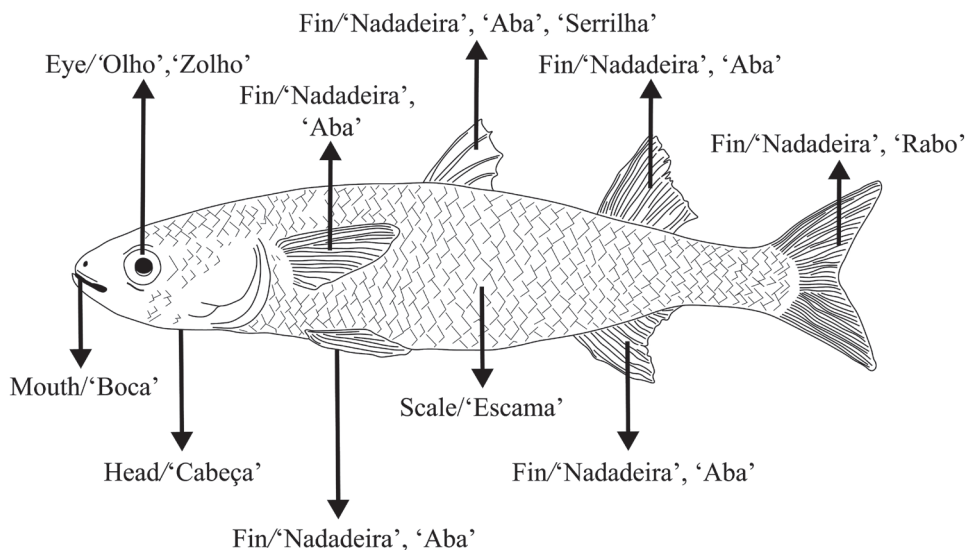
FIGURE 2 | Morphological features of a gray mullet (Mugilidae), showing the terminology used by the fishers of the Caeté-Taperaçu Marine Extractive Reserve in Bragança, Pará, Brazil.

TABLE 2 | Scientific species of *Mugil* genus with their respective vernacular names and number of reports by the fishers of the Caeté-Taperaçu Marine Extractive Reserve in Bragança, northern Brazil. Catalog of photographs of mugilid species to view of photographs of mugilid species used (see **S2**).

| Species	Ethnospecies	Number of reports	Characteristics in Portuguese
Mugil curema	'Tainha chata'	19	Pula, escama grande, cabeça grande e chata, mais larga, olhos grandes e vermelhos
Mugil brevirostris	'Caica'	16	Cresce pouco, escama e olhos pequenos, tem cheiro
Mugil rubrioculus	'Tainha chata'	15	-
Mugil margaritae	Does not know / occurs	12	-
Mugil incilis	'Tainha grande'	10	Cresce muito, cabeça grande e um pouco mais aguda, não pula, escama menor e mais próxima
Mugil trichodon	'Tainha chata'	9	-
Mugil trichodon	Does not know / occurs	8	-
Mugil incilis	'Caica'	6	-
Mugil liza	Does not know / occurs	6	-
Mugil curvidens	Does not know / occurs	5	-
Mugil liza	'Tainha curimã'	5	Cresce muito, cabeça e escama grande, meio preta
Mugil curvidens	'Tainha'	4	-
Mugil curvidens	'Tainha chata'	4	-
Mugil liza	'Tainha'	4	-
Mugil rubrioculus	'Tainha'	4	-
Mugil brevirostris	'Pratiqueira'	3	Cresce pouco, escama e olhos pequenos, tem cheiro
Mugil curema	'Tainha'	3	Cresce muito, escama e cabeça grande

TABLE 2 | (Continued)

|			
Mugil curvidens	'Tainha grande'	3	-
Mugil incilis	'Pratiqueira'	3	-
Mugil liza	'Tainha grande'	3	-
Mugil rubrioculus	'Tainha grande'	3	-
Mugil trichodon	'Tainha'	3	-
Mugil brevirostris	'Tainha chata'	2	-
Mugil incilis	'Caicão'	2	Mais esquia e cabeça mais comprida
Mugil margaritae	'Caica'	2	-
Mugil margaritae	'Tainha'	2	-
Mugil margaritae	'Tainha chata'	2	-
Mugil trichodon	'Caica'	2	-
Mugil trichodon	'Tainha grande'	2	-
Mugil brevirostris	'Caicão'	1	-
Mugil brevirostris	'Tainha'	1	-
Mugil brevirostris	'Tainha branca'	1	Escama pequena, cabeça chata e olhos grandes
Mugil curema	'Caica'	1	-
Mugil curema	'Pratiqueira'	1	-
Mugil curvidens	'Caica graúda'	1	-
Mugil curvidens	'Caicão'	1	-
Mugil curvidens	'Macharrão'	1	Macho
Mugil curvidens	'Pratiqueira'	1	-
Mugil curvidens	'Tainha curimã'	1	-
Mugil curvidens	'Tainha da costa preta'	1	-
Mugil curvidens	'Tainha de cabeceira'	1	-
Mugil curvidens	'Irichona'	1	Buchuda, ovada
Mugil incilis	'Ribação'	1	Cresce pouco, cabeça e olhos pequenos
Mugil incilis	'Tainha chata'	1	-
Mugil incilis	'Tainha macho'	1	-
Mugil liza	'Pratiqueira'	1	-
Mugil liza	'Tainha chata'	1	-
Mugil liza	'Tainha de pancada'	1	-
Mugil liza	'Irichona'	1	-
Mugil margaritae	'Filho da tainha'	1	Filhote da tainha
Mugil margaritae	'Ribação'	1	-
Mugil margaritae	'Irichoca'	1	-
Mugil margaritae	'Tainha ovada'	1	-
Mugil margaritae	'Tainha/Sajuba'	1	-
Mugil margaritae	'Caica tamatarana'	1	Lombo azul
Mugil rubrioculus	'Barrasco'	1	Curto, cresce pouco, sempre macho
Mugil rubrioculus	Does not know / occurs	1	-

A total of eight generic folk taxa (corresponding to the family Mugilidae) were identified and considered 'parentes' or relatives. In most cases, these taxa were monotypic, that is, they corresponded to a single folk species. Six *Mugil* species were recognized by the fishers: *M. brevirostris*, *M. curema*, *M. incilis*, *M. liza*, *M. rubrioculus*, and *M. trichodon*. However, *M. liza* and *M. trichodon* were designated as 'unrecognized' or 'absent from the region' in a large number of cases.

Each scientific species corresponded to at least three generic folk taxa and one folk species, however, the endings of the terms often overlapped. Six interviewees referred to *M. incilis* as the 'caica', for example, but ten others classified it as the 'tainha grande', while *M. curema*, *M. rubrioculus*, and *M. trichodon* were all identified by most fishers as 'tainha chata' (Fig. 3).

The Redundancy Analysis (Figs. 4A–B) indicates that most of the ethnospecies have similar definitions. The 'caica', for example, can be included in a group of ethnospecies that are small and have smaller scales and eyes, together with 'pratiqueira', 'sajuba/ribação', and 'ribação'. It was not possible to define which characteristics best fit definition of the ethnospecies 'sajuba', 'barrasco', 'pratiqueira/barrasco', 'sajuba/barrasco/ribação', and 'irichona', given that they are all associated with the characteristics 'baby mullet' and 'sexual dimorphism' (Fig. 4C). The 'ribação' is what we call the baby mullet, that's what we call them when they come in large shoals, by the thousand (interviewee P22; 32 years old).
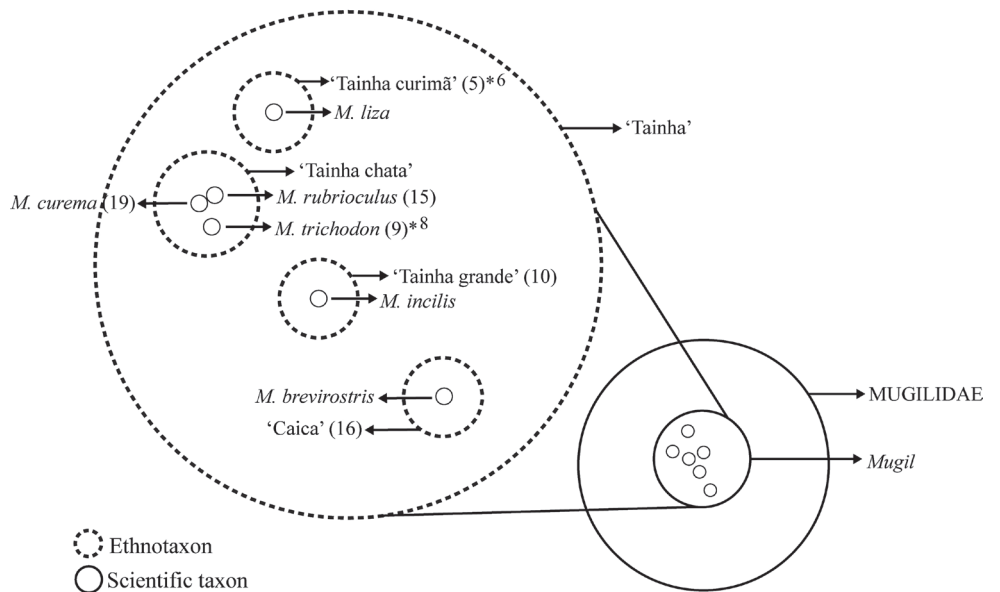
FIGURE 3 | Folk taxonomy designated by the artisanal fishers of the Caeté-Taperaçu Marine Extractive Reserve for the gray mullet (Mugilidae) and the corresponding scientific classification. The numbers within parentheses indicate the number of fishers reporting the ethnospecies. * = the number of fishers who stated that they did not know the ethnospecies or that it did not occur in the region.
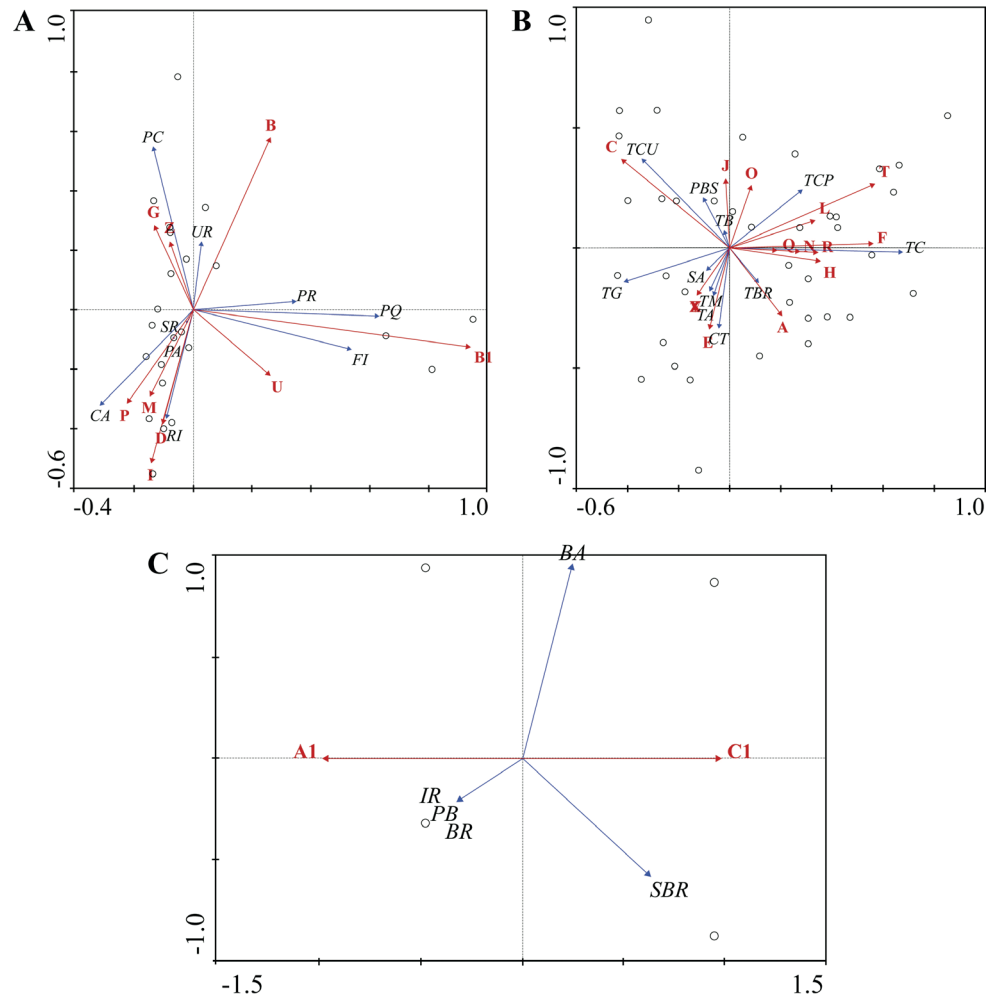
FIGURE 4 | Results of the Redundancy Analysis (RDA) of the definition of the ethnospecies by the artisanal fishers from the Caeté-Taperaçu Marine Extractive Reserve in Bragança, northern Brazil, with the characteristics that best identify each taxon. **A.** *CA*: 'caica', *PA*: 'pratiqueira', *PR*: 'pratiqueira/ ribação', *SR*: 'sajuba/ribação', *RI*: 'ribação', *UR*: 'urubarana', *PQ*: 'pratiqueirão', *FI*: 'filhotes'; B: narrow body, B1: juvenile of large mullet, D: does not grow a lot, G: narrow headed, I: small headed, M: small eyed, P: small scales, U: does not jump, Z: smells. **B.** *TA*: 'tainha', *TM*: 'tainha macho', *TBR*: 'tainha branca', *TB*: 'tainha boi', *TC*: 'tainha chata', *TGP*: 'tainha grande/puá', *TG*: 'tainha grande', *TCU*: 'tainha curimã', *CT*: 'caica tamatarana', *SA*: 'sajuba', A: rounded body, C: grows a lot, E: back dark/bluish, F: flattened head, H: rounded head, J: large headed, L: large eyed, N: red eyed, O: large scales, Q: rounded scales, R: shiny scales, S: scales close together, V: smart, X: stupid. **C.** *PB*: 'pratiqueira/barrasco', *BA*: 'barrasco', *BR*: 'barrasco/ribação', *SBR*: 'sajuba/barrasco/ribação', *IR*: 'irichona', A1: sexual dimorphism, C1: 'baby mullet'.

Few of the characteristics used by the fishers interviewed in the present study are consistent with those used in scientific descriptions of *Mugil* species. The red eyes of the 'tainha chata' may nevertheless correspond to the 'reddish orange' eyes observed in recently-preserved specimens of *M. rubrioculus* by Menezes *et al.* (2015); (Tab. 3).

A practical guide for the identification of Mugilidae species was generated using the information obtained from the questionnaire responses (**S3** and **S4**).

TABLE 3 | Comparison of the folk and scientific taxonomies of the species of the genus *Mugil* (Menezes *et al.*, 2015) identified by the artisanal fishers of the Caeté-Taperaçu Marine Extractive Reserve in Bragança, northern Brazil.

Species	Ethnospecies	Fish characteristics
Mugil curema Valenciennes, 1836	'Tainha chata'	Pectoral fin short and with dark patch over most of the basal portion; dark spot at the end of the second dorsal fin or slightly darker than the rest of the fin; eyes lack coloration in recently preserved specimens. Total length of 30 cm. Large head, eyes, and scales; flat head; jumps; smarter; grows a lot; red eyes. These fish disappear from the estuary in the winter. Mean total length of 39 cm.
Mugil rubrioculus Harrison, Nirchio, Oliveira, Ron & Gaviria, 2007	'Tainha chata'	Basal portion of the pectoral fin dark or dotted with small spots, which cover the base of the two unbranched rays; eyes redfish orange in recently preserved specimens. Total length of 26 cm. Large head, eyes, and scales; flat head; jumps; smarter; grows a lot; red eyes. These fish disappear from the estuary in the winter. Mean total length of 39 cm.
Mugil trichodon Poey, 1875	'Tainha chata'	Anal and second dorsal fins with fine scales, and reduced in number in the distal portion; 16 scales in the longitudinal line of the caudal peduncle. Total length of 21.3 cm. Large head, eyes, and scales; flat head; jumps; smarter; grows a lot; red eyes. These fish disappear from the estuary in the winter. Mean total length of 39 cm.
Mugil incilis Hancock, 1830	'Tainha grande'	This fish has 41–44 scales in a straight line from the base of the pectoral fin to the base of the caudal fin; the origin of the first spine of the dorsal fin is closer to the tip of the snout than to the base of the caudal fin. Total length of 34 cm. This fish grows a lot; it has a big, more angular head; it doesn't jump; small scales close together. More abundant in the estuary in the winter. Mean total length of 42 cm.
Mugil liza Valenciennes, 1836	'Tainha curimã'	Anal fin and second dorsal fin with scales in the basal portion; pectoral fin with two spines and 14–17 rays; 29–40 scales in an oblique line from the base of the pectoral fin to the base of the caudal fin. Maximum total length of 100 cm. Large head, scales, and eyes; this fish grows more than all the others; medium black in color; flattened head. Mean total length of 68.1 cm.
Mugil brevirostris Miranda Ribeiro, 1915	'Caica/ Pratiqueira'	Origin of the first dorsal fin equidistant between the tip of the snout and the base of the caudal fin. End of the pectoral fin reaches or exceeds the origin of the spiny dorsal fin. Total length of 20.9 cm. Small eyes and scales; narrow body; thin head; doesn't jump; this fish grows to only a small size and has a strong smell. Found in the estuary all year round. Mean total length of 22 cm.

DISCUSSION

A number of features have direct influence on the identification of mugilid species by the local fishers in the study area on the Ajuruteua Peninsula. Considering the often-subtle differences among the taxa of this family, the folk classification applied by the fishers may minimize the difficulties of species recognition. In this context, and considering the relative abundance and the wide knowledge of fishers about *Mugil* species in the catches landed by the local artisanal fisheries, the local nomenclature may facilitate the cataloging of catches on the Ajuruteua Peninsula.

The fishers almost invariably use morphological characteristics to identify *Mugil*, including the size and shape of the body, the configuration of its scales, head, eyes, and tail, as well as coloration, the presence or absence of teeth and odors. Even so, the fishers themselves admit to the difficulty of differentiating these mullets, given their morphological similarities: 'the mullets are almost all pretty much the same, there is little difference between them'.

The identification of *Mugil* is not only linked to the morphology of the fish, but also to their behavior and biological characteristics (Mourão, Nordi, 2002b; Herbst, Hanazaki, 2014). The presence of a characteristic scent in some species, for example, has not been reported previously, and is unlikely to be a valid trait in zoological taxonomy due to its subjectivity. In the present case, however, interviewees referred specifically to characteristic scent in the 'caica' and 'pratiqueira' folk species, although possibly only in the juveniles of these taxa.

In the present study, the fishers cited at least once the ethnospecies ('caica') to designate most small scientific species, reinforcing the idea of an association between identification and the size or age of the specimen (Clauzet *et al*., 2005, 2007). As the term 'caica' has not been associated with *Mugil brevirostris*, which is the smallest species of mullet found on the northern coast of Brazil (Menezes *et al*., 2015), and considering the scarcity of data on the biology of the *Mugil* species from this region, it seems likely that the generic term 'caica' can be associated with the recruited juveniles of various *Mugil* species, which may be common in local estuaries and coastal lagoons (Aguirre, Gallardo-Cabello, 2004). This reinforces the conclusion that the ontogenetic development of the organism may be among the main criteria for designation as a folk taxa.

Similarly, to the fishers interviewed in the present study, the large mullet corresponds to *M. incilis*, whose principal diagnostic trait in its scientific classification is the large numbers of scales (41–44) in the longitudinal line from the base of the pectoral fin to the base of the tail (Araújo *et al*., 2004; Menezes *et al*., 2015). To the fishers, however, these large mullets have smaller scales that are 'closer together', which may be related to large number of scales or their overlap in this species.

The scientific classification of *M. curema* and *M. rubrioculus* relies heavily on the coloration of the tip of the second dorsal fin and the base of the pectoral fin (Harrison *et al*., 2007; Menezes *et al*., 2015). However, these traits were not recognized by the artisanal fishers interviewed in the present study, who classified the two species in the same folk species, 'tainha chata'. The folk classification prioritizes the flattened shape of the body in both species, even though this may not discriminate between the adult specimens of the two species, and there is no scientific evidence of any difference in this trait.

In general, the traits recognized by the fishers refer to the most evident characteristics of the fish, which often contradicts the criteria accepted by systematic zoologists. In some cases, however, the criteria used by the fishers may be even richer than those adopted by conventional science, including aspects of trophic ecology and spatial distribution (Silvano, Begossi, 2012; Damasio *et al.*, 2015; Ramires *et al.*, 2015).

The folk species 'tainha chata' has been fractionated into subspecies according to Berlin's (1992) classification system, given that it corresponds to three scientific species, even though some of the traits listed for the folk species correspond to only one scientific species, in particular the presence of reddish orange eyes in the fresh specimens, found only in *M. rubrioculus*. Many folk classification systems identify species that correspond to more than one scientific taxon (Pinto *et al.*, 2016; Carvalho *et al.*, 2018; Mourão, Barbosa Filho, 2018).

Mugil margaritae, the new mullet species described by Menezes *et al.* (2015) was not recognized by 12 (42.9%) of the fishers, with one referring to the fish as a 'captive species, which occurs only in southern Brazil'. Up to now, *M. margaritae* has been recorded only on the coast of Venezuela, although it is not entirely unlikely that it may occur in Brazilian waters, given the proximity of these habitats (Menezes *et al.*, 2015).

The designations 'sajuba/barrasco/ribação', 'barrasco', 'pratiqueira/barrasco', and 'irichona' include 'male specimens' and 'juveniles.' The 'barrasco' is a type of 'ribação' that starts off as a male and grows as big as the 'tainha chata', but it is fatter, and rather than eggs, it produces this white stuff that comes out like milk if you squeeze its belly (interviewee P7; 58 years old). The 'irichona' is small, but it has a belly because it is always spawning (interviewee P12; 61 years old).

At the present time, the fishery statistics of the region register the species *M. curema*, *M. liza*, and *Mugil* sp. under the vernacular names 'tainha' and 'caica', without distinguishing the ethnospecies (Lutz *et al.*, 2016), or only as 'tainha' (Nascimento *et al.*, 2016). As observed in the present study, the term 'tainha' is the vernacular for all the *Mugil* species that occur in the region, that is, 'mullet'. It is important to note, however, that this lack of precision in the logging of catches may not only reflect cultural misunderstandings, but also impact management practices, given that some species (*M. liza*) are already overfished in some regions (MPA, 2015), while others (*e.g.*, *M. curema*, *M. incilis*, and *M. rubrioculus*) are still abundant the northern coast of Brazil (Giarrizzo *et al.*, 2013).

Many of the popular names and the folk classification of the *Mugil* species of the northern coast of Brazil are local denominations. In southern Brazil, *M. curema* is widely denominated 'parati', for example, while *M. liza* is referred to as the 'curimã' or 'tainha' (Menezes, 1983; Seckendorff, Azevedo, 2007; Mendonça, Bonfante, 2011). Given this, new studies are necessary in other coastal regions of Brazil to determine the specificity of the vernacular names recorded up to now (Fischer, 2013).

This regional vernacular reinforces the need for an in-depth investigation of fish ethnotaxonomy not only of *Mugil*, but of all groups, but in particular those of significant commercial interest (Freire, Pauly, 2005). In addition, fishery management that does not integrate cultural practices and traditional knowledge will distance public policies from local realities, weakening top-down management strategies, an all-too common phenomenon in Brazilian politics. Local knowledge of the diversity of organisms reflects their economic, cultural, and psychological

importance (Mourão, Nordi, 2002a), and should be prioritized in any initiative for fishery or conservation management, such as producing a guide that assists in species identification: Ethnoguide of the mullet species of the Amazon coast (**S3**) and the Portuguese version "Etnoguia das espécies de tainhas da costa Amazônica" (**S4**).

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