Cultural Consensus in Ethnotaxonomy - Lessons From a Fishing Community in Northeast Brazil

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Abstract

Background - Traditional fishing communities are strongholds of ethnobiological knowledge but establishing to what degree they harbor cultural consensus about different aspects of this knowledge has been a challenge in many ethnobiological studies.

Methods - We conducted an ethnobiological study in an artisanal fishing community in northeast Brazil, where we interviewed 91 community members of different genders and dedicated to distinct activities, in order to obtain free lists and salience indices of the fish they know. To establish whether there is cultural consensus in their traditional knowledge on fish, we engaged a smaller subset of 45 participants in triad tasks where they chose the most different fish out of 30 triads. We used the similarity matrices generated from the task results to detect if there is cultural consensus in the way fish were classified by them. We also modelled the effect of gender, age and type of activity on the agreement rate of participants with modal responses in the triad tasks (i.e., that pair of fish in which most participants considered the most similar within each triad).

Results - The findings show how large is the community's knowledge of fish, with 197 ethnospecies registered, of which 33 species were detected as salient or important to the community. In general, men cited more fish than women. We also found that there was no cultural consensus in the ways fish were classified, but younger participants tended to use similar criteria for classifying fish.

Conclusions - Both free-listing and triad task methods revealed little cultural consensus in the way knowledge is structured and how fish were classified by community members. Our results suggest that it is prudent not to make assumptions that a given traditional community has a single cultural consensus model in classifying the organisms in their environment.

Introduction

Human societies respond to the biological diversity of their environments by grouping organisms by similarity or separating them by difference [1]. These categorization processes have been described as culturally influenced and organized in different taxonomic structures [2, 3], and one of the most striking observations in ethnobiology is the common occurrence of agreement both within and across cultures in the categorization of plants and animals [4-6]. Nevertheless, ethnobiologists have also documented many differences in intra and intercultural categorization, and other factors such as age, social role, and religion may influence categorizations of nature [7-9].

In fishing communities from around the world, fishers have developed their own classification systems to name and organize the fish they use [1]. For example, in Rio de Janeiro, Brazil, the fishers from Sepetiba Bay categorize fish by morphological, ecological, economical value, and meat quality [10]. At another location in Rio de Janeiro, Piratininga, fishers base their classification on how fish behave [11]. Begossi and Garavello [12] observed that the criteria used by the Tocantins River fishers, in the Brazilian states of Maranhão and Tocantins, are mainly morphological. The fishing community of Piaroa, in Colombia,

classifies fish and other animals based on food taboos and religious elements [13]. It is clear, then, that different goals can affect categorical organization of fish and other organisms [14, see 15 & 6].

Ross et al. [14] criticized the simple approach of reporting species lists of organisms in ethnoscientific research, raising the question of whose knowledge is being reported. More specifically, Ross et al. [14, p. 270] assert that, “in most descriptions of folk-knowledge systems, it is not clear whether the reported knowledge is held by every individual or even by any single individual in a community. Most often, neither is the case; instead, the data represent an artificial collage of knowledge bits reported by individuals and put together by the author in a systemic fashion”.

In order to understand the knowledge available in a community, and how it is shared among its members, scholars have therefore also adopted the approach of inquiring into cultural consensus (or its lack) within communities. Romney et al. [16] proposed the so-called cultural consensus model (CCM), which is a method for computing levels of agreement and disagreement in the structure and distribution of information within and across populations. The model assumes that widely-shared information is reflected in a high level of agreement, or “cultural consensus” among individuals [6]. Some examples of ethnobiological researches that used this methodology are Ross et al. [14], who studied plant categorization by the Tzotzil Maya from Zinacantán (Highlands of Chiapas, Mexico), Medin et al. [15], who studied the categorization of trees by tree experts in the Chicago region (USA) and Medin et al. [6], who studied the categorization of freshwater fish by Native American and majority-culture fish experts from the north central Wisconsin (USA).

The loss of local biological knowledge in various parts of the world is also a great concern and target of many ethnobiological studies. This phenomenon is often attributed to globalization, environmental degradation, and disruptive changes in social and economic systems [see 17-21]. Even though indigenous and local knowledge is being lost at an alarming rate [17, 19], many communities maintain local knowledge and practices despite the threats impacting them. A number of artisanal fishing communities in the Northeast of Brazil provide notable examples.

Over the last five years, we have engaged in a project to build up dialogical and knowledge coproduction efforts with members of two artisanal fishing communities in the Itapicuru estuary, in the Northeast of Brazil, and to help these communities with documenting and preserving their ethnobiological knowledge [e.g. 22-23]. One aspect of their ethnobiological knowledge that is still lacking documentation is their knowledge of fish, which is the focus of this study. In addition to a lack of understanding about whether and to what extent there is cultural consensus among the fishers and other community members, how fish knowledge is patterned by gender, type of activity (fishers or non-fishers) and age is also in need of inquiry.

Therefore, the overarching aim of this study is to understand how traditional knowledge in an artisanal fishing community is distributed among its members. Specifically, we aim to: (1) document the most culturally salient fish (ethno)species (locally considered of high importance) in the community; (2) investigate the criteria that community members use to categorize fish; (3) determine if there is a

consensual cultural model regarding fish ethnotaxonomy and; (4) examine how gender, type of activity and age influence differences in knowledge composition within the fishing community.

Methods

Study Area

The fishing village of Siribinha (11°48'49"S, 37°36'38"W) is part of the municipality of Conde and is located in the Itapicuru estuary in Bahia, in the northeast of Brazil [23]. The area consists of freshwater alluvial wetlands, mangroves, beach vegetation, and shrubby thicket-like forests (locally known as *restingas*) growing on sand dunes. Coconut plantations and cattle ranches also make up part of the land use tenure of the region.

Siribinha is a community of artisanal fishers comprising ca. 500 inhabitants. The community was relatively isolated up to the 1990s, since prior to that there were no roads connecting it to nearby villages and cities. Despite the emergence of small-scale tourism starting from the mid-1990s, Siribinha is still predominantly a fishing community, where fishing and shellfish gathering constitute the main economic activity of the majority of the community members.

Artisanal fishing in the north coast of Bahia is characterized by family work, where members of the family are variously involved in the activity of catching and processing the catch, especially shellfish. In Siribinha, as well as in other Brazilian fishing communities, fishing is typically a male activity, while shellfishing, which comprises the activity of gathering mollusks and crustaceans, is carried out primarily by women and children [1].

Most of the information provided on the community results from our own interview data and participant observation in the larger project in which the present study is included.

Data Collection

Throughout the paper, we indicate the community members by the initial letter of their names followed by a dot and their age (e.g. E.68), for confidentiality reasons. The Portuguese transcripts were translated by the first author and the translation was revised by the other authors. In the quotes from community members' interviews, pauses are indicated with a slash (/), and the end of a speech turn, with a period (.). The transcripts are shown in italics and, if we need to comment or add something, this is done using parentheses, without italics. For each transcript included in the paper, we provide the Portuguese original excerpts in the Supplementary Material 1. To carry out the research reported here, we combined two methods: free listing and triad tasks.

Free Listing

For our specific purposes of understanding fish ethnotaxonomy, we performed a free listing task to determine the most salient species of fish, that is, the fish that the community members consider to be the most important. Free listing interviews were performed either in their houses, during door-to-door visits, or in the shared social spaces in the village. Most interviews happened in their free time, i.e., during the day when they were at home or sitting on their porches, but some of them were also done when they were repairing their nets or landing fish. Their consent to be interviewed was obtained in audio recordings after stating the terms of an Informed Consent Form.

The free listing was carried out in April 2018 with 91 community members (approx. 20% of the community), comprising a total of 49 men and 42 women, all aged 18-89 years old. The interviewees consisted of 38 fishermen and 25 fisherwomen (shellfish gatherers), but also another 11 male and 17 female community members dedicated to other activities (students, teachers, traders, accommodation providers, among others). We considered fishermen or fisherwomen those who engaged in fishing/shellfish gathering activities ≥ 3 days a week or, in the case of retirees, if they had engaged in these activities at such an intensity before retiring.

Each participant was asked “What fish do you know?”. We then let the interviewees speak freely so as not to influence their train of thought, and we noted the cited fish in the order they were mentioned. In instances where interviewees cited ethnogenera of fish such as *arraia* (stingray), *bagre* (catfish), *cação* (small shark), *pescada* (hake), and *robalo* (snook), we sought further clarification by asking later if there is more than one type of each of them. If that was the case, these would be annotated just after each ethnogenus mentioned.

Triad tasks

To understand how members of the community categorize fish and to what extent the categories are shared across the community, we carried out triad tasks (or triad tests) [24, 14]. The triad task allows us to derive a consensual cultural model without assuming that such a model exists beforehand [14]. For this purpose, we randomly selected 45 people that took part in the free list task (15 fishermen, 15 shellfish gatherers/fisherwomen, and 15 other community members) and solicited their participation on the triad tasks. The triad tasks were conducted between October 2018 and January 2019.

During the triad task, a series of 10 sets of three photographs (a triad) of fish were presented to each participant. They were then asked which ethnospecies was the most different among the three shown in the photographs. It was then assumed that the two other ethnospecies were being considered more similar to each other by the interviewee. If the participant had difficulty with a specific triad, that triad was postponed until the end of the task. If the participant still could not provide an answer after this second round of questioning, he or she was asked whether the difficulty of making the requested judgment was due to the ethnospecies being very similar or very different. For each attempt, participants could choose an item, therefore, as “different” (codes 1–3), “very different” (code 0) or “very similar” (code 4). We

followed this procedure to avoid situations where participants felt forced to produce an answer, thereby choosing items randomly and biasing the data [14].

The triad task was performed with a Lambda 2 design [24, 25], which means that each pair of ethnospecies was compared exactly twice. Using 10 ethnospecies, this design generates 30 triads, a number that was deemed to be manageable for the triad tasks, without taking too much of interviewees' time or tiring them out and thereby compromising data quality.

To generate the triad tasks, we randomly selected ten ethnospecies of fish (Table 1) among the 33 most salient ones to the community, according to the findings from the free listing interviews (see later).

Table 1

Ethnospecies of fish selected for the triad tasks (in alphabetical order) in Siribinha, northeast Brazil.

Ethnospecies	Academic scientific species (family)
Bagre fidalgo	<i>Bagre bagre</i> (Ariidae)
Carapeba	<i>Eugerres brasiliensis</i> (Gerreidae)
Cavala	<i>Scomberomorus cavala</i> (Scombridae)
Corvina	<i>Micropogonias furnieri</i> (Sciaenidae)
Curimã	<i>Mugil liza</i> (Mugilidae)
Pescada amarela	<i>Cynoscion acoupa</i> (Sciaenidae)
Pescada branca	<i>Cynoscion leiarchus</i> (Sciaenidae)
Robalo branco	<i>Centropomus parallelus</i> (Centropomidae)
Tainha	<i>Mugil curema</i> (Mugilidae)
Xaréu	<i>Caranx hippos</i> (Carangidae)

The photographs of fish were taken with the same camera approximation to ensure that fish body size proportions were maintained. All the photographs used in the triad task are presented in the Supplementary Table S1.

To obtain an idea of how the participants classified the fish they saw in the photographs, we also asked them at the end of the triad tasks which criteria they would use to differentiate one fish from the others.

Data Analysis

During the free listing tasks, we observed that some interviewees provided two or more different names or synonyms for some fish (28 of the cited ethnospecies corresponded to 13 academic scientific species). Small phonetic differences were common, like *arraia jamanta* and *arraia jalamanta* (*Mobula sp.*) or *bagre upemba* and *bagre urupemba* (unidentified species). In some cases, different names were also cited for the same fish species at different ontogenetic phases, like *saúna* (smaller) and *tainha* (bigger) (*Mugil curema*) or *pescada amarela* (smaller) and *pescada selvagem* (bigger) (*Cynoscion acoupa*). Therefore, when running the analyses, we selected the most frequently used name by the community for each fish to which there were synonyms, in order to avoid artificially inflating the number of fish mentioned, thus biasing the salience estimation. The academic scientific species names for the ethnospecies and general fish types were provided by a fish specialist, José Amorim dos Reis Filho, on the basis of the ethnospecies' names. A rarefied ethnospecies-interviewee curve (Supplementary Figure S1) indicated that the number of participants engaged to generate our free lists was adequate, as the number of ethnospecies captured approached an asymptote.

To determine whether the gender and activity of the interviewees had any influence on the number of ethnospecies (or general fish types) cited, we performed two-way ANOVAs with gender (male, female) and activity (fishers, other activities) as factors ($\alpha = 0.05$).

We calculated the Salience Index (S) of each fish ethnospecies following Chaves et al. [26], using the formula: $S = \sum((L - R_j + 1)/L)/N$, where L is the length of a list, R_j is the rank of item j in the list, and N is the number of lists in the sample. The index takes into account not only the frequency of occurrence of each item, but also the order in which they were mentioned in the interviews [26]. In cases where an interviewee mentioned a general type, for instance, *cação* (small shark), as the first item but clarified more specific ethnospecies later, we substituted the general fish type for the mentioned ethnospecies. However, in some cases in which the interviewee did not provide any ethnospecies for a general fish type when questioned at the end of interview, we maintained the general fish type as he or she listed.

The Salience Index of each ethnospecies cited is calculated by the probability of occurrence of these values in a null scenario [26], and varies between 0 and 1, which denote ethnospecies with extremely low or high salience, respectively. The *p*-values of salience show the probability that the salient values occur in a null scenario, calculated from simulated populations with similar characteristics to the real one, using Monte Carlo techniques [26]. Following Chaves et al. [26], we accepted a threshold *p*-value < 0.05 to denote significance. Using this methodology, it is possible to establish a cut-off point in a free list and select only the most salient items, i.e., the ones showing high salience index and *p*-value < 0.05.

To visualize how fish knowledge varies between interviewees (i.e. how their knowledge composition varies), we used a non-metric multidimensional ordination to summarise all the ethnospecies citations by the interviewees. The fish citations were coded as presence-absence data and used to compute a Bray-Curtis dissimilarity matrix. In the ordination graph, interviewees were represented using different markers to denote different genders and activities [male - fisher, male - other (non-fisher), female - fisher, female - other (non-fisher)]. A permutational multivariate analysis of variation (PERMANOVA; $\alpha = 0.05$) was run to

determine if the composition of knowledge differed between the four groups. A Bonferroni correction was applied in order to reduce the chances of obtaining false-positive results.

To analyze the triad task data, we used the Anthropac 4.98 software [27]. Anthropac generates an “aggregate proximity matrix”, which is a similarity matrix showing the percentage of times each pair of ethnospecies were considered more similar within a triad (agreement = matched responses/30). Using these similarity matrices generated by Anthropac, we performed a non-metric multidimensional scaling ordination to determine how the participants were categorizing the fish and to visualize the degree of similarity between them according to the participants.

For each triad, Anthropac also provides the agreement rate, which is the proportion of triads in which each participant agreed with the modal response (i.e. that pair of fish in which most participants considered the most similar within each triad). Using a principal components analysis (PCA) on the interviewee vs. interviewee matrix also enabled us to determine the presence of a cultural consensus model [16]. Widely shared information would be reflected in a “cultural consensus” or high agreement among individuals. To achieve this, each interviewee’s fish–distance matrix was correlated with that of every other interviewee, yielding a 45 x 45 matrix in which entries correspond to the observed agreement among interviewees on pairwise fish distances. A PCA was then performed on the inter-participant correlation matrix. Following Romney et al. [16], we deemed that a strong group consensus existed if (1) the ratio first and second factor eigenvalue was high, (2) the first eigenvalue accounted for a large portion of the variance, and (3) all individual first-factor scores were positive and relatively high. If these criteria are met, the structure of the agreement can be explained by a single factor solution, namely, the consensual model; otherwise, we may reach reliable conclusions about inter-participant differences [14].

We also carried out PERMANOVAs on the interviewee fish-distance matrices to determine if gender, activity and their interactions had any bearing on fish ethnotaxonomic classification. To determine if the agreement rate of participants with the modal response was related to gender, age and activity, we fitted a generalized linear model of the participants’ modal response (dependent variable) with their respective ages, genders, and activities as independent variables, using $\alpha < 0.05$. All analyses were performed in R (R Core Team 2017). The R script for calculating Saliency indices was provided by L. Chaves upon request and ordinations and PERMANOVAs were performed using the *adonis* function in the *vegan* package.

Results

Free Lists and Saliency Indices

The 91 interviewees cited 197 ethnospecies or general fish types of which 33 were considered salient to the community ($p < 0.05$) (Table 2).

Table 2

List of the 33 most salient ethnospecies and ethnogenera of fish for Siribinha, Brazil.

Ethnospecies	Probable academic scientific species	Salience	p-value
Tainha	<i>Mugil curema</i>	0.717	<0.001
Carapeba	<i>Eugerres brasiliensis</i>	0.584	<0.001
Robalão	<i>Centropomus undecimalis</i>	0.464	<0.001
Robalo branco	<i>Centropomus parallelus</i>	0.386	<0.001
Pescada branca	<i>Cynoscion leiarchus</i>	0.339	<0.001
Pescada amarela	<i>Cynoscion acoupa</i>	0.330	<0.001
Robalo espalmado	<i>Centropomus parallelus</i>	0.303	<0.001
Curimã	<i>Mugil liza</i>	0.299	<0.001
Vermelho	<i>Lutjanus purpureus</i>	0.294	<0.001
Robalo*	<i>Centropomus</i> spp.	0.224	<0.001
Corvina	<i>Micropogonias furnieri</i>	0.220	<0.001
Bagre fidalgo	<i>Bagre bagre</i>	0.215	<0.001
Bagre amarelo	<i>Sciades herzbergii</i>	0.206	<0.001
Bagre griçaçu	<i>Sciades proops</i>	0.191	<0.001
Bagre do mangue	<i>Genidens barbatus</i>	0.178	<0.001
Xaréu	<i>Caranx hippos</i>	0.171	<0.001
Cavala	<i>Scomberomorus cavalla</i>	0.165	<0.001
Sardinha	<i>Opisthonema oglinum</i>	0.165	<0.001
Pescada barracuda	<i>Sphyrna guachancho</i>	0.142	<0.001
Bagre urucu	<i>Apistotilapia luniscutis</i>	0.136	<0.001
Cação martelo	<i>Sphyrna</i> spp.	0.132	<0.001
Sororoca	<i>Scomberomorus brasiliensis</i>	0.115	0.001
Capadinho	Unidentified	0.109	0.002
Cação*	Several species	0.107	0.003
Catana	<i>Trichiurus lepturus</i>	0.103	0.005
Bagre cagão	Unidentified	0.099	0.008
Badejo	<i>Mycteroperca bonaci</i>	0.088	0.025
Pescada*	<i>Cynoscion</i> spp.	0.088	0.026

Caçonete*	Several species	0.086	0.030
Arraia*	Several species	0.086	0.033
Roncador	<i>Ballistes vetulla</i>	0.084	0.039
Guaricema	<i>Caranx crysos</i>	0.083	0.041
Mirucaia	<i>Ctenosciaena gracilicirrus</i>	0.083	0.042

The probable overlapping academic scientific species to the ethnospecies are indicated (See main text for context). *Ethnogenes that encompasses many species. (See Supplementary Table S2 for complete list).

Of the 33 ethnospecies and general fish types, 28 overlapped with an academic scientific species or genus. The remaining five were left unidentified, either because the ethnospecies/general fish type comprised many species from different genera or simply because the ethnospecies name for the fish was unknown to the fish specialist.

The calculated salience index for the recorded fish ranged from 0.717 (“tainha” – *Mugil curema*) to 0.0002 (“tainha meio olho” – *Mugil sp.*), with the former being cited in 85 out of 91 lists. Of the 197 fish ethnospecies/ethnogenes, 118 fish (60%) had low but statistically significant salience indices (0.022 - 0.0002). Because of the low salience indices, they cannot be considered salient ethnospecies/ethnogenes. A further 46 fish (23%) had insignificant *p*-values.

Knowledge Composition, Gender and Type of Activity

Our non-metric multivariate analysis ordination of the free list data shows very little structure in knowledge composition (Fig. 1A). However, the number of fish cited correlated positively with NMDS axis 1. Also, seven ethnospecies exhibited strong correlations ($r > 0.45$, $p < 0.00047$) with NMDS axes 1 or 2 (Fig. 1A) and are among the list of the 33 most salient fish ethnospecies to the community (Table 2). Additionally, a PERMANOVA showed that gender was a significant factor influencing the number of fish cited ($F_{1,90} = 3.39$, $p = 0.005$), but type of activity ($F_{1,90} = 1.255$, $p = 0.184$) and the interactions ($F_{1,90} = 1.282$, $p = 0.110$) between gender and type of activity were not significant.

In terms of the number of fish cited, male non-fisher interviewees cited the highest mean number of fish, followed by male fishers, female fishers, and female non-fishers (Fig. 1B).

Triad Tasks

Our non-metric multidimensional scaling ordinations (Fig. 2) based on the interviewees’ triad task results showed no distinct groupings in the 10 fish (Fig. 2A).

PCA results on the inter-interviewee correlation matrix, used to determine if there were a single underlying model for fish categorization (Fig. 2B), returned a first factor to second factor eigenvalue ratio of 1.563

and the variation explained by the first two axes were 19.86% and 12.07% respectively. There were also negative loadings on the first factor (See Supplementary Table S3). These results indicate weak agreement among interviewees, and suggest a lack of a cultural consensus model.

Our PERMANOVA analyses on the PCA scores of the inter-interviewee correlation matrices showed that gender and type of activity were both significant factors for fish ethnotaxonomy ($p = 0.005$ and <0.001 respectively) (Table 3). However, the interactions between these factors were not significant ($p = 0.328$) (Table 3).

Table 3

F-statistics and significance level (P) of PERMANOVA comparisons of inter-interviewee correlation matrices of fish distances obtained from triad.

	$F_{1,41}$	P
Gender	2.287	0.005
Occupation	4.419	<0.001
Gender & Occupation	1.080	0.328

When we analyzed the proportion of triads in which each participant agreed with the “modal response”, there was no clear and significant distinction between the agreement of the 45 participants in the categorization of fish (one-way ANOVA: $F = 0.391$; $p = 0.679$).

There is therefore no consensual cultural model regarding the categorization of fish. That is, the information on fish categories is not widely shared among the participants. However, our generalized linear models (Table 4) and the plotted regressions of agreement rate vs. age (Fig. 3) showed that the age of the participants was negatively related with the agreement rates with the modal response for the fish triad tasks. In other words, younger participants are more likely to agree with the modal responses of each triad, while the opposite was observed for older participants.

Table 4

Results of generalized linear models to participant agreement rate with the modal response.

Attribute	Estimate	SE	<i>t</i> value	<i>p</i>
(Intercept)	0.785	0.083	9.508	<0.001***
Age	-0.005	0.002	-3.035	0.004**
Gender (Male)	-0.013	0.096	-0.137	0.892 ^{ns}
Type of activity (Other)	-0.063	0.070	-0.896	0.376 ^{ns}
Type of activity (Fisherman)	0.051	0.117	0.437	0.665 ^{ns}
Significance levels: * <i>p</i> <0.05, ** <i>p</i> <0.01, *** <i>p</i> <0.001. ns, not significant.				

Criteria for distinguishing fish in triad tasks

When queried about how they distinguished the fish, the majority of the participants (71%) cited morphological criteria, such as fish shape, color, size, presence of stripes, scale, leather, spur etc. Five participants (11%), four of whom were women, did not mention morphological criteria but rather offered details on the differing flavors of the fish. Other less expressive criteria to distinguish the fish were: their difficulty to catch, lack of familiarity, specific locations for catching the fish, and value or marketability.

Discussion

Salience indices

The salient ethnospecies or general fish types considered by the 91 participants of the free lists ($p < 0.001 - 0.042$) are also the most fished ones in the community and, therefore, the ones they have more contact with.

The 118 fish ethnospecies with lower salience values (0.022 - 0.0002) but significant *p* values can be considered idiosyncrasies [e.g. 26]. Such items were cited at the end of the free lists or were known by very few people, or yet very few people knew these fish by this name (e.g., some fish would have many different common names). For these reasons, items with low saliency have been interpreted in the literature as being of little or no cultural importance, or even mistakes [26]. In the free lists results, 73 fish out of 197 (37%) were cited only once.

The role of gender, age and type of activity in ethnotaxonomy

Gender roles are very important in artisanal fishing communities in Brazil [e.g., 28-29], and the Siribinha community is no exception. Reported differences in knowledge about the environment in several studies suggest a link between gender and type of activity or social role [30-31]. Our data support this association as the average number of fish cited during the free listing was higher among men than among women. Since fishing is performed primarily by men while women play a predominant role in collecting shellfish, it is not surprising that men have a greater knowledge about fish (as reflected in a greater average number of citations). Follow-up studies could perhaps examine if this could be related to direct contact with fish (and if so, if women would have a greater knowledge of shellfish species than men) or to a "moral authority" local people would recognize to men to talk about fish since fishing can be identified as their specific activity. However, it is not clear why male non-fishers cited more fish on average than male fishers.

We found a negative relationship between agreement rates with a modal triad task response and participants' age. Our results showed that younger participants tended to use the same criteria (usually morphological) to categorize fish, and thus agreed more with each other. In contrast, the opposite pattern was seen in older participants, who showed little agreement and tended to use different criteria to distinguish and categorize fish. This may be an outcome of the fact that they master a larger diversity of kinds of knowledge on which to base a similarity judgment [32]. These observations are in line with the literature [see 32-34], who showed that variation in knowledge, folk classification and similarity judgments could be explained by the level of expertise of a community member.

Another hypothesis for the significant negative correlation between agreement and participants' age might be the level of education. Older people have little or no formal education, while there was a higher tendency for younger people to have access to primary and secondary education. Schooling provide access to a more standardized knowledge, which can make younger people agree more on the basis of such shared knowledge. The knowledge of the younger participants therefore tended to be more similar (and they consequently categorize fish in a more similar way), while the knowledge of the older participants tended to vary more.

Criteria used to distinguish fish

The prominent use of morphological criteria by this traditional community to distinguish fish is consistent with previous literature [10]. In particular, the presence of scales was a key feature that participants used to distinguish fish in the triad tasks. For instance, Bagre fidalgo is a scaleless fish, and Xaréu have such small scales that it is also considered a scaleless fish by the interviewees, and this feature explains why these fish are often considered different from the others, as shown in Fig. 2A.

However, some of the interviewees also distinguish fish by the perceived quality of their meat. For example, Xaréu and Bagre fidalgo are considered fish that are "carregado" or "reimoso". These terms are commonly used in many artisanal fishing communities in Brazil to discriminate fish that should be avoided for consumption by people with wounds, measles, tumors, skin rash, and other maladies, or

by women after childbirth or undergoing menstruation, because they are believed to cause inflammation [35]. Statements like the following were common:

E.68: *Xaréu and bagre are two carregado fish.*

D.49: *Almost no one likes xaréu/ its meat is dark/ has a third quality meat/ (...) bagre is different from the others/ it's out of the ordinary.*

L.42: *xaréu and bagre are the most different ones/ they are not so tasty.*

E.33: *I don't like xaréu so much/ it has worms/ we use it for bait mainly/ (...) it's a scaleless fish/ (...) it smells bad/ there's no taste/ (...) bagre fidalgo has no scales/ just leather.*

Lack of cultural consensus

Debates about indigenous and local knowledge often treat knowledge of a community as homogenous. This tendency can be further reinforced by ethnotaxonomic traditions of emphasizing cross-cultural stability and universality of categories [4]. But we encountered a very different pattern as we found no clear and significant distinction between the agreement of fishermen, fisherwomen and non-fishers in the categorization of fish in Siribinha. That is, even within relatively homogeneous cultural groups, there was greater variation of response, agreeing with Boster and Johnson [32].

In both free list and triad task MDS, we did not find cultural consensus regarding the similarity of fish ethnospecies and their categorization. This may be in part due to the different criteria used for distinguishing fish. Most of them distinguished fish by phenotype, but some of them also used other criteria, such as flavor, difficulties to catch, lack of familiarity, specific locations for catching and value or marketability. The lack of cultural consensus might be also a result of the production of individual knowledge (innovations), recent information inputs (immigration), changes of the original information (mutations) or low mnemonic relevance [26].

Additionally, we did not find a common conceptual organization of the ethnospecies and ethnogenera. These results varied substantially from those of Ross et al. [14] who studied plant categorization by the Tzotzil Maya from Zinacantán (Highlands of Chiapas, Mexico), and also from Medin et al.'s [16] work on the categorization of freshwater fish by Native American and majority-culture fish experts from north central Wisconsin (USA). Nevertheless, our results reinforce the Ross et al.'s [14] argument for caution about beginning ethnobiological research with the assumption that a community possesses a single cultural consensus model, as is sometimes done.

In a similar vein, Vandebroek [34] argues that it is challenging to extrapolate knowledge of individual participants to a community or cultural group. Therefore, the careful selection of participants deserves considerable attention before the start of fieldwork since interviewing only the oldest or most experienced traditional experts in a community does not imply that representative (general and commonly-shared)

cultural information will be recorded. On the contrary, when the development of expertise results in learning many alternate devices or bases for structuring a domain, the experts will be more variable in their responses than novices and so appear to deviate more often from a consensus [32].

Conclusions

Traditional communities are strongholds of ethnobiological knowledge but establishing if there is cultural consensus related to this knowledge within them has been a challenge in many ethnobiological studies [e.g. 6, 14, 15]. Our ethnobiological study in Siribinha, an artisanal fishing community in northeast Brazil, revealed that the community has a rich knowledge of fish which is patterned by gender. We also found that there was no cultural consensus in the ways fish are classified by the community. These observations call for caution in making assumptions that a given traditional community has a single cultural consensus model in classifying the organisms that they encounter in their daily lives.

The lack of "cultural consensus" as it is commonly operationalized does not mean that there are no patterns or even that responses are only random noise. We therefore need to address ethnobiological knowledge in ways that are sensitive to issues of social stratification (e.g., along gender and profession) and epistemic diversity within communities without assuming that there is nothing to be said about communities more generally. In this sense, ethnobiologists are challenged not to treat communities as monolithic epistemic units but also not as entirely fragmented collections of individuals.

Abbreviations

CCM: Cultural Consensus Model; NMDS: Non-Metric Multidimensional Scaling; PCA: Principal Components Analysis; PERMANOVA: Permutated Multivariate Analysis of Variance.

Declarations

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Authors' contributions

VR and CNE conceived the study and planned the fieldwork. VR conducted the fieldwork. VR, DMGA and DYPT analyzed the data. All authors contributed to the writing and edition of the final manuscript, and approved it.

Ethics approval and consent to participate

Across all stages, the participants provided informed verbal consent for the interviews, which was recorded at their beginning. The project has been approved by the Committee for Ethics in Research from the Nursing School of the Federal University of Bahia under n. 2.937.348 (Certificate of Presentation of Ethical Appreciation - CAAE - n. 97380718.3.0000.5531) and followed the Brazilian laws concerning research ethical procedures. It was also registered in the National System for the Management of Genetic Heritage and Associated Traditional Knowledge (SisGen) under n. A053F57. The principles from the ISE Code of Ethics were also followed in the study [36].

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

(A) Non-metric multidimensional ordination of ethnospecies and ethnogenera of fish cited during the free listing task by 91 interviewees from the fishing community of Siribinha, northeast Brazil. The interviewees consisted of male fishers, male others (non-fishers), female fishers, female others (n=38, 11, 25 and 17,

respectively). The arrows along the axes indicate significant positive or negative Pearson correlations ($p > 0.00047$ after Bonferroni correction for multiple comparisons) between individual fish or factors and the axes. For conciseness, only fish with $r > 0.45$ are shown. (B) Boxplots showing the median number of fish cited during the free listing tasks by gender and type of activity. Boxes enclose median (thick line), the mean (thin dashed line), and the 25 and 75 percentiles.

Figure 2

Non-metric multidimensional scaling (MDS) ordinations of fish (A) similarity judgments as determined by triad tasks from 45 interviewees from an artisanal fishing community in Siribinha, northeast Brazil. The inter-interviewee fish (B) distance matrix correlations were analyzed with Principal Components Analyses to check for consensus within and across groups of interviewees (male fishers, male non-fishers, female fishers, and female non-fishers).

Figure 3

Generalized linear model regressions between the fish agreement rate and the age of participants from an artisanal fishing community in Siribinha, northeast Brazil. See Table 4 for model results.

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