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VÍTOR RENCK

ONDE O RIO ENCONTRA O MAR: SOBREPOSIÇÕES PARCIAIS ENTRE DUAS ONTO-EPISTEMOLOGIAS

Estudos sobre os Conhecimentos Biológicos e Ecológicos da Comunidade Pesqueira de Siribinha, Bahia

Salvador, maio de 2022

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Orientador: Dr. Charbel Niño El Hani

Coorientador: Dr. David Ludwig

Coorientador: Dr. Paride Bollettin

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"Sou biólogo e viajo muito pela savana do meu país.

Nessas regiões encontro gente que não sabe ler livros.

Mas que sabe ler o seu mundo.

Nesse universo de outros saberes, sou eu o analfabeto"

Mia Couto

A seu Valdemir

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ONDE O RIO ENCONTRA O MAR: SOBREPOSIÇÕES PARCIAIS ENTRE DUAS ONTO-EPISTEMOLOGIAS

Estudos sobre os Conhecimentos Biológicos e Ecológicos da Comunidade Pesqueira de Siribinha, Bahia

VÍTOR RENCK

O conhecimento indígena e local está sob inúmeras ameaças em várias partes do mundo, impulsionado pela globalização, modernização, integração de mercado e mudanças nos sistemas sociais, econômicos e ambientais. Nesta pesquisa, não somente reconhecemos a importância de tal conhecimento, como salientamos a importância da integração do mesmo com a ciência acadêmica. Portanto, nesta tese discutimos potencialidades e limitações do diálogo entre sistemas de conhecimento e dos processos de coprodução de conhecimentos.

Nosso estudo empírico foi inteiramente conduzido em Siribinha, uma comunidade pesqueira artesanal do estuário do rio Itapicuru, litoral norte da Bahia. Comunidade esta que ainda mantém conhecimento tradicional ecológico a respeito dos animais e plantas que a circunda, a despeito de inúmeras outras comunidades pesqueiras ou tradicionais de outras regiões. Diante disso, analisamos o conhecimento local dos pescadores e das marisqueiras de Siribinha acerca da biologia e ecologia de peixes. Além disso, analisamos de que forma a comunidade classificava seus organismos, buscando compreender se havia algum padrão na categorização dos mesmos. Através de uma abordagem intercultural (evitando reproduzir atitudes neo-coloniais, utilitaristas e paternalistas), integramos os resultados encontrados com o conhecimento acadêmico científico.

Nossos resultados mostram que a comunidade tem um rico conhecimento sobre peixes. Através de um método chamado listagem livre, foram registrados 197 tipos de peixes. Encontramos também uma grande diversidade na forma como os peixes são classificados pelos membros da comunidade, o que indica a necessidade de cautela frente à suposição de que uma dada comunidade tradicional utilize os mesmos critérios, ou similares, para classificar e categorizar organismos.

Mostramos como o conhecimento dos pescadores e marisqueiras artesanais pode complementar o conhecimento acadêmico, mas existem alguns desafios que precisam ser superados através de um diálogo intercultural, como será visto ao longo dos três capítulos desta tese.

Finalmente, mostramos a importância da incorporação do conhecimento de especialistas tradicionais na formulação de políticas públicas, tais como aquelas relacionadas ao defeso (período em que se proíbe a pesca ou caça de determinados animais ameaçados). A incorporação desse conhecimento pode tanto melhorar as práticas de manejo sustentável da biodiversidade quanto contribuir para o empoderamento das comunidades tradicionais e povos indígenas.

WHERE THE RIVER MEETS THE SEA: PARTIAL OVERLAPS BETWEEN TWO ONTO-EPISTEMOLOGIES

Studies on the Biological and Ecological Knowledge of the Fishing Community of Siribinha, BA

VÍTOR RENCK

Indigenous and local knowledge is under numerous threats in many parts of the world, driven by globalization, modernization, market integration and changes in social, economic and environmental systems. In this research, we not only recognize the importance of such knowledge, but also emphasize the importance of integrating it with academic science. Therefore, in this Dissertation we discuss potentialities and limitations of the dialogue between knowledge systems and knowledge co-production processes.

Our empirical study was entirely conducted in Siribinha, an artisanal fishing community on the estuary of the Itapicuru River, on the northern coast of Bahia. This community still maintains traditional ecological knowledge about the animals and plants that surround it, despite countless other fishing or traditional communities from other regions. Therefore, we analyzed the local knowledge of fishers from Siribinha about the biology and ecology of fish. In addition, we analyzed how the community classified their organisms, seeking to understand if there was any pattern in their categorization. Through an intercultural approach (avoiding reproducing neo-colonial, utilitarian and paternalistic attitudes), we integrate the results found with scientific academic knowledge.

Our results show that the community has a great knowledge about fish. Through a method called free listing, 197 types of fish were recorded. We also found great diversity in the way fish are classified by community members, which requires caution when assuming that a given traditional community uses the same or similar criteria to classify and categorize their organisms.

We show how the knowledge of artisanal fishers can complement academic knowledge, but there are some challenges that need to be overcome through an intercultural dialogue, as will be seen throughout the three chapters of this Dissertation.

Finally, we show the importance of incorporating the knowledge of traditional experts in the formulation of public policies, such as those related to the closed fishing season (period in which fishing or hunting of certain endangered animals is prohibited). By doing so, we can improve sustainable biodiversity management practices and also contribute to the empowerment of traditional communities and indigenous peoples.

Resumo

Em abordagens de conservação e uso sustentável da biodiversidade, tem sido comum a proposta de integração de conhecimentos acadêmicos e indígenas ou locais. Pesquisas em etnoecologia e etnobiologia adquirem importância central em tais propostas de integração, bem como em iniciativas de diálogo, pois permitem entender como comunidades locais compreendem organismos e ecossistemas, o que não somente possibilita mobilizar conhecimentos potencialmente importantes na conservação da biodiversidade, mas também criar condições mais favoráveis para que essas comunidades tenham voz e participem dos processos de decisão sobre conservação. Portanto, nesta tese discutimos potencialidades e limitações do diálogo entre sistemas de conhecimento e dos processos de coprodução de conhecimentos em Siribinha, uma comunidade de pescadores e marisqueiras artesanais do litoral norte da Bahia. Siribinha, assim como outras comunidades pesqueiras do Brasil, sofre várias ameaças ambientais, sociais e econômicas. Diante dessas ameaças, é importante realizar estudos que documentem os corpos de conhecimentos e práticas de pescadores e marisqueiras, contribuindo, assim, para a preservação da sua identidade, bem como para o reconhecimento de sua contribuição para a conservação da biodiversidade. Portanto, discutimos a necessidade de que tenham voz em decisões sobre conservação, especialmente em seus territórios. Assim, o presente estudo busca analisar o conhecimento local de pescadores e marisqueiras de Siribinha acerca de aspectos biológicos e ecológicos dos peixes com os quais interagem, bem como a taxonomia local relativa a esses organismos. Buscamos construir um entendimento dos seus sistemas de conhecimentos e práticas, que possa informar o estabelecimento de processos dialógicos entre os sistemas de conhecimento pesqueiro artesanal e científico-acadêmico no domínio da conservação e do uso sustentável de recursos. Para tanto, utilizamos como métodos a listagem livre, entrevistas semiestruturadas e tarefa de tríades. Nossos resultados mostram que a comunidade tem um rico conhecimento sobre peixes (com 197 etnoespécies registradas, das quais 33 foram detectadas como salientes). Porém, encontramos uma diversidade intracultural na forma como os peixes são classificados pelos membros da comunidade, o que exige cautela ao fazer suposições de que a comunidade teria um modelo único a este respeito, o que constituiria um consenso cultural. Mostramos também como o conhecimento de pescadores e marisqueiras artesanais pode ter uma relação de complementaridade com o conhecimento científico-acadêmico, mas também trazer tensões que precisam ser abordadas por meio de diálogo intercultural. Finalmente, mostramos a importância da incorporação do conhecimento local na formulação de políticas públicas, tais como aquelas relativas ao defeso. Dessa forma, podemos melhorar as práticas de manejo sustentável da biodiversidade e contribuir para o empoderamento das comunidades tradicionais e povos indígenas.

Palavras-chave: Conhecimento Indígena e Local, Ecologia Humana, Etnobiologia, Etnoecologia, Etnotaxonomia, Etnozoologia, Coprodução de Conhecimentos, Pescadores Artesanais, Sobreposições Parciais, Transdisciplinaridade.

Abstract

In conservation and sustainable use of biodiversity approaches, proposals of integration between academic and indigenous and local knowledge have been common. Research in ethnoecology and ethnobiology acquire central importance in such integration proposals, as well as in dialogue initiatives, since they enable us to understand how local communities comprehend organisms and ecosystems. This makes it possible to mobilize potentially important knowledge in the conservation of biodiversity, but also to create more favorable conditions for these communities to have a voice and participate in conservation decision-making processes. Therefore, in this Dissertation we discuss potentialities and limitations of the dialogue between knowledge systems and knowledge co-production processes in Siribinha, an artisanal fishing community on the northern coast of Bahia. Siribinha, like other fishing communities in Brazil, suffers from various environmental, social and economic threats. Faced with these threats, it is important to carry out studies that document the bodies of knowledge and practices of fishers, thus contributing to the preservation of their identity, as well as for the recognition of their contribution to biodiversity conservation. Therefore, we discuss the need for them to have a voice in conservation decisions, especially in their territories. Thus, the present study seeks to analyze the local knowledge of fishers from Siribinha about biological and ecological aspects of the fish they interact with, as well as the local taxonomy related to these organisms. We sought to build an understanding of their knowledge systems and practices, which can inform the establishment of dialogic processes between artisanal fisheries and scientific-academic knowledge systems in the field of conservation and sustainable use of resources. In order to do so, we used methods such as free listing, semi-structured interviews and triad task. Our results show that the community has a great knowledge about fish (with 197 ethnospecies recorded, of which 33 were considered by the interviewees as salient). However, we found an intracultural diversity in the way fish are classified by the members of the community, which requires caution when making assumptions that it would have a unique model in this regard, which would constitute a cultural consensus. We also show how the knowledge of artisanal fishers can have a complementary relationship with scientific-academic knowledge, but also bring tensions that need to be addressed through intercultural dialogue. Finally, we show the importance of incorporating indigenous and local knowledge in the formulation of public policies, such as those related to closed fishing seasons. By doing so, we can improve sustainable biodiversity management practices and also contribute to the empowerment of traditional communities and indigenous peoples.

Keywords: Indigenous and Local Knowledge, Human Ecology, Ethnobiology, Ethnotaxonomy, Ethnozoology, Knowledge Co-production, Artisanal Fishers, Partial Overlaps, Transdisciplinarity.

Sumário

Introdução geral

A conservação da biodiversidade do planeta, assim como de processos ecológicos e serviços ecossistêmicos, é um dos grandes desafios dos tempos atuais, especialmente devido à extensiva e progressiva perda de habitats (Harrison e Bruna 1999, Bustamante et al. 2019).

Isso se torna especialmente preocupante em países tropicais, que detêm grande porção da biodiversidade planetária, parte dela ainda não registrada na literatura científica ou estudada (Whitmore e Sayer 1992). Comunidades tradicionais e povos indígenas compreendem menos de 5% da população global (Garnett et al. 2018), porém estima-se que protejam até 80% da biodiversidade do planeta (World Bank 2008). O(s) conhecimento(s) indígena(s) e local(is)[1] (ILK – do inglês, *Indigenous and local knowledge*) acerca dessa biodiversidade também vêm sendo perdidos, em decorrência de processos como colonização, globalização e mudanças disruptivas nos sistemas sociais, econômicos e ambientais aos quais comunidades indígenas/locais estão vinculadas (Wolff et al. 1999, Atran et al. 2004, Aswani et al. 2018). É de extrema importância conhecer e registrar esses conhecimentos, para que não sejam perdidos entre as novas gerações e para a manutenção da identidade de comunidades indígenas e locais (Pedrollo et al. 2016).

Em abordagens de conservação e uso sustentável da biodiversidade, tem sido comum a proposta de integração de conhecimentos acadêmicos (AK – do inglês *academic knowledge*) e ILK, bem como de processos de coprodução envolvendo esses conhecimentos (e.g., Rist e Dahdouh-Guebas 2006, Alessa et al. 2016, Ludwig 2016, Tengö et al. 2017). A consideração de seus conhecimentos na tomada de decisão sobre conservação é importante para o empoderamento de comunidades locais e povos indígenas, detentores de sistemas de conhecimento frequentemente marginalizados e

[1] Entendemos sistema de conhecimento indígena/local como um corpo de conhecimento, experiência e crença, evoluindo e governado por processos adaptativos e transmitido de geração em geração por transmissão cultural, sobre a relação dos seres vivos (incluindo humanos) uns com os outros e com seu ambiente. Esse conhecimento é dinâmico e mutável (Albuquerque e Alves 2016, Tengö et al. 2017).

não reconhecidos, bem como para um eficaz manejo sustentável de recursos naturais, manutenção de serviços ecossistêmicos e planejamento efetivo de estratégias de conservação (Ludwig 2016, Albuquerque et al. 2021).

Os debates sobre possíveis processos de integração, diálogo e coprodução envolvendo conhecimentos indígenas e locais e conhecimentos acadêmicos são amplos e marcados por grande controvérsia. É importante considerar, por exemplo, limitações e potenciais efeitos adversos de projetos de integração. Enquanto perspectivas pessimistas a respeito da integração de conhecimentos podem criar fronteiras artificiais e contribuir para marginalizar o conhecimento indígena e local através da suposição de diferenças intransponíveis entre sistemas de conhecimento (Ludwig e El-Hani 2020), visões excessivamente otimistas geralmente obscurecem as diferenças entre as partes interessadas e, assim, reproduzem hierarquias entre cientistas e comunidades locais na negociação de práticas e políticas (Lertzman 2009). Frequentemente, os detentores de ILK são instados a provar o valor de seu conhecimento, em termos de sua validade à luz de critérios epistemológicos e metodológicos assumidos por pesquisadores acadêmicos. Em contrapartida, não se solicita, tipicamente, que AK seja validado à luz de ILK (Ludwig e El-Hani 2020), o que resulta numa situação de "injustiça epistêmica" ou "testemunhal" (Anderson 2012, Fricker 2007, Wanderer 2011). Isso contribui para práticas que tratam ILK como meramente uma fonte de dados para a pesquisa acadêmica, ignorando-se aspectos de ILK que desafiam pressupostos de cientistas academicamente treinados. Além disso, contribui para que ILK seja silenciado em arenas de decisão sociopolítica.

De modo a evitar posições inteiramente otimistas ou pessimistas, Ludwig (2016) desenvolveu um modelo de sobreposição ontológica, mostrando exemplos de integração de conhecimentos bem-sucedidos, além de falhas na integração. A partir disso, Ludwig e El-Hani (2020) propuseram uma abordagem de "sobreposições parciais", estendendo o modelo às dimensões epistemológicas, políticas e valorativas. Defendem, portanto, a necessidade de se investigar e dar a devida atenção tanto a sobreposições (semelhanças) quanto a parcialidades de sobreposição (diferenças) entre ILK e AK, na forma como povoam o mundo de entidades e processos e distinguem suas diferentes categorias (as distintas ontologias dos sistemas de conhecimento), na forma como compreendem a natureza do conhecimento e estabelecem critérios para julgar sua validade (suas epistemologias) e se posicionam normativa e valorativamente no mundo natural e social (suas axiologias, seus sistemas de valores).

Pesquisa etnoecológica e etnobiológica adquire importância central em tais propostas de integração e diálogo, pois permitem adquirir da comunidade estudada conhecimento ecológico local sobre organismos e ecossistemas, potencialmente relevante para a conservação da biodiversidade. Etnobiologia e etnoecologia são campos do conhecimento relacionados e complementares, cujas raízes datam do fim do século XIX (Sobral e Albuquerque 2016). A primeira visa estudar o conhecimento e as conceituações desenvolvidas por qualquer sociedade a respeito de seres vivos ou organismos (Posey 1986). A segunda busca estudar "como os grupos tradicionais organizam e classificam seu conhecimento do ambiente e dos processos ambientais" (Brosius et al. 1986).

A presente tese tem um embasamento teórico na abordagem de sobreposições parciais (Ludwig 2016, Ludwig e El-Hani 2020) e reúne estudos empíricos realizados em Siribinha, uma comunidade de pescadores e marisqueiras artesanais localizada no estuário do rio Itapicuru, litoral norte da Bahia. Assumindo uma atitude intercultural (Rist e Dahdouh-Guebas 2006) frente ao conhecimento indígena e local, interpretada em termos pluralistas e pragmáticos (El-Hani & Mortimer, 2007; El-Hani et al., 2014; El-Hani, 2022), realizamos uma pesquisa etnobiológica e etnoecológica com métodos qualitativos e quantitativos, com o objetivo de compreender o conhecimento local acerca dos peixes que os circundam e a forma como a comunidade os categoriza.

Siribinha, assim como muitas outras comunidades pesqueiras, sofre ameaças de diversos tipos, entre elas: impactos ambientais que acarretam declínio das capturas na pesca (por exemplo, o aumento do uso de barcos a motor no estuário e a pesca de arrasto de camarão realizada no mar na região do estuário do rio Itapicuru por pescadores não artesanais, provenientes predominantemente de Sergipe); condições econômicas e sociais desiguais que levam à exploração dessas comunidades (fruto da ampliação da rodovia BA-099 e consequente urbanização e especulação imobiliária, por exemplo); mudanças em suas práticas tradicionais que fazem com que elas percam sustentabilidade (através, por exemplo, do turismo de exploração e da chegada de artefatos pesqueiros mais predatórios), entre outras (Guimarães 2018, Fonseca 2021).

Diante dessas ameaças, é importante realizar estudos que documentem os corpos de conhecimentos e práticas dos pescadores e das marisqueiras (que guardam importantes subsídios culturais para a conservação de recursos naturais em ecossistemas fluviais, estuarinos e marinhos), contribuindo, assim, para a conservação da biodiversidade e para uma maior visibilidade aos seus conhecimentos e direitos, bem como favorecendo que suas vozes tenham espaço em arenas de tomada de decisões que afetam seus modos de vida.

Apresentação dos capítulos

A presente tese está composta por três capítulos. No **primeiro capítulo** (*Cultural Consensus and Intracultural Diversity in Ethnotaxonomy - Lessons From a Fishing Community in Northeast Brazil*), buscamos analisar, através de métodos comumente utilizados em estudos etnobiológicos (listagem livre e tarefa de tríades), o modelo de consenso cultural da comunidade de Siribinha quanto à categorização e classificação de peixes. Diante disso, discutimos a importância em estudos etnobiológicos de não pressupor que uma dada comunidade tradicional ou população indígena possua um modelo de consenso cultural.

No **segundo capítulo** (*Exploring Partial Overlaps Between Knowledge Systems in a Brazilian Fishing Community*), realizamos estudo empírico acerca dos conhecimentos de pescadores e marisqueiras de Siribinha sobre peixes, baseado na abordagem de sobreposições parciais (Ludwig 2016, Ludwig e El-Hani 2020). Ao integrar um quadro filosófico geral de sobreposições parciais com um estudo empírico (qualitativo e quantitativo) sobre o conhecimento dos pescadores e das marisqueiras artesanais, mostramos como a etnobiologia pode contribuir para abordagens transdisciplinares reflexivas e empiricamente fundamentadas em temas como o diálogo intercultural e a conservação da biodiversidade.

No **terceiro capítulo** (*Taking Fishers' Knowledge and their Implications to Fisheries Policy Seriously*), discutimos a necessidade da coprodução de conhecimentos para melhorar políticas públicas ambientais, tais como o defeso das espécies marinhas. Argumentamos não apenas sobre a importância do conhecimento científico acadêmico na formulação e revisão de tais políticas públicas, como também acerca da necessidade de incorporação do conhecimento indígena e local, que é geralmente marginalizado ou não reconhecido pelos tomadores de decisão. Debatemos essa problemática à luz da literatura, como também através de estudos empíricos realizados nas comunidades pesqueiras de Siribinha e Poças. Por meio de entrevistas semiestruturadas com especialistas tradicionais, buscamos investigar o conhecimento deles acerca do período reprodutivo de algumas espécies marinhas e, assim, analisar as incongruências encontradas entre esse sistema de conhecimento e algumas legislações de defeso.

A presente tese contém também uma seção com as **considerações finais**, na qual sumariamos os conhecimentos gerados nos três capítulos, com o objetivo de discutir as lacunas preenchidas dentro dos campos etnobiológico e etnoecológico, bem como as consequências de levar a sério os conhecimentos e práticas de especialistas tradicionais.

General Introduction

The planet's biodiversity conservation, as well as ecological processes and ecosystem services, is one of the great challenges of current times, especially due to the extensive and progressive loss of habitats (Harrison and Bruna 1999, Bustamante et al. 2019).

This becomes especially worrying in tropical countries, which hold a large portion of the planet's biodiversity, part of which has not yet been recorded in the scientific literature or studied (Whitmore and Sayer 1992). Traditional communities and indigenous peoples comprise less than 5% of the global population (Garnett et al. 2018), but are estimated to protect up to 80% of global biodiversity (World Bank 2008). Indigenous and local knowledge[2] (ILK) about this biodiversity is also being lost as a result of colonization, globalization and disruptive changes in social, economic systems and environmental issues to which indigenous/local communities are linked (Wolff et al. 1999, Atran et al. 2004, Aswani et al. 2018). It is extremely important to know and record this knowledge, so that it is not lost among new generations and to maintain the identity of indigenous and local communities (Pedrollo et al. 2016).

In approaches to conservation and sustainable use of biodiversity, it has been common to propose the integration of academic knowledge (AK) and ILK, as well as co-production processes involving them (e.g., Rist and Dahdouh-Guebas 2006, Alessa et al. 2016, Ludwig 2016, Tengö et al. 2017). The consideration of their knowledge in conservation decision-making is important for the empowerment of local communities and indigenous peoples, holders of often marginalized and unrecognized knowledge systems, as well as for an effective sustainable management of natural resources, maintenance of ecosystem services and effective planning of conservation strategies (Ludwig 2016, Albuquerque et al. 2021).

[2] We understand indigenous/local knowledge system as a body of knowledge, experience and belief, evolving and governed by adaptive processes and transmitted from generation to generation by cultural transmission, about the relationship of living beings (including humans) with each other and with the environment. This knowledge is dynamic and mutable (Albuquerque and Alves 2016, Tengö et al. 2017).

The debates on possible processes of integration, dialogue, co-production involving indigenous and local knowledge and academic knowledge are broad and marked by great controversy. It is important to consider, for example, limitations and potential adverse effects of integration projects. While pessimistic perspectives on knowledge integration can create artificial boundaries and contribute to marginalizing indigenous and local knowledge through the assumption of insurmountable differences between knowledge systems (Ludwig and El-Hani 2020), overly optimistic views often obscure the differences between stakeholders and, thus, reproduce hierarchies between scientists and local communities in negotiating practices and policies (Lertzman 2009). Often, ILK holders are urged to prove the value of their knowledge, in terms of its validity in light of epistemological and methodological criteria assumed by academic researchers. On the other hand, AK is not typically asked to be validated in light of ILK (Ludwig and El-Hani 2020), which results in a situation of "epistemic" or "testimonial injustice" (Anderson 2012, Fricker 2007, Wanderer 2011). This contributes to practices that treat ILK as merely a source of data for academic research, ignoring aspects of ILK that challenge assumptions of academically trained scientists. Furthermore, it contributes to ILK being silenced in sociopolitical decision-making arenas.

In order to avoid entirely optimistic or pessimistic positions, Ludwig (2016) developed the overlapping ontologies model, showing examples of successful knowledge integration, as well as exposing failures in integration. From this, Luwig and El-Hani (2020) proposed an approach of "partial overlaps", extending the model to epistemological, political and value system dimensions. Therefore, they defend the need to investigate and give due attention to both overlaps (similarities) and overlapping partialities (differences) between ILK and AK, in the way they populate the world with entities and processes and distinguish their different categories (the different ontologies of knowledge systems), how they understand the nature of knowledge and establish criteria for judging its validity (their epistemologies) and how they position themselves normatively and evaluatively in the natural and social world (their axiologies, their value systems).

Ethnoecological and ethnobiological research acquires central importance in such proposals for integration and dialogue, as they allow the acquisition of local ecological knowledge about organisms and ecosystems from the studied community, potentially interesting in biodiversity conservation. Ethnobiology and ethnoecology are related and complementary fields of knowledge, whose beginnings date back to the late 19th century (Sobral and Albuquerque 2016). The first aims to study the knowledge and concepts developed by any society regarding living beings or organisms (Posey 1986). The second seeks to study “how traditional groups organize and classify their knowledge of the environment and environmental processes” (Brosius et al. 1986).

The present Dissertation has a theoretical basis in the partial overlaps framework (Ludwig 2016, Ludwig and El-Hani 2020) and brings together empirical studies carried out in Siribinha, a community of artisanal fishers located in the estuary of the Itapicuru River, north coast of Bahia. Taking an intercultural approach (Rist and Dahdouh-Guebas 2006) to indigenous and local knowledge, interpreted in pluralistic and pragmatic terms (El-Hani & Mortimer, 2007; El-Hani et al., 2014; El-Hani, 2022), we carried out an ethnobiological and ethnoecological research with qualitative and quantitative methods, seeking to understand the local knowledge about the fish that surround them and the way in which the community categorizes and classifies them.

Siribinha, like many other fishing communities in tropical regions, is threatened by: environmental impacts that lead to a decline in fisheries catches (for example, increased use of motor boats in the estuary and shrimp trawling carried out at sea in the region of the Itapicuru river estuary by non-artisanal fishers predominantly from Sergipe); unequal economic and social conditions that lead to the exploitation of these communities (the result of the expansion of the BA-099 highway and consequent urbanization and real estate speculation, for example); changes in their traditional practices that make them lose sustainability (through, for example, extractive tourism and the arrival of more predatory fishing artifacts), among others (Guimarães 2018, Fonseca 2021).

Faced with these threats, it is important to carry out studies that document the bodies of knowledge and practices of fishers (who hold important cultural subsidies for the conservation of natural resources in river, estuarine and marine ecosystems), thus contributing to the biodiversity conservation and giving greater visibility to their knowledge and rights, as well as allowing their voices to have space in decision-making arenas that affect their ways of life.

Presentation of Chapters

This Dissertation is composed of three chapters. In the **first chapter** (*Cultural Consensus and Intracultural Diversity in Ethnotaxonomy - Lessons From a Fishing Community in Northeast Brazil*), we seek to analyze, through methods widely used in ethnobiological studies (free listing and triad task), the cultural consensus model of the fishing community of Siribinha regarding the categorization and classification of fish. Therefore, we discuss the importance in ethnobiological studies of not assuming that a given traditional community or indigenous population has a cultural consensus model.

In the **second chapter** (*Exploring Partial Overlaps Between Knowledge Systems in a Brazilian Fishing Community*), we carried out an empirical study on the knowledge of fishers from Siribinha about fish based on the partial overlaps approach (Ludwig 2016, Ludwig and El-Hani 2020). By integrating a general philosophical framework of partial overlaps with a qualitative and quantitative study of the knowledge of artisanal fishers, we show how ethnobiology can contribute to reflective and empirically grounded transdisciplinary approaches to issues such as intercultural dialogue and biodiversity conservation.

In the **third chapter** (*Taking Fishers' Knowledge and their Implications to Fisheries Policy Seriously*), we discuss the need for co-production of knowledge to improve public environmental policies, such as the closed fishing season of marine species. Not only do we argue about the importance of academic scientific knowledge in the formulation and review of such public policies, but also about the need to incorporate indigenous and local knowledge, which is generally marginalized and not recognized by policy-makers. We discuss this issue in the light of the literature, as well as through empirical studies carried out in the fishing communities of Siribinha and Poças. Through semi-structured interviews with traditional experts, we sought to investigate their knowledge about the reproductive period of some marine species and, thus, analyze the inconsistencies found between this knowledge system and some closed season legislation.

This Dissertation also contains a section with **final considerations**, in which we summarize the knowledge generated in the three chapters, discussing the gaps filled within the ethnobiological and ethnoecological fields, as well as taking traditional experts' knowledge and practices seriously.

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“A gente saía quando ele (o mar) vacila. Quando ele não vai com a cara, quando ele cisma, ele não deixa a pessoa sair.”

Seu Waldemir Celestrino, sobre entrar no mar de canoa.

Capítulo I

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CULTURAL CONSENSUS AND INTRACULTURAL DIVERSITY IN ETHNOTAXONOMY - LESSONS FROM A FISHING COMMUNITY IN NORTHEAST BRAZIL

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 (49 men and 42 women) with different type of activities (fishers and non-fishers), 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.

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.

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 local community has a single cultural consensus model in classifying the organisms in their environment.

Keywords: Artisanal fishers, Ethnobiology, Ethnozoology, Indigenous and local knowledge, Free list, Triad task.

Introduction

Human societies have always built ways of making sense of the biological diversity surrounding them, for instance, by grouping organisms by similarity or separating them by difference [1, 2]. These categorization processes are culturally influenced and organized in different taxonomic structures [3, 4]. 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 [5-7]. However, 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 [8-10].

In fishing communities all 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 [11]. At another location in Rio de Janeiro, called Piratininga, fishers base their classification on how fish behave [12]. Begossi and Garavello [13] observed that the criteria used by the Tocantins River fishers, in the Brazilian states of Maranhão and Tocantins, are mainly morphological. The indigenous and fishing community of Piaroa, in Colombia, classifies fish and other animals based on food taboos and religious elements [14].

Ross et al. [15] 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. [15, 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 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 [7]. Some examples of ethnobiological researches that used this methodology are Ross et al. [15], who studied plant categorization by the Tzotzil Maya from Zinacantán (Highlands of Chiapas, Mexico), Medin et al. [17], who studied the categorization of trees by tree experts in the Chicago region (USA), and Medin et al. [7], who studied the categorization of freshwater fish by Native American and majority-culture fish experts from the north central Wisconsin (USA). While the two latter document intercultural variation, the former analyze intracultural variation in the Tzotzil Maya biological knowledge.

The intracultural variation of indigenous and local knowledge (ILK) is patterned following sociodemographic characteristics of community members, geographic characteristics as well as domains of knowledge [18]. Reasons for the intracultural variation of ILK are suggested to include gender [19-21], age [22-24], levels of expertise [25], distribution of work [20], among others. Analyzing intracultural variation of ILK enables scholars to raise hypotheses about the social organization in a culture, gives indications of persistence or loss of ILK and thereby help to identify the conditions for its thriving and vanishing [18].

The need for a better understanding of Indigenous and local biological knowledge in many parts of the world as well as its growing disappearance is of great concern to ethnobiologists [46]. The loss of local biological knowledge is often attributed to globalization, environmental degradation, and disruptive changes in social and economic systems [see 26-30]. Even though indigenous and local knowledge is being lost at an alarming rate [26, 28], many communities maintain local knowledge and practices despite the threats impacting them. A number of artisanal fishing communities in Brazil provide notable examples [31, 32].

Over the last five years, we have built a trust relationship and engaged in a research-action project to build up dialogue with members of two artisanal fishing communities in the Itapicuru estuary, in Northeast Brazil, and engaged in documenting and preserving their ethnobiological knowledge [e.g. 21, 33]. The present study is part of a project that is both interdisciplinary, involving a team of researchers from different academic areas and from different institutions seeking to build an integrated body of knowledge, and transdisciplinary, aiming to produce an effective and symmetrical dialogue with the non-academic knowledge, held by other social actors, such as fishers.

During this time, we have been performing mixed-methods studies in the areas of intercultural education, biodiversity conservation, and ethnobiology. One aspect of the local artisanal fishers' ethnobiological knowledge 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 and type of activity (fishers or non-fishers) is also in need of inquiry.

Therefore, the overarching aim of this study is to understand how local knowledge in an artisanal fishing community situated in Northeast Brazil is distributed among its members. More specifically, we aim to: (1) document the most culturally salient fish (ethno)species (locally considered as being of high importance) in the community; (2) determine if there is a consensual cultural model regarding fish ethnotaxonomy; and (3) examine how gender and type of activity influence differences in intracultural knowledge composition within the fishing community.

Methods

Study Area

The fishing village of Siribinha (11º48'49"S, 37º36'38"W) is part of the municipality of Conde and is located in the Itapicuru estuary in Bahia, in northeast Brazil. 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 [21].

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 was no road 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 on the community provided here 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 purpose of understanding fish ethnotaxonomy, we performed a free listing task to determine the most salient species of fish. 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, 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) [15, 34]. The triad task allows us to derive a consensual cultural model without assuming that such a model exists beforehand [15]. 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. To generate the triad tasks, we randomly selected ten ethnospecies of fish (Table 1) among the 33 most salient to the community, according to the findings from the free listing interviews (see section "Free Lists and Salience Indices" in the Results). 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 / 1 - item on the left / 2 - item on the middle / 3 - item on the right), "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 [15].

The triad task was performed with a Lambda 2 design [34, 35], which means that each pair of ethnospecies was compared exactly twice. Using 10 ethnospecies, this design generates 30 triads, a number that was deemed manageable for the triad tasks. A higher number of ethnospecies was used in pilot interviews. However, the interviews were too long (lasting approximately 50 minutes), tiring the interviewees and thereby compromising data quality.

Table 1. Ethnospecies of fish selected for the triad tasks (in alphabetical order) in Siribinha, northeast Brazil.

Ethnospecies	Academic scientific species (family)
Bagre fidalgo	*Bagre bagre* (Ariidae)
Carapeba	*Eugerres brasilianus* (Gerreidae)
Cavala	*Scomberomorus cavalla* (Scombridae)
Corvina	*Micropogonias furnieri* (Sciaenidae)
Curimã	*Mugil liza* (Mugilidae)
Pescada amarela	*Cynoscion acoupa* (Sciaenidae)
Pescada branca	*Cynoscion leiarchus* (Sciaenidae)
Robalo branco	*Centropomus parallelus* (Centropomidae)
Tainha	*Mugil curema* (Mugilidae)
Xaréu	*Caranx hippos* (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 used 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. By analyzing the whole set of interviews, we concluded that these different names referred to the same ethnospecies. For example, small phonetic differences were common, like *arraia jamanta* and *arraia jalamanta* (*Mobula sp.*) or *bagre upemba* and *bagre urupemba* (unidentified species). In some other cases, different fish names were also recognized by the interviewees as referring to one single ethnospecies, but 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 scientific species names for the ethnospecies and ethnogenera were provided by a fisheries specialist, Dr. José Amorim dos Reis Filho, based on the ethnospecies' names. Dr. Dos Reis Filho investigates fishers' practices and has extensive knowledge of the species named by fishers in the study region. 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 listed approached an asymptote.

To determine whether the gender and activity of the interviewees had any influence on the number of ethnospecies (or ethnogenera) 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. [36], using the formula: $S=\Sigma((L–Rj + 1)/L))/N$, where L is the length of a list, Rj 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 [36]. In cases where an interviewee mentioned an ethnogenus, for instance, *cação* (small shark), as the first item but mentioned more specific ethnospecies later, we substituted the ethnogenus for the mentioned ethnospecies. However, in some cases in which the interviewee did not provide any ethnospecies for an ethnogenus when questioned at the end of interview, we maintained the ethnogenus 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 [36], 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 [36]. Following Chaves et al. [36], 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 summarize 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 [37]. 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 [38]. 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 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 if there was 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 between the 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 [15].

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. All analyses were performed in R (R Core Team 2017). The R script for calculating Salience 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 Salience Indices

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

<Table 2>

Of the 33 ethnospecies and ethnogenera, 28 (85%) overlapped with an academic scientific species or genus. The remaining five were left unidentified, either because the ethospecies/ethnogenus comprised many species from different genera or simply because the fisheries specialist could not ascertain the relationship between ethnospecies and academic scientific species.

The calculated salience indices 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/ethnogenera, 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/ethnogenera. A further 46 fish (23%) had insignificant p-values, and were also not considered salient.

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), although intergroup comparisons were not statistically significant.

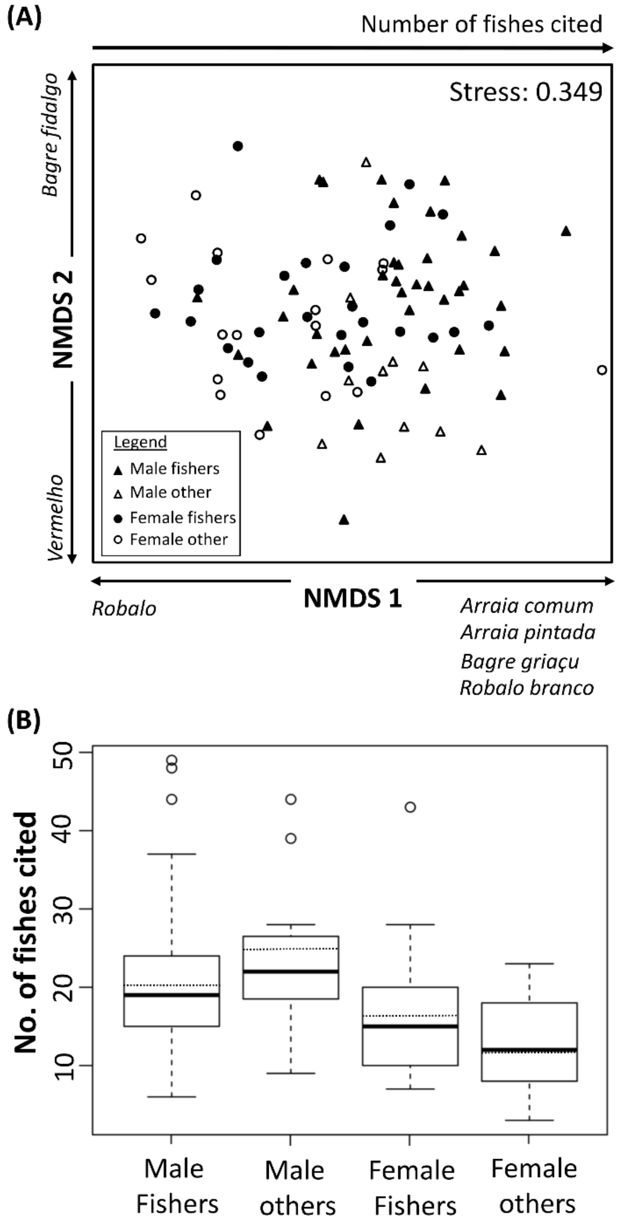

Fig. 1. (A) Non-metric multidimensional ordination of ethnospecies and ethnogenera of fish cited during the free listing task by 91 interviewees from the fishing community of Siribinha, northeast Brazil. The arrows along the axes indicate significant positive or negative Pearson correlations (p > 0.00047 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 number of fish cited during the free listing tasks by gender and type of activity. Boxes enclose the median (thick line), the mean (thin dashed line), and the 25 and 75 percentiles.

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), although intergroup comparisons were not statistically significant.

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). Bagre fidalgo and xareu stood out from the others, mainly for their morphological traits, behaviour or taste, used by the interviewees to distinguish them from the other ethnospecies. Statements like the following were common:

L.42: Xareu 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.

E.68: Xareu *and bagre are two* ***carregado*** *fish (commonly used term 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 [44]).*

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

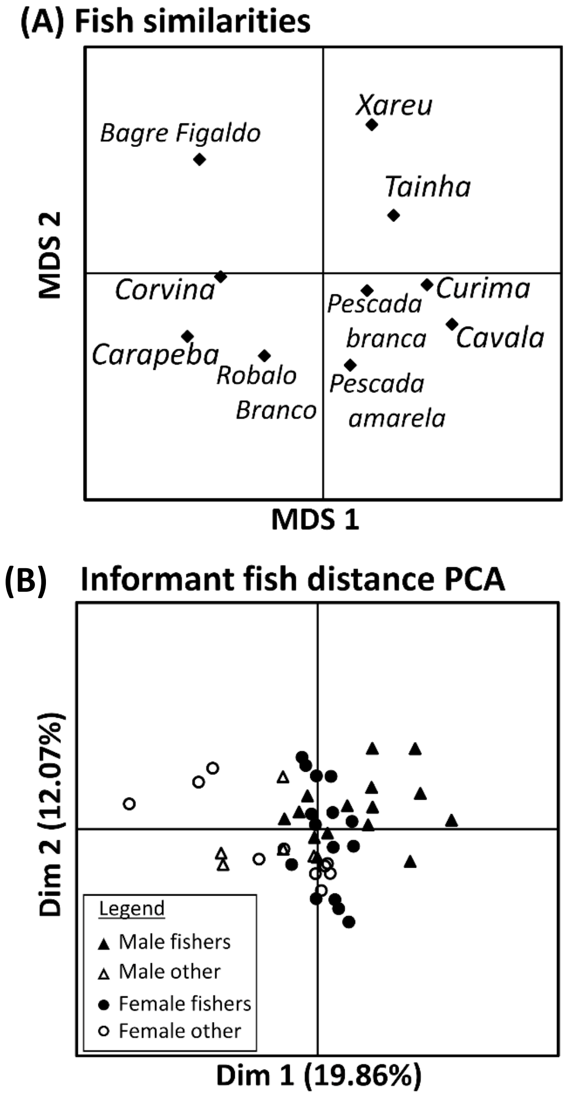

Fig. 2. Non-metric multidimensional scaling (MDS) ordinations of fish (A) similarity judgments as determined by triad tasks from 45 interviewees from an artisanal fishing community in Siribinha, northeast Brazil. The inter-interviewee fish (B) distance matrix correlations were analyzed with Principal Components Analyses to check for consensus within and across groups of interviewees (male fishers, male non-fishers, female fishers, and female non-fishers).

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

Discussion

Salience indices

The salient ethnospecies or ethnogenera considered by the 91 participants in the free listing task (p < 0.042) are also, according to them, the most fished ones in the community. Therefore, the community members naturally have more contact with them.

The 118 fish ethnospecies with lower salience values (0.022 - 0.0002) but significant *p* values can be considered idiosyncrasies [e.g. 36]. 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., when a fish has many different common names and some of them are not widely spread around). For these reasons, items with low saliency have been interpreted in the literature as being of little or no cultural importance, or even mistakes [36]. Items that were cited only once (73 fish out of 197 - 37%) are also considered idiosyncratic.

We tried to decrease the limitations and biases in the method as much as possible, but some methodological decisions have influenced the results in a relevant manner. For instance, when we asked for scrutinization on the ethnogenus, these were excluded when the interviewees mentioned ethnospecies linked to them. Therefore, it is possible that, by doing so, we deflated the salience indices of some ethnogenus, and inflated those of some ethnospecies.

The role of gender and type of activity in ethnotaxonomy

Gender roles are very important in artisanal fishing communities in Brazil [e.g., 39-40], and the Siribinha community is no exception. Reported differences in intracultural knowledge about the environment in several studies suggest a link between gender and type of activity or social role [41-42]. 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). Tng et al. [21], for example, performed an ethnobotanical study in Siribinha and found that female and male traditional experts possess a different set of plant use knowledge, with women generally citing more food and medicinal plants, and men citing more wood and fiber plants. Therefore, intracultural variation in plant knowledge and probably fish knowledge in Siribinha is also related to social role and type of activity.

Nevertheless, it is still not clear why we did not find male-fishers citing significantly more fish than non-fishers. Even though we did not find statistically significant intergroup comparisons, this is still a relevant and intriguing result, since in this specific case, type of subsistence activity does not clearly relate to what might be expected based on the knowledge of local people, as assessed through the number of fish cited in a free list. It is fair to say, however, that this is a predominantly fishing village, and even though many inhabitants do not depend on fishing directly for their livelihoods, their lives are closely intertwined with the fishing culture. The vast majority engage in fishing in their free time (either for self-consumption or for leisure) and/or live in the same household or have a close relationship (married to/mother or father/son or daughter etc.) with a fisherman or a fisherwoman.

We acknowledge that age plays a considerable role in the distribution of indigenous and local knowledge [22-24], alongside gender and type of activity, however we were not able to account for many of the interviewees' age, hindering the age analysis on both free lists and triad tasks.

Lack of cultural consensus

Debates about indigenous and local knowledge often treat knowledge of a community as homogenous [15]. This tendency can be further reinforced by ethnotaxonomic traditions of emphasizing cross-cultural stability and universality of categories [5]. But we encountered a very different pattern, since a lack of cultural consensus was observed. That is, even within relatively homogeneous cultural groups, there was great variation of response, agreeing with findings of Boster and Johnson [25].

In the MDS analyses of both the free list and triad task results, 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 [36].

Nevertheless, the triad task shows a limitation. The number of triads used in a task grows exponentially, the higher the amount of items used. In a Lambda 2 design, 10 items generate 30 triads. In the same design, 25 items generate 200 triads [35], which would make an interview last a few hours. Even if we had opted to use a Lambda 1 design, performing an interview with the 33 most salient ethnospecies and ethnogenera, would make the interview too long, affecting the quality of the interviewees' responses. If that would have been possible, nevertheless, we would have probably observed a few clusters in the ordinations of fish (Fig. 2A), for instance, a cluster with some of the six ethnospecies of *bagre* (catfish) that are part of the most salient ethnospecies and ethnogenera, or another one with the three ethnospecies of *robalo* (snook) that are part of that list. However, we believe that would not be enough for the structure of the agreement to be explained by a single factor solution, and, thus, a lack of cultural consensus would still be found.

Additionally, we did not find a common conceptual organization of the ethnospecies and ethnogenera. These results varied substantially from the findings of Ross et al. [15], who studied plant categorization by the Tzotzil Maya from Zinacantán (Highlands of Chiapas, Mexico), and Medin and colleagues [7], who investigated the categorization of freshwater fish by Native American and majority-culture fish experts from north central Wisconsin (USA). Nevertheless, our results reinforce the argument of Ross and colleagues [15] 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 [43] 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. For instance, 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 will tend to deviate more often from a consensus [25].

Conclusions

Indigenous and local 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. 7, 15, 17]. 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 members. These observations call for caution in making assumptions that a given local community would have a single cultural consensus model in classifying the organisms that they encounter in their daily lives.

The lack of “cultural consensus”" does not mean, however, that there are no patterns in the community’s knowledge or even that the 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 type of activity) and epistemic diversity within communities without assuming that there is nothing to be said about communities more generally. In this sense, ethnobiologists are challenged to avoid treating communities either as monolithic epistemic units or as entirely fragmented collections of individuals.

List of abbreviations

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

Declarations

Acknowledgments

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Authors' contributions

VR, CNE and DL 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 [45].

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, provided that confidentiality and other ethical issues are respected and maintained.

Competing interests

The authors declare that they have no competing interests.

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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	*Mugil curema*	0.717	<0.001
Carapeba	*Eugerres brasilianus*	0.584	<0.001
Robalão	*Centropomus undecimalis*	0.464	<0.001
Robalo branco	*Centropomus parallelus*	0.386	<0.001
Pescada branca	*Cynoscion leiarchus*	0.339	<0.001
Pescada amarela	*Cynoscion acoupa*	0.330	<0.001
Robalo espalmado	*Centropomus parallelus*	0.303	<0.001
Curimã	*Mugil liza*	0.299	<0.001
Vermelho	*Lutjanus purpureus*	0.294	<0.001
Robalo*	*Centropomus* spp.	0.224	<0.001
Corvina	*Micropogonias furnieri*	0.220	<0.001
Bagre fidalgo	*Bagre bagre*	0.215	<0.001
Bagre amarelo	*Sciades herzbergii*	0.206	<0.001
Bagre griaçu	*Sciades proops*	0.191	<0.001
Bagre do mangue	*Genidens barbus*	0.178	<0.001
Xaréu	*Caranx hippos*	0.171	<0.001
Cavala	*Scomberomorus cavalla*	0.165	<0.001
Sardinha	*Opisthonema oglinum*	0.165	<0.001
Pescada barracuda	*Sphyraena guachancho*	0.142	<0.001
Bagre uruçu	*Apistor luniscutis*	0.136	<0.001
Cação martelo	*Sphyrna* spp.	0.132	<0.001
Sororoca	*Scomberomorus brasiliensis*	0.115	0.001
Capadinho	Unidentified	0.109	0.002
Cação*	Several species	0.107	0.003
Catana	*Trichiurus lepturus*	0.103	0.005
Bagre cagão	Unidentified	0.099	0.008
Badejo	*Mycteroperca bonaci*	0.088	0.025
Pescada*	*Cynoscion spp.*	0.088	0.026
Caçonete*	Several species	0.086	0.030
Arraia*	Several species	0.086	0.033
Roncador	*Ballistes vetulla*	0.084	0.039
Guaricema	*Caranx crysos*	0.083	0.041
Mirucaia	*Ctenosciaena gracilicirrhus*	0.083	0.042

The probable overlapping academic scientific species to the ethnospecies are indicated (identified by José Amorim dos Reis Filho/see main text for explanation). *Ethnogenera that encompasses many species. (See Supplementary Table S2 for complete list).

APPENDIX

Supplementary Material

1. Portuguese originals from the translated excerpts

L.42: *xareu e bagre são os mais diferentes/ são ruins de comer.*
Xareu and bagre are the most different ones/ they are not so tasty.

E.33: *não gosto muito do xareu/ tem verme/ a gente usa mais pra isca/ (...) é peixe de couro/ (...) tem cheiro ruim/ não tem gosto/ (...) bagre fidalgo não tem escama/ só couro.*
I don’t like xareu 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 scale/ just leather.

E.68: *xareu e bagre são dois peixes carregados.*
Xareu and bagre are two carregado fish.

D.49: *o xareu quase ninguém gosta/ a carne é escura/ de terceira qualidade/ (...) bagre é diferente dos outros/ é fora do normal.*
Almost no one likes xareu/ its meat is dark/ of third quality/ (…) bagre is different from the others/ it's out of the ordinary.

Table S1. Triad Task Photographs

Ethnospecies (scientific name)	**Photographs**
Bagre Fidalgo (*Bagre bagre*)	 Photo by author
Carapeba (*Eugerres brasilianus*)	 Photo by author
Cavala (*Scomberomorus cavala*)	 Photo by author
Corvina (*Micropogonias furnieri*)	 Photo by author
Curimã (*Mugil liza*)	 Photo by José Amorim dos Reis Filho

Pescada amarela (*Cynoscion acoupa*)	 Photo by José Amorim dos Reis Filho
Pescada branca (*Cynoscion leiarchus*)	 Photo by José Amorim dos Reis Filho
Robalo branco (*Centropomus parallelus*)	 Photo by author
Tainha (*Mugil curema*)	 Photo by José Amorim dos Reis Filho
Xareu (*Caranx hippos*)	 Photo by author

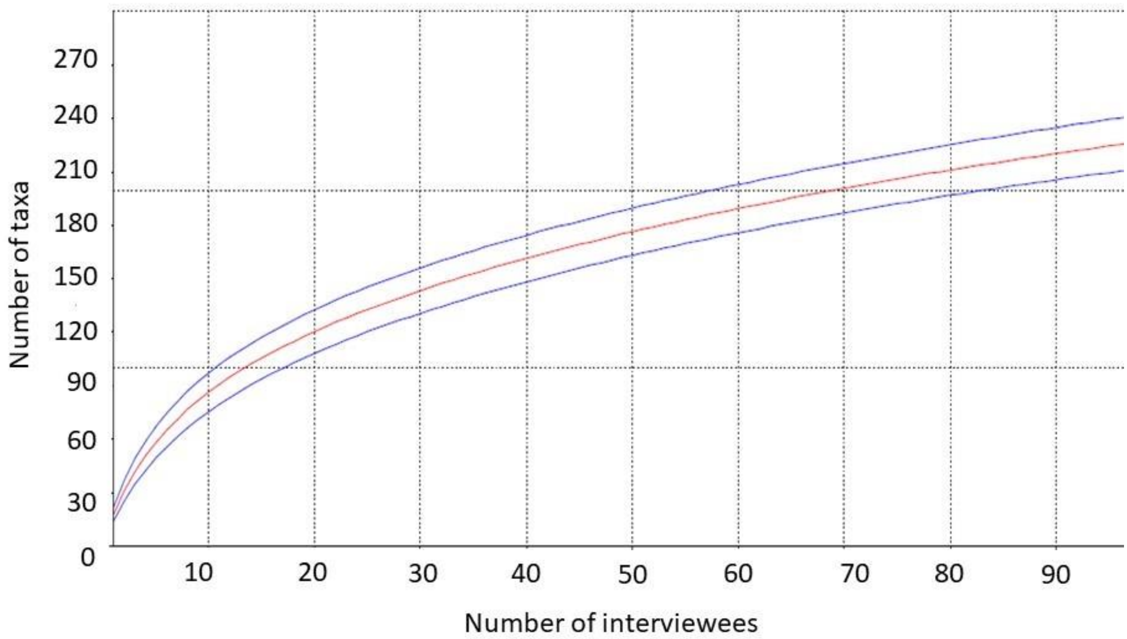

Fig. S1. Free List Rarefied Ethnospecies-interviewee Curve Analysis

Table S2. Complete list of fish saliency according to the participants of the free listing task in Siribinha, Brazil

	Ethnospecies	Probable academic scientific species	Salience	*p*-value
1	Tainha	*Mugil curema*	0.717	<0.001
2	Carapeba	*Eugerres brasilianus*	0.584	<0.001
3	Robalão	*Centropomus undecimalis*	0.464	<0.001
4	Robalo branco	*Centropomus parallelus*	0.386	<0.001
5	Pescada branca	*Cynoscion leiarchus*	0.339	<0.001
6	Pescada amarela	*Cynoscion acoupa*	0.330	<0.001
7	Robalo espalmado	*Centropomus parallelus*	0.303	<0.001
8	Curimã	*Mugil liza*	0.299	<0.001
9	Vermelho	*Lutjanus purpureus*	0.294	<0.001
10	Robalo	*Centropomus spp.*	0.224	<0.001
11	Corvina	*Micropogonias furnieri*	0.220	<0.001
12	Bagre fidalgo	*Bagre bagre*	0.215	<0.001
13	Bagre amarelo	*Sciades herzbergii*	0.206	<0.001
14	Bagre griaçu	*Sciades proops*	0.191	<0.001
15	Bagre do mangue	*Genidens barbus*	0.178	<0.001
16	Xareu	*Caranx hippos*	0.171	<0.001
17	Cavala	*Scomberomorus cavalla*	0.165	<0.001
18	Sardinha	*Opisthonema oglinum*	0.165	<0.001
19	Pescada barracuda	*Sphyraena guachancho*	0.142	<0.001
20	Bagre uruçu	*Apistor luniscutis*	0.136	<0.001
21	Cação martelo	*Sphyrna sp.*	0.132	<0.001
22	Sororoca	*Scomberomorus brasiliensis*	0.115	0.001
23	Capadinho	Unidentified	0.109	0.002
24	Cação	Several species	0.107	0.003
25	Catana	*Trichiurus lepturus*	0.103	0.005
26	Bagre cagão	Unidentified	0.099	0.008
27	Badejo	*Mycteroperca bonaci*	0.088	0.025
28	Pescada	*Cynoscion spp.*	0.088	0.026
29	Caçonete	Several species	0.086	0.030
30	Arraia	Several species	0.086	0.033
31	Roncador	*Ballistes vetulla*	0.084	0.039
32	Guaricema	*Caranx crysos*	0.083	0.041
33	Mirucaia	*Ctenosciaena gracilicirrhus*	0.083	0.042
34	Cação lixa	*Ginglymostoma cirratum*	0.080	0.056
35	Caranha	*Lutjanus cyanopterus*	0.077	0.073
36	Mero	*Epinephelus itajara*	0.075	0.089
37	Pescada cumbucu	*Cynoscion sp.*	0.072	0.121
38	Bagre	Several species	0.068	0.158
39	Barbudo	*Polydactilus virginicus*	0.067	0.167

40	Cação gaia preta	*Carcharhinus sp.*	0.064	0.203
41	Cação rabo seco	*Rhizoprionodon sp.*	0.063	0.229
42	Arraia pintada	*Aetobatus narinari*	0.060	0.276
43	Arraia morcego	*Rhinoptera bonasus*	0.056	0.343
44	Robalo cachorro	*Centropomus sp.*	0.055	0.363
45	Pescadinha	*Stellifer sp.*	0.055	0.367
46	Papa terra	*Stellifer sp.*	0.049	0.505
47	Cação viola	*Pseudobatos percellens*	0.046	0.433
48	Dentão	*Lutjanus sp.*	0.043	0.366
49	Cutupá	Unidentified	0.042	0.342
50	Olho de boi	*Seriola dumerili*	0.041	0.323
51	Bonito	*Euthinus alleteratus*	0.040	0.302
52	Beiju pirá	*Rachycentron canadum*	0.039	0.286
53	Bagre branco	*Sciades sp.*	0.038	0.278
54	Traíra	*Hoplias malabaricus*	0.038	0.276
55	Boca larga	Unidentified	0.038	0.268
56	Robalo corcunda	*Pomadasys crocro*	0.038	0.260
57	Pampo	*Trachinotus sp.*	0.037	0.245
58	Azeiteira	*Mugil sp.*	0.037	0.243
59	Arraia jamanta	*Mobula sp.*	0.036	0.232
60	Baiacu	*Sphoeroides sp.*	0.035	0.217
61	Robalinho	*Centropomus*	0.035	0.213
62	Vermelha	*Lutjanus alexandrei*	0.034	0.201
63	Amoreia	*Dormitator maculatus*	0.032	0.169
64	Carapicum	*Eucinostomus sp.*	0.032	0.155
65	Galo	*Selene vômer*	0.031	0.149
66	Graçaim	*Caranx lugubris*	0.031	0.148
67	Xira	*Haemulon plumieri*	0.031	0.145
68	Tilápia	*Oreochromis niloticus*	0.031	0.144
69	Caramuru	*Gymnothorax sp.*	0.031	0.142
70	Dourado	*Coryphaena hippurus*	0.030	0.136
71	Piranha	*Serrasalmus brandtii*	0.030	0.136
72	Gaiuba	*Ocyurus chrysurus*	0.030	0.129
73	Cangurupim	*Megalops atlanticus*	0.028	0.102
74	Atum	*Thunnus spp.*	0.027	0.092
75	Cação galinha	Unidentified	0.026	0.089
76	Arraia comum	*Dasyatis spp.*	0.026	0.081
77	Cação tigre	*Galeocerdo cuvier*	0.025	0.069
78	Carapebinha	*Diapterus sp.*	0.024	0.064
79	Cação branco	*Rizoprionodon sp.*	0.022	0.052
80	Paru	*Pomacanthus sp.*	0.022	0.048
81	Suia	*Symphurus sp.*	0.021	0.044
82	Tinga	*Diapterus sp.*	0.020	0.034
83	Cação bico doce	*Rhizoprionodon sp.*	0.018	0.026
84	Peixe boi	*Trichechus manatus*	0.018	0.026

85	Tubarão	Several species	0.018	0.024
86	Arraia mijona	*Dasyatis sp.*	0.018	0.023
87	Bagre upemba	Unidentified	0.017	0.021
88	Corró	*Geophagus brasiliensis*	0.017	0.020
89	Vermelho dentão	*Lutjanus sp.*	0.017	0.019
90	Arraia gereba	Unidentified	0.016	0.018
91	Pescada jambuiu	*Cynoscion sp.*	0.016	0.016
92	Vermelho rabo aberto	*Ocyurus chrysurus*	0.016	0.016
93	Aracanguira	*Selene setapinnis*	0.016	0.016
94	Bagre do rio	Unidentified	0.015	0.014
95	Cioba	*Lutjanus analis*	0.015	0.013
96	Arraia branca	*Dasyatis sp.*	0.014	0.012
97	Solteira	*Oligoplites sp.*	0.014	0.012
98	Cação cabeça lisa	Unidentified	0.013	0.009
99	Bagre jundiá	*Rhamdia quelen*	0.010	0.005
100	Baleia	*Megaptera novaeangliae*	0.010	0.005
101	Garapau	*Chloroscombrus chrysurus*	0.010	0.004
102	Cascudinha	Unidentified	0.010	0.004
103	Niquim	*Thalassophryne sp.*	0.010	0.004
104	Robalo coco	*Pomadasys corvinaeformis*	0.010	0.004
105	Bagre da praia	Unidentified	0.009	0.004
106	Bagre do mar	Unidentified	0.009	0.004
107	Tainha olho de fogo	*Mugil sp.*	0.009	0.004
108	Trambitara	Unidentified	0.009	0.004
109	Bagre preto	Unidentified	0.009	0.004
110	Cação da areia	*Pseudobatos percellens*	0.009	0.004
111	Peixe porco	*Balistes vetula*	0.009	0.004
112	Robalo espada	*Centropomus undecimalis*	0.009	0.004
113	Bagre mandí	Unidentified	0.009	0.004
114	Enxova	*Pomatomus saltatrix*	0.009	0.003
115	Barana	*Albula vulpes*	0.009	0.003
116	Pescada dentão	*Cynoscion microlepidotus*	0.009	0.003
117	Bagre barbudo	*Bagre bagre*	0.008	0.003
118	Bagre cabeçudo	Unidentified	0.008	0.003
119	Dorminhoco	*Lobotes surinamensis*	0.008	0.003
120	Pescada olho de conta	*Cynoscion sp.*	0.008	0.003
121	Garoupa	*Epinephelus sp.*	0.008	0.003
122	Bagre cangatá	Unidentified	0.008	0.002
123	Ariocó	*Lutjanus synagris*	0.008	0.002
124	Avacora	*Thunnus sp.*	0.008	0.002
125	Pescada guete	*Cynoscion sp.*	0.008	0.002
126	Robalo falcão	*Centropomus sp.*	0.008	0.002
127	Bagre veleiro	*Bagre bagre*	0.008	0.002
128	Giruna	Unidentified	0.007	0.002
129	Língua de vaca	*Cynoglossidae*	0.007	0.002

130	Cação espada	Unidentified	0.007	0.002
131	Cação mouriço	*Mustelus sp.*	0.007	0.002
132	Linguado	*Achiridae sp.*	0.007	0.002
133	Gaibira	*Oligoplites sp.*	0.007	0.002
134	Piau	*Leporinus sp.*	0.007	0.002
135	Arraia amarela	*Dasyatis sp.*	0.007	0.002
136	Tucunaré	*Cichla sp.*	0.007	0.002
137	Mututuca	*Mirychthys sp.*	0.006	0.002
138	Voador	*Parexocoetus sp.*	0.006	0.001
139	Bagre azul	Unidentified	0.006	0.001
140	Arraia manteiga	*Gymnura micrura*	0.006	0.001
141	Vermelho boca negra	Unidentified	0.006	0.001
142	Cocelo	Unidentified	0.006	0.001
143	Pescada perna de moça	*Cynoscion sp.*	0.006	0.001
144	Pescada de água doce	*Plagioscion squamosissimus*	0.005	0.001
145	Pescada vermelha	*Cynoscion breviceps*	0.005	0.001
146	Tapa	*Citharichthys sp.*	0.005	0.001
147	Budião azul	*Scarus trispinosus*	0.005	0.001
148	Gutupá	Unidentified	0.005	0.001
149	Cação treme treme	*Narcine brasiliensis*	0.005	0.001
150	Mututuca pintada	*Mirychthys sp.*	0.005	0.001
151	Pocomon	*Amphichthys cryptocentrus*	0.005	0.001
152	Cação panã	*Sphyrna sp.*	0.005	0.001
153	Caboge	*Hoplosternum littorale*	0.005	0.001
154	Cara suja	Unidentified	0.004	0.001
155	Pescada de água salgada	*Cynoscion sp.*	0.004	0.001
156	Vermelho amarelo	*Ocyurus chrysurus*	0.004	0.001
157	Curimatá	*Prochilodus sp.*	0.004	<0.001
158	Baiacu xareu	*Colomesus sp.*	0.004	<0.001
159	Paramirim	*Rhomboplites aurorubens*	0.004	<0.001
160	Marlim	*Xyphia sp.*	0.004	<0.001
161	Olho de cão	*Priacanthus arenatus*	0.004	<0.001
162	Vermelho branco	*Lutjanus sp.*	0.004	<0.001
163	Peixe morcego	*Ogcocephalus sp.*	0.003	<0.001
164	Jabú	*Cephalopholis fulva*	0.003	<0.001
165	Cavalinha	*Scomberomorus sp.*	0.003	<0.001
166	Golfinho	*Tursiops truncatus*	0.003	<0.001
167	Cação amarelinho	Unidentified	0.003	<0.001
168	Aratubaia	Unidentified	0.002	<0.001
169	Cavala aipim	*Acanthocybium sp.*	0.002	<0.001
170	Lauê	Unidentified	0.002	<0.001
171	Iuiú	*Hoplerytrinus unitaeniatus*	0.002	<0.001
172	Peixe agulha	*Hemiramphus sp.*	0.002	<0.001

173	Cavala manteiga	Unidentified	0.002	<0.001
174	Pacu	*Myleus sp.*	0.002	<0.001
175	Vermelho saramonete	*Pseudupeneus maculatus*	0.002	<0.001
176	Muçum	*Synbranchus marmoratus*	0.002	<0.001
177	Paru branco	*Chaetodipterus faber*	0.001	<0.001
178	Caranha do rio	Unidentified	0.001	<0.001
179	Sauara	Unidentified	0.001	<0.001
180	Carapebota	*Diapterus sp.*	0.001	<0.001
181	Corongo	Unidentified	0.001	<0.001
182	Mandí	*Pimelodus maculatus*	0.001	<0.001
183	Pinima	*Sphoeroides sp.*	0.001	<0.001
184	Tainha curiaçu	*Mugil sp.*	0.001	<0.001
185	Caranha do mar	*Lutjanus cyanopterus*	0.001	<0.001
186	Pirarucu	*Arapaima giga*	0.001	<0.001
187	Tupa	Unidentified	0.001	<0.001
188	Lambarí	*Astyanax sp.*	0.001	<0.001
189	Acarí	*Astronotus ocellatus*	0.001	<0.001
190	Arraia chapeu de couro	Unidentified	0.001	<0.001
191	Cação de couro	Unidentified	0.001	<0.001
192	Tainha patriaçu	*Mugil sp.*	0.001	<0.001
193	Milongo	Unidentified	<0.001	<0.001
194	Suia da lama	*Symphurus sp.*	<0.001	<0.001
195	Pescada boca larga	Unidentified	<0.001	<0.001
196	Suia do rio	*Symphurus sp.*	<0.001	<0.001
197	Tainha meio olho	*Mugil sp.*	<0.001	<0.001

Table S3. PCA loadings for the inter-interviewee fish distance matrix correlations (see main text Figure 2B).

LOADINGS	PC 1	PC 2
1	-0.111	-0.101
2	-0.023	-0.018
3	0.011	-0.440
4	-0.058	-0.157
5	0.038	0.058
6	0.220	-0.272
7	-0.206	0.147
8	0.176	-0.140
9	0.306	-0.181
10	-0.183	-0.010
11	0.036	0.177
12	-0.291	-0.095
13	0.135	0.091
14	0.157	-0.014
15	0.219	-0.068
16	-0.361	-0.012
17	0.291	0.130
18	0.113	0.145
19	-0.231	0.094
20	0.043	0.345
21	-0.163	0.034
22	-0.260	0.061
23	0.053	0.001
24	0.190	-0.082
25	0.236	0.466
26	0.029	0.071
27	0.240	0.192
28	0.051	-0.156
29	-0.075	0.277
30	0.133	-0.171

"Quando a maré tá morta (lua crescente e minguante), ela amanhece enchendo. Quando a maré tá grande (lua cheia e nova), ela amanhece vazando."

Maicon

Capítulo II

Artigo aceito no periódico *Human Ecology*

EXPLORING PARTIAL OVERLAPS BETWEEN KNOWLEDGE SYSTEMS IN A BRAZILIAN FISHING COMMUNITY

Abstract: Based on a mixed-methods study involving triad tasks and ethnobiological models, we analyze local categories and knowledge of key ethnospecies of fish exploring partial overlaps between artisanal fishers' and academic knowledge in a fishing community in northeast Brazil. We argue that overlaps between fishers' and academic knowledge may provide common ground for transdisciplinary collaboration, while their partiality requires reflection about epistemological and ontological differences. Here, we show how knowledge of artisanal fishers can complement academic knowledge, but can also bring about tensions that need to be addressed through intercultural dialogue. By integrating a general philosophical framework of partial overlaps with a mixed-methods study on fishers' knowledge, we show how ethnobiology can contribute to reflective and empirically-grounded transdisciplinary practices.

Keywords: artisanal fishers, knowledge integration, partial overlaps, philosophy of ethnobiology, transdisciplinarity.

Introduction

Socio-ecological challenges such as food production, biodiversity loss, and public health require transdisciplinary approaches that bring together the knowledge of heterogeneous stakeholders (Brown et al. 2010; Pohl et al. 2017; Poliseli and El-Hani 2020). Ethnobiology constitutes an important field for transdisciplinary knowledge coproduction because it does not only document Indigenous and Local Knowledge (ILK), but also considers its relations to academic knowledge (AK) (Albuquerque et al. 2020; Ludwig and Poliseli 2018; Pieroni 2006; Wolverton 2013; Wyndham et al. 2011).

Ethnobiology has a long tradition of emphasizing similarities between ILK and AK in classifying "discontinuities in nature" (Hunn 1977; cf. Berlin 1992) and of highlighting "that the ethnobiological knowledge of traditional peoples conforms in many respects to basic scientific principles" (Berlin and Berlin 1996, 3). However, an exclusive focus on similarity brings risk of "epistemic" or "testimonial injustice" (Fricker 2007; Wanderer 2011; Anderson 2012) through a demand that ILK holders prove the value of their knowledge by showing that it holds up to the methodological and epistemological criteria of academic researchers. As a consequence, ILK is required to be validated through academic criteria but AK is typically not regarded in need of validation through compliance with ILK. This imbalance contributes to knowledge mining practices that have been subject to fierce criticism for using ILK as just sources of novel data for academics, while ignoring their aspects that challenge the assumptions of academically trained scientists (*e.g.*, Nadasdy 1999, 2003, 2005; Kimmerer 2012).

More recently, ethnobiology has incorporated these concerns through an increasing focus on questions of difference and underlying ontological tensions between ILK and AK (Daly et al. 2016; Ellen 2016; Ludwig and Weiskopf. 2019). Nabhan's *Ethnobiology for the Future* (2016, 78) exemplifies this shift from similarity to difference in his critique that an "over-simplified use of universal principles risks ignoring the very essence of diversity itself. Instead, we must give particular attention to the anomalies, the unique cultural expressions, and the collisions of dissonant taxonomic structures". The result is an increasing and largely unresolved tension between traditional ethnotaxonomic studies that focus on issues of similarity and anthropological debates about radical alterity that focus on difference as they are most salient in the ontological turn literature (e.g., Descola 2005; Kohn 2013; Viveiros de Castro 2014).

While negotiations of similarity and difference in ethnobiology provide important lessons for transdisciplinary research, they also run the risk of producing oversimplified dichotomies between universalism and relativism, realism and constructivism, cognitivism and culturalism, intellectualism and utilitarianism, and so on (Ellen 2016; Zent 2009; Ludwig 2018b). In guiding transdisciplinary research and practice, ethnobiology, as well as other academic fields, need to rely on more complex frameworks to identify common ground for the negotiation of knowledge as well as sources of disagreement and tension (Wolverton 2013; McAlvay 2021).

Ludwig and El-Hani (2020) proposed a framework of "partial overlaps" to provide substantial accounts of both similarities and differences between knowledge systems (Figure 1). Focusing on three dimensions of epistemology, ontology, and values, they argue for overlaps between ILK and AK in the production of knowledge (epistemology), reasoning about the structure of the world (ontology), and moral concerns about biocultural diversity (values). Also, they argue that overlaps remain partial and that transdisciplinary research needs to address politized questions of difference when ILK and AK diverge in epistemological, ontological, and value assumptions.

<Figure 1>

According to this framework, finding partial overlaps between ILK and AK does not aim to validate the former based on the latter but rather to explore spaces for intercultural dialogue (Rist and Dahdouh-Guebas 2006). To find overlaps is not to do some straightforward mapping between the entities, properties, relations, etc. that are shared by distinct knowledge systems, as one could validate the others. It rather means to point to similarities between AK and ILK that can open up spaces for coproduction and mutual learning without neglecting issues of difference and self-determination.

The framework both recognizes, thus, that knowledge systems (including AK) are embedded in social and historical circumstances in which they develop in different ways from one another, assuming distinct ontological, epistemological, and value commitments, and that knowledge systems can often benefit from comprehensive and dialogical interaction (Rist and Dahdouh-Guebas 2006, Tengö et al. 2014). To look for partial overlaps is, in sum, to look for the space for such interaction and mutual learning.

While Ludwig and El-Hani's (2020) notion of partial overlaps aims to overcome polarized debates about similarity and difference, it is largely formulated as an abstract philosophical framework about the relations between epistemologies, ontologies, and values. The aim of our work is to further develop and empirically ground this framework through an ethnozoological and ethnotaxonomic study of fishers' knowledge in a community located in northeast Brazil. The focus on fishers' knowledge allows for a fine-grained analysis of ontological and epistemological relations that are investigated through triad tasks and ethnobiological models. While such a fine-grained focus on fish populations allows for a more nuanced analysis of partial overlaps, we do not mean to suggest that it covers the whole range of epistemological and ontological relations between AK and ILK in the community. Instead, we consider the micro-level of local fish populations to be an entry point for moving beyond the contrast of focusing either on similarities or differences between knowledge systems that has contributed to the disconnect between traditions of cognitive ethnobiology (e.g. Berlin 1992) and ontologically oriented anthropology (e.g. Viveiros de Castro 2014). Furthermore, our focus on epistemology and ontology largely excludes values as a third dimension of partial overlaps in Ludwig and El-Hani's (2020) framework. A systematic analysis of the values embedded in AK and ILK would require thorough ethnographic description that is beyond the scope of the data presented in this article. At the same time, our conclusions highlight how our findings are entangled with ethical and policy questions that require further attention to partially overlapping value systems.

Methods

Study Area

The fishing village of Siribinha (11º48'49"S, 37º36'38"W), located in the Itapicuru estuary, in the Municipality of Conde, Bahia, northeast Brazil, is a community of artisanal fishers comprising ca. 500 inhabitants, which has been up to the 1990s relatively isolated, since there was no road connecting it to nearby villages and cities (Figure 2).[3] Before the road was built, the community used the river to reach other localities in Conde. According to the local narrative, the community was originally established by three families from Cobó, a nearby village that is also located in the Itapicuru estuary. The community has mixed descendancy from enslaved people

[3] 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.

brought to this part of Brazil mostly from West Africa, Portuguese settlers and Tupinambá Indigenous people, who occupied the region until some decades ago. As it is usually the case in Brazil, its fishing culture (and its current ethnobiological knowledge) is a product from native Tupinambá and Portuguese influences, with some African contributions (Ott 1944).

While formal education is a relatively recent phenomenon, today the community possesses a primary school (which offers only first and second cycles) and part of the youth completes the third and fourth cycles, as well as high school in a nearby but much larger community (ca. 4,000 inhabitants). A rather limited proportion of the youth have access to higher education.

Fishermen usually harvest fish while fisherwomen specialize on shellfish. Many also earn their living from small-scale tourism, but most dwellers rely on fishing. As their village is located on a small strip of land between the river and the sea, they use both of these natural environments to fish, both for self-consumption and small-scale commercialization.

Siribinha is situated in freshwater alluvial wetlands, occupied by a natural vegetation of mangroves, beach vegetation, and shrubby thicket-like forests growing on sand dunes (known as *restingas*). Coconut plantations and cattle ranches also make up part of the land use tenure of the region (Tng et al. 2021).

Despite all the environmental threats (overfishing, upstream river pollution, deforestation, real estate speculation, etc.), the mangroves in the estuary are still well preserved (Guimarães et al. 2019), due to the relatively small scale of activities such as fishing and tourism, and the fact that a part of the fishing techniques used is traditional and more sustainable than more recent, predatory techniques. The conservation status of the estuarine environments is also indicated by the abundant presence of sensitive species to environmental impacts, such as the rufous crab-hawk (*Buteogallus aequinoctialis*), locally known as gacici, a near threatened species (BirdLife International 2018a), the grey-breasted parakeet (*Pyrrhura griseipectus*), locally known as *periquito-da-cara-suja* or *periquito-cigano*, an endangered species (BirdLife International 2018b), and the buff-headed capuchin (*Sapajus xanthosternos*), locally known as macaco-prego, a critically endangered species (Kierulff et al. 2015).

<Figure 2>

Data Collection and Analysis

The study was conducted between May 2018 and November 2019 and used two methods for data gathering. On the ontological level (how do communities categorize the entities, processes, and properties that populate their experiences in the world), we employed triad tasks to explore partial overlaps in fishers' and academic categorizations of fish. On the epistemological level (what they know, how they build knowledge, how they judge what counts or not as knowledge), we carried out semistructured interviews to investigate fishers' knowledge about salient ethnospecies of fish, in order to build ethnobiological models that allowed to investigate different forms of overlap and partiality between fishers' and academic knowledge.

Ethnobiological Models

In order to build ethnobiological models of fish, we conducted semi-structured naturalistic interviews (Beuving and de Vries 2015) applied to traditional experts. Expertise on fish was defined by a combination of peer nomination and fulfilling the following requisites: interviewee had to be at least 30 years of age and be an experienced fisher (or had been such, in the case of retired fisherman) (fishing ≥ 4 days a week). We interviewed a total of 22 traditional experts (30-87 years of age). This amounts to ca. 4% of the villagers and 30% of the fishers, based on estimates made by community members that there are around 150 active and retired fishers currently dwelling there. As our focus of interest was fish, we only interviewed fishermen, since fisherwomen predominantly collect shellfish, and only occasionally capture fish.

We built ethnobiological models of the most salient ethnospecies for the community, according to a previous free listing task (Bernard 2011) carried out with approximately 20% of the community, randomly chosen (Renck et al. 2022). We extracted the Salience Index of each ethnospecies of fish, according to the method proposed by Chaves et al. (2019), taking into account not only the frequency of occurrence of each ethnospecies, but also the order in which they were mentioned in the interviews. We found 33 salient ethnospecies of a total of 197 ethnospecies mentioned in the free lists and decided to build ethnobiological models with the 16 most salient ones, since we had limited time on fieldwork. The scientific species were identified by a fisheries researcher (José Amorim dos Reis-Filho) who has extensive knowledge on the fish species found in the region.

Interviews were performed either in their own houses, during door-to-door visits (Davis and Wagner 2003), or in the shared social spaces in the village. Most interviews happened in the traditional experts' free time, i.e., during the day time, when they were at home or siting on their porches, but some of them were also done when they were repairing their nets or landing fish.

When we report data from interviews, we will indicate the traditional experts by the initial letter of their names followed by their age (e.g., L.30), for confidentiality reasons. The interviews were individual and guided by an interview protocol addressing the following themes for each fish: ethnotaxonomy, habitat, trophic relations, reproduction, interaction with fishing, seasonality, behavior, and uses. The interview protocol can be found in Supplementary Material 1.

Portuguese transcripts were translated by the first author and revised by the other authors. In the quotes from traditional experts' interviews, we indicate the pauses by slash (/), using period (.) only to signal the end of a speech turn. 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 2.

We sought to understand traditional knowledge about fish in as much detail as possible, as well as to assess whether or not there was variation in knowledge about each ethnospecies. For this purpose, we interviewed three different traditional experts for each ethnospecies. The next step involved a survey of variation or uniformity in the knowledge included in the model obtained from each expert. Only the information in which there was agreement between the three experts was internally validated with two additional fishermen, who have not participated in the original interview. The validation consisted of a confirmatory interview, in which we presented the model to the experts and verified whether or not they confirmed the information that was common among the three initial experts. The presentation of the model consisted of statements (e.g. "mackerel weighs between 1-1.5 kg") and they were expected to confirm it or not. Combining the data from the five participants, an ethnobiological model was created for each selected ethnospecies.

Instead of referring to "the knowledge of the community", which would suggest we are reporting knowledge held by everyone in the community, we follow Ross et al. (2005) in referring to "knowledge available in the community". When a particular piece of knowledge was expressed by the five traditional experts, showing a consensus among them, we treated it as “knowledge widely available in the community”. When there was variation among traditional experts, we treated it as “knowledge variably available in the community”.

It is important to bear in mind that we are not claiming that the fishers build models in their cognition or knowledge systems, which would require a different methodological approach than the one we used; rather, we are just stating that we built models to represent the ethnobiological knowledge for each species, based on the interview data, which means that these models are in themselves products of intercultural translation.

For analyzing the interviews, we derived assertions on ILK from interview extracts through an inductive process (Strauss 1987), while we were also guided by information available in the literature that allowed us to infer the presence of some ideas in the interview extracts. In order to check if there were overlaps with AK, as well as partialities in the overlaps, we considered knowledge available in the academic literature concerning the same topics included in the ethnobiological models. To do so, we consulted books and guides on Brazilian coastal ichthyofauna, an online and global database on fish species (http://www.fishbase.org/), and did an extensive search for scientific literature using Google Scholar®, Web of Science® and Scopus® databases with no time interval applied. The search strings used were: ‘*Centropomus undecimalis*’, ‘*Centropomus undecimalis* AND Brazil’, ‘*Centropomus undecimalis* AND ethnobiology’ and ‘*Centropomus undecimalis* AND ethnoichtiology’. Since they were classified by relevance by these search strings, the first 30 papers that came out were screened. If they were relevant to our purposes, they were added to the publications to compose the knowledge base.

Triad Tasks

We conducted triad tasks (or triad tests) (Bernard 2011; Ross et al. 2005) with 45 members (9%) of the community. We randomly selected 15 fishermen, 15 shellfish gatherers/fisherwomen, and 15 other community members, such as teachers, merchants, and guest house owners. Triad tasks are a tool for understanding how a given community categorizes cultural domains. They also indicate how knowledge is distributed in a community and what kind of knowledge is shared and by whom (Ross et al. 2005). That is why we included a wider range of stakeholders in this method.

During the triad task, three photographs of a given cultural domain (in this case, each triad combined different ethnospecies of fish) were presented to an individual, who was asked which of the three photographs was the most different one. It was assumed, then, that the two other items were more similar to the interviewee. If the interviewee had difficulty in answering about any specific triad, the triad was postponed until the end of the task. If the interviewee, when asked again, still couldn't provide an answer, she or he was asked whether the difficulty of making the requested judgment was due to the items being very similar or very different. For each attempt, individuals could choose an item, therefore, as "different" (codes 1–3), "very different" (code 0) or "very similar" (code 4). Many studies that use triad tasks require interviewees to necessarily choose one of the three options provided. We did not follow this procedure as we agree with Ross et al. (2005) that it can bias the data, because if we forced them, they could choose items randomly.

The triad task was performed with a Lambda 2 design (Bernard 2011; Burton 1976), in which each pair of ethnospecies was compared exactly twice, decreasing the amount of triads used in each test. This is a very important factor, because the larger the number of triads, the longer the duration of the interview, making the interviewee feel tired and, thus, affecting the quality of the data. In the Lambda 2 design, 10 items generate 30 triads. All respondents went through the same 30 triads, in the same order.

We selected ten ethnospecies of fish to carry out the triad task (Table 1) among the 34 most salient ones to the community. All the most salient ethnospecies selected for the triad task are captured by the fishers, due to their commercial importance.

<Table 1>

To analyze the triad task data, we used the Anthropac 4.98 software (Borgatti 1992). Anthropac generates an "aggregate proximity matrix" showing the percentage of times the respondents considered each pair of fish more similar within a triad. From this matrix, we elaborated a bar chart graph with the top 10 most similar pairs of fish (since the 11th most similar pair had the same similarity rate as the 10th, it was also included), from most to least similar. This enabled a clearer view of how the participants categorized the selected fish and which were the pairs considered most similar by them.

To apply the partial overlap methodology (Ludwig and El-Hani 2020), we compared the fishers' categorization (as part of ILK) to the academic scientific classification (as part of AK). In order to identify similarities and differences between academic and fishers' categorizations of fish, we compared the similarity judgements from the fishing community members with academic taxonomic groupings of fish in the same genus or at least in the same family.

Results and Discussion

Exploring Partial Overlaps Through Triad Tasks

The Siribinha dwellers we interviewed (fishermen, fisherwomen, and other community members) categorized 45 possible pairs of fish ethnospecies, but only the 11 pairs most frequently chosen as more similar to each other are shown in Figure 3B. The pair curimã/tainha was regarded as most similar by them. When that pair appeared together in the triads, it was chosen as the most similar 72% of the time. The same reasoning works for the other pairs of fish (Figure 3).

The partial overlap methodology revealed two overlaps between similarity judgments by the fishing community and grouping of fish in academic taxonomy (Figure 3).

<Figure 3>

There was an exact convergence between the two knowledge systems in the identification of all 10 (ethno)species. That is, while fishers and academic researchers naturally name the fish differently, they co-refer to the same (ethno)species with the same extensions. In this sense, our data confirm common claims about cross-cultural convergence in the recognition of natural kinds through ethnobiological classification (e.g., Hunn 1977; Berlin 1992).

There was, however, variation in the groupings of these kinds through similarity judgments. The tainha/curimã pair was considered the most similar by ILK holders in Siribinha (similarity rate of 72%), while they are classified in the same family (Mugilidae) and genus (*Mugil*) in academic taxonomy. The same occurs for the pair pescada-branca/pescada-amarela, which belong to the same family (Scianidae) and genus (*Cynoscion*) and showed a similarity rate of 59% in the triad task. In contrast, other pairs, for instance, pescada-branca/tainha, were considered substantially similar (similarity rate of 67%) by the fishing community members, while they are not closely related from the perspective of academic taxonomy, belonging to different scientific families (Scianidae and Mugilidae, respectively). In this case, we observe, therefore, a partiality in the overlap between the two knowledge systems. This is also true for the other eight pairs shown in Figure 3. Therefore, these results indicate a larger degree of partiality than overlap in similarity judgments about fish.

However, judgments of similarity come in degrees. Figure 4 shows relations between ILK and AK with a more relaxed demand for similarity on the side of the latter, that is, we considered joint membership in the next taxonomic rank, namely order. If we do so, overlaps increase from two (Figure 3) to five (Figure 4), such that degrees of partiality and overlap in similarity judgments about fish are roughly equivalent.

<Figure 4>

Exploring Partial Overlaps Through Ethnobiological Models

Based on the semistructured interviews, we built ethnobiological models of the 16 most salient ethnospecies for the community. Here, we will focus on the ethnobiological model of the robalão ethnospecies (*Centropomus undecimalis*) in order to apply the partial overlaps methodology (Table 2), due to its importance for the fishing activities, as a consequence of its economic value.

When applying the partial overlaps methodology, we found clear cases of overlap between the two knowledge systems, such as, for instance, the shared reference to the same biological kind, even though named differently (robalão and *Centropomus undecimalis*). Overlap was also salient in the description of several morphological, behavioral, and ecological properties, such as weight, jumping habits, and patterns of decreasing abundance (Table 2).

Regarding its decreasing abundance, the fishermen from Siribinha converged with widely articulated worries in the academic literature (e.g., Marshall 1958; Tilghman et al. 1996; Russell and Rimmer 1999; Taylor et al. 2001; Begossi 2008; Nora 2013) about shrinking stock due to commercial exploration, environmental degradation, and mangroves destruction (Table 2). However, the fishermen focused on the impact of fishing on the stock as a reason for its shrinkage, rather than on environmental or habitat degradation.

We also found cases of partiality. Some of them involve what we describe as "complementing partiality", where one knowledge system complements information from the other. For example, ILK includes knowledge about *C. undecimalis*' swimming habits, when they are found in the region where they live, what hinders fishing it, which was not present in the literature we surveyed, while AK includes knowledge about its morphology, ontogenetic changes in behavior, reproductive changes of behavior, which did not appear in the fishermen's interviews. Others involve "competing partiality", in which there is disagreement or at least tension between statements provided by holders of ILK and AK. For instance, most of the traditional experts say that the common snook swim in schools, while the academic literature says that "adults have lonely habits and juveniles swim in schools" (Pereira et al. 2015).

<Table 2>

A particularly interesting case of competing partiality relates to the closed season established in legislation aiming to protect commercially exploited species from fishing (or hunting) during their spawning period. In Brazil, legislation on the common snook closed season (Brazil 1992) seems to be derived from very limited information from AK. According to a fisheries researcher (personal communication), the closed season of the common snook was based on reproductive biology studies carried out in Pernambuco (over 400km northeast of Siribinha) more than 30 years ago. This policy has been applied, then, to almost the entire northeastern coast of Brazil. Our data indicate a mismatch between the spawning period and the closed fishing season of *C. undecimalis* in the Itapicuru estuary. The closed season in Bahia, according to the corresponding Brazilian law, ranges from May 15 to July 31, contradicting what all of the five respondents said about the spawning period of *C. undecimalis*:

L.30: The spawn (period) *is from November until January.*

Z.44: The president of the (Fishing) *Colony said* (the closed season happens in) *May/ June and July/ But me/ as a fisherman/ see the spawning from December to February.*

G.48: We do have closed season of the robalo/ but here we don't receive it (the closed season insurance) (…) *Its spawn is in January.*

J.59: The robalo has closed season/ but for us there isn't (referring to the closed season insurance)*/ Its closed season is in June/ July and August/* (Researcher: and when does it spawn?)*/ The robalão enters the river in December and January to spawn.*

G.44: They want to place the closed season (insurance) *now/ from May to June/ Meanwhile/ we don't have it/* (Researcher: And when is the robalão spawning?) *In the summer.*

Siribinha fishers' reports on the period in which *C. undecimalis* spawns in the Itapicuru estuary are in agreement with studies carried by Begossi (2008) and Nora (2013) in southern parts of Brazil. Thus, we obtain in this case a more complex situation, in which there is competing partiality between a particular academic study and the legislation based on it and both later developments in AK and ILK, which overlap with one another.

To sum up, the ethnobiological models illustrate complex relations between ILK and AK according to the framework of partial overlaps, as we found both overlaps and two distinct kinds of partialities (complementing and competing) between the knowledge systems, and even a competing partiality between both and the closed season legislation for *C. undecimalis* and its underlying academic study.

Interpretation of Partial Overlaps

The findings from the present study, which combine triad tasks and ethnobiological models, allow us to explore partial overlaps between Siribinha fishers' knowledge and AK, at ontological and epistemological levels (Figure 5).

<Figure 5>

At the ontological level, our analysis does not only confirm but expands the analysis of partial overlaps. First, our data show that overlaps and partiality are not evenly distributed across taxonomic ranks and domains of knowledge. Overlaps were most salient in the 1:1 correspondence of ethnospecies and academic taxa, while partiality was more prominent at a higher rank, namely, that of families, as found in other studies, such as Berlin (1992) and Mourão and Montenegro (2006). However, this does not mean that categories always converge at the (ethno)species level and always diverge at higher taxonomic ranks. As widely argued in the philosophy of biology (e.g., Boyd 1999; Ereshefsky 1991; Wilson et al. 2007), such a dichotomy of species as natural kinds and higher taxa as mere conventions is too simple. In line with this literature, our data provide a complex picture of convergence and divergence in similarity judgments at higher ranks. An analysis of partial overlaps at the ontological level requires, therefore, an analysis of complex relations rather than simple claims of convergence or divergence.

Second, our analysis also indicates that quantification of overlaps depends on pragmatic choices in their operationalization and should therefore not be misunderstood as a purely objective process independent from researchers' methodological choices. In the case of our 11 pairs of fish that are considered most similar in the community, we found two overlaps with more stringent criteria (Figure 3), but five overlaps with more relaxed requirements (Figure 4). While the triad tasks show how quantitative methods can help to explore relations between ILK and AK, this variation constitutes an important reminder that any comparison of knowledge systems is subject to interpretation and goals.

Moving from the ontological to the epistemological level, the ethnobiological models provide more fine-grained insights concerning the partial overlaps in knowledge about biological entities such as *C. undecimalis*. Table 2 provides 9 examples of overlaps between the two knowledge systems and 14 examples of partiality (12 of complementing and 2 of competing partiality). Beyond this general finding of partial overlaps, we highlight three insights for deepening their analysis.

First, the diagnosis of partial overlaps does not only apply to the relation between ILK and AK but is also relevant for an analysis of knowledge within the community. By constructing and validating the models with three-to-five experienced fishermen, we found cases of overlap ("knowledge widely available in the community") and partiality ("knowledge variably available in the community"). Applying the method not only externally in the comparison between AK and ILK but also internally shows, therefore, that knowledge systems are rarely homogenous, but require further studies and careful analysis of internal variation through overlaps and partiality. While this is often recognized in the case of AK, as shown by the so-called disunity of science view, which emphasizes that scientific work is in itself a heterogeneous enterprise (e.g., Dupré, 1995; Galison and Stump, 1996), the same is not equally often recognized in the case of ILK, which is at times described as if it corresponded to a homogeneous body of knowledge and practices (Sillitoe 1998; Turner et al. 2000; Butler 2004; Ross et al 2005).

Second, partiality comes in different flavors and our analysis introduced a distinction between complementing and competing partiality. In some cases, ILK and AK add up in rather straightforward ways. An academic researcher may not know about the specific periods in which a particular ethnospecies, such as *robalão*, is found in a given region, but may readily accept local expertise on that matter. In other cases, partiality indicates disagreement and competing claims, as shown by the example of the different assumptions about the spawning period of *C. undecimalis* in the closed season legislation and both ILK and AK.

Furthermore, some cases are more difficult to classify as they do not fall neatly on the complementing or competing side of the argument. For example, Table 2 indicates that both ILK and AK use morphology to distinguish *C. undecimalis* from other snooks, but rely on different criteria: as expected, due to the different knowledge production practices in ILK and AK (in particular, in the natural sciences), the latter describes the morphological traits with technical language and quantitative emphasis, for instance, quantifying dorsal and anal spines, soft rays, etc., while descriptions emphasize qualitative aspects in ILK: *the color of each one/ robalão has a black stripe and is all yellow and is big* (L.30) or *Bigger/ slimmer/ longer beak/ The female gets wider than the male* (J.59). While such alternative sets of criteria can be partly complementing (e.g., helping an academic researcher with qualitative distinctions during fieldwork), they can be also competing if they suggest different classifications in certain cases.

Third, such a nuanced analysis of different types of partiality also helps to address the normative dimensions and policy implications of comparing AK and ILK. At first sight, Table 2, showing the ethnobiological model of *C. undecimalis* and the analysis of partial overlaps, might suggest for some that the underlying intention has to do with validation, with checking the accuracy of ILK based on AK. This would suggest that the partial overlaps framework is committed to epistemic hierarchies, rather than an intercultural attitude towards knowledge systems (Rist and Dahdouh-Guebas 2006; Poliseli and El-Hani 2020). However, this is a misunderstanding of the partial overlaps methodology, which is about finding fruitful avenues for mutual understanding and learning, not about validating one knowledge system based on another, as different knowledge systems come with different epistemologies. As Santos (2015) argues, recognition of epistemic diversity challenges the idea of one general epistemology that would provide universal standards of evaluating and validating knowledge. Nonetheless, it would be deeply flawed to enter a local community assuming that everyone is an expert on everything. As is well known, when we investigate ILK, it is of key importance to identify who are the traditional experts. For instance, we discussed in the methods section how we operationalized expertise based on direct factors, such as age and fishing frequency, and epistemic trust, as expressed in peer nomination. Indeed, by moving the analysis towards underlying ontological and epistemological levels, the partial overlaps methodology avoids an equation of similarity/difference with verification/falsification. For example, ontological and epistemological differences between ILK and AK does not imply that the former is falsified by the latter.

But our study also indicates that this conciliatory pluralism of different but equally valid ontologies and epistemologies has its limitations. Differences between ILK and AK do not always have to be resolved through validation, but cases of competing partiality also show that questions of validation cannot be always avoided. When it comes to policy decisions, such as those on the closed season for *C. undecimalis*, validation of competing claims such as the spawning period becomes unavoidable. Notice, however, that concerns about validation in the case of policy-relevant conflicts are a consequence of mutual recognition of expertise. If holders of ILK and AK recognize each other as experts, this also implies that their statements are accessible for mutual critique (Koskinen and Rolin 2019). This openness to mutual critique is symmetrical, as our example of the spawning period illustrates by showing that in this case a particular academic study and the legislation based on it are falsified by both ILK and later developments in AK, rather than ILK being shown to be false. This is not some isolated instance, as the same has been observed in other studies: for instance, the contradictions between the closed fishing season of the Atlantic seabob (*Xiphopenaeus kroyeri*) and fishers' knowledge on its reproductive and recruitment period in the States of Bahia and Espírito Santo, Brazil (Musiello-Fernandes et al. 2017). Another example is the decision on a harvest quota for bowhead whales (*Balaena mysticetus*) in Alaska, which involved the dispute of Western scientists' estimates in a whale census by local hunters and the replacement by the estimates from a new census incorporating local knowledge about migration behavior (Huntington 2000).

Conclusion

Ethnobiology has become widely characterized as having entered an "applied phase" that focuses on the relevance of ILK for a wide range of socioenvironmental problems such as food security, biodiversity loss, and public health (Ludwig 2018a; Wolverton 2013; Wyndham et al. 2011). These transdisciplinary promises of applied ethnobiology require procedures for relating ILK and AK that are reflective about limitations of knowledge integration, but without rejecting the possibility of dialogue and mutual learning.

The methodology of partial overlaps provides a framework for relating ILK and AK in transdisciplinary practice that moves beyond simple dichotomies between cross-cultural similarity and difference. This study has explored this methodology through ethnobiological research that synthesizes a general philosophical framework with a concrete empirical case study. Such an integrative approach shows how ethnobiology can contribute to reflective transdisciplinary approaches to issues such as intercultural dialogue and biological conservation.

First, intercultural dialogue cannot be carried out in denial of important differences in knowledge assertions and epistemological, ontological, and value assumptions among knowledge systems. That is why the partiality of overlaps is a key aspect to be considered, demanding from the researcher a normative and political position that we derive from an intercultural attitude (Rist and Dahdouh-Guebas 2006; Poliseli and El-Hani 2020). Our study shows not only that different knowledge systems can learn mutually from complementing partiality, but also from competing partiality, showing epistemic productivity when two knowledge systems disagree with each other.

Second, such processes of mutual learning through partial overlaps can contribute to transdisciplinary negotiation of biological conservation and environmental policy. For example, the case of the closed season for fisheries, as shown by the *C. undecimalis* example, illustrates how findings of competing partiality may lead to the identification of a failure in the current Brazilian environmental legislation. Environmental policy that aims to protect fisheries, such as *Centropomus undecimalis* in Bahia, needs to take ILK experts and their knowledge about spawning periods seriously. Engagement with partial overlaps can therefore contribute to challenge widespread epistemic injustices (Koskinen and Rolin 2019; Santos 2015) that marginalize ILK in biological conservation and, more generally, in responses to social-environmental issues.

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Data Availability

The datasets generated and analyzed during the current study are not publicly available because they contain information that could compromise research participant privacy/consent. However they are available from the corresponding author upon request, according to ethical agreement with third parties that guarantee the protection of the privacy and confidentially of the participants.

Compliance with Ethical Standards

Conflict of Interest The author declares that there is no financial or nonfinancial conflict of interest.

Informed consent 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 (International Society of Ethnobiology 2006).

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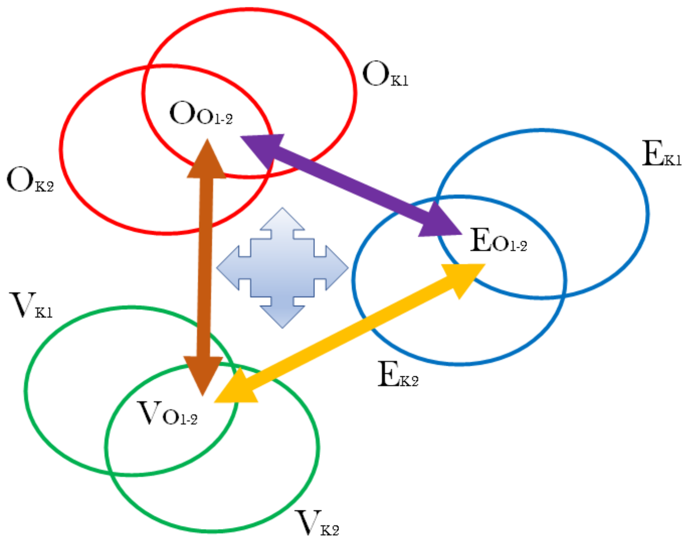

Figure 1: Complexity of the codeterminations and partial overlaps of ontologies, epistemologies, and value systems. *O*, ontology; *E*, epistemology; *V*, value systems; *K*1, knowledge system 1; *K*2, knowledge system 2; *Oo*, ontological overlap; *Eo*, epistemological overlap; *Vo*, value systems overlap. The figure in the middle indicates the complexity of the mutual determinations between the ontological, epistemological, and value dimensions of the body of knowledge arising from successful coproduction.

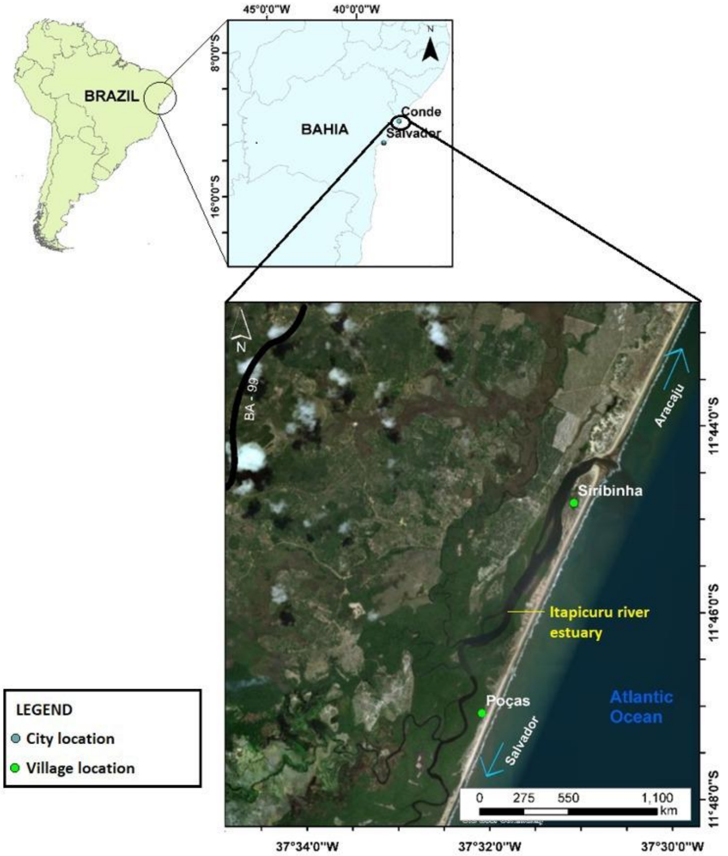

Figure 2: Itapicuru River estuary, Northeast Bahia, Brazil, showing the fishing villages of Siribinha and Poças (modified from Guimarães et al. 2020).

Table 1: Ten ethnospecies of fish selected to compose the triad task.

Ethnospecies name	**Scientific name**	**Family**	**Salience Index**
Tainha	*Mugil curema*	Mugilidae	0.717
Carapeba	*Eugerres brasilianus*	Gerreidae	0.584
Robalo branco	*Centropomus parallelus*	Centropomidae	0.386
Pescada branca	*Cynoscion leiarchus*	Sciaenidae	0.339
Pescada amarela	*Cynoscion acoupa*	Sciaenidae	0.330
Curimã	*Mugil liza*	Mugilidae	0.299
Corvina	*Micropogonias furnieri*	Sciaenidae	0.220
Bagre fidalgo	*Bagre bagre*	Ariidae	0.215
Xareu	*Caranx hippos*	Carangidae	0.171
Cavala	*Scomberomorus cavalla*	Scombridae	0.165

A

Ethnospecies	Scientific names	Family
Bagre fidalgo	*Bagre bagre*	Ariidae
Xareu	*Caranx hippos*	Carangidae
Robalo branco	*Centropomus parallelus*	Centropomidae
Carapeba	*Eugerres brasilianus*	Gerreidae
Curimã	*Mugil liza*	Mugilidae
Tainha	*Mugil curema*	Mugilidae
Corvina	*Micropogonias furnieri*	Sciaenidae
Pescada amarela	*Cynoscion acoupa*	Sciaenidae
Pescada branca	*Cynoscion leiarchus*	Sciaenidae
Cavala	*Scomberomorus cavala*	Scombridae

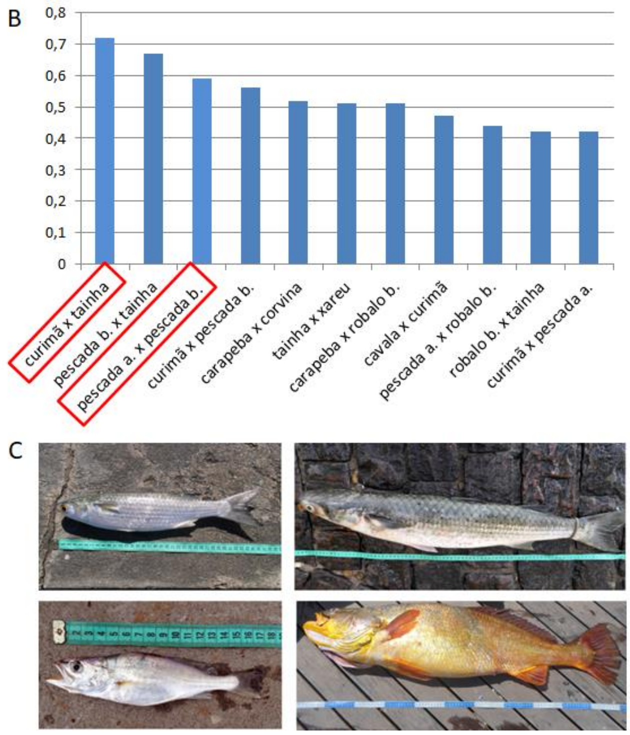

Figure 3: Overlaps between fishers' categorization and academic fish taxonomy. A: academic taxonomic categorization of the 10 selected fish used in the triad task (in orange and green, fish belonging to the same family, Mugilidae and Sciaenidae, respectively). B: the eleven most similar pairs of fish according to Siribinha dwellers (overlaps between the two knowledge systems highlighted in red). C: tainha (left above) and curimã (right above); pescada branca (left below) and pescada amarela (right below) (Photographs: José Amorim Reis Filho, reproduced under permission).

A

Ethnospecies	Scientific names	Family	Order
Curimã	*Mugil liza*	Mugilidae	Mugiliformes
Tainha	*Mugil curema*	Mugilidae	Mugiliformes
Xareu	*Caranx hippos*	Carangidae	Perciformes
Robalo branco	*Centropomus parallelus*	Centropomidae	Perciformes
Carapeba	*Eugerres brasilianus*	Gerreidae	Perciformes
Corvina	*Micropogonias furnieri*	Sciaenidae	Perciformes
Pescada amarela	*Cynoscion acoupa*	Sciaenidae	Perciformes
Pescada branca	*Cynoscion leiarchus*	Sciaenidae	Perciformes
Cavala	*Scomberomorus cavalla*	Scombridae	Perciformes
Bagre fidalgo	*Bagre bagre*	Ariidae	Siluriformes

B

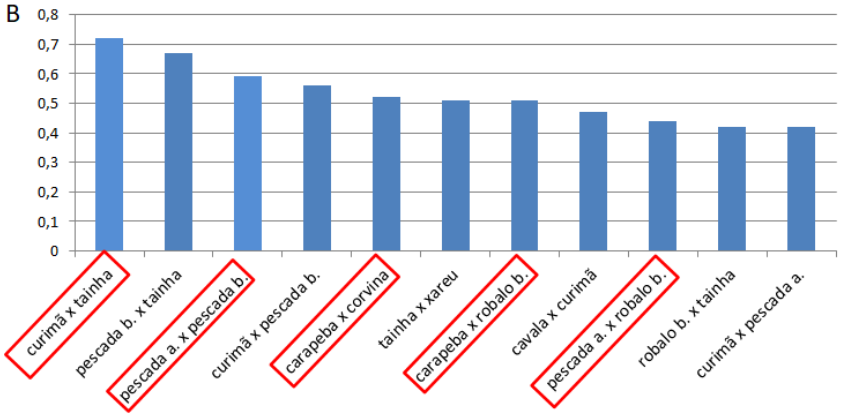

Figure 4: Overlap between fishers' categorization and academic fish taxonomy. A: academic taxonomic categorization of the 10 selected fish used in the triad task (in orange and green, fish belonging to the same scientific order, Mugiliformes and Perciformes, respectively). B: the eleven most similar pairs of fish according to Siribinha dwellers (overlaps between the two knowledge systems highlighted in red).

Table 2: Application of the partial overlaps methodology to the ethnobiological model of the common snook, locally known as robalão (*Centropomus undecimalis*). The table shows only the relevant issues to the present analysis. We indicate when the knowledge aspects reported were widely or variably available in the community, according to a combined analysis of the interviews with three-to-five traditional experts, as explained in the methods section.

Issues	**ILK**	**AK**	**Partial overlaps analysis**
(Ethno)genus	Knowledge widely available Robalo	*Centropomus*	Overlap
Are there different kinds of robalos? If so, what similarity do they show such that they can be all called robalo?	Knowledge widely available Everyone agreed there are many kinds of robalos. One fisherman cited the stripe in the middle of the body (the lateral line) as a similarity in all ethnospecies recognized as robalos. Other characteristics were also mentioned to be shared across the robalos: L.30: *They are all from the same species/ They have size and strength/ They are the strongest fish.*	There are 12 species of the genus *Centropomus* (Fishbase 2020). They all have 6 rays in the anal fin; 13-21 gill rakers in the first arch; 67-77 scales in the row above the line (to the tail fin base); 67-72 scales with pores in lateral line (up to the tail fin base) (Cervigón 1992).	Complementing partiality
Ethnospecies	Knowledge widely available Robalão	*Centropomus undecimalis*	Overlap

Is there any other name for them?	Knowledge widely available Flecha or suvela	No	Complementing partiality
If I find a fish like that, how do I know that it's a robalão?	Knowledge variably available Although the experts varied in their descriptions, there was a consensus among all of them that robalão is a big fish - some said "the biggest of all robalos".	Dorsal spines (total): 8-9; Dorsal soft rays (total): 10; Anal spines: 3; Anal soft rays: 67-72 pored scales on the lateral line to the caudal fin base (Smith 1997).	Complementing partiality
Weight (kg)	Knowledge widely available 4-25 kg	Up to 24,3 kg (Cervigón 1992)	Overlap
Where do you fish it? Do you find it in any other place than the fishing places?	Knowledge widely available *L.30: We find them more on the river/ The robalos/ all of them/ we find more/ catch more in branches/ trunks/ places with many hooks/ Also in lairs/ Because there are not many fishing spots in the river/ they feel safe in this place/ But you find it at sea too/ It is rare to catch them at sea/ but we always do.* *J.59: More on the river/ when it rains/ in January you find more at sea.*	In coastal waters. Juveniles are found in estuaries and lagoons, in both brackish and hypersaline waters. Adults usually found in shallow marine waters of soft substrate, less than 20 meters deep (Cervigón 1992). Adults inhabit coastal waters, estuaries and lagoons, penetrating into freshwater. (Fraser 1978). Fishers are aware of the migratory movements of the snook between salt and freshwater. They have reported their habitat to be river, sea, freshwater, salt water, rock, lagoon and bay (Begossi et al.	Overlap

	G.48: Here in the river/ at sea/ in the rocks too/ in the river/ it stays more under the branches. *G.44: In the river and where the river meets the sea/ Or in the 'back' of the sea.*	2016).	
How do you catch this fish? Why do you catch them like that?	Knowledge widely available Every traditional expert said they catch it with fishing nets, two mentioned cast nets, one, hook and line.	Mainly artisanal, with hook and line, seine net and gillnet (Cervigón 1992). Nora (2003) reported the gillnet to be responsible for most of the captures, followed by hook and line, and diving.	Overlap
Where does it swim? Does it swim mainly near the floor or near the surface?	Knowledge widely available *L.30: Always near the floor/ Only when it wants to eat/ it goes up.* *J.59: More in the deep.* *G.44: It stays below and above/ To hunt it goes up/ It likes to eat mullets and sardines.*	It lives between the bottom and the middle water (Clauzet et al. 2005). Usually at depths less than 20m (Fraser 1978). Its swimming habits change according to the ontogenetic phase. The adults inhabit deeper waters. Juveniles have a pelagic preliminary stage (Pereira et al. 2015). Their position also varies in the water column according to the water temperature, as they prefer warmer waters (Nora 2013).	Complementing partiality
Does it jump out of the water?	Knowledge variably available Most of them said it jumps.	The fish jumps out of the water to capture food (Bórquez and Cerqueira 1998).	Overlap
Are they	Knowledge variably	Adults have lonely habits and	Competing

usually alone or do they form schools?	available Most of them reported them swimming in schools.	only juveniles swim in schools (Pereira et al. 2015).	partiality/ complementing partiality
What hinders fishing them (engine noise, rain, dirt in the water)?	Knowledge variably available Most of them said that when the water is clean, the fish can see the nets and deviate from them. Only one of them said the contrary, the dirtier the water, more difficult it gets for them to fish it.	No information found	Complementing partiality
Do you find it all year round or at a specific time of the year? If so, which?	Knowledge variably available J.59: *All year round/ but in the winter we catch more than in the summer.* G.48: *No/ when the water is clean/ we can't find it/ it's hard/ now/ when the water is dirty/ we catch it (…) now/ in the Winter/ that the water begins to clean up.*	No information found	Complementing partiality
Was there more or less in the past? Why?	Knowledge widely available *L.30: The older people always say there was more* (in the past)*/ The more the* (human) *population increases/ everything*	*C. undecimalis* have declined substantially in the Gulf Coast of Florida (Tilghman et al. 1996). Marshall (1958) attributes its decline to environmental variation and mangroves destruction, as these ecosystems play a fundamental role in its life	Complementing partiality/overlap

	decreased. *J.59: There was more/ but its price was lower/ Today/ there is less/ but when you arrive* (from fishing)/*it rapidly sells.* (…) *Don't know why there was more.* *G.48: When I was younger/ there was more/ Now the production has dropped/ Today there are more fishermen.*	cycle. Commercial extraction is also responsible for reducing its populations (Russell and Rimmer 1999).	
Is there a time of the year that you cannot fish it (closed season)?	Knowledge widely available They all agreed on the closed season being from May until July.	The closed season in Bahia takes place from May 15 to July 31 (Brazil 1992).	Overlap
When do they breed?	Knowledge widely available Compiling the information provided by the 5 traditional experts, they can breed from November until February.	Although the Brazilian legislation assumes that its spawning period ranges from May until July in the States of Bahia and Espírito Santo (Brazil 1992), no information was found in the literature about when its spawning occurs in the region where Siribinha is located. After macroscopic analysis of gonad maturation, Begossi (2008) found them to reproduce between spring and summer, in the warmest months of the year, in two different sites in the States of São Paulo and Rio de Janeiro, the closest from Siribinha being over 1.300 km distant in	Competing partiality/ overlap

		a straight line to the South. Nora (2013) also found a similar reproductive period (spring and summer, mainly in the months of November and December) in Paraty, Rio de Janeiro (1.500 Km south of Siribinha).	
What do they eat?	Knowledge variably available *L.30: Mullet* (*Mugil sp.*)/ *crab/ mojarra* (*Eugerres sp.) and other fish.* *J.59: White sea bass* (*Centropomus parallelus*)/ *mullet/ hake* (*Cynoscion sp.*)/ *miroró (Gymnothorax sp.)/ amoreia* (*Bathygobius sp.*)/ *what passes in front of it/ it eats.* *G.48: Small fish/ shrimp/ mullet/ there's a little ground bait/ when it rains a lot/ that they also eat* (…) *it's a little earthworm.* *Z.44: Mullet/ sardine* (Clupeidae and Engraulidae)*/ crab.* *G.44: Mullet/ sardine.*	Its feeding habits change according to the ontogenetic phase. Adults prefer to eat fish. Juveniles have a preference for crustaceans (Pereira et al. 2015). The folk diet from 5 different localities in Brazil is comprised of mullets, sardines, shrimp, piaba, pititinga and manjuba (Engraulinae) (Begossi et al. 2016). Based on stomach contents analysis, the main items found in *C. undecimalis* are represented by "rest of fish" (45.5%), caratinga (*Diapterus rhombeus*, 18.2%), sardines (16.4%) and cangoá (*Stellifer spp*, 12.7%) (Nora 2013).	Complementing partiality
Which other animals eat them?	Knowledge variably available *L.30: us* (humans). *G.48: cangurupim (Megalops atlanticus)/*	No Information found	Complementing partiality

	mero (Epinephelus itajara).		
Can you tell which is the male and which is the female? How?	Knowledge variably available *L.30: The females always have eggs (inside)/ at the time of reproduction/ Out of the season/ it's difficult to identify.* *J.59: Yes/ Males are slimmer/ Females are fatter/ You can only differentiate them from about 4 kg onwards.* *G.48: Always females are thicker than males/ And males are slimmer/ thinner.*	Sex identification is made by extracting the gonads in laboratory (Pereira et al. 2015). The majority of small common snook are male and most large snook are female (Florida Museum of Natural History 2020).	Overlap
Do you know how they do to have offspring? Do they behave differently? Do they change color, style, behavior?	Knowledge variably available Most of them didn't know, but L.30 said: *They are more aggressive* (at the time of reproduction)/ *Female thickens more its body.*	Their pelvic and caudal fins are noticeably more yellow during spawn. Common snook are protandric hermaphrodites, changing from male to female after maturation. Research shows that female gonads mature directly from the mature male gonads shortly after spawning. The probability that a common snook of a particular size will be female increases with length or age (Florida Museum of Natural History 2020).	Compleme nting partiality
Have you ever seen the eggs? Have you ever seen its offspring? How are they (eggs	Knowledge variably available *L.30: They're small/ They are all made like chicken*	"In the laboratory, eggs averaged 0.70 mm diameter. (…) Newly hatched larvae (1.4–1.5 mm notochord length) spend ~2.5 weeks in nearshore waters before their arrival at	Compleme nting partiality

and offspring)? Where can you find them?	*eggs/ A super thin cover/ There are several eggs/ Not several/ thousands/ They always put them in lairs.* *J.59: I only see the eggs in the belly.* *G.44: I see the eggs in the belly/ It doesn't keep offspring in its belly/I believe they stay in the corners/ sticks/ stones.*	shallow-water nursery sites. (…) Late-stage larvae recruit to vegetated shorelines of quiet, shallow-water creeks, canals, and lagoons" (Peters et al. 1998:509).	

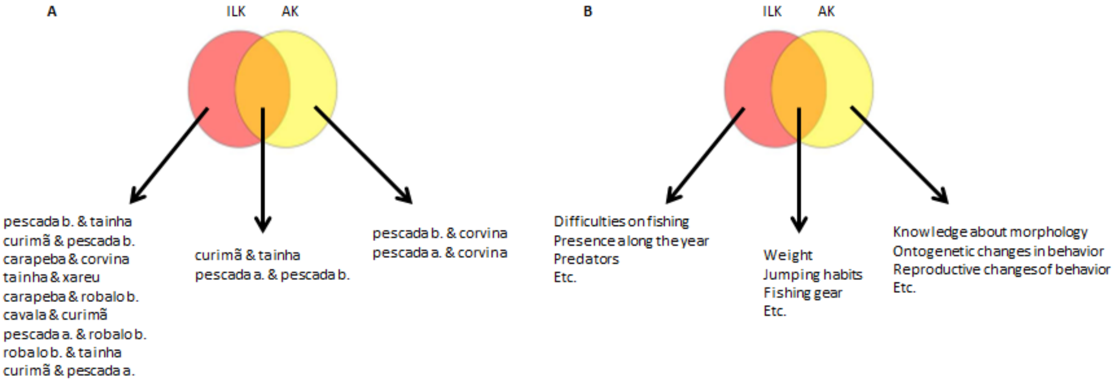

Figure 5: Overlaps and partialities between two knowledge systems (Siribinha fishers' knowledge and AK) regarding: A - the taxonomy of fish (ontological dimension), considering more stringent criteria for similarity on the side of AK that leads to two overlaps in the triad task data; and B - the biology and ecology of *C. undecimalis* (epistemological dimension). Analysis of partialities and overlaps in A between Siribinha fishers' knowledge and AK using a more relaxed demand for similarity on the side of the latter is shown in Supplementary Material 3.

APPENDIX

Supplementary Material 1 - Interview protocol

As we carried out semi-structured interviews, the questions listed here just provided guidelines for the interviewer, who did not have to phrase the questions as shown in the protocol. During the interview we attempted to use as much as possible the words commonly employed by the fishers to refer to animals, fishing artifacts, environments, etc.

Questions

1. (Ethno)genus?
2. Are there different kinds of robalos? If so, what similarity they show such that they can be all called robalo?
3. If so, what do they have in common to be called robalos?
4. Is there any fish similar to robalo? Why does it look like robalo (size, color, weight, seasonality)?
5. Ethnospecies?
6. Is there any other name for them?
7. If I find a fish, how do I know that it's a robalo?
8. Weight (kg)?
9. Price/kg?
10. Where do you fish it? Do you find it in any other place than the fishing places?
11. Is there any specific place where you find this fish?
12. How do you catch this fish? Why?
13. Where does it swim? Does it swim mainly near the floor or near the surface?
14. Does it jump out of the water?
15. Are they usually alone or do they form schools?
16. How many kg do you usually fish at once?
17. What hinders fishing them (engine noise, rain, dirt in the water)?
18. Is it found all year round or at a specific time of the year? If so, which?
19. Where does it go when it's not around?

20. Do you remember any time that you caught a lot of them?
21. Was there more or less in the past? Why?
22. Is there a time of the year that you cannot fish it (closed season)?
23. When do they breed?
24. What do they eat?
25. Which other animals eat them?
26. Can you tell which is the male and which is the female? How?
27. Do you know how they do to have offspring? Do they behave differently? Do they change color, style, behavior?
28. Have you ever seen the eggs? Have you ever seen its offspring? How are them (eggs and offspring)? Where can you find them?
29. What’s the flesh color? Do you know why it's that color?
30. Are they good for anything other than to eat?
31. Do you use it to treat any disease (now or in the past)? Does it have any use, any importance for any religion?
32. Is it tasty? Is there anyone who can't eat it? If you eat it (or eat a lot), can you have any problem?
33. Is there a time of the year that you can't eat it?
34. When you fish it, do you keep it for self-consumption? Give it? Sell?
35. Does the fish spoil quickly?
36. How do/did you conserve the fish?

Supplementary Material 2 - Portuguese originals from the translated excerpts

L.30: *They are all from the same species/ They have size and strength/ They are the strongest fish of the river.*
São todos da mesma espécie/ Eles têm tamanho e força/ São os peixes mais fortes do rio.

L.30: We find them more on the river/ The robalos/ all of them/ we find more/ catch more in branches/ trunks/ places with many hooks/ Also in lairs/ Because there are not many fishing spots in the river/ they feel safe in this place/ But you find it at sea too/ It is rare to catch them at sea/ but we always do.
A gente encontra mais no rio/ Os robalos/ todos eles/ a gente encontra mais/ pega mais em galho/ troncos/ lugares que tem muito gancho/ Em loca também/ Porque não tem muito pesqueiro no rio/ Se sentem seguros nesse local/ Mas encontra no mar também/ É raro pegar no mar/ mas sempre pega.

J.59: More on the river/ when it rains/ in January you find more at sea.
Mais no rio/ quando chove/ Mês de janeiro encontra mais no mar.

G.48: Here in the river/ at sea/ in the rocks too/ in the river/ it stays more under the branches.
Aqui no rio/ No mar/ nas pedras também/ No rio/ ele fica mais debaixo das galhadas.

G.44: In the river and where the river meets the sea/ Or in the 'back' of the sea.
No rio e no encontro do rio com o mar/ Ou então nas costas do mar.

L.30: Always near the floor/ Only when it wants to eat/ it goes up.
Sempre é pelo chão/ Só quando quer comer/ aboia.

J.59: More in the deep.
Mais no fundo

G.44: It stays below and above/ To hunt it goes up/ It likes (to eat) *mullets and sardines.*
Ele fica embaixo e em cima/ Pra caçar ele aboia/ Ele gosta da tainha e da sardinha.

J.59: *All year round/ but in the winter we catch more than in the summer*.
O ano todo/ agora no inverno/ nóis sempre pega mais do que no verão.

G.48: No/ *when the water is clean/ we can't find it/ it's hard/ now/ when the water is dirty/ we catch it* (…) *now/ in the Winter/ that the water begins to clean up.*
Não/ quando a água tá limpa nóis não encontra ele/ É difícil/ Agora quando a água tá suja/ nóis pega/ (...) Agora no inverno que a água começa a ficar mais limpa.

L.30: The older people always say there was more (in the past)*/ The more the* (human) *population increases/ everything decreased.*
O pessoal mais velho sempre fala que tinha mais/ Quanto mais a população (humana) aumenta/ tudo diminuiu.

J.59: There was more/ but its price was lower/ Today/ there is less/ but when you arrive (from fishing)*/ it rapidly sells.* (…) *Don't know why there was more.*
Tinha mais/ mas o valor era menor/ Hoje tem menos/ mas quando chega você vende logo/ (...) Não sei porque tinha mais.

G.48: When I was younger/ there was more/ Now the production has dropped/ Today there are more fishermen.
Quando eu era menor tinha mais/ Agora caiu a produção/ Hoje tem mais pescador.

L.30: Mullet (*Mugil sp.*)*/ crab/ mojarra* (*Eugerres sp.)/ and other fish.*
Tainha/ siri/ carapeba e outros peixes.

J.59: White sea bass (*Centropomus parallelus*)*/ mullet/ hake* (*Cynoscion sp.*)*/ miroró (Gymnothorax sp.)/ amoreia* (*Bathygobius sp.*)*/ what passes in front of it/ it eats.*
Robalo branco/ tainha/ pescada/ miroró/ amoreia/ o que passa na frente dele ele come.

G.48: Small fish/ shrimp/ mullet/ there's a little ground bait/ when it rains a lot/ that they also eat (…) *it's a little earthworm.*

Peixinho pequeno/ camarão/ tainha/ Tem uma iscazinha da terra/ quando chove muito/ que eles comem também (...) É uma minhocazinha.

Z.44: Mullet/ sardine/ crab.
Tainha/ sardinha/ siri.

G.44: Mullet/ sardine.
Tainha/ sardinha.

L.30: Us (humans).
Somos nós.

G.48: Cangurupim (Megalops atlanticus)/ mero (Epinephelus itajara).
Cangurupim/ mero.

L.30: The females always have eggs (inside)/ at the time of reproduction/ Out of the season/ it's difficult to identify.
Fêmea sempre tá ovada/ na época da reprodução/ Quando não tá na época da reprodução fica difícil identificar.

J.59: Yes/ Males are slimmer/ Females are fatter/ You can only differentiate them from about 4 kg onwards.
Sim/ Macho mais esguio/ Fêmea mais gorda/ Só dá pra diferenciar a partir de uns 4 kg em diante.

G.48: Always females are thicker than males/ And males are slimmer/ thinner.
Sempre a fêmea é mais grossa que o macho/ E o macho é mais esguio/ mais seco.

L.30: *They are more aggressive* (at the time of reproduction)*/ Female thickens more its body.*
São mais agressivos (na época da reprodução)/ Fêmea engrossa mais o corpo.

L.30: They're small/ They are all made like chicken eggs/ A super thin cover/ There are several eggs/ Not several/ thousands/ They always put them in lairs.

São pequenos/ Todos eles são feitos que nem ovos de galinha/ A capa superfina/ São vários ovos/ Vários não/ são milhares/ Sempre deixam em locas.

J.59: I only see the eggs in the belly.
Só vejo os ovos no buxo.

G.44: I see the eggs in the belly/ It doesn't keep offspring in its belly/ I believe they stay in the corners/ sticks/ stones.
Eu vejo os ovos na barriga/ Ele não guarda filhotes na barriga/ Acredito que ficam nos cantos/ paus/ pedras.

L.30: The spawn (period) *is from November until January.*
A desova é de Novembro a Janeiro.

Z.44: The president of the (Fishing) *Colony said* (the closed season happens in) *May/ June and July/ But me/ as a fisherman/ see the spawning from December to February.*
Presidente da Colônia (de pescadores) falou (que o defeso acontece em) maio/ junho e julho/ Mas eu como pescador/ vejo a desova de dezembro a fevereiro.

G.48: We do have closed season of the robalo/ but here we don't receive it (the closed season insurance)/ (…) *Its spawn is in January.*
Tem defeso do robalo/ mas só que aqui nóis não recebe (o seguro defeso)/ (...) A desova dele é no mês de janeiro.

J.59: The robalo has closed season/ but for us there isn't (referring to the closed season insurance)/ Fishing is forbidden/ but we just keep fishing and selling it hidden/ Its closed season is in June/ July and August/ (And when does it spawn?)*/ The robalão enters the river in December and January to spawn.*
O robalo tem defeso/ mas pra nóis não tem não (se referindo ao seguro defeso)/ É proibido pescar/ mas só que a gente continua pescando e vendendo escondido/ O defeso dele no caso é em junho/ julho e agosto/ (E quando ele desova?)/ O robalão entra no rio no mês de dezembro e janeiro pra desova.

G.44: They want to place the closed season (insurance) *now/ from May to June/ Meanwhile/ we don't have it/* (And when is the robalão spawning?)/ *In the summer.*
Estão querendo colocar o (seguro) defeso agora no mês de maio a junho/ Por enquanto não tá tendo/ (E quando o robalão desova?)/ No verão.

Supplementary Material 3 - Analysis of partialities and overlaps in the ontological dimension using a more relaxed demand for similarity

Considering the academic scientific order, overlaps and partialities between two knowledge systems (TEK and AEK) regarding the taxonomy of fish.

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“Aqui é a escola em que você aprende eu fazendo”

Seu Jonas, ao ensinar como era a confecção de redes antigamente.

Capítulo III

Artigo submetido ao periódico *Ecology & Society*

TAKING FISHERS' KNOWLEDGE AND THEIR IMPLICATIONS TO FISHERIES POLICY SERIOUSLY

Abstract: Sustainable fishing is one of humanity's most pressing challenges and it requires insightful knowledge of the drivers that may foster or hinder predatory exploitation. It has been widely recognized that Indigenous and local knowledge can contribute to biodiversity conservation and sustainable use of resources such as fisheries worldwide, even though it continues to be marginalized and unacknowledged by a range of academic scientists and policy makers. In the present paper, we tackle this issue by discussing laws regarding closed fishing seasons, which are part of the Brazilian environmental policies for protecting marine fauna, from the perspective of artisanal fishers. In Brazil, these legislations are typically based on governmental decisions (i.e., by administrative organizations and researchers acting as consultants) without taking fishers' knowledge into account. Through semi-structured interviews with traditional experts of fishing villages situated in the northeast coast of Brazil, we aimed to investigate their knowledge on fish's reproductive periods and analyze how it is related to the closed seasons at work in their region. We found an exact agreement between fishers' knowledge and closed season regulations on the reproductive period of the mangrove crab (Ucides cordatus), but a conflict on the reproductive period of two snook species and four species of shrimps. Thus, we advocate for the inclusion of Indigenous and local knowledge into policy making about fisheries. Such inclusion can improve conservation management practices and also contribute to the empowerment of local and Indigenous peoples.

Keywords: artisanal fishers; closed fishing season; environmental policies; Indigenous and local knowledge; policy making; transdisciplinarity.

Introduction

Environmental policies worldwide are usually based on a narrow understanding of expertise that relies exclusively on academic knowledge and/or on policy makers' knowledge while disregarding other non-academic actors, including Indigenous peoples and local communities and their knowledge. While such a narrow understanding of expertise is deeply entrenched in hierarchical governance structures (Scott 1998), it has been widely challenged in the literature on environmental policy, which highlights the epistemic and political importance of transdisciplinary and participatory approaches that bring different actors together (Turnhout et al. 2019). From an epistemic perspective, Indigenous and local knowledge (ILK) is often crucial for understanding local ecosystem dynamics and for anticipating the impact of environmental policies (Berkes 2017, Albuquerque et al. 2021). Politically, local communities are often most directly affected by the implementation of environmental policies while their perspectives remain marginalized in governance processes that only respond to external academic knowledge and/or on policy makers' knowledge (Nadasdy 2003, Whyte 2018).

The establishment of closed fishing seasons, which is the focus of the present paper, provides a clear example of this state of affairs. Closed seasons are environmental policies used worldwide to ban fishing of targeted species during their breeding period in order to increase their reproductive success (Arendse et al. 2007). After all, harvesting pressure of species during spawning periods is considered to be one of the main causes of recruitment collapse (Sadovy and Domeier 2005), with unbalanced effects on both exploited populations and maintenance of artisanal fisheries (Reis-Filho et al. 2021) as well as their practices linked to fishing culture heritage. In Brazil, governmental and scientific interest in these themes involving small-scale fishing communities has been reduced to local interventions, with poor or ineffective communication among stakeholders. As a result, ILK is typically left out of development strategies for resource conservation.

In Brazil, the closed season policies are developed by technicians and researchers linked to government and research institutions, usually without taking ILK into account (Vasques and Couto 2011; see Estatuto do Fórum da Lagoa dos Patos 1998). The Brazilian fisheries management model relies almost exclusively on academic and government technicians' knowledge on aspects of the biology and/or population dynamics of the fisheries resources (Castello 2008). Accordingly, these policies do not consider what is known by local fishing communities on the behavior, reproduction, seasonality, and other features of fish species, as well as about human-wildlife interactions. This knowledge has been shown to be relevant, however, for conservation measures. Castello et al. (2009), for instance, present a case in which the participation of fishers in the management process was crucial for recovering an overexploited small-scale fishery, namely, that of the pirarucu (Arapaima spp.) in the Amazon basin. In this process, ILK has been mobilized by the regional government agencies. By conducting management under conditions of uncertainty, those agencies incorporated knowledge held by the fishers in order to improve both yields and conservation goals. However, such local initiatives remain an exception in Brazil and do not scale up to the national level.

This lack of consideration of ILK in Brazilian fisheries management is in tension with a large body of literature that highlights its importance in ecology and biodiversity conservation (Huntington 2000, Gilchrist et al. 2005, Gagnon and Berteaux 2009, Braga-Pereira et al. 2021). As the knowledge systems of local communities have evolved together with local ecosystems, community members often hold knowledge about animal and plant species and ecological processes that can improve understanding of biological phenomena as well as conservation management (Albuquerque et al. 2021). Thus, the establishment of closed fishing seasons is one of the identified conservation measures which will only reach maximum effectivity - as well as social justice - by involving Indigenous and local communities and their knowledge in the whole process (Macusi et al. 2021).

This article focuses on the challenges and tensions between ILK and academic knowledge (AK) and their relation with conservation policies in the fishing communities of Siribinha and Poças, in the Itapicuru estuary, northeast coast of Bahia, Brazil. Motivated by an apparent mismatch between these two knowledge systems and the closed fishing season policies of some marine species (see Renck et al. in press), we investigated the tensions involving these different stakeholders and this important environmental public policy by conducting interviews with local traditional experts to understand their knowledge on the reproductive periods of animals protected by the policy.

Methods

Study area

The fishing villages of Siribinha and Poças, located in the estuary of the Itapicuru river (Conde, Bahia S 11 45 29, W 37 31 41), northeast Brazil, are communities of artisanal fishers comprising ca. 500 and 800 inhabitants, respectively, and being 6 Km apart from each other (Figure 1). They have been relatively isolated all the way to the 1990s, since there was no road connecting them to nearby villages and cities until then. They are representatives of the fishing culture typical from northeast Brazil, named “Jangadeiros culture” after the kind of boat used (a “jangada” or raft; see Diegues, 1999). This fishing culture is a product from native Tupinambá and Portuguese influences, with some African contributions (Ott 1944).

In the Itapicuru estuary, fishermen usually harvest fish while fisherwomen specialize on shellfish. Many also earn their living from small-scale tourism, but most dwellers rely on fishing. As their villages are located on a small strip of land between the river and the sea, they use both of these natural environments to fish, both for self-consumption and small-scale commercialization.

In these communities, fishers usually fish in pairs and use small boats for short day trips to the coastal sea to capture fish stuck in their gillnets. The main difference from these two communities is that some fishers from Poças own bigger boats in which they use gillnets and hook and line on the open sea, staying there up to seven days in a row (Fonseca 2021). Poças also has sandstone rock on its beach, which allows fishers to capture crustaceans, such as lobsters (Panulirus spp.) and a crab locally known as espichado (Grapsus sp.), during the low tide. Both villages use the estuary and canals in the mangroves for capturing both fish and shellfish, with several fishing arts: covo (traps for small crustaceans and fish), hook and line, gillnets, seine nets, cast nets, among others (Fonseca 2021).

Siribinha and Poças are situated in freshwater alluvial wetlands, occupied by a natural vegetation of mangroves, beach vegetation, and shrubby thicket-like forests growing on sand dunes (known as restingas). Coconut plantations and cattle ranches also make up part of the land use tenure of the region (Tng et al. 2021).

Despite anthropic threats to the environment (upstream river pollution, deforestation, real estate speculation, etc.), the mangroves in the estuary are still well preserved (Guimarães et al. 2019), due to the relatively small scale of activities such as fishing and tourism, and the fact that part of the fishing techniques used are artisanal and more sustainable. The conservation status of the estuarine environments is also indicated by the abundant presence of species sensitive to environmental impacts, such as the top predator rufous crab-hawk (Buteogallus aequinoctialis), locally known as “gacici”, a near threatened species (BirdLife International 2018).

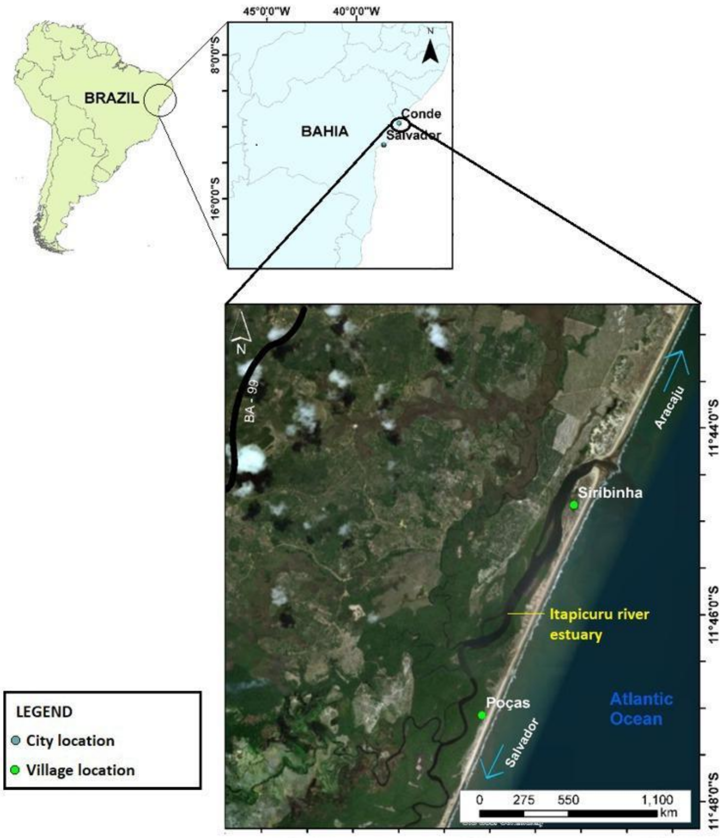

Figure 1: Itapicuru River estuary, northeast Bahia, Brazil, showing the fishing villages of Siribinha and Poças (modified from Guimarães et al. 2020).

Data collection and analysis

In order to analyze the fishers’ knowledge on fish's reproductive periods, we conducted semi-structured naturalistic interviews (Beuving and de Vries 2015) with traditional experts. Expertise on fish was defined by a combination of peer nomination (who the members of the community consider as being an expert) using a snowball sampling procedure (Albuquerque et al. 2014) and fulfilling the following requisites: interviewees had to be at least 30 years of age and be an experienced fisher (or had been such, in the case of retired fishermen) (this meant that they perform or performed fishing activities ≥ 4 days a week).

The fishers from Siribinha and Poças have to abide by three different closed fishing seasons (Table 1).

For the mangrove crab (Ucides cordatus), locally known as caranguejo-sal, between the 1st of December and the 31st of May (for female crabs) and between January and March, on the full and the new moons (for both male and female) (Brazil 2017). The latter is a period in which the crabs get out of their shelters in large groups to mate (making it easy for the locals to capture them), a phenomenon known as “andada” (walk).

For the snooks Centropomus undecimalis and Centropomus parallelus (Brazil 1992), locally known as robalão and robalo branco, respectively, between the 15th of May and the 31st of July.

For the shrimp species Farfantepenaeus subtilis, Farfantepenaeus brasiliensis, Xiphopenaeus kroyeri, and Litopenaeus schmitti, between the 1st of April and the 15th of May, and from the 1st of December until the 15th January (Brazil 2004).

Table 1: Closed fishing seasons set (in grey) in the Itapicuru estuary region.

Closed Season /Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Crab ♀ (Brazil 2017)												
Crab ♀♂ (Brazil 2017)												
Snooks (Brazil 1992)												
Shrimps (Brazil 2004)												

Renck at al. (in press) interviewed five traditional experts from Siribinha to build an ethnobiological model of the common snook. Among many other aspects, the model explored their knowledge about the common snooks’ reproduction period and their matching or mismatching in relation to the closed season legislation. In the present work, we not only extended this study to interview more traditional experts, but also included traditional experts from Poças and inquired into the spawning periods of the fat snook (Centropomus parallelus), the mangrove crab (Ucides cordatus), and four different shrimp species.

The present study was conducted in November 2019, and we interviewed a total of 18 traditional experts (43-87 years of age), twelve in Siribinha (fish and crab interviews) and six in Poças (shrimps interviews).

Interviews were performed either in their own houses, during door-to-door visits (Davis and Wagner 2003), or in the shared social spaces in the village, such as the square or the pier. Most interviews happened during the day time, when the traditional experts were at home or sitting on their porches, but some of them were also done when they were repairing their nets or landing fish. The interviews followed the technical and ethical recommendations provided by Bunce et al. (2000) regarding respectful and low disturbance interviewing techniques. This approach, along with the familiarity and trust established between researchers and fishers along the several years carrying out the project in the field, likely contributed to the reliability of the data collected.

When we report data from the interviews, we will indicate the traditional experts by the initials of their first name for confidentiality reasons. The interviews were individual and guided by an interview protocol (Supplementary Material 1).

Portuguese transcripts were translated by the first author and revised by the other authors. In the quotes from traditional experts' interviews, we indicate the pauses by slash (/), using period (.) only to signal the end of a speech turn. 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 2.

Ethical aspects

In all research procedures, 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 (International Society of Ethnobiology 2006).

Results

We found consensus between ILK and the regulations on the reproductive period of the mangrove crab. The twelve experts agreed that U. cordatus is spawning in the same period regulated by Brazil (2017). However, there was conflict on the reproductive period of the two snook and the shrimp species (Figure 2).

For the snook species, only four of the traditional experts (33%) agreed partially with the Brazilian legislation, with most of the traditional experts' citations pointing to the months of August (for both species) and January (for the robalão) as reproductive periods. For robalão (C. undecimalis), in a total of 22 month citations from the traditional experts (the sum of every traditional expert's citation for each month acknowledged for C. undecimalis to be reproducing), only two (9%) citations overlapped with the Brazilian legislation, whereas for robalo branco (C. parallelus) six citations out of a total of 22 citations (27%) showed such overlap. Furthermore, five of the twelve traditional experts (42%) distinguished the spawning period for both snook species (reporting that robalão spawns in the summer and robalo branco, in the winter) (Figure 2A), as expressed by E.: The spawning of the robalão is concentrated in January/ but sometimes we find some ovulating in August/ The spawning of the robalinho (robalo branco) is concentrated in July and August/ but sometimes we find some ovulating in January. However, the other fishers reported these species to spawn in the same period, as we can see in N.: August is the spawning month for the robalo/ Both the robalo branco and the robalão.

For the shrimp species, three out of six traditional experts didn't give a precise period, so we've done an inference based on their discourse (excerpts from interviews), adding a time span of one month for the inferred period: (a) Pe.: sometimes it varies (the spawning)/ The closing season ends and we still find eggs. (b) Z.: After the closing season the little white one (shrimp) will appear full of eggs/ It is never on the date. (c) Pr.: They are spawning before / that's when there's that little white shrimp/ So the closed season is covering the period of growth/ It doesn't cover the spawning period/ The spawning is a date between these two.

Therefore, there was a complete mismatch between ILK and the shrimp closed season legislations, as expressed by G.: The closed season is from December 1st to January 15th and from April 1st to May 15th/ It doesn't match (with the reproductive period)/ At that time it's not spawning/ It's spawning in the month of São João (Midsummer's Day)/ June/ July/ it goes until the end of August/ (…) The closed season doesn't match in this whole region. The month that received more citations was June (67%), a month after the second closed season period (Figure 2B).

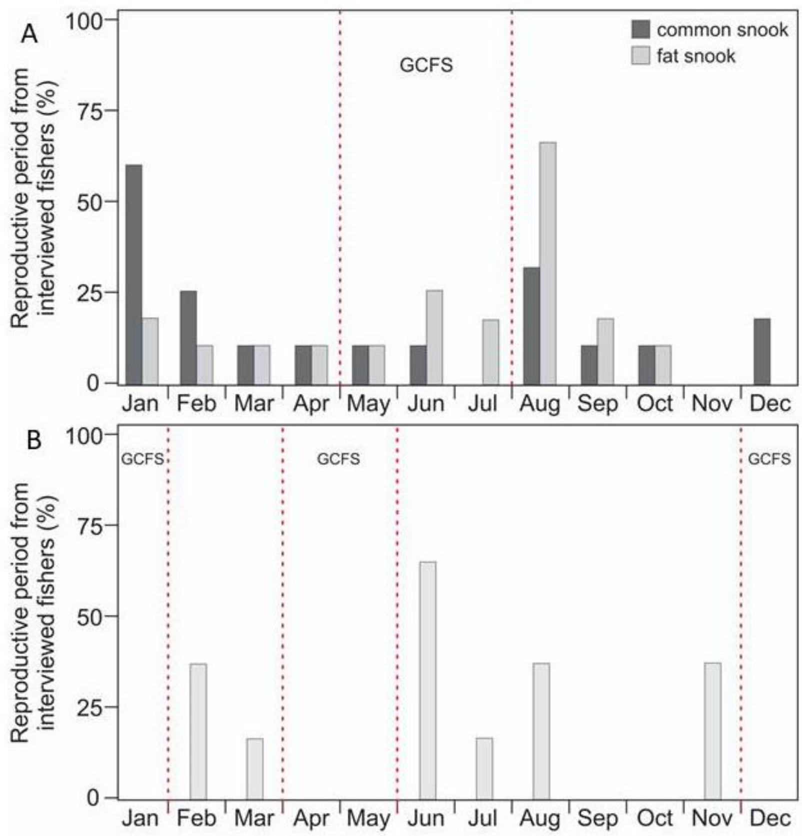

Figure 2. Traditional experts' knowledge on the snooks' (A) reproductive period and the shrimps' (B). GCFS: governmental closed fishing season.

Considering only the months that had more than 10% of citations (as suggested by Nora 2013), the reproductive period indicated by the traditional experts lies in January, February, and August for the robalão, and June and August for the robalo branco (Table 2), as opposed to May, June and July, according to the Brazilian legislation (1992). Regarding the shrimps, the reproductive period indicated by the Poças' fishers lies in February, June, August and November (Table 2), as opposed to April-May and December-January, as stated in the Brazilian closed season legislation

(2004). Therefore, we found very low agreement between ILK and these two closed fishing season legislations.

Table 2: Seasonality of reproductive periods cited by the traditional experts during interviews (n=12 for the snooks and n=6 for shrimps). In bold, citations that were higher than 10%.

	Months	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Robalão	N. of citations	7	3	1	1	1	1	0	4	1	1	0	2	22
	%	**31.8**	**13.6**	4.5	4.5	4.5	4.5	0	**18.2**	4.5	4.5	0	9.1	100
Robalo b.	N. of citations	2	1	1	1	1	3	2	8	2	1	0	0	22
	%	9.1	4.5	4.5	4.5	4.5	**13.6**	9.1	**36.4**	9.1	4.5	0	0	100
Shrimps	N. of citations	0	2	1	0	0	4	1	2	0	0	2	0	12
	%	0	**16.7**	8.3	0	0	**33.3**	8.3	**16.7**	0	0	**16.7**	0	100

Discussion

The findings of this study show consensus between ILK and the closed season legislations of the mangrove crab, whereas there was an expressive disagreement related to the reproductive periods for snook and shrimp species (Figure 3). Since the fishers are banned to fish these marine species in the closed fishing season, the Brazilian Federal Government compensates the fishers formally registered (including the traditional experts who participated in this research) with a closed season insurance (called “seguro defeso”) corresponding to the Brazilian minimum wage (around 260 U.S. Dollars) for each banned month. These subsidies are interesting socio-environmental mechanisms to compensate for the fishers’ economic losses, given that artisanal fisheries in Brazil, both inland and coastal, are responsible for about half of the country’s catches (Begossi 2008). However, given the mismatch mentioned, they are forced to choose between following their knowledge on the reproductive period or their legal obligations, as also discussed by Galdino (1995) and Martins et al. (2013).

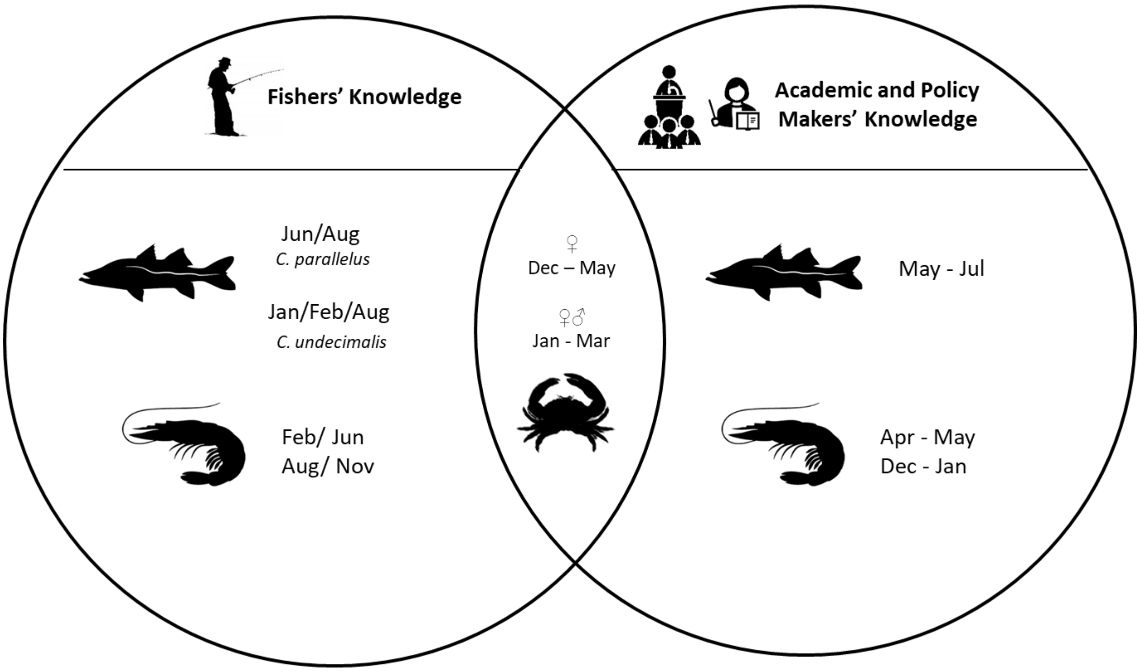

Figure 3. Stakeholders' disagreements on marine animals' reproductive periods in the Itapicuru estuary.

This environmental policy is congruent with scientific understanding, which shows the need that the populations survive at a minimum size under a given recruitment regime until conditions of adequate productivity for fishing are re-established (MacCall 2002, Parma 2002). As such, fish populations (i.e., stocks) should be maintained to permit their re-growth until the following reproduction period, so as to regionally permit sustainable (i.e., long-term) fisheries (Reis-Filho and Leduc 2017). Therefore, the mismatch indicated by our findings has potentially important impacts on the conservation of marine and freshwater biota, with lasting repercussions on regional economy and fishing communities' life quality (Pinheiro et al. 2015, Reis-Filho and Leduc 2017).

Our findings partially agree with the results found by Nora (2013), who reported that the fishers from Paraty (southeast Brazil) indicated that the reproductive period of the same two snook species included in our study is between November and February. Regarding robalão, in particular, after a combination of macroscopic analysis of gonad maturation and interview with traditional experts, Begossi (2008) also found them to reproduce between spring and summer, in the warmest months of the year, in two different sites in the States of São Paulo and Rio de Janeiro. These reproductive period differences in relation to what was found in the Itapicuru estuary are not surprising, since their studied sites are located 1.500 Km and 1.300 Km southern from ours, respectively, and behavioral traits are expected to differ from one region to another in such distant latitudinal zones, due to different environmental conditions, such as temperature, photoperiod, salinity, sediment type, hydrodynamics, and biotic interactions (Silva et al. 2018).

With regard to the shrimp species, our findings also partially agree with the scientific literature, considering studies that are also from different regions of the country. The fishers from Lucena, Paraíba (600 Km north from our studied site), indicated that Litopenaeus schmitti and Xiphopenaeus kroyeri should be protected during the months of June, July and August, since the shrimps would be small (i.e. developing) or spawning (i.e. fertile and mature phase) in these months (Nascimento et al. 2018). The closed season proposed by the fishers from Ilhéus (370 Km south from our studied site) ranges from May until July and from November until December (Vasques and Couto 2011). Santos et al. (2003) found a bimodal reproductive period of X. kroyeri for the Ilhéus region, with the main peak in November/December and a secondary peak between April/May. Nascimento et al. (2018) call for attention to the possibility that these different shrimp species might have their reproductive and recruitment cycles at different times. Therefore, the closed seasons for them should be carefully evaluated.

These findings available in the academic literature and our own findings show that closed season legislations may benefit from taking into account both ILK and academic knowledge (AK). After all, there seems to be also a research-practice gap on the AK side: these policies seem to be derived from very limited information from AK itself (or, alternatively, AK seems to have been hardly taken into account in these policies, too), as shown by Renck et al. (in press). According to a fisheries researcher (personal communication), the closed season for C. undecimalis, for example, has been based on reproductive biology studies carried out in a locality over 400 Km northeast of Siribinha more than 30 years ago. This policy has been applied, however, to almost the entire northeastern coast of Brazil.

The tensions between ILK and environmental policies documented here, particularly regarding the closed fishing seasons, are far from being isolated cases (see, e.g., Souza 2008, Vasques and Couto 2011, Musiello-Fernandes et al. 2017, Nascimento et al. 2018). Musiello-Fernandes et al. (2017), for instance, also reported a mismatch between the closed fishing season of Xiphopenaeus kroyeri and fishers' knowledge on its reproductive and recruitment period in the States of Bahia and Espírito Santo, Brazil. According to them, most of the fishers were against that policy, and many did not obey it. Fortunately, Musiello-Fernandes reported (pers. comm.) that in 2019 a task force involving researchers, fishers and policy makers led to a change in legislation, so as to incorporate ILK.

Our findings and the available literature show that taking fishers' knowledge seriously can contribute to more accurate environmental policies. After all, they suggest that these marine species are probably being protected at the wrong time. However, our results also indicate that incorporating ILK is not a straightforward process. There are some tensions and methodological challenges involving the different stakeholders that need to be addressed. Firstly, ILK is informally acquired and shared. It is experiential, built in practice and through practice. Accessing it requires, therefore, careful and time-consuming qualitative research, as illustrated by the 18 interviews done in this study. Academic researchers often consider ILK as employing non-standardized methods which are not "transparent" in the same way as scientific methods and, thus, may be difficult to validate and are easily dismissed by state officials as indefensible before citizens' questioning (Marlor 2010). Ultimately, it seems much more difficult, if not impossible to use them when one aims at generating data that will adhere to academic standards, such as statistical significance. Nevertheless, to assume such a goal may be said to mean, in effect, not taking into account the very nature and potential role of ILK in policy making.

Secondly, ILK usually reflects local ecological dynamics while Federal legislation aims at much larger scales (e.g. the legislation for the snooks [Brazil 1992] is intended to cover more than 1.500 Km of coastline). A lot of the available knowledge simply does not scale up in such a manner (e.g., spawning periods vary along the coastline). Therefore, it is not to be expected, indeed, that a single closed season may be established for the whole coastline. For ILK to be incorporated into policy-making, it will be necessary to transcend local knowledge through covering a wider area, including several fishing communities, and, accordingly, performing interviews with larger numbers of fishers.

Lastly, labels like "ILK" can obscure that knowledge in a community is not homogenous and easily standardized. This can be illustrated by considering lack of community consensus. Many ethnobiological studies begin with the assumption that a community possesses a single cultural consensus model, but instead of some self-evident premise this is an empirical conjecture that needs testing (Ross et al. 2005). And this conjecture can obviously be false. Renck et al. (2022), for instance, found a lack of cultural consensus in how members of the community of Siribinha categorize and classify fish. That is, we may find disagreements not only when we compare two knowledge systems, but inside each system as well. In fact, the findings we report in this paper show by themselves intracultural knowledge diversity. Surely, the same can happen in the case of AK.

Reflecting on these three challenges highlights an important tension in debates about the relations between ILK and AK. On the one hand, our results reinforce the growing consensus about the importance of ILK in conservation management (e.g., Braga-Pereira et al. 2021, Albuquerque et al. 2021), including co-management and ecosystem approaches that complement traditional methods of management (Berkes et al. 2001, Sowman et al. 2003). On the other hand, our results also show that the incorporation of ILK into policy is a complex process that often clashes with dominant forms of academic knowledge production and governance structures. There is no simple process of integrating ILK and AK or taking them as starting points for knowledge co-production in policy making; on the contrary, the negotiation of knowledge diversity is fraught with methodological and political challenges.

Addressing these challenges requires transdisciplinary approaches that decentralize the negotiation of policies rather than merely incorporate ILK into existing academic debates and governance structures. The bridging of knowledge systems therefore requires the creation of settings for multiple forms of knowledge exchange and learning across key aspects of the system: its actors (knowledge carriers), institutions (critical moderators of knowledge systems), and processes. Tengö et al. (2017) propose an approach addressing five tasks required for successful collaboration across diverse knowledge systems, including mobilization, translation, negotiation, synthesization, and application. If these tasks are properly performed, the challenges for transdisciplinary work towards policy making about fisheries sustainability and other environmental issues may be overcome.

The insertion of distinct social actors, such as fishers, in the implementation of legal measures can provide a basis for more inclusive negotiation of the management of fisheries resources (Vasques and Couto 2011). Moreover, decentralization and the use of ILK in management of local artisanal fisheries have already given better results than centralized, top-down management (Begossi 2008). Using ILK is also vital to empower local communities (Albuquerque et al. 2021) so that they have a voice in public policies that affect them by being recognized in their ability to explain local ecological phenomena, sometimes in rather complex ways (El-Hani et al. 2022). For instance, explaining ecological dynamics and conserving biodiversity in the Itapicuru River estuary requires the epistemic expertise of local community members. Fishers who are intimately familiar with this ecological context provide fine-grained causal explanations that complement the epistemic resources of academically trained biologists (El-Hani et al. 2022).

Therefore, we claim that fishers should have a voice and participate in the definition of closed fishing season legislations. We also propose that both ILK and AK should be taken into consideration for future closed seasons policy making. Once we consider intra- and intercultural variation in knowledge and a lack of consensus within and across knowledge systems, it follows that participatory research processes (Freire 1970, Fals-Borda 1987, Long et al. 2016) are needed to this end.

Conclusion

Our study suggested a mismatch between closed fishing season regulations and the actual reproductive or recruitment period of the protected species. This mismatch is likely a consequence of the variability of reproductive periods of these species along the Brazilian coast, as shown by the comparison with the available literature and also by the fact that the very legislations were based on scant knowledge, either from ILK or academic knowledge (AK). The chance that such a mismatch happens can be diminished, however, if fishers' knowledge about reproductive periods, which often remains unrecognized in fisheries management and legislation, is taken in due account. Our findings reinforce, thus, the importance of mobilizing both ILK and AK in a participatory research approach for both epistemic and political reasons: recognizing fishers' knowledge can lead to legislation that matches more accurately local spawning periods and responds more efficiently to the needs of local communities and of biological conservation, while empowering their participation in decision making that affects their own lives.

But our findings also caution against the expectation of a straightforward knowledge integration in which ILK simply provides data for use in established governance frameworks. ILK is often produced and validated in ways that do not match academic standards, as reflected in the fishers' experiential and informally acquired knowledge about spawning periods, which may lack a robust cultural consensus within a fishing community. Rather than simply assuming that ILK provides additional data for already established frameworks and models of fisheries management, we therefore argue for the need to develop an intercultural approach (Rist and Dahdouh-Guebas 2006) that takes knowledge co-production seriously (e.g., Tengö et al 2017), as well as both synergies and tensions between different knowledge systems (Ludwig 2016, Ludwig and El-Hani 2020). Such an intercultural approach recognizes that improving conservation management practices and policy making is intertwined with challenging the marginalization of local and Indigenous communities in decision making processes, so as to not reproduce epistemic and political injustice.

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APPENDIX

Supplementary Material

1. Interview protocol

1) What fish or shellfish are prohibited to fish at certain times of the year?
2) Why can't you fish them during this period?
3) When are these fish and shellfish with eggs/spawning (time of the year)?
4) And when are you forbidden to fish them (check if it matches with the reported reproductive period/is it recognized by them as an incompatibility?)?

2. Portuguese originals from the translated excerpts

E.: *The spawning of the robalão is concentrated in January/ but sometimes we find some ovulating in August/ The spawning of the robalinho (robalo branco) is concentrated in July and August/ but sometimes we find some ovulating in January.*

E.: A desova do robalão se concentra em janeiro/ mas às vezes encontra algum ovado em agosto/ A desova do robalinho (robalo branco) se concentra em julho e agosto/ mas às vezes encontra algum ovado em janeiro.

N.: August is the spawning month for the robalo/ Both the robalo branco and the robalão.

N.: Agosto é o mês da desova do robalo/ Tanto do robalo branco e do robalão.

Pe.: sometimes it varies (the spawning)/ The closing season ends and we still find eggs.

Pe.: As vezes vareia (a desova)/ Termina a data do defeso e encontra ainda ovado.

Z.: After the closing season the little white one (shrimp) will appear full of eggs/ It is never on the date.

Z.: Depois do defeso que vai aparecer o (camarão) branquinho todo ovado/ Nunca é na data.

Pr.: They are spawning before / that's when there's that little white shrimp/ So the closed season is covering the period of growth/ It doesn't cover the spawning period/ The spawning is a date between these two.

Pr.: Eles tão ovando antes/ que é quando dá aquele camarãozinho branco/ Então o defeso tá pegando o período do crescimento/ Não pega o período que desova/ A desova é numa data entre essas duas.

G.: The closed season is from December 1st to January 15th and from April 1st to May 15th/ It doesn't match (with the reproductive period)/ At that time it's not spawning/ It's spawning in the month of São João (Midsummer's Day)/ June/ July/ it goes until the end of August/ (…) The closed season doesn't match in this whole region.

G.: O defeso é 1 de dezembro a 15 de janeiro e 1 de abril a 15 de maio/ Não bate (com o período reprodutivo)/ Nessa época ele não tá ovado/ Ele tá ovado no mês de São João/ junho/ julho/ vai até final de agosto/ (...) O defeso não bate nesta região toda.

Considerações Finais

A presente tese de doutorado explorou a abordagem de sobreposições parciais por meio de pesquisa etnobiológica e etnoecológica, mobilizando esse arcabouço filosófico geral para a realização de pesquisa empírica e discutindo processos dialógicos entre os sistemas de conhecimento pesqueiro artesanal e científico-acadêmico no domínio da conservação e do uso sustentável de recursos.

No primeiro capítulo, mostramos que a comunidade de Siribinha tem um rico conhecimento sobre peixes, sendo o gênero dos entrevistados um fator significativo influenciando o número de peixes citados na listagem livre. Porém, o tipo de atividade exercido pelos membros da comunidade e as interações entre gênero e tipo de atividade exercida não foram significativas. Encontramos também uma diversidade intracultural na forma como os peixes são classificados pelos membros da comunidade, mostrando a necessidade de cautela ao se fazer suposições de que uma determinada comunidade local teria um único modelo cultural consensual. A falta de "consenso cultural" não significa, no entanto, que não haja padrões no conhecimento de uma dada comunidade. Portanto, precisamos abordar o conhecimento etnobiológico de maneira sensível a questões de estratificação social e diversidade epistêmica dentro das comunidades, sem assumir que é impossível fazer afirmações gerais sobre uma determinada comunidade (como os critérios utilizados para classificação de peixes), caso um modelo cultural consensual não seja encontrado. Nesse sentido, defendemos a necessidade de não tratar comunidades humanas nem como unidades epistêmicas monolíticas, nem como coleções inteiramente fragmentadas de indivíduos.

No segundo capítulo, mostramos que diferentes sistemas de conhecimento podem aprender mutuamente a partir de parcialidades complementares e que, além disso, pode haver produtividade epistêmica quando há parcialidade competidora, ou seja, quando dois sistemas de conhecimento discordam entre si. Pela abordagem de sobreposições parciais, mostramos que tais processos de aprendizado mútuo podem contribuir para a negociação transdisciplinar na tomada de decisão sobre a conservação da biodiversidade e outras políticas públicas, como ilustrado no caso do defeso de *Centropomus undecimalis*, no qual a identificação de uma parcialidade competidora levou ao reconhecimento de uma falha na atual legislação ambiental brasileira. A abordagem de sobreposições parciais pode contribuir, portanto, para desafiar injustiças epistêmicas que marginalizam os conhecimentos indígenas e locais na tomada de decisão sobre conservação da biodiversidade e, em termos mais gerais, nas propostas de resoluçãode questões socioambientais.

No terceiro e último capítulo, partimos dessa constatação de parcialidade competidora entre o conhecimento de especialistas tradicionais e políticas de defeso, expandindo a investigação para outros organismos marinhos, como o caranguejo-sal (*Ucides cordatus*), outra espécie de robalo (*Centropomus parallelus*) e quatro espécies de camarão (*Farfantepenaeus subtilis, Farfantepenaeus brasiliensis, Xiphopenaeus kroyeri* e *Litopenaeus schmitti*). Constatamos que os especialistas tradicionais possuem conhecimentos sobre os períodos reprodutivos dos peixes que permanecem não reconhecidos no manejo e na legislação pesqueira. Nesse sentido, nossos achados reforçam a importância de colocar conhecimento acadêmico e pesqueiro em diálogo, em uma abordagem de pesquisa participativa, por razões tanto epistêmicas quanto políticas: reconhecer o conhecimento dos pescadores e das marisqueiras pode levar a uma legislação que corresponda com mais precisão aos períodos reprodutivos das espécies locais e responda de forma mais eficiente às necessidades das comunidades locais e à conservação dessas espécies.

Porém, nossos achados também alertam contra a expectativa de uma simples integração de conhecimentos, em que ILK simplesmente forneceria dados para uso na formulação de políticas públicas. Em vez de simplesmente assumir que ILK fornece dados adicionais para estruturas e modelos já estabelecidos de gestão pesqueira, defendemos a necessidade de desenvolver uma abordagem intercultural que leve a sério a coprodução de conhecimento, bem como sinergias e tensões entre diferentes sistemas de conhecimento. Ao fazer isso, não apenas teremos maiores possibilidades de melhorar as práticas de gestão de conservação e formulação de políticas públicas, mas também poderemos desempenhar um papel no empoderamento e na defesa da autodeterminação de povos indígenas e comunidades locais.

Final Considerations

The present Doctoral Dissertation explored the approach of partial overlaps through ethnobiological and ethnoecological research, mobilizing this general philosophical framework to carry out a concrete empirical case study and discussing dialogic processes between scientific-academic and artisanal fisheries knowledge systems in the domain of conservation and sustainable use of resources.

In the first chapter, we show that the community of Siribinha has a rich knowledge about fish, with the gender of the interviewees being a significant factor influencing the number of fish mentioned in the free listing. However, the type of activity performed by community members and the interactions between gender and type of activity performed were not significant. We also found an intracultural diversity in the way fish are classified by community members, showing the need for caution when making assumptions that a given local community would have a single cultural consensus model. The lack of "cultural consensus" does not mean, however, that there are no patterns in the knowledge of a given community. Therefore, we need to approach ethnobiological knowledge in a way that is sensitive to issues of social stratification and epistemic diversity within communities, without assuming that there is nothing to be said about a given community in general terms (such as the criteria used for classifying fish) if a consensual cultural model is not found. In this sense, communities should be treated neither as monolithic epistemic units, nor as entirely fragmented collections of individuals.

In the second chapter, we not only show that different knowledge systems can learn mutually from complementing partialitiy, but also from competing partiality, showing epistemic productivity when two knowledge systems disagree with each other. Furthermore, through partial overlaps, such processes of mutual learning can contribute to transdisciplinary negotiation in decision-making on biodiversity conservation and other public policies, as shown in the case of the closed fishing season of *Centropomus undecimalis*, in which the finding of a competing partiality led to the identification of a flaw in the current Brazilian environmental legislation. Partial overlaps consideration can therefore contribute to challenging epistemic injustices that marginalize indigenous and local knowledge in decision-making on biodiversity conservation and, more generally, in responses to socio-environmental issues.

In the third and final chapter, we start from this finding of competing partiality between traditional experts' knowledge and closed season policies, expanding the investigation to other marine organisms, such as the mangrove crab (*Ucides cordatus*), another species of snook (*Centropomus parallelus*) and four shrimp species (*Farfantepenaeus subtilis, Farfantepenaeus brasiliensis, Xiphopenaeus kroyeri* and *Litopenaeus schmitti*). We found that traditional experts have knowledge about the reproductive periods of fish that remain unrecognized in fisheries management and legislations. In this sense, our findings reinforce the importance of putting academic and fisheries knowledge into dialogue, in a participatory research approach, for both epistemic and political reasons: recognizing the knowledge of fishers can lead to policies that correspond more precisely to the reproductive periods of local species and respond more efficiently to the needs of local communities and the conservation of these species.

However, our findings also warn against the expectation of a straight-forward knowledge integration, in which ILK would simply provide data for use in the formulation of public policies. Rather than simply assuming that ILK provides additional data to already established structures and models of fisheries management, we advocate the need to develop an intercultural approach that takes knowledge co-production seriously, as well as synergies and tensions between different knowledge systems. In doing so, not only will we be able to improve conservation management practices and public policymaking, but potentially play a role in empowering and advocating self-determination for indigenous peoples and local communities.