**COMPROVANTE DE CAPACIDADE TÉCNICA OBRIGATÓRIA**
Vaga 34: SET – C
Candidato: Andrey Paulo Cavalcanti Soares
CPF: 095.225.944-31

Este documento reúne comprovantes de experiência técnico-científica em:

- Ecologia de sistemas pesqueiros

- Trabalhos em sistemas estuarinos e marinhos

- Identificação taxonômica de recursos pesqueiros

- Processamento biológico em laboratório

- Análise de tecidos e órgãos para parâmetros reprodutivos e de crescimento

- Atuação em projetos de Ciência, Tecnologia e Inovação (CT&I)

**DOCUMENTO 1 – Projeto PROTUNA (Bolsa DTI)**

Projeto: PROTUNA – Projeto de Apoio Científico e Tecnológico ao Desenvolvimento da Pesca de Atuns e Afins no Brasil

Instituição: CNPq / Comitê Permanente de Assessoramento – Atuns e Afins (CPG)

Período de atuação: 2019 – 2021

Descrição das atividades desenvolvidas:

- Atuação em projeto de Ciência, Tecnologia e Inovação (CT&I) aplicado à pesca oceânica;
- Coleta e sistematização de dados de história de vida de peixes a partir da literatura científica;
- Curadoria, padronização e integração de bancos de dados biológicos e pesqueiros;
- Execução de análises de risco ecológico e Análises de Produtividade e Suscetibilidade
- Avaliação de estoques e vulnerabilidade de espécies de pequenos atuns (small tunas)
- Atuação em estudos no âmbito das recomendações e metodologias da ICCAT
- Suporte técnico à gestão e conservação de recursos pesqueiros

PROTUNA

# DECLARAÇÂO

Declaro para os devidos fins, que Andrey Paulo Cavalcanti Soares CPF 095.225.944-31 participou como bolsista de desenvolvimento tecnológico industrial nível B (DTI-B), do Projeto de apoio técnico-científico ao desenvolvimento da pesca de atuns e afins no Brasil – PROTUNA, de março de 2019 até fevereiro de 2021. Coordenado por mim, Paulo Eurico Pires Ferreira Travassos (Professor, Universidade Federal Rural de Pernambuco). O projeto foi financiado pelo o Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq.

Recife, 10 de maio de 20 22

Paulo Eurico Pires Ferreira Travassos

Professor Associado – DEPAq UFRPE

Coordenador do PROTUNA

Dr. Paulo Travassos / CNPq
Proc. 445810 / 2015 - 7
Coordenador PROTUNA
UFRPE

Paulo Travassos – Universidade Federal Rural de Pernambuco

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**DOCUMENTO 2: Cruzeiro Científico AMAZOMIX**

Projeto: AMAZOMIX – *Amazon Shelf Mixing and its Impact on Ecosystems*

Tipo de atividade: Campanha oceanográfica científica internacional (Legs 1 e 2)

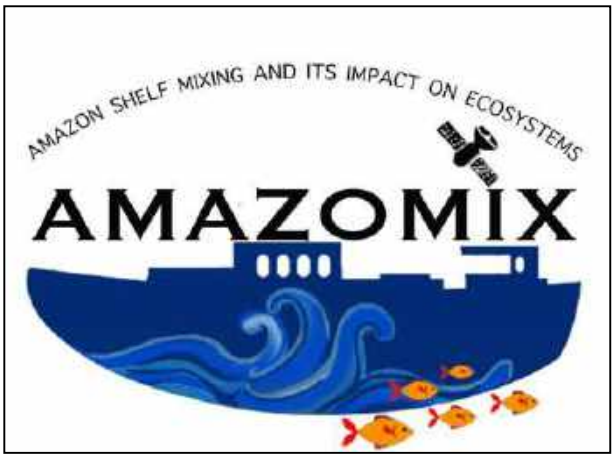
Ano: 2021

Descrição das atividades desenvolvidas:

- Participação como membro da equipe científica (Scientific and technical staff) em cruzeiro oceanográfico internacional;
- Atuação em atividades de coleta de organismos marinhos em sistemas pelágicos e demersais;
- Participação em amostragens biológicas por meio de arrastos e métodos oceanográficos;
- Atuação em estudos de ecologia aplicada em ecossistemas marinhos;
- Apoio ao processamento inicial de amostras biológicas e organização de dados de campo;

# Report of the AMAZOMIX survey - Legs 1 and 2

## R/V ANTEA 27/08 – 29/09, 2021




Chief Scientist Leg 1 and Leg 2: Arnaud BERTRAND, IRD/MARBEC

*Report redacted aboard the R/V Antea the 29/09/2021*

Flotte océanographique française

# 1. Objective of the AMAZOMIX survey

The Amazon shelf encompasses a variety of physical processes, such as fluvial inputs, coastal currents, mesoscale, filaments, tides, internal waves and upwelling, influencing nutrient concentrations, chlorophyll and suspended matter. They also affect energy, salt and heat balances; parameters that condition physical/biogeochemical interactions and ecosystem functioning, from bacteria to plankton to fish resources. In particular, internal tidal waves are very energetic in this region. They impact biogeochemical cycles via the vertical mixture induced by their dissipation or vertical movements induced by their propagation. They thus allow a significant input of nutriments into the euphotic layer enhancing primary production, as observed on the surface from watercolour data. Internal tidal waves could thus influence the biological pump and the carbon cycle. In addition, overall marine biodiversity of the region, from bacteria to fish is not well described. The connectivity of species in the tropical Atlantic is also still an open question. The Caribbean region is by far more bio-diverse than the Brazilian one. One of the hypotheses is that the Amazon plume, which can extend up to 3,000 km off the mouth, would constitute a barrier for some organisms. The Amazon Shelf is thus an ideal experimental laboratory to study the impact of physical processes on the structure and function of neritic and oceanic marine ecosystems.

In this context, the objective of the multidisciplinary AMAZOMIX survey was to study the impact of the Amazon River plume, internal tides and associated turbulent mixing, on marine ecosystem in contrasting regions off the Amazon shelf. For that purpose, the multidisciplinary AMAZOMIX project brings together physicists, biogeochemists, bioopticians and biologists. The sampling strategy consists in the simultaneous acquisition of a comprehensive set of environmental and biological compartments, including micro-organisms (bacteria, phyto and zooplankton) and higher trophic levels (micronecton, demersal and pelagic fish). AMAZOMIX is the first campaign to develop this multi-disciplinary approach off the Amazon shelf. *In situ* results will be analysed in interaction with digital tools and data, modelling (1/36°, with and without tides, 1/12° coupled) and satellite data analyses.

The survey is organized by the French Institute for Development (IRD), CNRS and CNES in France, Federal Rural University of Pernambuco (UFRPE), Federal University of Pernambuco (UFPE), Federal University of Pará (UFPA) and Federal Rural University of the Amazon (UFRA) for Brazil, and benefits from the structuring role of the International Joint Laboratory (LMI) TAPIOCA (IRD, UFPE, UFRPE). Technical services, research units and universities are associated to AMAZOMIX, of which: UMR MARBEC (University of Montpellier, IRD, Ifremer, CNRS), UMR LEGOS (CNES, CNRS, IRD, University Paul Sabatier), UMR LEMAR (UBO, CNRS, IRD, Ifremer), DT-INSU (CNRS), US IMAGO (IRD), UMR LOG (CNRS, IRD, University of Lille, ULCO), UMR MIO (University of Aix-Marseille, University of Toulon, IRD, CNRS), Federal University of Rio de Janeiro (UFRJ, Brazil), the National Brazilian Institute for Spatial research (INPE, Brazil) and the University of Porto (Portugal). The Rockland Scientific firm is also participating in the campaign as an industrial organization.

In addition to the scientists on board, AMAZOMIX includes a whole team that will remain on land. A total of about 70 Brazilian, French and other countries' researchers are involved in the campaign, which will also have a research training role for about 50 international students. AMAZOMIX is the result of a long-standing federative work based on numerous funded projects, including the TRIALTAS European project and articulated through the LMI TAPIOCA (IRD, UFPE, UFRPE). It should also be emphasized that the analysis of the data collected will be carried out jointly by the different partners and that the findings will be pooled.

The aim of this report is to resume the activities performed during the Legs 1 and 2 of the AMAZOMIX survey and to assemble in a document the main protocols.

Contact for the AMAZOMIX survey: Arnaud.Bertrand@ird.fr

Contact for the AMAZOMIX project: Ariane.Koch-Larrouy@ird.f

# 2. Scientific and technical staff

*Table 1. List of scientific and technical staff.*

| Surname | Name | Nationality | Speciality | Role on-board | Institute | Status | | | | Leg | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Researcher | Engineer | Student. | Other. | 1 | 2 |
| Bertrand | Arnaud | French | Acoustics, Ecology | Chief Scientist | IRD | X | | | | X | X |
| Barreto | Thaiza | Brazilian | Biology | Biology | UFRPE | | | X | | | X |
| Carré | Claire | French | Phytoplankton | Plankton | IRD | | X | | | X | |
| Cervelli | Evan | Canadian | Oceanography | Oceanography | Rockland | | X | | | X | |
| Eduardo | Leandro | Brazilian | Biology | Biology | UFRPE | X | | | | X | |
| Fouilland | Eric | French | Biochemistry | Biochemistry | CNRS | X | | | | X | |
| Le Ridant | Arnaud | French | Oceanography | Oceanography | CNRS | | X | | | | X |
| Lebourges-Dhaussy | Anne | French | Acoustics | Acoustics | IRD | | X | | | | X |
| Melo | Pedro | Brazilian | Zooplankton | Plankton | UFPE | X | | | | | X |
| Mériaux | Xavier | French | Biochemistry | Biochemistry | ULCO | | X | | | X | |
| Passarone | Rafaela | Brazilian | Biology | Biology | UFRPE | | | X | | | X |
| Roubaud | Fabrice | French | Electronic, oceanography | Electronic, oceanography | IRD | | X | | | | X |
| Roudaut | Gildas | French | Acoustics | Acoustics | IRD | | X | | | | X |
| Rousselot | Pierre | French | Electronic | Electronic, oceanography | IRD | | X | | | X | |
| Soares | Andrey | Brazilian | Biology | Biology | UFRPE | | | X | | X | |
| Ternon | Jean-François | French | Biochemistry | Biochemistry | IRD | X | | | | | X |
| Vantrepotte | Vincent | French | Biochemistry | Biochemistry | CNRS | X | | | | X | |
| Augusto de Oliveira | Felipe | Brazilian | Hydrography | Observer | Marine Brazil | | | | X | X | X |
| | ***Total*** | | | | | 6 | 8 | 2 | 1 | 10 | 10 |

*IRD: Institut de Recherche pour le Développement, CNRS : Centre National de la Recherche Scientifique, UFRPE : Université Fédérale Rurale du Pernambouc, UFPE : Université Fédérale du Pernambouc, ULCO : Université du Littoral côte d'Opale.*

**DOCUMENTO 3 – Artigo Científico**

Nolé Eduardo et al. (2020). Scientific Reports

Atuação do candidato:

- Processamento de amostras biológicas em laboratório
- Abertura e análise de estômagos
- Identificação taxonômica das presas
- Uso de equipamentos óticos (estereomicroscópio)
- Organização do banco de dados trófico

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scientific reports

OPEN

# Trophic ecology, habitat, and migratory behaviour of the viperfish *Chauliodus sloani* reveal a key mesopelagic player

Leandro Nolé Eduardo[1,2✉], Flávia Lucena-Frédou[1], Michael Maia Mincarone[3], Andrey Soares[1], François Le Loc'h[4], Thierry Frédou[1], Frédéric Ménard[5] & Arnaud Bertrand[1,2,6]

Mesopelagic fishes are numerically the most important vertebrate group of all world's oceans. While these species are increasingly threatened by anthropogenic activities, basic biological knowledge is still lacking. For instance, major uncertainties remain on the behaviour, ecology, and thus functional roles of mesopelagic micronektivores, particularly regarding their interactions with physicochemical features. Here, we examine the trophic ecology, habitat, and migratory behaviour of the viperfish (*Chauliodus sloani*)—a poorly known and abundant deep-sea species—to further understand the ecology and thus functional role of mesopelagic micronektivores. Moreover, we explore how physical drivers may affect these features and how these relationships are likely to change over large oceanic areas. The viperfish heavily preys on epipelagic migrant species, especially myctophids, and presents spatial and trophic ontogenetic shifts. Temperature restricts its vertical distribution. Therefore, its trophodynamics, migratory behaviour, and functional roles are expected to be modulated by the latitudinal change in temperature. For instance, in most tropical regions the viperfish stay full-time feeding, excreting, and serving as prey (e.g. for bathypelagic predators) at deep layers. On the contrary, in temperate regions, the viperfish ascend to superficial waters where they trophically interact with epipelagic predators and may release carbon where its remineralization is the greatest.

Mesopelagic fishes (200–1000 m depth) are numerically the most important vertebrate group of the world's oceans[1], usually presenting global distribution[2,3], high biodiversity[4], and several adaptations to overcome challenges imposed by the deep-sea[4]. Most of these species vertically migrate to the surface to feed at night and actively transport the ingested carbon to deep waters during daylight[5], a pathway enhancing the oceanic carbon storage and thus global carbon cycles[6–8]. Moreover, they are an important trophic link for the maintenance of harvestable fish stocks[9–11] and the connection between shallow and deep-sea ecosystems[12]. However, while there is a major lack of knowledge regarding their global composition, ecology, and ecosystem functions[13–15], these species are increasingly threatened by anthropogenic activities. For instance, effects of climatic change[16,17], plastic pollution[18], and exploitation of deep-sea resources[15,19] stand to alter the structure and function of deep-sea ecosystems. Therefore, as threats to the diversity and stability increase, the understanding of mesopelagic ecosystems, their processes, and functions is mandatory, especially when sustainability is intended to be achieved[15,20].

Although research on mesopelagic species has considerably advanced over the past few years[3,5,20–24], most works focused on zooplanktivorous groups (e.g. myctophids, sternoptychids), while less attention has been paid to micronektivores (e.g. stomiids) that occupy higher trophic levels[25]. Given their high abundance[26], deep migrations[26,27], great body mass[4], and high predation on migrant zooplanktivorous fishes[23], mesopelagic micronektivores are a crucial component of deep-sea systems that hitherto has been overlooked. Indeed, the trophic ecology, migratory behaviour, and environmental interactions of mesopelagic micronektivores remains poorly known worldwide and unexplored in most oceanic areas[13,15,25]. It is therefore not clear how physical drivers (e.g. temperature, oxygen) structure these communities and how these relationships are likely to change in the

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DOCUMENTO 4 – Artigo Científico

Soares et al. (2020). Scientia Marina

Atuação do candidato:

- Processamento biológico das amostras
- Análise de conteúdo estomacal
- Organização do banco de dados
- Análise ecológica da dieta

SCIENTIA MARINA 84(2)
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https://doi.org/10.3989/scimar.04958.24A

# Feeding habits and population aspects of the spotted goatfish, *Pseudupeneus maculatus* (Perciformes: Mullidae), on the continental shelf of northeast Brazil

Andrey Soares [1], Alex Souza Lira [1,2], Júlio Guazzelli Gonzalez [1], Leandro Nolé Eduardo [1,4], Flávia Lucena-Frédou [1], François Le Loc'h [2], Beatrice Padovani Ferreira [3], Thierry Frédou [1]

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**Summary:** This study provides information about the feeding habits, population aspects and spatial distribution of the spotted goatfish, *Pseudupeneus maculatus*, along the coast of the tropical Brazilian continental shelf. Distribution patterns are described using length frequencies and catch rates. Stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$), along with stomach contents, were analysed to determine the diet of the spotted goatfish. Multivariate analysis and numerical indicators of the diet, such as numerical frequency, frequency of occurrence and weight percentage, were computed to evaluate the diet composition. The mean trophic position was defined using both stable isotope ratios and stomach content analysis. The length at first maturity for the species was determined as 13.7 cm. A slight pattern in size distribution was observed, with mean size increasing with depth along the shelf. The diet was mainly composed of crustaceans, teleosts and Polychaeta. No clear dietary difference was found between habitat types, water depth or latitude. Both trophic positions estimated by stable isotopes and stomach contents analysis ranged between levels 3 and 4. *P. maculatus* was found to be feeding on many rare and infrequent prey items, classifying it as a generalist zoobenthivorous predator, probably due to its efficient search strategy.

**Keywords:** distribution patterns; stomach content analysis; Brazil; cross-shelf; stable isotopes.

**Hábitos alimenticios y aspectos poblacionales del salmonete manchado, *Pseudupeneus maculatus* (Perciformes: Mullidae) sobre la plataforma continental del noreste de Brasil**

**Resumen:** En este estudio se analizaron los hábitos alimenticios y aspectos biológicos del salmonete manchado (*Pseudupeneus maculatus*) frente a la costa brasileña. Para describir los patrones de distribución se analizó la estructura de tallas y las tasas de captura. El nivel trófico y la dieta alimenticia se determinaron mediante análisis isotópicos de carbono ($\delta^{13}C$) y nitrógeno ($\delta^{15}N$), además del contenido estomacal. La composición de la dieta fue determinada con análisis multivariados e indicadores numéricos, como la frecuencia numérica, frecuencia de ocurrencia y el porcentaje del peso. Los resultados indicaron que la talla de primera madurez se encuentra en 13.7 cm. Se observó que la talla media incrementó en relación con el fondo. Por otro lado, la dieta estuvo compuesta por crustáceos, teleósteos y poliquetos, asimismo no se evidenciaron diferencias significativas por tipo de hábitats, profundidad y grado de latitud. Los niveles tróficos estimados oscilaron entre 3 y 4, determinándose que *P. maculatus* se alimentó de diversas presas, probablemente debido a su eficiente estrategia de búsqueda, clasificándose como depredador zoobentívoro generalista.

**Palabras clave:** patrones de distribución; análisis de contenido estomacal; Brasil; plataforma continental; isótopos estables.

**Citation/Como citar este artículo:** Soares A., Lira A.S., Gonzalez J.G., Eduardo L.N., Lucena-Frédou F., Le Loc'h F., Ferreira B.P., Frédou T. 2020. Feeding habits and population aspects of the spotted goatfish, *Pseudupeneus maculatus* (Perciformes: Mullidae), on the continental shelf of northeast Brazil. Sci. Mar. 84(2): 000-000. https://doi.org/10.3989/scimar.04958.24A

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DOCUMENTO 5 – Artigo Científico

Soares et al. (2025). Fisheries Management and Ecology

Atuação do candidato:

- Execução da avaliação de estoques
- Implementação de modelo integrado
- Análise estatística de séries temporais
- Estimativa de parâmetros populacionais

*Fisheries Management and Ecology*

WILEY

Fisheries Management and Ecology

ARTICLE OPEN ACCESS

# 20 Years Later: Updated Stock Assessment of Snappers in Northeast Brazil Using an Integrated Stock Assessment Framework

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**Correspondence:** Andrey Soares (andrey.soares@ufrpe.br)

**Received:** 2 November 2024 | **Revised:** 12 July 2025 | **Accepted:** 28 July 2025

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**Keywords:** data-limited stock assessment | fish management | groundfish | Lutjanidae | marine ecoregions | stock synthesis

## ABSTRACT

We updated the stock status of *Lutjanus analis*, *Lutjanus jocu*, *Lutjanus synagris*, and *Ocyurus chrysurus* harvested along the Brazilian northeastern coast. Stock boundaries were defined according to the Marine Ecoregion classifications at a finer scale, to reflect the population structure of each species. Data were exclusively from the handline fishing fleet, with removals obtained from fisheries national statistics and published commercial fishery records. Length compositions were from commercial and scientific surveys. Abundance indices were estimated from data from three projects and Brazilian official fishery statistics reports. Growth parameters were from the literature, and natural mortality was estimated using the Natural Mortality Tool. Data were analyzed using the Stock Assessment Continuum Tool. Three of the four species were currently overexploited, with populations having declined by >70% from 1950 to 2021. In contrast, *O. chrysurus* yield did not exceed sustainable thresholds, although stocks were declining. Without appropriate management measures, *O. chrysurus* could also become overexploited. Our results emphasize the need to integrate these species into Brazil's fishery management plans to prevent further stock depletion and ensure long-term sustainability.

## 1 | Introduction

Snapper (family Lutjanidae) are tropical and subtropical marine species found in many parts of the world with high socioeconomic commercial and recreational value (Grimes 1987; Duarte and García 1999; Freitas et al. 2011). Historically, snappers were widely exploited for income by many small-scale fishing communities in Brazil, for landings and high market value (Resende et al. 2003). As key predators, snappers are often grouped with similar species like groupers (snapper-grouper complex) due to their life-history traits, trophic ecology, habitat use, and fishery dynamics (Coleman et al. 2000; Heyman 2014). Species within the snapper-grouper complex typically share life-history traits like relatively slow growth, late maturity, and spawning aggregations that contribute to their vulnerability to overexploitation (Chuenpagdee and Pauly 2005; Schärer-Umpierre et al. 2014; França et al. 2021). In Brazil, especially in the Northeast Region, 12 snapper

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DOCUMENTO 6 – Artigo Científico

Craveiro et al. (2022). Acta Zoologica

- Participação ativa em campanhas de campo com pescadores artesanais, incluindo a realização de arrastos experimentais de praia para captura de organismos.
- Coleta, triagem e processamento inicial de amostras biológicas em campo e em laboratório, com foco em tecidos e órgãos reprodutivos.
- Obtenção e organização de dados biométricos e reprodutivos utilizados na descrição da maturação gonadal e parâmetros populacionais.

Received: 14 December 2021 | Revised: 6 April 2022 | Accepted: 28 June 2022

DOI: 10.1111/azo.12433

ORIGINAL ARTICLE

WILEY

# Ovarian maturation of *Penaeus subtilis* (Decapoda: Penaeidae): A new insight to describe oocyte development and somatic structures

Cecília Craveiro[1] | Roberta Soares[1] | Hildemário Castro-Neto[1] | Emanuell F. Silva[2] | Andrey Soares[1] | Paulo G. V. de Oliveira[1] | Evelyn Gonzalez[2] | Silvio Peixoto[1]

[1]Departamento de Pesca e Aquicultura, Universidade Federal Rural de Pernambuco, Recife, Brazil

[2]Instituto Federal de Educação, Ciência e Tecnologia da Paraíba, Campus Cabedelo, Cabedelo, Brazil

**Correspondence**
Cecília Craveiro, Departamento de Pesca e Aquicultura, Universidade Federal Rural de Pernambuco, Rua Dom Manoel de Medeiros s/n – Dois Irmãos, 52171-900 – Recife-PE, Brazil.
Email: ceciliacraveiro@yahoo.com.br

**Funding information**
Conselho Nacional de Desenvolvimento Científico e Tecnológico, Grant/Award Number: 407552/2016-2 and 468391/2014-2

**Abstract**

We observed the presence of follicular cells (FC) in the ovaries of *Penaeus subtilis* ($n = 1198$), which led us to classify the development of germ cells into six phases: oogonia, previtellogenic oocytes, primary and secondary vitellogenic oocytes, mature oocytes and atretic oocytes. The FC changes their shape according to the development of germ cells and showed a different distribution along the ovary, which allowed differentiating vitellogenic oocytes into primary and secondary. We also observed that the postovulatory follicles (POF) are composed of follicular cells. The presence of POF in penaeids ovaries is rarely reported, but allows the differentiation between spent and resting stages, commonly grouped in reproductive biology research. Furthermore, observation of ovarian lining was useful to differentiate immature females from females that had spawned at least once. Thus, ovarian development was classified into six stages: immature, early developing, advanced developing, ripe, spent and resting. The distribution and shape variations of FC, ovarian lining features and presence of POF were considered crucial for the classification of ovarian maturation stages. The methods developed here may improve estimates of their reproductive cycle, size at first maturity and spawning season, which are important variables in future studies of the reproductive dynamics.

**KEYWORDS**

follicular cells, histology, maturation, ovary development, vitellogenesis

DOCUMENTO 7 – Artigo Científico

Santos, et al. (20211);. Regional Studies in Marine Science

- Atuação direta em atividades de campo com pescadores artesanais, incluindo pesca experimental por arrasto de praia para obtenção de amostras biológicas.
- Processamento biológico das amostras coletadas, com análise de gônadas, determinação de estágios de maturação e parâmetros reprodutivos.
- Organização e sistematização dos dados de campo e laboratório para análises populacionais e elaboração do artigo científico.

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# Reproductive biology of the shorthead drum *Larimus breviceps* (Acanthuriformes: Sciaenidae) in northeastern Brazil

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ABSTRACT

The shorthead drum *Larimus breviceps* is one of the main bycatch species of the shrimp fisheries in Brazil. However, studies addressing the biology and fisheries impacts on this species are still scarce. Here we describe the main aspects of the reproductive biology and the female gonadal development of *L. breviceps* on Paraíba, northeast Brazil. The reproductive tract was described by macroscopic and microscopic analysis. The ovaries were composed by oogonia, pre-vitellogenic, vitellogenic, mature, and atretic oocytes. A total of 970 individuals (549 females and 421 males) were caught between December 2016 and November 2017 through beach seining. The total length (TL) varied from 4.2 to 23.0 cm. Females dominated over males (1 female: 0.77 male). The length–weight relationship did not differ between the sexes, presenting a positive allometric growth. The following stages were thus defined for females: immature, initial development, advanced development, mature, and regressing. The period of highest reproductive activity occurs between November and March and immature individuals occur throughout the year. Mean length at first maturity ($L_{50}$) was estimated as 11.1 cm TL. The information provided here contributes to the overall knowledge of this species and may be helpful for further development of management practices that ensure the sustainability of marine species exploitation.
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## 1. Introduction

Fisheries in tropical coastal ecosystems are commonly known for the great discard of species caught as bycatch, especially in shrimp trawling (Pauly, 2005). Among gears used for shrimp harvesting, the motorized bottom trawling is most common and destructive in Brazil and elsewhere (Pina and Chaves, 2009). This activity causes high incidental mortality and increases the extinction risk of several species (Thomas et al., 2017) by declining populations, catching juveniles, and leading to many alterations in the ecosystem (e.g., great physical disturbance; Diamond et al., 2000; Arendse et al., 2007; Thomas et al., 2017).

In the Northeastern Brazil, shrimp fisheries are predominantly artisanal, carried out mainly by motorized artisanal trawling boats (Dias-Neto, 2011). In the state of Paraíba, northeastern Brazil, the ordinance IBAMA nº 833/1990 prohibited this activity in the coastal areas (3 nautical miles; Moura et al., 2003). Currently, fisheries are carried out exclusively through beach seining targeting mainly the white (*Penaeus schmitti*), pink (*Penaeus subtilis*), and seabob (*Xiphopenaeus kroyeri*) shrimps (Santos, 2010). Despite being limited to areas nearshore, the beach seine can harvest greater diversity of bycatch species than the motorized bottom trawling (Passarone, 2020). Moreover, this activity may cause several impacts (e.g., incidental mortality of juveniles and endangered species) that, given the current state of knowledge, may go mostly unnoticed by scientists, marine resource managers, and conservation biologists.

The shorthead drum, *Larimus breviceps* Cuvier, 1830, distributed in the Central and Southwest Atlantic (from Costa Rica to Santa Catarina in Brazil) (Vianna and Almeida, 2005; Cattani et al., 2011), may reach up to 10% of the bycatch caught by beach seine (Nunes and Rosa, 1998; Passarone, 2020). This species has

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DOCUMENTO 8 – Artigo Científico

Melo et al. (2020) Regional Studies in Marine Science

- Processamento biológico das amostras, com biometria, identificação taxonômica e estimativa do tamanho de primeira maturação.
- Organização e análise dos dados populacionais para avaliação de padrões de distribuição espacial e estrutura dos estoques.

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# Haemulidae distribution patterns along the Northeastern Brazilian continental shelf and size at first maturity of the most abundant species

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## 1. Introduction

The Haemulidae are one of the most abundant fish families along the Brazilian coast (Rangel et al., 2007; Souza et al., 2007). They inhabit various habitats, but mostly use reef environments because of the resources they provide (Souter and Linden, 2000). They play important ecological roles in the reefs by regulating invertebrate abundance and transferring nutrients across habitats (Holmlund and Hammer, 1999; Appeldoorn et al., 2009; Araújo et al., 2018). Species of this family are also considered good quality food fishes and are widely consumed across the globe by coastal residents, especially in tropical regions (Munro, 1996; Lindeman and Toxey, 2002). In addition, this family is important to the underwater tourism industry because members of this family are often the most abundant on artificial reefs and shipwrecks (Uyarra et al., 2009; Honório et al., 2010).

According to the latest Brazilian official statistics, 14000 metric tons of grunts were landed in the Northeast region between 1997 and 2007, which generated a profit equivalent to $9.3 million (IBAMA/CEPENE, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2007a,b, 2008). The average production per year of haemulids during this period doubled from 711 t in 1997 to 1550 t in 2007. Grunts are usually captured by pole and line, traps, and gill nets. They are also a common bycatch of the shrimp trawling fisheries (Lindeman and Toxey, 2002; Eduardo et al., 2018b; Silva-Júnior et al., 2019). In Northeast Brazil, *Haemulon plumierii*, *H. aurolineatum*, and *H. squamipinna* used to be Bycatch of the lobster and goatfish fisheries (Lessa et al., 2009). Currently, haemulids and lutjanids are commonly caught by artisanal fisheries as the target species, owing to the decrease in abundance of lobster and goatfish (Lessa et al., 2009; Marques and Ferreira, 2010).

Despite their ecological and economic importance, many biological aspects of this family are still unknown or knowledge is restricted in terms of spatial coverage. Available studies do not integrate information about population structure, distribution, abundance, and the habitats occupied by these species. Previous studies in Northeast Brazil have mainly investigated specific aspects of population dynamics, such as the length–weight relationship (Eduardo et al., 2019), reproduction (Silva et al., 2012; Shinozaki-Mendes et al., 2013a,b; Eduardo et al., 2018b), feeding (De Almeida et al., 2005; Pereira et al., 2015), age and growth (Vasconcelos-Filho et al., 2018; Eduardo et al., 2018b). According to the regional and global International Union for Conservation of Nature (IUCN) assessments (Icmbio, 2018), haemulids are not under imminent threat and are classified in the Least Concern category, except *H. plumierii*, whose threats are recognized, however, because there is not enough available information for an evaluation, the species is categorized as Data Deficient.

The present study investigated the diversity and length at first maturity ($L_{50}$) of the main haemulid species in Northeast Brazil. Considering that reefs are highly complex environments that provide areas for reproduction, feeding, and shelter for many different species (Lindeman and Toxey, 2002; Almary, 2004), this study also evaluated haemulid distribution, abundance, and

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DOCUMENTO 9 – Artigo Científico

Limeira et al. (2022). Neotropical Ichthyology.

- Processamento de amostras biológicas em laboratório, com abertura de estômagos e análise de conteúdo estomacal.
- Identificação taxonômica das presas e classificação trófica dos organismos analisados.
- Organização e curadoria do banco de dados trófico para análises ecológicas e interpretação dos padrões de partilha de recursos.

Neotropical Ichthyology

Original article

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# Trophic ecology and resource partitioning of Haemulidae species along the Northeastern Brazilian continental shelf

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In the Southeastern Tropical Atlantic, Haemulidae family play an important role both environmentally, acting as a link between lower and higher trophic levels, and socioeconomically, being widely caught by artisanal fleets. This study aimed to describe the trophic ecology of three grunt species (*Haemulon aurolineatum*, *H. plumierii* and *H. squamipinna*) considering spatial, temporal and ontogenetic aspects, integrating stomach content and stable isotopes analysis. Sampling occurred in 26 stations along the Northeast of Brazil (04° – 09° S), in August 2015 and April 2017, using bottom trawling net. There was greater feeding intensity at night, at latitudes below 08° S and in the inner continental shelf. Higher values of $\delta^{15}N$ were reported for *H. aurolineatum* and *H. plumierii* collected near coastline. The isotopic niche breadth indicated that *H. aurolineatum* has a narrower diet than *H. plumierii*. For the three species, the trophic level ranged between three and four. Considering stomach content and isotopic niche, diet was similar comparing species. This trophic ecology pattern reveals a likewise use of the habitat, which may be essential for identifying priority areas for conservation on an ecosystem basis, especially in rich reef zones that are subject to several increasing pressures, such as those in Northeast Brazil.

Keywords: Feeding, Grunts, Stable isotopes, Stomach contents, Trophic ecology.

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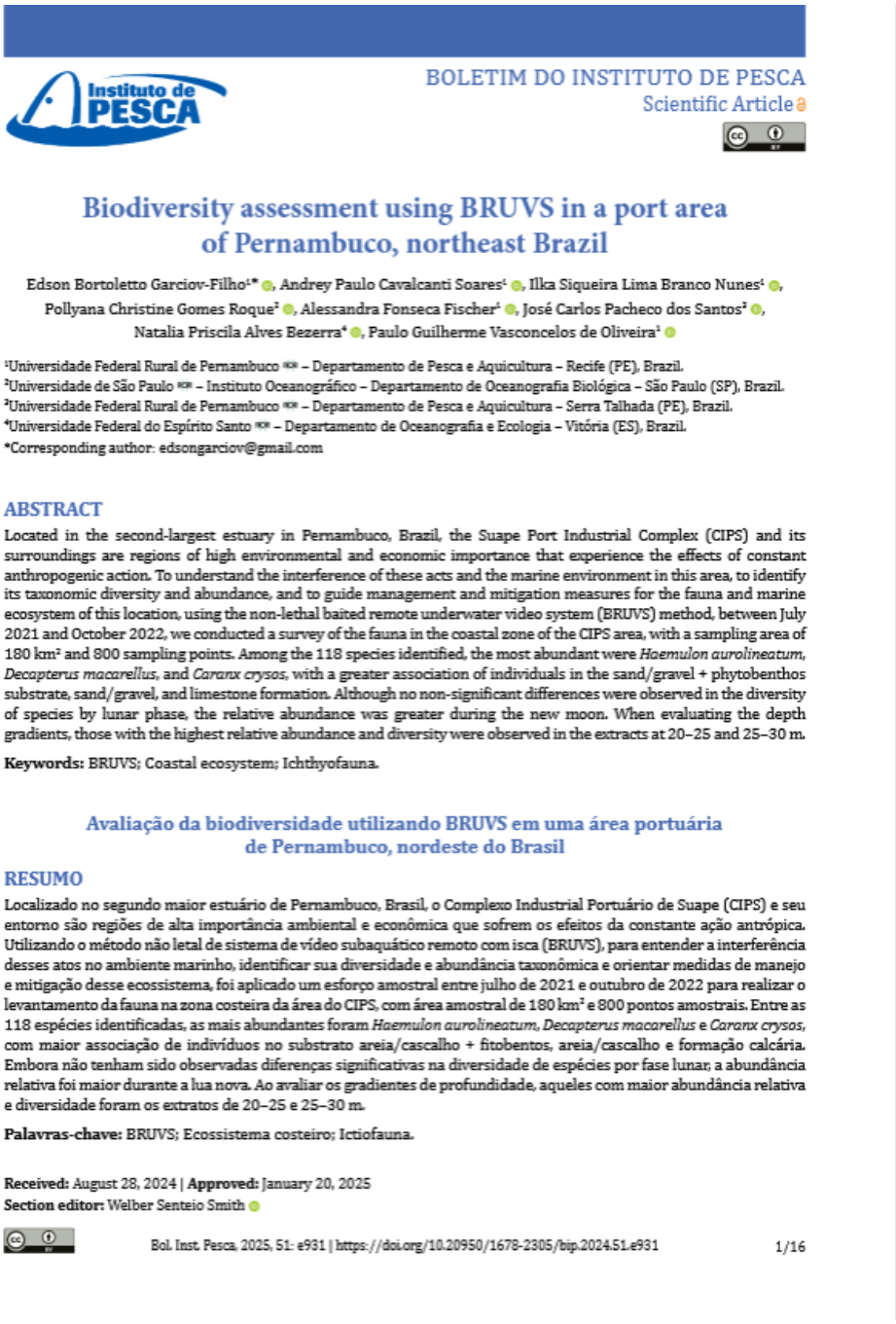
Documento 10 – Artigo científico

Garciov-Filho et al. (2025). Boletim do Instituto de Pesca.

- Curadoria, organização e padronização do banco de dados de BRUVS, incluindo informações biológicas e variáveis ambientais associadas a 800 pontos amostrais.
- Execução das análises estatísticas multivariadas em R, utilizando nMDS, ANOSIM e SIMPER para avaliar a influência de fatores ambientais (substrato, profundidade, visibilidade, fase lunar etc.) sobre a estrutura da ictiofauna.
- Interpretação ecológica dos padrões espaciais e ambientais de abundância e diversidade de espécies, subsidiando diagnósticos de impacto antrópico e propostas de manejo em área portuária.



BOLETIM DO INSTITUTO DE PESCA
Scientific Article

# Biodiversity assessment using BRUVS in a port area of Pernambuco, northeast Brazil

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## ABSTRACT

Located in the second-largest estuary in Pernambuco, Brazil, the Suape Port Industrial Complex (CIPS) and its surroundings are regions of high environmental and economic importance that experience the effects of constant anthropogenic action. To understand the interference of these acts and the marine environment in this area, to identify its taxonomic diversity and abundance, and to guide management and mitigation measures for the fauna and marine ecosystem of this location, using the non-lethal baited remote underwater video system (BRUVS) method, between July 2021 and October 2022, we conducted a survey of the fauna in the coastal zone of the CIPS area, with a sampling area of 180 km² and 800 sampling points. Among the 118 species identified, the most abundant were *Haemulon aurolineatum*, *Decapterus macarellus*, and *Caranx crysos*, with a greater association of individuals in the sand/gravel + phytobenthos substrate, sand/gravel, and limestone formation. Although no non-significant differences were observed in the diversity of species by lunar phase, the relative abundance was greater during the new moon. When evaluating the depth gradients, those with the highest relative abundance and diversity were observed in the extracts at 20–25 and 25–30 m.

**Keywords:** BRUVS; Coastal ecosystem; Ichthyofauna.

## Avaliação da biodiversidade utilizando BRUVS em uma área portuária de Pernambuco, nordeste do Brasil

## RESUMO

Localizado no segundo maior estuário de Pernambuco, Brasil, o Complexo Industrial Portuário de Suape (CIPS) e seu entorno são regiões de alta importância ambiental e econômica que sofrem os efeitos da constante ação antrópica. Utilizando o método não letal de sistema de vídeo subaquático remoto com isca (BRUVS), para entender a interferência desses atos no ambiente marinho, identificar sua diversidade e abundância taxonômica e orientar medidas de manejo e mitigação desse ecossistema, foi aplicado um esforço amostral entre julho de 2021 e outubro de 2022 para realizar o levantamento da fauna na zona costeira da área do CIPS, com área amostral de 180 km² e 800 pontos amostrais. Entre as 118 espécies identificadas, as mais abundantes foram *Haemulon aurolineatum*, *Decapterus macarellus* e *Caranx crysos*, com maior associação de indivíduos no substrato areia/cascalho + fitobentos, areia/cascalho e formação calcária. Embora não tenham sido observadas diferenças significativas na diversidade de espécies por fase lunar, a abundância relativa foi maior durante a lua nova. Ao avaliar os gradientes de profundidade, aqueles com maior abundância relativa e diversidade foram os extratos de 20–25 e 25–30 m.

**Palavras-chave:** BRUVS; Ecossistema costeiro; Ictiofauna.

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