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COMMUNICATION

FEEDING HABITS AND BEHAVIOUR OF *BAGRE BAGRE* AND *GENIDENS BARBUS*, TWO ARIID CATFISHES (PISCES: SILURIFORMES) FROM SOUTHEASTERN BRAZIL

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Feeding habits and behaviour of *Bagre bagre* and *Genidens barbus*, two ariid catfishes (Pisces: Siluriformes) from southeastern Brazil

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Abstract: The feeding habits and behaviour of adult specimens of *Bagre bagre* (Linnaeus, 1766) and *Genidens barbus* (Lacepède, 1803), both targets of commercial fisheries in coastal southeastern Brazil, were evaluated through stomach content analysis. These catfish are generalistic benthophagous feeders and daytime consumers, and the analysis points to fish and crustaceans as their primary prey. The fish *Trichiurus lepturus* and the shrimp *Xiphopenaeus kroyeri* were the main prey species, indicating that both catfish species prey upon the most abundant resources available in the study area.

Keywords: Ariidae, coastal fisheries, stomach contents, tropical waters.

Portuguese Abstract: Os hábitos alimentares e o comportamento alimentar dos espécimes adultos de *Bagre bagre* (Linnaeus, 1766) e *Genidens barbus* (Lacepède, 1803) alvos de pescarias comerciais em uma área costeira do sudeste do Brasil (~21ºS) foram avaliados através da análise do conteúdo estomacal. Os bagres são generalistas bentófagos e consumidores diurnos, com peixes sendo as presas mais frequentes, seguidos de crustáceos. O peixe *Trichiurus lepturus* e o camarão *Xiphopenaeus kroyeri* se destacaram como espécies de presas. Ambos os bagres utilizam os recursos mais disponíveis ao longo da área de estudo.

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Author Contribution: MTMT analysed the stomach contents of the catfishes and identified their prey items. APMDB organized the data from the stomach contents to elaborate this article.

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INTRODUCTION

Catfish are Siluriformes with a wide distribution throughout tropical, subtropical and temperate waters in lagoons, rivers, estuaries and marine coastal areas (Diogo 2004). The family Ariidae inhabits marine waters and is abundant in coastal areas associated with muddy or sandy bottoms (Marceniuk 2005; Silva et al. 2016), seeking out rivers and coastal lagoons during the spawning period (Ferraris 2007).

Marine catfish are generalist benthophagous feeders, consuming vertebrates and invertebrates such as fish, crustaceans, molluscs and polychaetes (Mishima & Tanji 1982; Froese & Pauly 2017). The mouth width and tooth-plate arrangements of Ariidae species are suitable for dealing with broad classes of prey, allowing them dietary flexibility (Blaber et al. 1994).

The family Ariidae is an important fish group in commercial fisheries worldwide (Marceniuk 2005; Froese & Pauly 2017). *Bagre bagre* and *Genidens barbus* occur along the southwest Atlantic coast, being sympatric from northern to southern Brazil, where they provide resources to artisanal coastal fisheries (Froese & Pauly 2017). *Genidens barbus* is of conservation concern in Brazilian waters, since it is considered to be an endangered species of economic interest (MMA 2014).

In the present study, we analyse the feeding habits and behaviour of *B. bagre* and *G. barbus* from a coastal area in Rio de Janeiro State, southeastern Brazil, to evaluate how adult specimens use available resources. Both species are important targets of artisanal commercial fisheries in this region (FIPERJ 2015), but information about their biology, including their feeding habits, is locally non-existent.

MATERIALS AND METHODS

The sampling site is a marine coastal area in Rio de Janeiro State, southeastern Brazil (Fig. 1). *B. bagre* and *G. barbus* (Image 1) are targets of commercial gillnet fishing occurring between -21.6268 S, -41.0208 W and -21.9833 S, -40.9833 W from less than one to 10 nautical miles from shore and at depths varying from 10–30 m. The specimens captured by these fisheries are adults based on their total length: the asymptotic or maximum length recorded for *B. bagre* is 55.0cm (Marceniuk et al. 2015), while for *G. barbus*, it is 120cm, with first maturity reached at approximately 40.0cm (Froese & Pauly 2017).

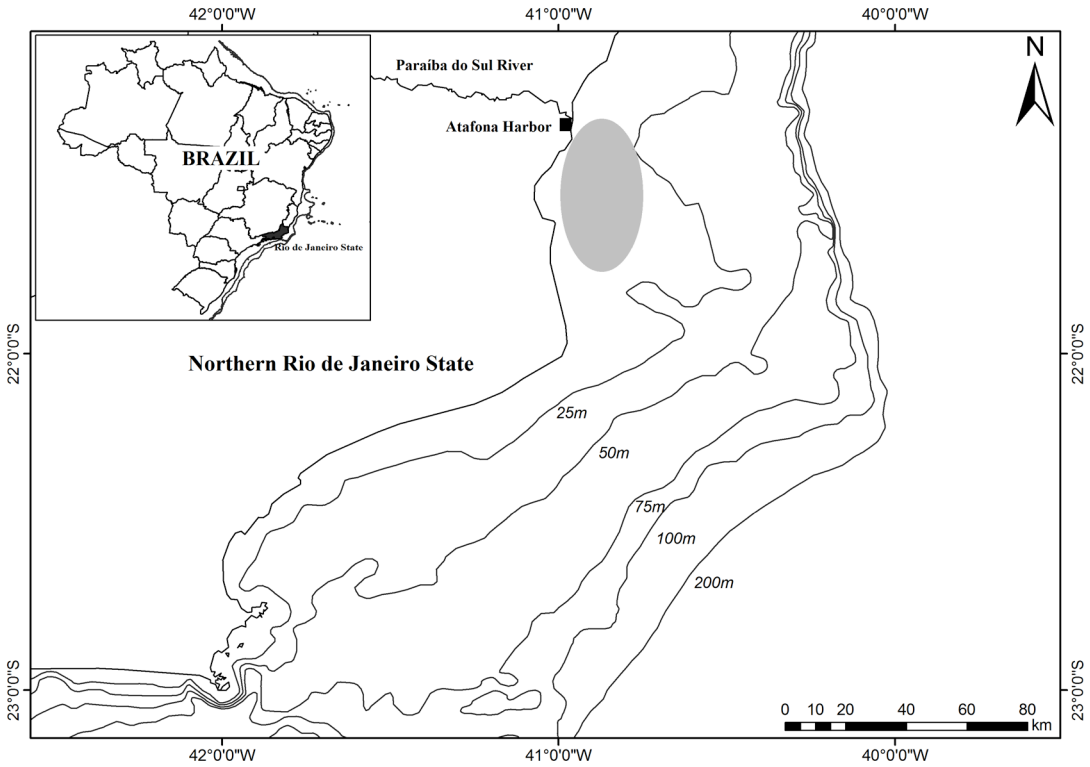

Figure 1. Northern Rio de Janeiro State, southeastern Brazil, where *Bagre bagre* and *Genidens barbus* specimens were collected (grey ellipse).

Image 1. *Genidens barbus*

In 2016 (January and August), 29 specimens of *B. bagre* (49.8±4.7 cm mean total length; 1,003.4±255.6 g mean total weight) and 33 of *G. barbus* (51.9±4.1 cm mean total length; 1,393.9±273.1 g mean total weight) were obtained for stomach content analysis. The sampling included only adult specimens captured by commercial fisheries in the same location during the same time period, providing fish specimens in the same ontogenetic phase and sharing the same local habitat.

The stomach of each specimen was removed from the abdominal cavity, and the contents were washed in running water using a 500-µm mesh-size sieve and preserved in 70% ethanol. The items recovered from the stomach contents were analysed using a stereomicroscope. Partially digested fish, fish bones (e.g., spines, vertebrae, heads/skulls), scales and crystalline lenses, partially digested crustaceans and crustacean carapaces were recorded and identified whenever possible. The supraoccipital bone of *Trichiurus lepturus* and otoliths of *Porichthys porosissimus, Conodon nobilis* and *Paralonchurus brasiliensis* were removed from the fish skulls to back-calculate the original size of the ingested prey using the regression equations proposed by Di Beneditto et al. (2001).

The representation of the consumed food items was calculated using the percentage of frequency of occurrence (FO%): the number of stomachs with a given food item divided by the total number of stomachs with food items. The biomasses of prey were not calculated, since most recovered food items were fish or crustacean remains without any taxonomic features. Bias in the interpretation of feeding habits is expected when only one variable is examined, such as FO%, because the presence or absence of a given food item in the stomach contents does not consider the amount of food taken in (Wetherbee & Corte´s 2004). This measure, however, represents population-wide food habits, allowing a general assessment of food ingestion (Cortés 1997).

RESULTS AND DISCUSSION

Twenty-two *B. bagre* (75.8%) and 27 *G. barbus* (87.8%) specimens had food remains inside their stomachs. Teleost fish remains (partially digested fish, spines, vertebrae, scales and crystalline lenses) occurred in 18 stomachs of *B. bagre*, and prey taxonomic identification was possible for 10 stomachs. Crustacean remains (partially digested shrimps and shrimp and crab carapaces) occurred in eight stomachs, but prey identification was conducted for only two. For *G. barbus*, teleost fish remains occurred in 22 stomachs, and prey identification was possible for only three. Crustacean remains occurred in nine stomachs, with prey identification conducted for seven stomachs. Fishes were the more frequent prey species (82% in *B. bagre* and 81% in *G. barbus*), followed by crustaceans (36% in *B. bagre* and 33% in *G. barbus*). Table 1 shows the food items recovered from the stomach contents and their FO%.

The analysis of the stomach contents of both catfishes corroborated previous studies describing them as generalist benthophagous feeders (Mishima & Tanji 1982). All food items are bottom-associated resources and common year-round along the coast of northern Rio de Janeiro State (Di Beneditto et al. 2001; Gomes et al. 2003; Fernandes et al. 2011). The fish *Trichiurus lepturus* is the target of gillnet fishing in the study area (FIPERJ 2015), as well as the shrimp *Xiphopenaeus kroyeri*, which is the species most captured by local shrimp fisheries (Fernandes et al. 2011; 2014). The fishes *P. porosissimus*, *C. nobilis*, *Gymnothorax ocellatus* and *P. brasiliensis* are by-catch in local shrimp fisheries (Di Beneditto et al. 2001; Di Beneditto & Lima 2003). Moreover, *T. lepturus* and *P. porosissimus* are also important prey species for a coastal dolphin that inhabits the study area (Di Beneditto & Ramos 2004; Di Beneditto et al. 2017). Thus, the local availability of these prey species to consumers is high.

The feeding guilds of marine catfishes are related to their dentition. Piscivorous groups have large mouths with relatively large multiple palatine tooth plates armed with sharp, recurved teeth (Blaber et al. 1994). This description matches the oral apparatuses of *B. bagre* and *G. barbus*. Indeed, fish were the most frequent item in the stomach contents of both catfishes, although the importance of crustaceans as prey is not negligible in the study area.

The stomach content analysis also allowed inferences to be made regarding the consumer feeding behaviour, revealing an unusual pattern of predation in *B. bagre*. Some of the ingested prey had an estimated length that

Table 1. Food items recovered from the stomach contents of the catfishes *Bagre bagre* (n=22) and *Genidens barbus* (n=27) in northern Rio de Janeiro State, southeastern Brazil.

Food item	% of frequency of occurrence in *B. bagre*	% of frequency of occurrence in *G. barbus*	Remarks
Fish partially digested without taxonomic identification, spines, vertebrae, scales and crystalline lenses	40	70	One to seven fish partially digested (<12cm of total length) per stomach, mainly backbone with muscle tissue.
Porichthys porosissimus (Cuvier, 1829)		7	One partially digested fish (20.5cm of total length); one partially digested head (12.4cm of total length estimated by otolith).
Conodon nobilis (Linnaeus, 1758)		4	One partially digested head (13.8cm of total length estimated by otolith).
Gymnothorax ocellatus (Agassiz, 1831)	9		One partially digested fish (47cm of total length); one partially digested head (16 cm of head length).
Trichiurus lepturus (Linnaeus, 1758)	27		Two partially digested heads (70.1cm and 73.9cm of total length estimated by supraoccipital bone); three supraoccipital bones (53.7, 77.6 and 88.3 cm of total length estimated); vertebral bones.
Paralonchurus brasiliensis (Steindachner, 1875)	9		One partially digested head (18.3cm of total length estimated by otolith).
Shrimp carapace without taxonomic identification	27	4	One carapace per stomach.
Xiphopenaeus kroyeri (Heller, 1862)	9	22	One to eight partially digested shrimps per stomach (<4.0cm of total length).
Farfantepenaeus sp.		4	One partially digested shrimp (7.2cm of total lenght).
Crab carapace without taxonomic identification		4	One carapace per stomach.

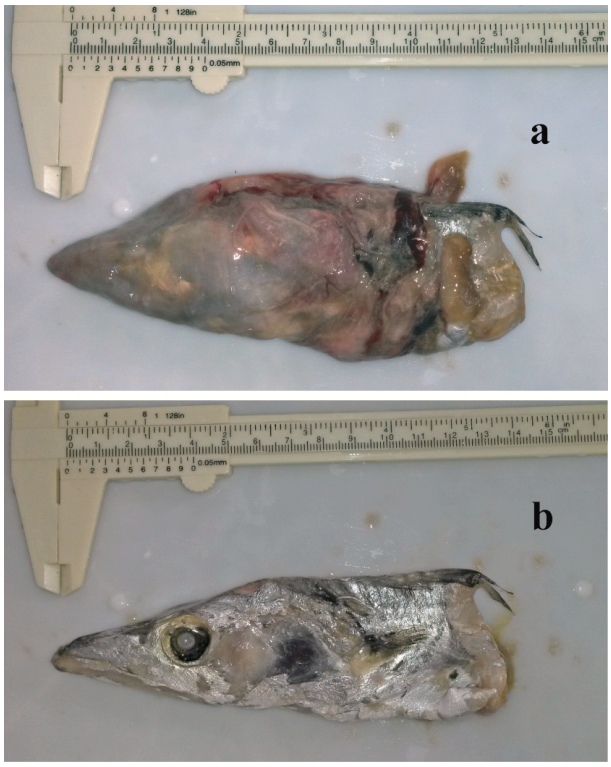

Image 3. Head of *Trichiurus lepturus* recovered from the stomach content of a *Bagre bagre* specimen in northern Rio de Janeiro State, southeastern Brazil (consumer total length: 45cm; prey estimated total length: 70.1cm): (a) head inside the stomach and (b) head recovered from the stomach. © APM Di Beneditto.

was close to that of the consumer, as in *G. ocellatus*, or even longer, as in *T. lepturus* (1.5 times longer) (Table 1). Meanwhile, for *T. lepturus*, only partially digested fish heads or supraoccipital bones were recovered from most of the stomach contents (Image 3). These records represent an unusual feeding behaviour, in which only the head of larger prey is ingested during predation; the position of these fish heads in the stomach, as illustrated in Image 1, suggests this kind of feeding behaviour.

Larger prey species, such as *T. lepturus* and *G. ocellatus*, are voracious consumers (Froese & Pauly 2017). Both species have a higher activity pattern during the night. During the day, *T. lepturus* remains close to the sea bottom, resting (Martins & Haimovici 1997; Froese & Pauly 2017), while *G. ocellatus* remains buried in the sand or muddy bottom with only the head above the sea bottom (Santos & Castro 2003). Prey behaviour likely influences catfish catch strategies during the day, reducing the chances of agonistic behaviour among prey during predation. Additionally, the shrimps recorded as catfish prey also remain buried in the sea bottom during the day, moving vertically in the water column in the night period (Simões et al. 2010). Thus, *B. bagre* and *G. barbus* are mainly daytime consumers.

The present study provides the first information about the feeding preferences of adult *B. bagre* and *G. barbus* in southeastern Brazil, where they are important targets in local artisanal fisheries. The results point to fish and crustaceans as the main prey species. Previous

studies have mainly focused on the feeding habits of juveniles, showing ontogenetic changes from a crustacean-based diet to a fish-based diet (Mendoza-Carranza & Vieira 2009; Denadai et al. 2012) or even highlighting the presence of both prey groups (Pinheiro-Souza et al. 2015).

Although the sample size of both catfishes was too low to describe their local feeding habits accurately, it is evident from the data that they prey upon the most available resources. Since the conservation status of *G. barbus* in Brazil deserves attention (Endangered), data regarding its ecology, including its feeding demands and feeding strategies, are relevant to future management practices.

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