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# Dietary shift of a pimelodid catfish in response to the flood pulse in the Xingu River

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We assessed the effect of a flood pulse on the diet composition, trophic niche breadth, and feeding intensity of the mandi catfish *Pimelodus blochii* (Pimelodidae) in the middle Xingu River region, throughout different hydrological periods. Specimens were collected monthly between December 2020 and November 2021, using gillnets. Specimens were measured for standard length (cm) and body weight (g) and then eviscerated to remove the stomach, which was weighed and stored for content identification. In total, we analyzed 93 stomachs of *P. blochii*, with the species' diet predominantly composed of fish (86.5%) and terrestrial plants (6.9%). However, this dietary composition varied seasonally, particularly during the flood period when the species exhibited an omnivorous/carnivorous diet, as opposed to other periods when it had a carnivorous/piscivorous diet. Trophic niche breadth also varied, with the species showing a more specialist diet during the filling period. Finally, there was no difference in the amount of food (g) ingested during the hydrological periods. These results highlight the influence of the flood pulse on the feeding ecology of *P. blochii*, particularly regarding the diet composition. Our findings contribute to advancing the understanding of the relationship between abiotic dynamics and the life history of Amazonian fish species.

Keywords: Amazon, Feeding ecology, Floodplain, Hydrological periods, Siluriformes.

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Avaliamos o efeito do pulso de inundação na composição da dieta, amplitude de nicho trófico e intensidade alimentar do bagre mandi *Pimelodus blochii* (Pimelodidae) na região do médio rio Xingu, ao longo de diferentes períodos hidrológicos. A coleta dos espécimes ocorreu mensalmente entre dezembro de 2020 e novembro de 2021, utilizando redes de espera. Os espécimes coletados foram mensurados quanto ao comprimento padrão (cm) e peso total (g) e, em seguida, eviscerados para remoção do estômago, que foi pesado e armazenado para identificação do conteúdo. No total, foram analisados 93 estômagos de *P. blochii*, sendo a dieta da espécie composta predominantemente por peixes (86,5%) e plantas terrestres (6,9%). No entanto, essa composição da dieta variou sazonalmente, especialmente durante a cheia, quando a espécie apresentou uma dieta onívora/carnívora, em contraste com outros períodos em que teve uma dieta carnívora/piscívora. A amplitude do nicho trófico também variou, e a espécie apresentou uma dieta mais especialista durante a enchente. Por fim, não houve diferença na quantidade de alimento ingerido (g) entre os períodos hidrológicos. Esses resultados evidenciam que o pulso de inundação exerce influência na ecologia alimentar de *P. blochii*, principalmente em relação à composição da dieta. Nossos achados contribuem para o avanço do conhecimento sobre a relação entre dinâmicas abióticas e a história de vida de espécies de peixes amazônicas.

Palavras-chave: Amazônia, Ecologia alimentar, Períodos hidrológicos, Planície aluvial, Siluriformes.

## INTRODUCTION

Plains environments worldwide experience natural seasonal changes in their landscapes due to variations in river water levels, known as the flood pulse (Junk *et al*., 1989; van der Sleen, Rams, 2023). This phenomenon is characterized by the rise in river water levels during rainy periods, leading to the overflow and inundation of extensive marginal areas, followed by the retreat of these aquatic environments during the dry season (Junk *et al*., 1989; Junk, Wantzen, 2004). This hydrological dynamic is considered one of the primary shaping forces of the local biota and plays a crucial role in maintaining the diversity and productivity of aquatic ecosystems (Humphries *et al*., 2014; Forsberg *et al*., 2017; Chea *et al*., 2020).

For fish, the flood pulse directly influences their migration patterns, distribution, and ecology (Goulding, 1980; Bailly *et al*., 2008, 2018). One of the main ecological aspects affected by this hydrological seasonality is trophic dynamics, where fishes exhibit various strategies in response to these environmental changes (Lowe-McConnell, 1987; Ru *et al*., 2022). For instance, during the flooding of marginal forests in the rainy periods, terrestrial items (allochthonous), such as fruits, seeds, and insects, fall into the water and become available for fish, favoring omnivorous, frugivorous, and insectivorous species (Freitas *et al*., 2022). In contrast, during the dry season, the reduced interaction between aquatic and terrestrial environments forces organisms to mainly consume autochthonous items, such as aquatic insects, crustaceans, fish, and other aquatic organisms, benefiting carnivorous and piscivorous species (Barbosa *et al*., 2018). Such behavioral changes can be interpreted in light of the Optimal Foraging Theory (MacArthur, Pianka, 1966), where organisms tend to feed on items that optimize their energy intake.

Knowledge about fish diet provides insights into how they interact with each other and their habitat (Gerking, 1994; Braga *et al*., 2012), generating essential information for the conservation of taxa and aquatic environments. In the Amazon, studies of fish trophic ecology become even more relevant to understand the dynamics of aquatic ecosystems, as the region boasts one of the largest floodplain areas on the planet (Assis *et al*., 2017) and harbors the most diverse ichthyofauna in the world (Dagosta, de Pinna, 2019). Although the effects of the flood pulse on the diet of Amazonian fish have been well-documented (Prudente *et al*., 2016; Dary *et al*., 2017; Barbosa *et al*., 2018), knowledge of species strategies in response to this phenomenon still has many gaps, given the enormous species richness of the region (Freitas *et al*., 2022).

In this regard, the Xingu River stands as one of the most important tributaries of the Amazon Basin, exhibiting a unique geomorphological complexity, with numerous stretches of rapids, backwaters, and anastomosed channels (Fitzgerald *et al*., 2018; Keppeler *et al*., 2022). The river also harbors a vast diversity of fish, many of which are endemic (Dagosta, de Pinna, 2019). Among these species, the mandi catfish *Pimelodus blochii* Valenciennes, 1840, a reproductive migratory species (Kerguelén-Durango, Atencio-García, 2015), belonging to the family Pimelodidae (Siluriformes), is widely distributed in the Xingu River and other Amazonian drainages, as well as the Orinoco River basin and coastal basins of Guyanas and Suriname (Fricke *et al*., 2023).

The species of the genus *Pimelodus* are generally described as opportunistic carnivores, primarily feeding on aquatic invertebrates (crustaceans, insect larvae), and smaller fish (Lolis, Andrian, 1996; López-Casas, Jiménez-Segura, 2007; Silva *et al*., 2019). However, for some species, including *P. blochii*, an omnivorous habit has been reported due to the consumption of fruits and other plant parts from the terrestrial environment (Cella-Ribeiro *et al*., 2016). Given the large number of species in this genus (currently over 30 valid species), knowledge of the diet of these species remains incipient, and little is known about the effects of environmental variations on their life history. Therefore, studying the trophic ecology of these fish is crucial to gain a better understanding of their position in the food chain and their role in the aquatic ecosystems they inhabit.

Based on the above, the aim of this study was to describe the diet and assess how the local flood pulse influence the feeding ecology of *Pimelodus blochii* in the middle region of the Xingu River. We expect to observe a higher consumption of allochthonous items during the flood periods, as well as a narrower dietary niche and higher feeding intensity. Conversely, during the dry periods, we anticipate a greater contribution of autochthonous items, a broader trophic niche, and lower feeding activity. It is worth noting that the study was conducted in an area directly affected by the Belo Monte Hydroelectric Plant (UHE Belo Monte), and thus, the results presented here provide important ecological information about the region and, until now, are unprecedented for the mentioned species in the Xingu River basin.

## MATERIAL AND METHODS

**Study area.** The research was conducted in the middle region of the Xingu River, specifically in the Reduced Flow Stretch (RFS) of the Belo Monte Hydroelectric Power Plant (UHE Belo Monte), situated in the area known as Volta Grande do Xingu (03°31'04"S 51°47'57"W) (Fig. 1). The Xingu River is characterized by clear waters with a visibility range of one to five meters, and its substrate consists of sand or rock (Fitzgerald *et al*., 2018). The climate in this region is classified as hot and humid tropical type Am, according to the Köppen-Geiger classification (modified by Peel *et al*., 2007). Throughout the research period, spanning from December 2020 to November 2021, the mean flow rates of the Xingu River exhibited fluctuations, ranging from around 8,200 $m^3/s$ in March to 700 $m^3/s$ in October (data sourced from Norte Energia, the concessionaire). Thus, four distinct hydrological periods can be observed in the middle Xingu River: filling (December to February), flood (March to May), ebb (June to August), and dry seasons (September to November) (Barbosa *et al*., 2015, 2018). For this study, we used the hydrological periods as a proxy for the flood pulse, where the filling and flood periods have the highest river levels, while the ebb and dry periods have the lowest levels.

**Sampling and processing of the biological material.** Specimens were collected monthly from December 2020 to November 2021, encompassing all hydrological periods of the region. Fish were captured using gillnets made of nylon monofilament lines, with different mesh sizes (2, 3, 4, 5, 6, 7, 8, 10, 12, 15, and 18 cm between opposite knots) - a set of these nets comprise a single battery. Each field campaign spanned a sampling period of 14 to 16 days, and on each day, three batteries of nets were deployed at different locations along the RFS (Fig. 1). Gillnets were deployed with the assistance of local fishermen, spaced approximately 5 km apart, and exposed for four hours (17h – 21h). The timing and duration of net exposure justify the species most active period and promote better preservation of stomach contents, respectively.

After capture, individuals were measured for standard length ($S_L$, in centimeters, with a precision of 0.1 cm) and total body weight ($W_T$, in grams; precision of 0.01 g). Subsequently, the individuals were eviscerated to remove the stomachs, which were preserved in 70% alcohol for later inspection. Voucher specimens are stored at the Museu de Zoologia, Universidade Federal do Pará, Belém, under the code MZUFPA 316.

In the laboratory, all stomachs were examined under a stereomicroscope, and the food items were identified to the lowest possible taxonomic level using specialized literature and expert consultation. Each identified item was then weighed using a precision analytical balance with a sensitivity of 0.0001 g.

**Data analysis.** For each food item, we calculated the Frequency of Occurrence (*FO*) (Hyslop, 1980), which represents the frequency of occurrence of a specific item among all stomachs containing at least one item, and the Mass Percentage (*M*) (Hynes, 1950), interpreted as the percentage of weight contribution of an item to the total weight of all consumed items. These indices were combined into the Alimentary index (*Ai*) using the formula: $Ai = (FO * M/\sum FO * M) * 100$ (modified from Kawakami, Vazzoler, 1980). The *Ai* assigns a balanced importance to the consumed items, considering both their occurrence and mass. Subsequently, the food items were grouped into nine food

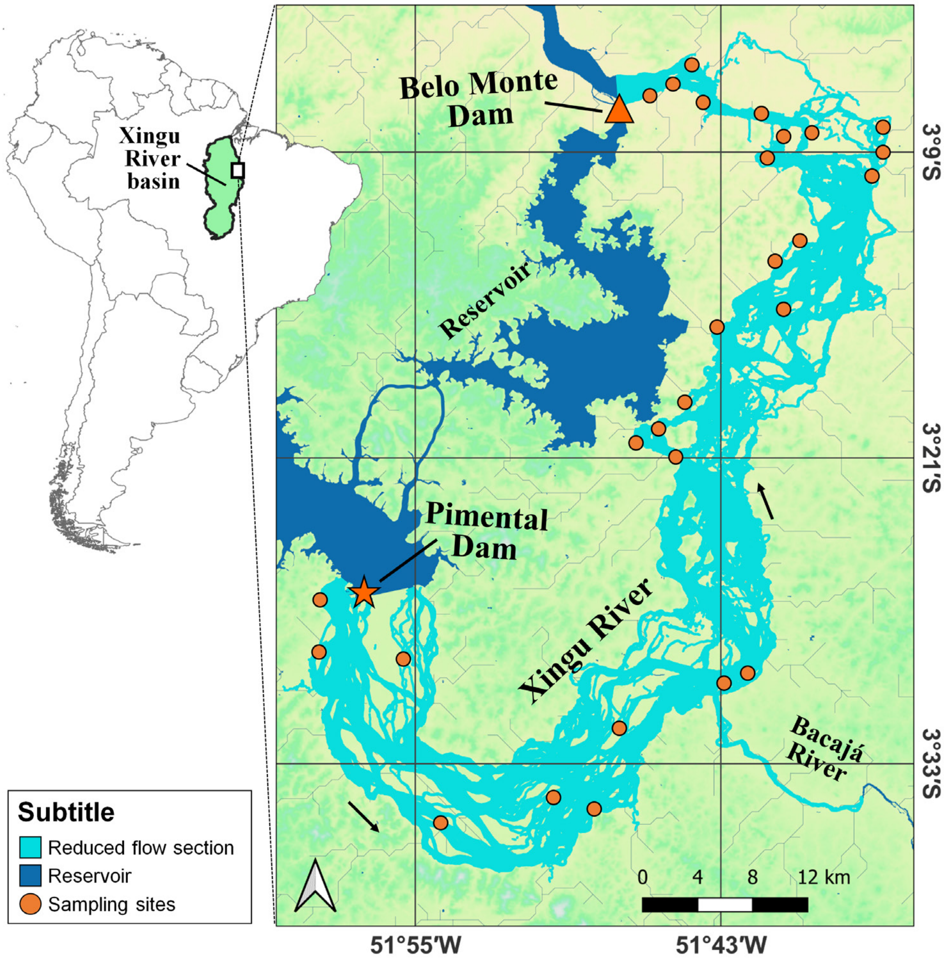


**FIGURE 1** | Map depicting the Volta Grande do Xingu (Xingu River, Brazil), with emphasis on the reduced flow section created by the construction of the Belo Monte Dam (including the Pimental Dam). The orange circles represent the sampling sites where *Pimelodus blochii* specimens were collected, and the arrows indicate the direction of water flow. The orange star and triangle represent the Pimental Dam and the Belo Monte Dam, respectively.

categories (terrestrial arthropods, algae, aquatic crustaceans, aquatic insects, terrestrial insects, aquatic mollusks, terrestrial plants, fish, debris), and their *FO*, *M*, and *Ai* values were computed. Empty stomachs were recorded but were excluded from the analyses.

The *Ai* values of the food categories were evaluated in three steps. We used the *Ai* values obtained from the set of individuals collected per day in each hydrological period as the sampling units. Firstly, we visually examined the diet composition in different hydrological periods using Non-metric Multidimensional Scaling (nMDS) based on the Bray-Curtis dissimilarity matrix of log-transformed *Ai* values. This analysis was conducted using the *metaMDS* function from the *vegan* package (Oksanen *et al*., 2022) in RStudio (R Development Core Team, 2022). Subsequently, differences in diet composition were tested using global Permutational Multivariate Analysis of Variance (PERMANOVA) for the hydrological periods. In case of significant differences, we applied a pairwise analysis. For these procedures, we used the *adonis2* function, also from the *vegan* package in RStudio.

Lastly, the *Ai* values of the food categories were used to assess the trophic niche breadth across the hydrological periods through a Permutational Multivariate Analysis of Dispersions (PERMDISP). In case of significant differences, we also applied a pairwise comparison. This analysis was conducted using the *vegdist* and *betadisper* functions from the *vegan* package in RStudio. The PERMDISP compares the average centroid distances among groups (in this case, hydrological periods) within a multivariate space, with greater values indicate broader trophic niche breadth.

Furthermore, we examined the variation in the feeding intensity of *P. blochii* across the different periods. To achieve this, we utilized the Repletion Index (*RI*) (Santos, 1979), which was calculated for each individual using the formula: $RI = (Mi/Mt) * 100$. Here, *Mi* represents the mass of the food items consumed by the specimen, and *Mt* is the total mass of the same individual. To test the variation in *RI* values across the hydrological periods, we conducted a non-parametric Kruskal-Wallis analysis (*kruskal.test* function), followed by a pairwise Mann-Whitney analysis (*wilcox.test* function). All analyses herein described were performed at a significance level of 0.05 (Zar, 2010).

## RESULTS

A total of 93 stomachs of *Pimelodus blochii* were analyzed, out of which 89 contained at least one item in their stomach content. These stomachs were collected during different hydrological periods, with 22 stomachs during the filling period, 16 during the flood period, 41 during the ebb period, and 10 during the dry period. The individuals exhibited a length range of 7.0 cm to 19.9 cm, with a mean $S_L$ of 13.2 cm and a standard deviation of 3.1 cm. Additionally, the body weight of the specimens ranged from 6.1 g to 198.2 g (mean $W_T = 42.3 \pm 34.5$ g).

In general, the diet of *P. blochii* consisted of 31 food items. The primary component of its diet was fish, accounting for 86.5% of the Alimentary index (*Ai*), followed by terrestrial plants (6.9% *Ai*), and aquatic insects (5.9% *Ai*). The other food categories represented less than one percent of the species' diet. The diet composition during each hydrological period is shown in Fig. 2 and Tab. 1.

The diet composition varied among the hydrological periods (PERMANOVA; Pseudo-F = 2.282, p = 0.048) (Fig. 3). Differences were observed when comparing the diet between the dry and filling periods (p = 0.034), dry and flood periods (p = 0.041), filling and flood periods (p = 0.009), and flood and ebb periods (p = 0.038) (Tab. 2). During the filling, the diet of *P. blochii* was predominantly composed of fish (95.9% *Ai*). In the flood season, while fish remained the primary food source (63.4% *Ai*), the species also showed relative importance in consuming aquatic insects (18.5% *Ai*) and terrestrial plants (17.6% *Ai*). In the low-water periods, the species maintained a high consumption of fish (ebb = 89.1% *Ai*; dry = 83.0% *Ai*), with a minor intake of aquatic insects during the dry season (12.8% *Ai*).

We also observed differences in the trophic niche breadth of *P. blochii* among the hydrological periods (PERMDISP; F = 3.931, p = 0.015) (Fig. 4). The biases were evident when comparing the mean centroid distances of the filling period (centroid distance; cd = 0.126) with flood (cd = 0.340; p < 0.001), ebb (0.246; p = 0.032), and dry seasons (0.342; p = 0.014) (see Tab. 2 for paired statistical comparison values of PERMDISP).

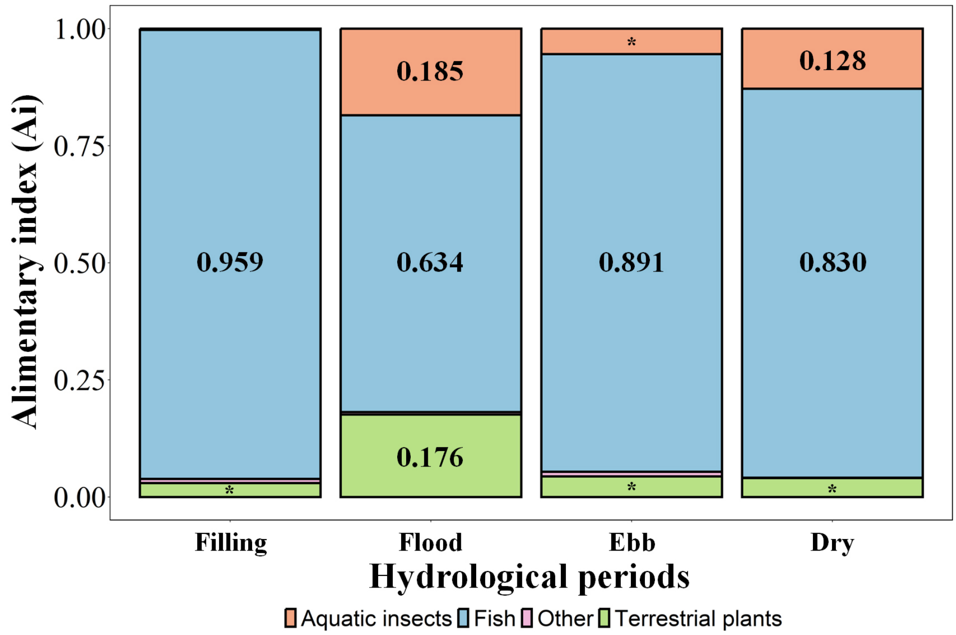


**FIGURE 2** | Alimentary index (*Ai*) of the diet of *Pimelodus blochii* collected in different hydrological periods in the middle Xingu River region, Eastern Amazon, Brazil. *Less than 5% of contribution.

Finally, the population presented an average Repletion Index (RI) of 0.742 in the filling, 0.573 in the flood, 0.608 in the ebb, and 0.577 during the dry period. However, the feeding intensity of *P. blochii* did not vary throughout the hydrological periods ($H = 2.813$, $p = 0.421$). In other words, we did not observe variation in food intake across seasons.

## DISCUSSION

Overall, the dietary analysis of *Pimelodus blochii* revealed a primarily piscivorous habit in the populations of the middle Xingu River region, Brazil. However, we observed variations in the composition of this diet throughout the hydrological periods, with an increased consumption of terrestrial plants and aquatic insects during the flood months. This variation also resulted in more specialized trophic niches in the specimens captured during the filling and more generalist niches in the other periods. Despite these changes in trophic aspects, the feeding intensity of the population, that is, the amount of ingested food, remained constant throughout the seasons. These findings partially corroborate our predictions of flood pulse effects and highlight the species' adaptability to environmental changes in the study area.

The predominantly piscivorous diet of *P. blochii* observed in this study differs from the feeding habit reported in other investigations. For instance, in a study conducted in the Magdalena River basin (Colombia), the same species exhibited a generalist carnivorous habit, mainly consuming aquatic and terrestrial macro- and micro-invertebrates (crustaceans and insects) (López-Casas, Jiménez-Segura, 2007). In another study, in the

**TABLE 1** | Alimentary index (*Ai*) of food items/categories in the diet of *Pimelodus blochii* collected during different hydrological periods in the middle Xingu River region, Eastern Amazon, Brazil. Light gray lines and bold values represent the feeding categories. n = number of non-empty stomach.

| Food resources | Filling n = 22 | Flood n = 16 | Ebb n = 41 | Dry n = 10 | Total n = 89 |
|---|---|---|---|---|---|
| **ALLOCHTHONOUS ITEMS** | | | | | |
| **TERRESTRIAL INSECTS** | **<0.001** | **0.004** | **0.001** | | **0.001** |
| Coleoptera | <0.001 | | <0.001 | | <0.001 |
| Coleoptera (Curculionidae) | | <0.001 | | | <0.001 |
| Hymenoptera | | 0.001 | <0.001 | | <0.001 |
| Hymenoptera (Formicidae) | <0.001 | <0.001 | <0.001 | | <0.001 |
| Fragments of terrestrial insects | <0.001 | | <0.001 | | <0.001 |
| **TERRESTRIAL ARTHROPODS** | | | **<0.001** | | **<0.001** |
| Chelicerata (Acari) | | | <0.001 | | <0.001 |
| **TERRESTRIAL PLANTS** | **0.030** | **0.176** | **0.044** | **0.040** | **0.069** |
| Plant parts (leaf) | | 0.052 | | | 0.002 |
| Plant parts (seed) | <0.001 | <0.001 | 0.001 | | <0.001 |
| Plant parts | 0.039 | 0.055 | 0.036 | 0.042 | 0.044 |
| **AUTOCHTHONOUS ITEMS** | | | | | |
| **FISH** | **0.959** | **0.634** | **0.891** | **0.830** | **0.865** |
| Characiformes (Characidae) | 0.014 | | | | 0.001 |
| Fish fragments | 0.939 | 0.786 | 0.919 | 0.864 | 0.912 |
| **AQUATIC INSECTS** | **0.003** | **0.185** | **0.055** | **0.128** | **0.059** |
| Diptera | | | <0.001 | | <0.001 |
| Ephemeroptera | | | <0.001 | | <0.001 |
| Hemiptera | | | <0.001 | 0.004 | <0.001 |
| Odonata (Anisoptera) | 0.001 | 0.003 | <0.001 | <0.001 | 0.001 |
| Odonata (Anisoptera: Gomphidae) | | <0.001 | | | <0.001 |
| Odonata (Anisoptera: Libellulidae) | | 0.010 | | | <0.001 |
| Odonata (Zygoptera) | | <0.001 | | | <0.001 |
| Trichoptera (Hydroptilidae) | | | | 0.001 | <0.001 |
| Trichoptera (Philopotamidae) | | | | 0.001 | <0.001 |
| Trichoptera | <0.001 | 0.003 | 0.014 | 0.001 | 0.005 |
| Fragments of aquatic insects | 0.001 | 0.087 | 0.019 | 0.086 | 0.028 |
| **AQUATIC CRUSTACEANS** | **0.001** | **0.001** | **<0.001** | | **<0.001** |
| Decapoda (Brachyura) | <0.001 | 0.001 | | | <0.001 |
| Decapoda (Caridea) | | | <0.001 | | <0.001 |
| Isopoda | <0.001 | | <0.001 | | <0.001 |
| Crustacean fragments | | | <0.001 | | <0.001 |
| **AQUATIC MOLLUSKS** | **0.005** | **<0.001** | **<0.001** | | **0.001** |
| Gastropoda | 0.002 | <0.001 | <0.001 | | 0.001 |
| Bivalve | <0.001 | | <0.001 | | <0.001 |
| **ALGAE** | **0.002** | **<0.001** | **0.003** | | **0.001** |
| Algae | 0.002 | <0.001 | 0.003 | | 0.002 |
| **SUBSTRATE** | **0.002** | **<0.001** | **0.002** | **0.001** | **0.001** |
| Rock/sand | 0.002 | <0.001 | 0.002 | 0.001 | 0.002 |
| **UNDETERMINED ORIGIN** | | | | | |
| **ARTHROPODS n.i.** | **<0.001** | **<0.001** | **0.004** | | **0.001** |
| Arthropod fragments | <0.001 | <0.001 | 0.004 | | 0.001 |

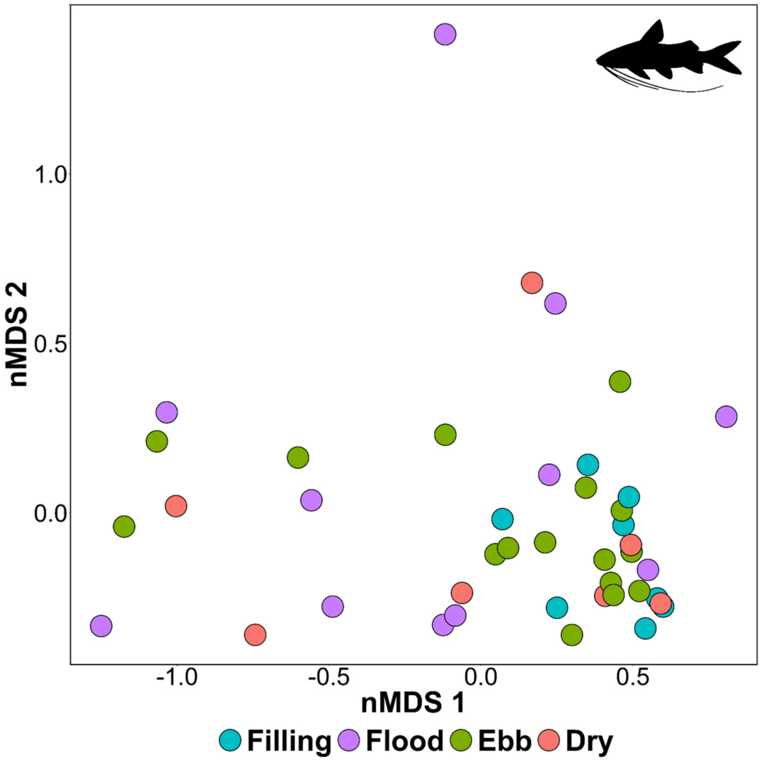


**FIGURE 3** | Non-metric Multidimensional Scaling (nMDS) graphical representation of the diet of *Pimelodus blochii* collected in different hydrological periods in the middle Xingu River region, Eastern Amazon, Brazil.

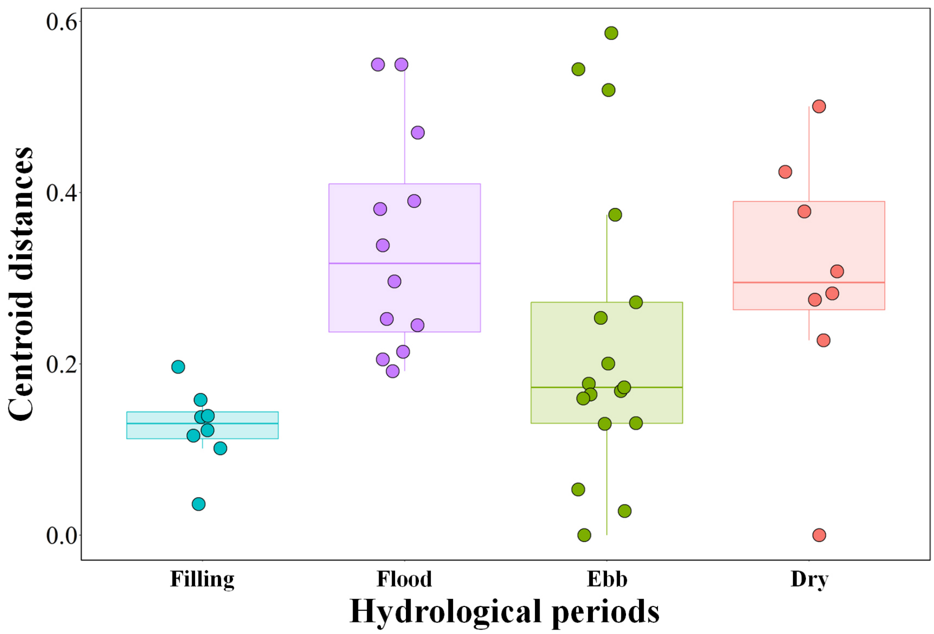


**FIGURE 4** | Trophic niche breadth of *Pimelodus blochii* collected in different hydrological periods in the middle Xingu River region (Eastern Amazon, Brazil). Based on centroid distances between groups from the Permutational Multivariate Dispersion Analysis (PERMDISP).

**TABLE 2** | Statistical values of the comparison of diet composition (PERMANOVA) and trophic niche breadth (PERMDISP) of *Pimelodus blochii* collected in different hydrological periods in the middle Xingu River region, Eastern Amazon, Brazil. *Statistically significant differences ($p < 0.05$).

| Hydrological periods | PERMANOVA (Pseudo-F = 2.282; p = 0.048) | | PERMDISP (F = 3.931; p = 0.015) | |
|---|---|---|---|---|
| | F value | p value | t value | p value |
| Filling - Flood | 4.804 | 0.009* | 5.259 | <0.001* |
| Filling - Ebb | 3.003 | 0.076 | 2.302 | 0.032* |
| Filling - Dry | 4.176 | 0.034* | -3.120 | 0.014* |
| Flood - Ebb | 1.408 | 0.038* | 1.919 | 0.066 |
| Flood - Dry | 0.628 | 0.041* | 0.629 | 0.540 |
| Ebb - Dry | 0.711 | 0.457 | 0.998 | 0.333 |

Madeira River basin (Brazil), *P. blochii* was described as omnivorous, feeding primarily on plant material (fruits and seeds) but also on terrestrial insects (Cella-Ribeiro *et al*., 2016). These contrasting results suggest that the feeding habits of *P. blochii* may vary across different regions and environmental conditions, reflecting its adaptability to available food sources.

The dietary composition of *P. blochii* exhibited noteworthy variation among the hydrological periods, suggesting that individuals also adjust their feeding throughout the flood pulse. Several studies have observed that fish inhabiting environments subject to seasonal changes tend to alter their diets according to the most advantageous food sources at the time (Lowe-McConnell, 1987; Pool *et al*., 2017; van der Sleen, Rams, 2023). Such behavior is in accordance with the Optimal Foraging Theory (MacArthur, Pianka, 1966), which posits that organisms seek to maximize energy acquisition through feeding, considering the costs and benefits associated with food search. In this sense, our observation revealed a perceptible change in the diet of *P. blochii*, transitioning from a predominantly piscivorous diet during the ebb, dry, and filling periods to an omnivorous one during the flood, with a notable increase in the consumption of terrestrial plant parts and aquatic insects during this period. This shift in diet could be attributed to a possible greater availability of terrestrial items for aquatic organisms during flood events, as the rising water levels flood the marginal forests, facilitating a greater interaction between terrestrial and aquatic environments (Goulding, 1980; Humphries *et al*., 2014). Additionally, fish are overdispersed in floodplain environments during the high-water period, which may reduce the availability of this resource for predation (Luz-Agostinho *et al*., 2008; Pereira *et al*., 2017).

In contrast to our findings, the aforementioned study in the Magdalena River basin reported that the *P. blochii* population exhibited a consistent dietary composition (generalist carnivore) across hydrological periods (López-Casas, Jiménez-Segura, 2007). Conversely, a study in Southeast Brazil focusing on a congeneric species, *Pimelodus maculatus* Lacepède, 1803, indicated an increased consumption of aquatic insect larvae (Chironomidae) during rainy periods (Silva *et al*., 2019). Besides observing the consumption of terrestrial plants, we also noted a significant increase in the consumption of aquatic insects. While we did not directly assess item availability, the substantial consumption of aquatic insects by *P. blochii* during the flood may also be linked to the rising water levels of the Xingu River. During high-water periods, the increased influx of allochthonous materials and nutrients, as well as the enhanced habitat heterogeneity, can promote the abundance of these organisms, as shown in other studies (Walker, 2009; Vinnersten *et al*., 2014; Amadeu-Santana *et al*., 2015). In summary, numerous studies underscore the importance of seasonal water level variations for fish communities and populations in the Amazon (Dary *et al*., 2017; Bayley *et al*., 2018), with particular relevance in the context of the Xingu River (Barbosa *et al*., 2015; Fitzgerald *et al*., 2018; Freitas *et al*., 2022).

Just like the dietary composition, the niche breadth of the *P. blochii* population also varied between hydrological periods, indicating a clear influence of the flood pulse on this trophic aspect. During the filling period, when the species displayed the smallest average niche breadth, the diet of all samples (set of individuals captured on the same day) consisted primarily of fish, suggesting a more specialist habit. In contrast, during the flood period, when the diet was characterized by an increased consumption of plants and insects, we recorded the largest average niche breadth, suggesting more generalist habits. This pattern is in line with expectations for flood periods, as the flooding of adjacent forests leads to an increased availability of allochthonous food sources (Goulding, 1980; Luz-Agostinho *et al*., 2008). During the low-water periods (ebb and dry seasons), although the diet remained predominantly piscivorous, some samples also exhibited a relative importance of other sources, such as aquatic insects, thereby expanding the trophic niche during these periods. This variety of food consumed by *P. blochii*, and consequently its generalist carnivorous habit (Wang *et al*., 2022), may enable a balanced approach to energy allocation and foraging strategies (Freitas *et al*., 2022), as predation on fish can be more energetically demanding (Elliott, Hurley, 2008). Furthermore, this energy allocation may also be aimed at avoiding predation, as *P. blochii* is commonly preyed upon by giant catfishes (Cella-Ribeiro *et al*., 2016).

Finally, in contrast to the observed variation in diet composition and niche breadth, the results of this study indicate that the flood pulse does not exert a significant influence on the feeding activity of *P. blochii* in the middle Xingu River. This suggests that, despite fluctuations in food availability during natural flood and dry cycles (Correa, Winemiller, 2014), the average amount of food ingested by individuals of this species remains consistent across the hydrological periods, demonstrating stability in this feeding strategy.

The behavior and feeding strategies of organisms are reflections of their historical niche conservation processes (Román-Palacios *et al*., 2019), as well as the environmental characteristics in which the species are present (Abelha *et al*., 2001). In this context, it is crucial to highlight that the fish analyzed in this study were collected from the influence area of a dam (UHE Belo Monte), where water flow is artificially controlled, leading to drastic alteration in the natural flood pulse. Consequently, the predominantly piscivorous habit herein described, contrasting with findings from other studies (López-Casas, Jiménez-Segura, 2007; Cella-Ribeiro *et al*., 2016), may be a response to the environmental changes taking place in the middle Xingu River region. With reduced connection to the terrestrial environment, even during floods, the organisms that previously relied on these periods and flooded environments for feeding (Pereira *et al*., 2017) are now forced to adapt to the new environmental conditions. However, additional studies are necessary to deepen ecological assessments and better understand the impacts of these changes on the feeding behavior of the species.

In summary, our study provides valuable insights into the trophic ecology of *P. blochii* in the middle Xingu River region, highlighting the direct influence of the flood pulse on aspects such as diet composition and niche breadth. Understanding the relationship between the flood pulse and the feeding ecology of aquatic organisms is crucial for comprehending dynamics of floodplain systems. The significance is particularly relevant in the Amazon basin, where the region has historically and continuously undergone environmental modifications, including river damming (Lees *et al*., 2016; Winemiller *et al*., 2016), mining activities (Tófoli *et al*., 2017), and changes in land use (Dala-Corte *et al*., 2020). Finally, our findings also provide significant ecological information about a widely distributed species in the Amazon basin and supplies feeding data for a fish population impacted by a river dam, which can be used in future research to expand knowledge about Amazonian fish ecology and contribute to understanding the effects of environmental changes in the region.

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## AUTHORS' CONTRIBUTION

**Mariele da Silva Lima:** Data curation, Formal analysis, Writing-original draft, Writing-review and editing.

**Sabrina Serrão Martins:** Data curation, Formal analysis, Writing-original draft, Writing-review and editing.

**Luciano Fogaça de Assis Montag:** Conceptualization, Funding acquisition, Methodology, Project administration, Writing-original draft, Writing-review and editing.

**Tiago Magalhães da Silva Freitas:** Conceptualization, Data curation, Formal analysis, Methodology, Writing-original draft, Writing-review and editing.

## ETHICAL STATEMENT

Collected specimens were anesthetized with benzocaine (0.1 g/L) and euthanized, following the guidelines of the Conselho Nacional de Controle Experimentação Animal (CONCEA). Fish collections and handling procedures carried out under the authorization of Abio license # 1267/2020 and the ethics committee of the Universidade Federal do Pará (UFPA, CEUA # 82932020478).

## COMPETING INTERESTS

The author declares no competing interests.

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