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# Larval diet of two Amazonian goliath catfish species

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## Abstract

Analysis of feeding habits was performed for early life stages of *Brachyplatystoma rousseauxii* and *Brachyplatystoma filamentosum* in the Madeira River, Brazil. Stomach contents of *B. rousseauxii* and *B. filamentosum* were identified and analysed to provide the percentage of frequency of occurrence (%FO) and area (%A) and the alimentary index (IAi). The order Diptera represented the most important item consumed by both species. This is the first analyses of the trophic ecology of these ecologically and economically important species of the Amazonian region in early life stages.

KEYWORDS

fish larvae, food resources, freshwater ecosystems, gut contents, Pimelodidae

Amazon River basin Pimelodid catfishes comprise one of the main groups of migratory fish species and include apex predator species of this system, playing an important ecological role structuring food webs (Barthem & Goulding, 1997). Species of the genus *Brachyplatystoma*, popularly known as the Amazonian goliath catfishes, are major river channel and estuarine predators. They are some of the most ecologically (Barthem *et al*., 2017) and economically important species of this region (Fabré & Barthem, 2005; Petrere *et al*., 2004). *Brachyplatystoma rousseauxii* (Castelnau 1855) and *B. filamentosum* (Lichtenstein 1819) have been intensely captured for decades across the Amazon River system. *B. rousseauxii* is one of the most important species landed in this basin (Petrere *et al*., 2004; Isaac *et al*., 2015; Lima *et al*., 2020a).

To date, there is no empirical data in natural environments about feeding habits and trophic ecology in the early stages of Amazonian goliath catfish species. Sustainable fisheries management depends on an understanding of population dynamics in different development stages, recruitment patterns and ecology (Santos & Santos, 2005). This study investigated the feeding habits of *B. rousseauxii* and *B. filamentosum* in early life stages, providing the first insight into the trophic ecology during their larval stages.

Ichthyoplankton samples were obtained from monthly samplings between July 2009 and July 2011, from the confluence of the Beni River (10°04′04,9″S, 064°22′37,0″W) and the mouth of the Madeira River, Brazil (03°25′87,9″S, 058°47′37,5″W) (Supporting information Figure S1). Samples were collected using a conical plankton net (0.3 mm mesh) and a trawl net (01 mm mesh). Although many individuals arrive dead to the surface, the few individuals collected alive were euthanized with eugenol and fixed in a solution of 5% formalin. Sampling was approved by the Brazilian

  

National Environmental authority (ICMBIO) through collection permit (number 540/2008).

The larvae were identified based on the morphological descriptions of Nakatani *et al*. (2001) and Leite *et al*. (2007). The food items of each stomach removed were identified using specialized literature (Elmoor-Loureiro, 1997; Hamada *et al*., 2012).

The feeding habits of the two species were quantified using percentage of frequency of occurrence (%FO) and area (%A) occupied by each item ($mm^2$) using graph paper (Hellawell & Abel, 1971). Additionally, the origin of the food items was classified as autochthonous or allochthonous. %FO and %A were used to calculate the alimentary index (IAi; Kawakami & Vazzoler, 1980). The feeding strategy of the

**TABLE 1** Percentage area (%A), percentage occurrence (%FO) and index of food importance (%IAi) for *B. rousseauxii* and *B. filamentosum* prey items

| | *B. rousseauxii* | | | *B. filamentosum* | | | |
|---|---|---|---|---|---|---|---|
| **Prey items** | **%A** | **%FO** | **%IAi** | **%A** | **%FO** | **%IAi** | **Source** |
| **Cladocera** | | | | | | | |
| Cladocerans n.i. | 0.125 | 6.426 | 0.039 | 5.078 | 24.219 | 7.656 | Aut |
| Bosminidae | 0.012 | 1.205 | 0.001 | | | | Aut |
| **Copepoda** | | | | | | | |
| Copepoda n.i. | 0.023 | 1.606 | 0.002 | 8.953 | 11.719 | 6.532 | Aut |
| Cyclopoid | 0.161 | 2.008 | 0.016 | | | | Aut |
| Ostracoda | 0.012 | 0.402 | 0.000 | 0.743 | 3.516 | 0.163 | Aut |
| **Rotifera** | | | | 0.005 | 0.781 | 0.001 | |
| *Lecane* spp. | 0.026 | 1.606 | 0.002 | | | | Aut |
| **Arachnida** | | | | | | | |
| Arenae | 0.079 | 0.402 | 0.001 | | | | |
| **Insecta** | | | | | | | |
| **Diptera** | | | | | | | |
| Diptera n.i | 11.472 | 17.269 | 9.564 | 18.697 | 10.937 | 12.732 | All |
| Diptera larvae | 0.553 | 2.008 | 0.054 | 19.701 | 23.047 | 28.269 | Aut |
| Ceratopogonidae | 0.150 | 0.803 | 0.006 | 0.030 | 0.391 | 0.001 | Aut-Allo |
| Chironomidae larvae | 2.155 | 8.032 | 0.836 | | | | Aut-Allo |
| **Coleoptera** | | | | | | | |
| Coleoptera n.i. | 1.369 | 3.614 | 0.239 | 0.488 | 0.391 | 0.012 | Allo |
| **Hemiptera** | | | | | | | |
| Hemiptera n.i. | 1.805 | 4.819 | 0.420 | 0.152 | 0.391 | 0.004 | Allo |
| Corixidae | 0.628 | 0.402 | 0.012 | | | | Allo |
| **Hymenoptera** | | | | | | | |
| Hymenoptera n.i | 0.497 | 2.008 | 0.048 | 3.571 | 2.734 | 0.608 | Allo |
| Chalcidoidea | 0.626 | 0.803 | 0.024 | | | | Allo |
| Formicidae | 4.393 | 3.614 | 0.766 | | | | Allo |
| Vespidae | 0.164 | 0.803 | 0.006 | 1.219 | 0.391 | 0.030 | Allo |
| **Odonata** | | | | | | | |
| Coenagrionidae larvae | 0.030 | 0.402 | 0.001 | | | | Aut |
| **Trichoptera** | | | | | | | |
| Trichoptera n.i. | 0.419 | 3.614 | 0.073 | 0.293 | 0.391 | 0.007 | Aut-Allo |
| Hydroptilidae | 0.092 | 0.402 | 0.002 | | | | Aut |
| Leptoceridae | 1.508 | 2.409 | 0.175 | | | | Aut |
| **Thysanoptera** | | | | 0.244 | 0.391 | 0.006 | All |
| **Nematoda** | 0.216 | 5.221 | 0.054 | 0.352 | 1.953 | 0.043 | All |
| **Unidentified eggs** | 0.267 | 2.008 | 0.026 | 0.351 | 1.172 | 0.026 | Aut |
| **Insect remains** | 72.856 | 24.899 | 87.577 | 40.123 | 17.578 | 43.912 | Aut-Allo |
| **Plant remains** | 0.357 | 3.213 | 0.055 | | | | All |

*Note:* All, allochthonous; Aut, autochthonous; n.i: not identified.

species was described using the graphical method proposed by Costello (1990) and modified by Amundsen *et al*. (1996).

A total of 261 stomachs were analysed, belonging to 113 individuals of *Brachyplatystoma rousseauxii* and 148 individuals of *B. filamentosum*. A total of 27 prey items were identified, 26 of which were consumed by *B. rousseauxii* (52% of autochthonous origin and 48% of allochthonous origin) and 16 consumed by *B. filamentosum* (46% of autochthonous origin and 54% of allochthonous origin, Table 1). Both species consumed several preys, which could be considered as occasional because they have a low frequency of occurrence and area (Table 1). At the highest taxonomic level, insect remains (unidentified insect parts) were the dominant dietary category in both species (87.58% IAi in *B. rousseauxii* and 43.91% IAi in *B. filamentosum*). At the lowest identifiable taxonomic level, the diet of both species is based on Diptera (Diptera adults: 9.56% IAi in *B. rousseauxii*; Diptera larvae: 28.27% IAi in *B. filamentosum*) (Table 1).

The graphical analysis of the diets showed that individuals of the two species fed on a high number of occasional items, such as Formicidae (Fo) and Chironomidae (Ch). Insect remains (In) were the dominant food components at the population level (Figure S2a,b). Additionally, *B. rousseauxii* showed individual specialization suggested by a high between phenotype component, for instance on Coenagrionidae (Cn) and Bosminidae (Bo) (Figure S2a). Some categories as Diptera larvae (Di. L) and Cladocera (Cl) were more frequent among *B. filamentosum* individuals (Figure S2b).

*B. rousseauxii* and *B. filamentosum* larvae are predators that feed mainly in insects of allochthonous origin, such as adult Diptera and their larval stages, of autochthonous origin. High consumption of insect larvae is common for larvae of fish that are piscivorous as adults, as exemplified by *Sorubim lima* (Bloch & Schneider, 1801) in the Paraná river (Rossi, 2001). Experimental studies on the larval diet of *Piaractus mesopotamicus* (Holmberg 1887) and *Colossoma macropomum* (Cuvier 1816) indicated that they select available food items such as chironomid larvae (Fregadolli, 1993; Sipaúba-Tavares, 1993). In this respect, besides the availability of the food source, other factors may determine the consumption of prey by these fish larvae such as the size of the larva/prey (Cunha & Planas, 1999), the escape capacity of the prey (Keef *et al*., 1998), visual and swimming efficiency of the predator (Cox & Pankhurst, 2000), and the palatability (Sipaúba-Tavares, 1993).

The consumption of larval and adult insects by *B. rousseauxii* and *B. filamentosum* show the relevance of both autochthonous and allochthonous resources during the larval stages of these species. These migratory fish suffer stresses not only because to dam construction impedes migration and changes the impact of fisheries (Anderson *et al*., 2018; Lima *et al*., 2020b), but also because anthropogenic change from deforestation of riparian forests (Trancoso *et al*., 2009), mining activity (Finer *et al*., 2008) and climate change can have important effects altering the autochthonous and allochthonous inputs, and thus the aquatic food webs (Guimberteau *et al*., 2017).

This work allows the identification of food components of the diet of two species of Amazonian goliath catfishes in early life stages. These species are currently under fishing pressure in the region and support the local economy of the Amazonian populations. For this reason, the knowledge generated in this research can be used to guide future research in sustainable production processes in the Amazon basin, which may ultimately support management and conservation strategies for these fishery resources in Amazonia.

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## CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

## AUTHOR CONTRIBUTIONS

V.M.V. and R.G.L. conceived and designed the study. V.M.V. compiled data from the literature and performed the laboratory work. R.G.L supplied these specimens and contributed materials. V.M.V. and F.A. analysed the data. V.M.V., R.G.L. and F.A. contributed to the interpretation of the results. V.M.V. wrote the paper and led the revisions, and R.G.L, F.A and A.H. critically reviewed and corrected the versions of the manuscript.

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