Ichthyofauna in an ecological station in the Pantanal of Brazil: the hydrological cycle affecting species composition

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Abstract

Ichthyofauna in an ecological station in the Pantanal of Brazil: the hydrological cycle affecting species composition. This research aims to describe the ichthyological fauna in the area surrounding the Taiamã Ecological Station in the state of Mato Grosso, Brazil. Three expeditions were carried out, in September 2014, February 2015 and May/2015, in seasons ranging from the hydrological conditions of high waters (flood), low waters (drought), and decreasing waters (ebbing). During the research we sampled 3,664 individuals from six orders, 28 families and 78 species. Characiformes was the most abundant order (~81% of individuals), followed by Siluriformes (~13% of individuals), and Gymnotiformes (~4% of individuals). The most representative species were *Moenkhausia dichroura* (Kner, 1858), *Serrapinus calliurus* (Boulenger, 1900), *Odontostilbe pequira* (Steindachner, 1882) and *Pimelodella gracilis* (Valenciennes, 1840). The dry period showed the highest abundance (1,541 individuals), richness (61 species), diversity (*H’* = 2.69) and equitability (*J’* = 0.65). These results fill a gap concerning species composition in the Pantanal, mainly referring to data available on Conservation Unit, and its surroundings. Moreover, this research provides a database to update the checklist of fish species in a remote wetland, offering a tool for management and conservation.

Data published through GBIF (Doi: 10.15470/jjpuuu)

Key words: Diversity, Ichthyofauna, Wetland, Conservation Unit

Resumen

Ictiofauna en un espacio natural protegido del Pantanal de Brasil: afectación de la composición de especies por el ciclo hidrológico. Esta investigación tiene por objeto describir la fauna ictiológica del área situada en torno al Espacio Natural Protegido (estação ecológica) de Taiamã, en el estado de Mato Grosso (Brasil). Para desarrollar el estudio realizamos tres expediciones en los meses de septiembre de 2014 y febrero y mayo de 2015, cubriendo las estaciones hidrológicas de aguas altas (inundación), aguas bajas (sequía) y aguas decrecientes (retroceso). Durante la investigación recolectamos 3.664 ejemplares pertenecientes a seis órdenes, 28 familias y 78 especies. El orden más abundante fue Characiformes (~81% de los ejemplares), seguido por Siluriformes (~13% de los ejemplares) y Gymnotiformes (~4% de los ejemplares). Las especies más representadas fueron *Moenkhausia dichroura* (Kner, 1858), *Serrapinus calliurus* (Boulenger, 1900), *Odontostilbe pequira* (Steindachner, 1882)
Ictiofauna en un espai natural protegit del Pantanal del Brasil: afectació de la composició d'espècies pel cicle hidrològic. L'objectiu d'aquesta recerca és descriure la fauna ictiològica de l'àrea situada al voltant de l'Espai Natural Protegit (estació ecològica) de Taiamã, a l'estat de Mato Grosso (Brasil). Per portar a terme l'estudi vam fer tres expedicions els mesos de setembre de 2014 i febrer i maig de 2015, de manera que vam cobrir les estadions hidrològiques d'aigües altes (inundació), aigües baixes (sequera) i aigües decreixents (retrocés). Durant la recerca vam recol·lectar 3.664 exemplars pertanyents a sis ordres, 28 famílies i 78 espècies. L'ordre més abundant va ser Characiformes (81% dels exemplars), seguit de Siluriformes (13% dels exemplars) i Gymnotiformes (4% dels exemplars). Les espècies més representades van ser *Moenkhausia dichrous* (Kner, 1858), *Serrapinus calliurus* (Boulenger, 1900), *Odontostilbe pequira* (Steindachner, 1882) i *Pimelodella gracilis* (Valenciennes, 1840). El període sec va registrar l'abundància més gran d'espècies (1.541 exemplars), riquesa (61 espècies), diversitat (*H' = 2,69*) i equitat (*J' = 0,65*). Aquests resultats omplen un buit en la composició d'espècies al Pantanal, principalment pel que fa a dades disponibles de les unitats de conservació i els seus voltants. A més, aquesta recerca proporciona una base de dades per incrementar la llista de control d'espècies de peixos en un aiguamoll remot, com també un instrument per gestionar–les i conservar–les.
Introduction

The Pantanal is an extensive plain composed of a series of periodically flooded landscape units (Pozer and Nogueira, 2004), and covering a range of approximately 140,000 km² in the Midwest of Brazil (Da Silva et al., 2001; Lourenço et al., 2008). Within this area, 11,555 ha belong to the Taimã Ecological Station (TES), delimited by the Paraguay River and containing a variety of aquatic environments. Southwest of the TES is a flood region named Campo. This region is a Conservation Unit and one of the most flooded areas of the Pantanal (Pereira et al., 2012; Ikeda–Castrillon et al., 2011). Fishery activity is now prohibited here (Resolução CEPESCA 02/2018) due to the region’s importance for ichthyofauna as an area for breeding, growth and feeding, and consequent high relevance for the conservation and maintenance of species. It is therefore important to determine the ichthyofauna present in the Conservation Unit in order to create a database of species that have a high probability of occurrence in the Northern Pantanal.

Each week, hundreds of tourists explore the abundance of high commercial value fish in the regions near the Conservation Unit from the boat hotels and professional fishermen. Exploration of these resources has a strong impact on fisheries in the region, emphasizing the importance of determining the local biodiversity and aspects related to conservation. Besides the fish of high commercial value, such as Piaractus mesopotamicus (Holmberg, 1887), other smaller, less known species are also found in high abundance, such as Astyanax lacustris (Lütken, 1875). This species is commonly found below the macrophyte beds as a result of the production of detritus and shelter availability (Schiesari et al., 2003), and it is the base of the food chain of many species. The importance of maintaining the base of the food chain reflects the maintenance of larger species (Layman et al., 2015), consequently affecting the ecological process of an environment (Sanders et al., 2014). However, to understand the food chain and the ecological processes, studies comprising checklists are needed to provide information about the species composition and create a robust database that will aid management and conservation of aquatic ecosystems (Corrêa et al., 2015).

Studies addressing lists of fish species in the Pantanal are scarce. We highlight the work of Súarez and Petrere–Júnior (2007), Pains–Silva et al. (2010), Fernandes et al. (2015) in a system of bays connected to the Paraguay River (MT); Teresa et al. (2016) in the drainage system of the Miranda and Aquidauana rivers (MS); Súarez et al. (2013) in Porto Murtinho (MS); and Severo–Neto et al. (2015) in Medal Bay (MS). However, only one work has been conducted in protected areas, that is, the study by Polaz et al. (2014) who conducted research in the Pantanal National Park (MT). This current research describes the fish species in the Taimã Ecological Station, in the Pantanal of Cáceres, Mato Grosso, Brazil. Furthermore, it provides an accretion of data that fills a gap about the ichthyofauna composition in the northern Pantanal, mainly referring to seasonal hydric variation.

Material and methods

Study area

The Taimã Ecological Station (TES) is located in the Pantanal of Mato Grosso (between 57º 24' W and 45º 40' W; and 16º 48' S and 16º 58' S; fig. 1), 165 km from the municipality of Cáceres. The TES covers an area of 11,550 ha, comprising the islands of Taimã and Sararé, and limited by a bifurcation of the Paraguay River (Ikeda–Castrillon et al., 2011). The annual average temperature is 26°C, with highest temperatures in the rainy season (October to December) according to Neves et al. (2011).

The flood pulse directly influences the area, promoting marked changes in the availability of aquatic habitats. The Pantanal is made up of several phyto physiognomies, such as wet
fields, and permanent and temporary bays (Carvalho, 1986; Junk and Da Silva, 2000). The uniform geographical relief denotes a lentic water flow, with periodic flooding due to the flood pulse, which regulates the ecological process in this region (Fernandes et al., 2010). The annual droughts and floods lead to variations in the abundance of certain species (Da Silva et al., 2001; Junk et al., 2014).

Sampling methods

We conducted three field excursions, in September 2014, February 2015, and May 2015. These three periods comprise the seasonal hydric periods of low waters (drought), decreasing waters (ebbing), and high waters (flooding). The study was approved by the Instituto Chico Mendes para a conservação da Biodiversidade–SISBIO num 46263–1). Fish samples were collected at three different points surrounding the TES. Fish capture were captured using a square metallic structure (1 m width x 2 m length x 1 m depth) with a 3 mm nylon net that was passed underneath the macrophyte beds three times. Netting of several mesh sizes and a dragging net (5 mm internode, 25 m length and 4 m high) were also passed once in the limnetic region of the water body. After the samples were collected, the fish were anesthetized with Eugenol (Keene et al., 1998; Fernandes et al., 2017) and fixed in formalin (concentration of 10%) until identification. Fish were identified following Britski et al. (2007) and manuscripts of species description. Specimens were then conserved in 70% alcohol (and deposited in the Laboratory of Ichthyology of the Northern Pantanal (LIPAN), linked to the Research Centre in Limnology, Biodiversity and Ethnobiology of the Pantanal (CELBE/UNEMAT). Abundance, richness (taxa S), diversity (Shaanon's index, $H'$) and equitability (Pielou index, $J'$) were calculated for each season with PAST 3.0 free software (Hammer et al., 2001).
Results

A total of 3,664 individuals belonging to six orders, 28 families and 78 species were sampled. The order Characiformes was the most abundant (2,970 individuals, -81% of the total), followed by Siluriformes (477 individual, -13% of the total), Gymnotiformes (138 individuals, -4% of the total), Cichliformes, Beloniformes and Synbranchiformes (table 1, data published through GBIF: Doi:10.15470/iiijpuuu, fig. 2). From the 29 families, Characidae was the most representative both in number of species and individuals (17 and 2,667, respectively), followed by Serrasalmidae, Cichlidae, Heptapteridae, Loricaridae and Pimelodidae (fig. 3). The most
| Family               | Voucher No | Frequency % | Taxa                                               |
|----------------------|------------|-------------|---------------------------------------------------|
| Belonidae            | 3,664      | 0.61        | Synbranchus marmoratus,  Pinirampus pirinampu,  Iheringichthys labrosus,  Hemisorubim platyrhynchos,  Rineloricaria parva,  Loricariichthys platymetopon,  Pterygoplichthys ambrosettii,  Hypostomus,  Pimelodella,  Imparfinis stictonotus,  Oxydoras kneri,  Mesonauta festivus,  Crenicichla lepidota,  Apistogramma commbrae,  Eigenmannia virescens,  Gymnorhamphichthys britskii,  Brachyhypopomus bombilla,  Serrasalmus marginatus,  Serrasalmus maculatus,  Bryconops melanurus,  Hemiodus semitaeniatus,  Gasteropelecus,  Hoplias malabaricus,  Steindachnerina conspersa,  Potamorhina squamoralevis,  Curimatopsis myersi,  Characidium zebra,  Serrapinnus kriegi,  Serrapinnus calliurus,  Moenkhausia oligolepis,  Jupiaba acanthogaster,  Hemigrammus ulreyi,  Astyanax lacustris,  Aphyocharax anisitsi,  Schizodon borellii,  Leporinus striatus,  Leporinus friderici,  Acestrorhynchus pantaneiro,  Eigenmann & Ward, 1907. |
abundant species were: *Moenkhausia dichroura* (Kner, 1858) presenting 44.41%, *Serrapinnus calliurus* (Boulenger, 1900) 8.71%, *Odontostilbe pequiura* (Steindachner, 1882) 8.11% and the catfish *Pimelodella gracilis* (Valenciennes, 1840) in 7.51% of the total (table 1, fig. 4).

During the three study periods, the dry season was the most representative in richness and abundance of fish (61 and 1541, respectively), while the ebbing season was lowest (34 and 742, respectively). In general, diversity and equitability in the wetlands of the Taiamã Ecological Station were high ($H' = 3.30$; $J' = 0.66$), with the dry season showing the highest value ($H' = 2.69$; $J' = 0.65$), and flooding showing the lowest values (see table 1).

**Discussion**

The Characiformes Order has the greatest distribution in the Neotropical region and represents about 30% of freshwater species in lentic and lotic waters (Reis et al., 2016). This order is found in a variety of environments. The high percentage of species belonging to this order in this study in the Pantanal is due to the provision of shelter and substrate underneath macrophyte beds (Lopes et al., 2015). Aquatic macrophyte beds have high structural complexity and are of great importance to ichthyofauna as they provide shelter from predation, food (aquatic invertebrates) and suitable sites for reproduction and growth.
In a study in the Pantanal of Poconé, Milani et al. (2010) highlighted the importance of aquatic macrophytes in the composition of fish species, where the family Characidae was the largest representative with a richness of 26 species underneath beds of *Eichhornia azurea*.

The high abundance of *M. dichroura*, *S. calliurus*, *O. pequira* and *P. gracilis* denotes a relation of coexistence, with little or no overlap of ecological niche. This may be because these species use different food resources, or it could be because the macrophyte bed provides a great variety of resources, such as periphytic algae, crustacean, invertebrates and organic detritus (Fulan and Henry, 2007; Santos et al., 2009; Câmara et al., 2012). Besides the fast reproduction of *M. dichroura* its abundance (1,627 individuals) was probably related to the fact that it has particular physiological adaptations such as modified gill rakers that allow water filtration and food capture (Da Silva and Hanh, 2009). These mechanisms can be influenced by the water regime of low and high waters. Many species spawn during the flood period and search for environments that provide shelter, which many find underneath the aquatic macrophyte beds (Súarez et al., 2004).
The abundance of small Characidae underneath the macrophyte bed shows that a high percentage of species from this family live here. Less abundant species are considered occasional visitors (Suárez et al., 2013) that mainly select this habitat during climatic events, such as alterations in the hydrological regime. The great quantity of fish belonging to the order Characiformes and the family Characidae in areas near the Taíamá Ecological Station is considered to be due to their adaptation to the numerous lakes that originated from a sedimentation process (Ikeda–Castrillon et al., 2011). Our findings support previous research on fish assemblage beneath the aquatic macrophyte bed in a non–protected area, with 107 species sampled over a two–year period (Pacheco and Da Silva, 2009; Pains–Silva et al., 2010, 2014).

Our results emphasize the need to protect these wetlands around Conservation Units and highlight the importance of these regions for small species that are the base of the food chain of fish species of commercial interest in the region of the Pantanal of Cáceres.

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