

# Parakeets as facilitators of fish frugivory in the Southern Pantanal

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Temporary foraging associations provide the interactions between species of diverse taxonomic groups and evolutionary histories. In general, a species leverages resources that are available from other species foraging. Foraging associations usually involve species that coexist in the same environment, such as fishes in coral reefs or neotropical streams (Strand 1988, Silvano 2001, Sazima *et al.* 2004, Leitão *et al.* 2007, Teresa & Carvalho 2008), hawks and coatis (Booth-Binczik *et al.* 2004), and birds and monkeys in tropical forests (Rodrigues *et al.* 1994). However, interactions between species can connect aquatic and terrestrial environments, like birds in commensal foraging interaction with fishes (Kajiura *et al.* 2009, Ubaid 2011), such as fishes that consume fruits dropped by monkeys foraging in the riparian forest (Sabino & Sazima 1999).

Similar behavior of monkeys during feeding can be found in parrots, one of the more diverse groups of Neotropical birds, and which feed basically on fruits and seeds. Foraging by a group of parrots often generates a great amount of dropped seeds and fruits (Gwynne *et al.* 2010). Nevertheless, no studies were found reporting other species that are directly favored by these resources provided by the activity of parrots. However, fish commonly feed on fruits dropped by foraging animals in riparian forest (Goulding 1993). Considering the abundance of fish and parrots in Neotropical communities, the interaction between these groups probably is underestimated in scientific literature.

This work emerged from casual observation of Monk parakeets (*Myiopsitta monachus cotorra*) foraging on fruits of sardinheira (*Banara arguta*) leading to the overthrow of fruits and consumption by sardines (*Triporthus pantanensis*) and piraputangas (*Brycon hilarii*), in the floodplain along the Miranda river, Pantanal of Mato Grosso do Sul.

The Monk parakeet is a non-migratory parakeet about 29 cm long, with gregarious behavior. Its natural distribution extends from Bolivia to central Argentina (Forshaw 2006). In the southern Pantanal 18 tree species of riparian vegetation are used in the foraging of Monk parakeets, which consumes aryls, flowers, nectar, fruit and seeds (Ragusa-Netto & Fecchio 2006). The main resource for the parakeets in the Pantanal is *Banara arguta* (Salicaceae), a very common tree in seasonal flooded habitats, reaching up to 6 meters tall and fruiting during the flood period in the Pantanal (April-May) (Pott & Pott 1994, Ragusa-Netto & Fecchio 2006). Its fleshy fruit has a purplish color and is eaten by parrots, toucans, bats, monkeys and fishes (Ragusa-Netto 2006, Ragusa-Netto & Fecchio 2006, Gonçalves *et al.* 2007, Bravo 2009). Regarding fish, at least nine species feed on the fruits of *B. arguta* in the Pantanal floodplain (Costa-Pereira *et al.* 2011). In light of this, here we report the interaction between fish that consume wasted fruits of *B. arguta* during its consumption by Monk parakeets in the southern Brazilian Pantanal.



Figure 1. Individuals of Monk Parakeets (*Myiopsitta monachus cotorra*) foraging on fruits of *Banara arguta* on Pantanal floodplain.

## Observations

The monitoring of the interaction was conducted on the 1st May 2011 in a focal individual of *Banara arguta* near the Pousada Passo da Lontra (19°34'47"S, 57°01'13"W), Pantanal, Brazil. The observed tree was located approximately 70 meters from the margin of the Miranda river, flooded at that date, with the water column ca. 1.5 m beneath the canopy. The behavior was observed from 08:00 h until 10:15 h, when the birds stopped feeding on the fruits.

Due to the need to count gill rakers to identify *Triporthus* species, a few fish that were under the tree were captured with rod and barbless hooks, using fruits of *B. arguta* collected *in situ* as bait. Thirteen specimens of sardines were collected, fixed in 10% formalin, transferred to 70% alcohol and taken to the laboratory for identification, following the key proposed by Malabarba (2004). We deposited the voucher specimens in the zoological collection of the Federal University of Mato Grosso do Sul (ZUFMS-PIS 3190). The taxonomic identification of piraputangas could be made on site, and then we released them.

The flock of Monk parakeets was composed of eight to 11 individuals during the observation period. No individuals were observed taking fruit off the focal tree to feed. It was possible to see two ways of obtaining the fruits of *B. arguta*: i) picking the fruit directly from the bunch (= infrutescence) with the beak and swallowing it (Figure 1), and ii) cutting the bunch with the beak, holding it with the foot and selecting a fruit with the beak, and discarding the others. When foraging ceased, the birds remained for a few minutes cleaning their beaks, scraping them on branches of the same tree before leaving. The discarded bunches fell in the water, where they were disputed by fish (Figure 2). We verified that the shoals were composed of Characiformes: sardinhas *Triporthus pantanensis* Malabarba, 2004 and piraputangas (*Brycon hilarii* Valenciennes, 1850).

## Discussion

Mammals are considered primarily responsible for the overthrow of fruits in forests. Howe (1980) was able to verify that they are responsible for 98% of the overthrown fruits of a tree species in Panama,



**Figure 2.** Schools of sardinhas *Triporthesus pantanensis* and piraputangas *Brycon hilarii* foraging on *Banara arguta* fruits dropped by Monk parakeets on Pantanal floodplain.

especially howler monkeys. In the Brazilian Pantanal, Desbiez *et al.* (2010) observed peccaries that feed on fruits dropped by howler monkeys and coatis. However, despite the great abundance of parrots in neotropical forests, few studies comment directly on the waste of fruit resources available from parrots foraging (but see Janzen 1981).

Howler monkeys have also been sighted consuming fruits of another individual of *B. arguta* during this work. However it is noteworthy that the fruits of *B. arguta* represent the bulk of the diet of Monk parakeets in the Pantanal (Ragusa-Netto & Fecchio 2006) and that, as in flooded Amazon forest trees (Kubitzi & Ziburski 1994), its fruiting period coincides with the period of flood.

Some *Triporthesus* species have frugivorous habits, such as the Amazonian ones studied by Goulding (1980). The same author considers them as the major frugivores of the Amazon flooded forest, covering a wider range of fruit species in their diet than other fish. For the Pantanal, the frequency of fruits in the diet of *T. pantanensis* is uncertain, but possibly it is an important resource, given the abundance of fish in the floodplain, especially under fruiting trees, as we observed during this work. Reys *et al.* (2009) observed piraputangas (*Brycon hilarii*) feeding on fruits of 12 plant species in streams at the edge of the Pantanal. The same authors also report piraputangas that jumped out of the water to obtain fruit directly from a tree. The same behavior we observed in this work, with individuals of *B. hilarii* that leaped towards the fruit of *Banara arguta* on branches closest to the water. Therefore, Monk parakeets acts as a facilitator for these fish species in obtaining fruit, with overthrown fruits and infrutescences of *B. arguta* in the water of the Pantanal floodplain.

Costa-Pereira *et al.* (2011) suggested that ichthyochory should be important to *Banara arguta* recruitment dynamics in the Pantanal wetland, once fructification occurs during the flood season and potentially fruit-eating fishes are diverse and abundant on floodplains. Hence, foraging of Monk parakeets on *B. arguta* may increase the rate of fruit drop, and consequently, the consumption of fruits by floodplain fishes. This foraging association between parakeets and fishes promotes a two-way zoochorical dispersal, ornithochory and ichthyochory, for this plant species in the Pantanal.

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