



Cats singing in the dark? Spawning aggregations of sound-producing fish in Amazonian floodplain forests

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Abstract The Amazon basin has a freshwater fish diversity comparable to a tropical sea. Although many Amazonian fish species are popular ornamental fish across the world, the ecology of most species in their natural habitat remains poorly known (van der Sleen and Albert 2017). We report on shoaling behavior in *Platydoras hancockii* in a floodplain forest of the middle Rio Negro, Brazil. As the shoal consisted of only adult males, whereas gravid females were caught individually in nearby areas, we hypothesize that this aggregation may relate to spawning. Moreover, considering that *Platydoras hancockii* is capable of producing sounds, it is possible that these aggregations entail the formation of a chorus-like call with the function of attracting females from a larger area.

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A predictable flood pulse in the Amazon basin inundates floodplain forests at vast spatial scales for several months each year, thereby creating crucial feeding and nursery grounds for Amazonian fish (e.g., Goulding 1980). How individuals of the same fish species find each other during this reproduction period and how mate selection takes place in these immense, shaded, and often murky waters remains largely unknown.

During the high-water season, on May 16, 2019, we collected a shoal of 28 individuals of the raphael catfish *Platydoras hancockii* (Siluriformes: Doradidae) in a blackwater floodplain forest (Fig. 1a, b), about 5 km from the town of Barcelos in the Mariuá Archipelago, middle Rio Negro, Brazil (0.56°S, 62.55°W). The sampling was part of a larger research project on the effects of floodplain forest loss by fire on fish communities (Lugo-Carvajal et al. in prep.). The fish were caught within an unburned floodplain forest and were retrieved from the net at 11 am, but probably got entangled at night or crepuscular hours. All individuals were collected close together and within a few meters of a gillnet of 60 mm mesh size in an area of about 1.2 m depth.

Strikingly, all individuals in this aggregation were adult males, with a size range of 135–180 mm SL and a weight range of 31–105 g. Sex determination for this species is difficult based on external morphological traits only, and was hence established anatomically after euthanizing the

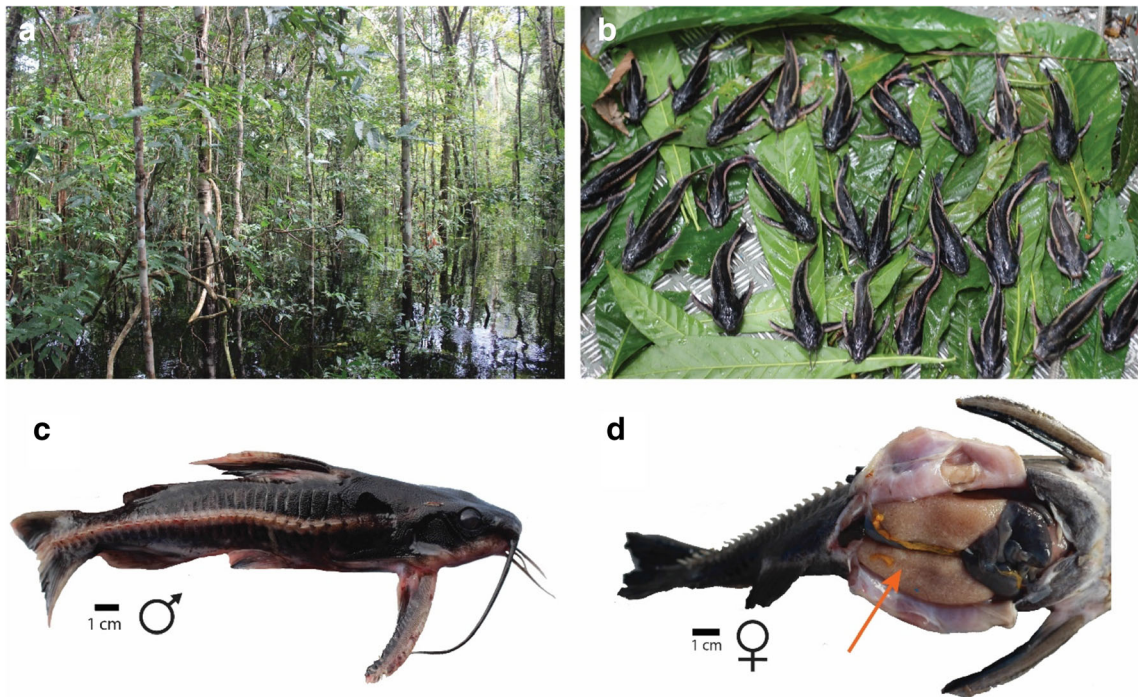


Fig. 1 Floodplain forest in the middle Rio Negro, Brazil (a). Collection of male *Platydoras hancockii*; individuals after retrieving them from the gillnet (b). The genus *Platydoras* consists of four species, with *P. hancockii* restricted to the upper Orinoco, Negro, Essequibo and Demerara drainages (Piorski et al. 2008). *Platydoras* species feed primarily on invertebrates, snails, bivalves

and detritus (Le Bail et al. 2000; Sousa et al. 2017). Some species may also exhibit cleaning behavior as juveniles, picking of parasites from larger predatory fish, and the strongly contrasting black and white coloration may function as a signal for being recognized as a cleaner (Carvalho et al. 2003). Close-up of a male (c) and a large gravid female, with orange arrow indicating eggs (d)

fish with an eugenol solution. In the same area, and at the same day and time, but apart from this group (less than 20 m), we collected a large gravid female of 180 mm SL (Fig. 1d) suggesting this assembly may relate to spawning. Individual females were also collected in nearby sites during the same sampling period. Shoaling behavior in catfish is not common, but has been reported for several species, including most *Corydoras* species (e.g., Paxton 1997; Breeland and Strauss 2005). For “*Amblydoras hancockii*” from French Guyana, Le Bail et al. (2000) reported it occurred in shoals of several hundred. Surprisingly, that information has subsequently been put under *Platydoras hancockii* in two major online databases (Eschmeyer’s Catalog of Fishes and FishBase), but the photograph accompanying Le Bail’s description appears to be a species of the genus *Anadoras*.

Male aggregations in *Platydoras hancockii* may be facilitated by its sound producing behavior. During the moment of capture, the fish were producing squeaking sounds (see Online Resource 1 for a short video of the moment of capture). In doradid catfishes, sounds are produced by the friction of the pectoral-fin spine against the

pectoral girdle (Ladich 2001), and by the contraction of muscles that move the parapophyses of the fourth vertebra (Müllerian ramus) and gas bladder, in a special arrangement named the elastic spring apparatus (Boyle et al. 2015). Although the doradid sonic mechanism appears relatively simple, the drumming sounds produced can be quite complex and exhibit variation in pulse rate, temporal patterning, waveform shape, and amplitude modulation (Kastberger 1978; Papes and Ladich 2011; Kaatz and Stewart 2012; Knight and Ladich 2014). Sounds are likely species-specific, and for *P. hancockii* three distinguishable sound types have been recorded (Boyle et al. 2015).

The advantage of using audial signals is that they propagate fast and in all directions, unlike olfactory cues, which travel downstream from the sender under lotic conditions, and to longer distances than visual signals, which quickly weaken with increasing distance in dark waters such as those of the Rio Negro. We hypothesize that the observed group of *P. hancockii* males may be related to the collective production of sounds. When three or more nearby animals have calls that overlap or are produced in rapid succession, this pattern of sound

production is referred to as a chorus (Greenfield and Shaw 1983), a fact that have been reported for several marine fishes (e.g. batrachoidids and sciaenids, Amorim et al. 2015; and ariid catfishes, Tavolga 1960). In the Amazon freshwaters there are also records of choruses by the sciaenid *Plagioscion squamosissimus* (Borie et al. 2014) and by several characiform species of the families Curimatidae and Prochilodontidae (Smith et al. 2017). However, as far as we know, there were no published evidences of choruses by freshwater catfishes. The louder sounds produced by the group could propagate information on their presence over a larger area, increasing the effectiveness of attracting females and possibly reproductive success. Such a strategy may be particularly advantageous in the Amazon during the flooding season, given the immense size of the wetlands during that time of the year. Although anecdotal, our observation provides a glimpse of the complex social behavior fish can exhibit, and highlights the importance of floodplain forests as spawning areas for Amazonian fish.

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