

Scientific Note

The more stirring the better: cichlid fishes associate with foraging potamotrygonid rays

Domingos Garrone-Neto¹ and Ivan Sazima^{2,3}

One hunting tactic of freshwater rays (Potamotrygonidae), termed “undulate the disc and stir substrate”, is here reported to attract cichlids at two sites in the upper Paraná River. The ray species involved in such association are *Potamotrygon falkneri* and *P. motoro*, whose activity attract four cichlid species, namely *Crenicichla britskii*, *Satanoperca pappaterra*, *Cichla kelberi*, and *Geophagus proximus*, the two latter non-native species to the study area. The cichlids approach a ray when it begins to stir the substrate and form sediment clouds, and remain close to the ray during this activity only. The association is here regarded as following behavior even if very transient.

Uma tática de caça das raias de água doce (Potamotrygonidae), chamada de “ondular o disco e agitar o substrato”, é aqui relatada como atrativa para Cichlidae em dois locais da bacia do alto rio Paraná. As espécies de raias envolvidas nesta associação são *Potamotrygon falkneri* e *P. motoro*, cuja atividade atrai quatro espécies de ciclídeos, *Crenicichla britskii*, *Satanoperca pappaterra*, *Cichla kelberi* e *Geophagus proximus*, as duas últimas exóticas à área de estudo. Os ciclídeos se aproximam de uma raia quando esta começa a remexer o substrato e formar nuvens de sedimento, e permanecem na proximidade da raia apenas durante esta atividade. A associação é aqui considerada como comportamento de seguir, ainda que transitório.

Key words: Cichlidae, Feeding association, Potamotrygonidae, Hunting tactics, Southeastern Brazil.

Several fish species that feed on benthic preys often associate with substrate-disturbing, generally larger fish species. So called following association comprise a fish or a fish group that excavate or otherwise disturb the substrate while foraging, and one or more opportunistic species that capitalize on the small animals and other food types displaced by the foraging activity of the former (Strand, 1988; Lukoschek & McCormick, 2000). This association is a well-known one in the marine environment (see Strand, 1988; Sazima *et al.*, 2007 for overviews), although a few instances are reported from freshwater habitats as well (*e.g.*, Sazima, 1986; Baker & Foster, 1994; Leitão *et al.*, 2007; Teresa & Carvalho, 2008).

Several species of rays (particularly of the Myliobatoidei) forage with use of a tactic we termed “undulate the disc and stir substrate”, as illustrated by species of the freshwater

Potamotrygonidae (Garrone-Neto & Sazima, 2009). Here we report on four cichlid species attracted to the stirring by two *Potamotrygon* species at two sites in the upper rio Paraná, Southwestern Brazil.

The study sites are in the vicinity of Campinal, SP (about 21°32'S 52°03'W) and Três Lagoas, MS (about 20°47'S 51°37'W) on the border of São Paulo and Mato Grosso do Sul, Southeastern Brazil. The association and the behavior of the fishes were recorded underwater while snorkeling or scuba-diving (Sabino, 1999) at day and night hours in the middle of the dry season in August and at the onset of the rainy season in November 2007 and 2008. A total of 84 h of underwater observations was made through the study, most of them with snorkeling (78 h at depths of 0.5 to 12 m) and the remainder time with scuba-diving (6 h at depths of 8-18 m).

¹Departamento de Zoologia, Universidade Estadual Paulista, CP 510, 18618-000 Botucatu, São Paulo, Brazil. garroneneto@yahoo.com

²Museu de Zoologia, Universidade Estadual de Campinas, CP 6109, 13083-970 Campinas, São Paulo, Brazil. isazima@gmail.com

³Retired and associated as voluntary researcher.

“*Ad libitum*” and “behaviour” sampling rules (Martin & Bateson, 1986) were used throughout the observational sessions, mostly recorded on a plastic slate (Garrone-Neto & Sazima, 2009). Size estimates (total length TL for the cichlids, and disc width DW for the rays) were calibrated against actual specimens or objects of known size.

The beginning of association may be conveniently exemplified by a ray stirring the unconsolidated (loose) substrate to uncover small invertebrates such as insect larvae, crabs, and snails. This activity stirs the substrate particles and discrete sediment clouds are formed near the foraging ray (Fig. 1). These clouds apparently catch the attention of nearby cichlids that approach the ray and feed on small preys and other food types exposed this way (Fig. 2). Clouds of sand and other sediment types are one of the most important visual cues for followers to approach a substrate-disturbing fish (e.g., Fricke, 1975; Fishelson, 1977; Sazima *et al.*, 2006; Leitão *et al.*, 2007).

Cichlids were attracted to foraging activity of *P. falkneri* (n = 6) and *P. motoro* (n = 1). We recorded four cichlid species attracted to rays, namely *Crenicichla britskii*, *Satanoperca*

food types such as plant debris (see Sazima, 1986 for *S. pappaterra*). The duration of the association varied 8-1,320 sec ($x = 12,1$; $sd = 4,94$; $N = 7$). While close to the ray, the cichlids were unusually wary and do not allowed close approach of the observer (this behavior also precluded photographs). No cichlid or any other fish was recorded close to rays foraging at night. From a total of 42 recorded instances of rays’ foraging over unconsolidated bottoms, association with cichlids was recorded for only seven (17%) of these. Thus, the association may be regarded as rare, possibly related to the recent colonization of the upper Paraná River by potamotrygonid rays (Garrone-Neto *et al.*, 2007; Garrone-Neto, 2009).

Although the cichlids only approached the ray while it was already stirring the substrate, the association is here regarded as following behavior even if a very transient one (see Sazima *et al.*, 2007; Leitão *et al.*, 2007; Teresa & Carvalho, 2008). The association between cichlids and rays was recorded in still water (marginal ponds and dammed river portions), which favors sediment deposition. This latter, in turn, favors “cloud” formation during foraging by rays and attracts zoobenthivorous and opportunistic cichlids. No association



Fig. 1. A freshwater ray (*Potamotrygon motoro*) forages with use of “undulate the disc and stir substrate” tactic. Note fine clouds of sediment adjacent to the ray.

pappaterra, *Cichla kelberi* and *Geophagus proximus*, the two latter non-native species introduced about a decade ago in the upper Paraná River for fishery purposes (Graça & Pavanelli, 2007). From these, the species most commonly recorded associated with a ray were *C. britskii* (n = 3), *Geophagus proximus* (n = 2), and *C. kelberi* (n = 2). The cichlids’ sizes varied from about 6 cm TL (*C. britskii*, *G. proximus*, and *S. pappaterra*) to about 14 cm (*C. kelberi*), and the rays’ sizes varied from 32 to 45 cm DW. Thus, in most instances both the rays and the cichlids were juveniles.

Up to four individuals of two cichlid species were attracted to a single ray (Fig. 2). Once close to a foraging ray (Fig. 2a), the cichlids hovered head-down near the ray’s undulating disc (Fig. 2b), watched intently and lunged forwards to snatch disturbed small prey (mostly larval aquatic insects) and other

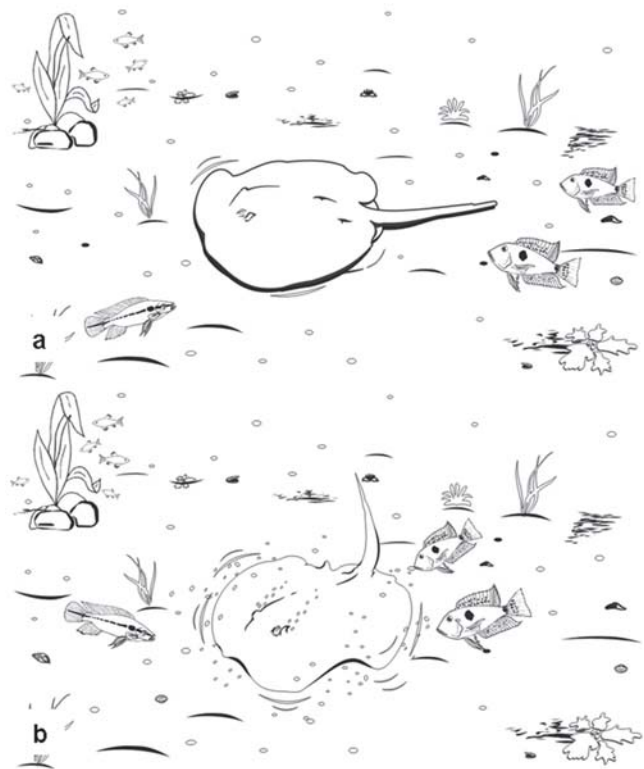


Fig. 2. Association between a foraging freshwater ray (*Potamotrygon falkneri*) and two species of cichlid fishes (*Crenicichla britskii* on the left and *Geophagus proximus* on the right). The ray settles close to the bottom, begins to undulate the disc and stir the substrate, which cause the cichlid to approach (a); as the ray proceeds foraging and forms a fine sediment cloud, the cichlids hover head-down close to the disc and watches potential prey to be uncovered by the ray’s movements (b).

was ever recorded for rays hunting in flowing water.

It is noteworthy that no characid species was recorded close to foraging rays, as tetras are opportunistic foragers and a few species are already reported as followers of substrate-disturbing fishes (Sazima, 1986; Teresa & Carvalho, 2008). Although not much probable, one explanation could be that the rays prey occasionally on small characids (Lonardoni *et al.*, 2006; Garrone-Neto, 2009). However, further field studies may disclose additional associations of fishes other than cichlids and even other aquatic animals with foraging freshwater rays.

Acknowledgements

We greatly thank Otilie Carolina Forster e Laura Furlan Luvisoto for help during fieldwork at the Três Lagoas area; Marcos Teixeira da Silveira, diving fisherman of the Colônia Z-3/MS gave us valuable information about the rays and the study sites; logistic support at the Universidade Federal de Mato Grosso do Sul - Campus Três Lagoas was possible through the kindness of Maria José Alencar Vilela; part of financial support went through the kindness of Virgínia Sanches Uieda (PROAP-CAPES/UNESP); both authors are grantees of the CNPq; two anonymous referees provided their time and valuable suggestions.

Literature Cited

- Baker, J. A. & S. A. Foster. 1994. Observations on a foraging association between two freshwater stream fishes. *Ecology of Freshwater Fish*, 3(3): 137-139.
- Fishelson, L. 1977. Sociobiology of feeding behavior of coral fish along the coral reef of the Gulf of Eilat (= Gulf of 'Aqaba), Red Sea, Israel. *Israel Journal of Zoology*, 26: 114-134.
- Fricke, H. W. 1975. The role of behaviour in marine symbiotic animals. Pp. 581-594. In: Jennings, D. H. & D. L. Lee (Eds.). *Symbiosis. Symposia of the Society for Experimental Biology* 29. Cambridge, Cambridge University Press, 346p.
- Garrone-Neto, D. 2009. História natural, diversidade e distribuição de raias na região do Alto Rio Paraná, Brasil. Unpublished Ph.D. Dissertation, Universidade Estadual Paulista, Botucatu, 204p.
- Garrone-Neto, D., V. Haddad Jr., M. J. A. Vilela & V. S. Uieda. 2007. Registro de ocorrência de duas espécies de potamotrigonídeos na região do Alto Rio Paraná e algumas considerações sobre sua biologia. *Biota Neotropica*, 7(1): 1-4.
- Garrone-Neto, D. & I. Sazima. 2009. Stirring, charging, and picking: hunting tactics of potamotrygonid rays in the upper Paraná River. *Neotropical Ichthyology*, 7(1): 113-116.
- Graça, W. J. & C. S. Pavanelli. 2007. Peixes da planície de inundação do alto rio Paraná e áreas adjacentes. Maringá, Eduem, 241p.
- Leitão, R. P., E. P. Caramaschi & J. Zuanon. 2007. Following food clouds: feeding association between a minute loricariid and a characidiin species in an Atlantic Forest stream, Southeastern Brazil. *Neotropical Ichthyology*, 5(3): 307-310.
- Lonardoni, A. P., E. Goulart, E. F. Oliveira & M. C. F. Abelha. 2006. Hábitos alimentares e sobreposição trófica das raias *Potamotrygon falkneri* e *Potamotrygon motoro* (Chondrichthyes, Potamotrygonidae) na planície alagável do alto rio Paraná, Brasil. *Acta Scientiarum, Biological Sciences*, 28(3): 195-202.
- Lukoschek, V. & M. I. McCormick. 2000. A review of multispecies foraging associations in fishes and their ecological significance. *Proceedings of the 9th International Coral Reef Symposium*, 2000: 23-27.
- Martin, P. & P. Bateson. 1986. *Measuring Behaviour - an Introductory Guide*. New York, Cambridge University Press, 200p.
- Sabino, J. 1999. Comportamento de peixes em riachos: uma abordagem naturalística. Pp. 183-208. In: Caramaschi, E. P., R. Mazzoni & P. R. Peres-Neto (Eds.). *Ecologia de Peixes de Riachos*. Rio de Janeiro, PPGE-UFRJ, 260p.
- Sazima, C., J. P. Krajewski & R. M. Bonaldo. 2006. The goatfish *Pseudupeneus maculatus* and its follower fishes at an oceanic island in the tropical West Atlantic. *Journal of Fish Biology*, 69(4): 883-891.
- Sazima, C., J. P. Krajewski, R. M. Bonaldo & I. Sazima. 2007. Nuclear-follower associations of reef fishes and other animals at an oceanic archipelago. *Environmental Biology of Fishes*, 80(4): 351-361.
- Sazima, I. 1986. Similarities in feeding behaviour between some marine and freshwater fishes in two tropical communities. *Journal of Fish Biology*, 29(1): 53-65.
- Strand, S. 1988. Following behavior: interspecific foraging associations among Gulf of California reef fishes. *Copeia*, 1988(2): 351-357.
- Teresa, F. B. & F. R. Carvalho. 2008. Feeding association between benthic and nektonic Neotropical stream fishes. *Neotropical Ichthyology*, 6(1): 109-111.

Accepted July 23, 2009

Published September 30, 2009