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Association between fruit-eating fish and foraging monkeys in western Brazil

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Fishes may exploit, or benefit from, the foraging activity of other fishes and other aquatic animals as well. We report here on a feeding association between the characid fish *Brycon microlepis* and the brown capuchin monkey *Cebus apella*, in western Brazil. The monkeys feed on fruits from the vegetation along river banks, and during their destructive foraging broken twigs, leaves, and fruits are dropped in the water below. The fish are attracted by this activity and feed on the fruits, following the monkey troop during its foraging along the water course.

Peixes podem associar-se com outros peixes, ou mesmo outros organismos aquáticos, durante sua atividade alimentar, obtendo benefício desta relação. No presente estudo relatamos a associação alimentar entre o caracídeo *Brycon microlepis* (piraputanga) e o macaco-prego, *Cebus apella*, no oeste do Brasil. Os primatas comem frutos na vegetação marginal de riachos e, durante sua alimentação, derrubam ramos, folhas e frutos na água. Os peixes são atraídos por esta atividade e alimentam-se dos frutos, seguindo o bando de macacos durante seu forrageamento ao longo do riacho.

Introduction

Fishes may associate with other fishes, and other aquatic animals as well, to exploit or to benefit from their foraging activity (e.g., Strand, 1988; Yuma, 1994). Feeding association of fishes with animals other than fishes include serranids and labrids following octopuses in the Sea of Cortez, Gulf of California (Strand, 1988), cichlids following crabs in Lake Barombi Mbo, Cameroon (Dominey & Snyder, 1988), and cyprinids following and cleaning hippos in M'Zima Springs in Kenya (Hediger, 1953). We report here on the association between a fruit-eating characid fish, *Brycon microlepis*, and foraging brown capuchin monkeys, *Cebus apella* (Cebidae), in a riverine forest in Mato Grosso do Sul, western Brazil.

Several characiform fish species feed on fruits, especially in the Amazonian flooded forest (Gottsberger, 1978; Goulding, 1980; Kubitski & Ziburski, 1994). Fruits or seeds from vegetation along the river bank fall in the water, and are consumed whole or masticated, depending on the type and the size of both the fruit and the fish (Goulding, 1980; Kubitski & Ziburski, 1994). Native fishermen take advantage of these feeding habits, and catch fruit-eating fishes by mimicking falling fruits with precise movements of their fruit-baited angling gear (Goulding, 1979; pers. obs.)

The species of the South American characids of the genus *Brycon* consume mostly allochthonous food, i.e., that originating from the adjacent forest (Goulding, 1980). Food consumed by several species include fruits, seeds, and leaves,

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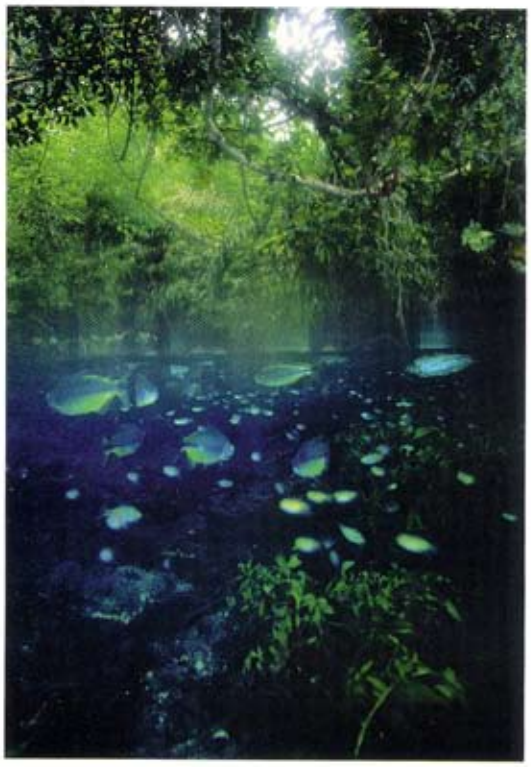

Fig. 1. *Brycon microlepis* schooling in the spring of Baía Bonita, Mato Grosso do Sul, western Brazil (smaller fishes are tetragonopterine characins). Note overhanging vegetation on riverbank.

as well as arboreal and terrestrial insects (Menezes, 1969; Goulding, 1980). *Brycon microlepis* occurs in the Paraguay River drainage, and plausibly has such a diet but its feeding habits remain mostly unrecorded.

Capuchin monkeys, genus *Cebus*, are omnivores widely distributed in the Neotropics (Freese & Oppenheimer, 1981), and their feeding activity causes a shower of broken twigs, leaves, and fruits down the vegetation (Terborgh, 1983). The brown capuchin monkey, *Cebus apella*, follows this foraging pattern (Galetti & Pedroni, 1994).

Study site and methods

Field observations were carried out at Baía Bonita spring, Paraguay River drainage in Bonito (56°25'W 21°09'S), Mato Grosso do Sul, western Brazil, from 11 to 13 October 1997. The Bonito springs are habitats of great scenic beauty, with crystal-clear waters and abundant aquatic vegetation, fringed by gallery forests (Fig. 1). The studied spring covers about 800 m², its depth ranges from 0.3 to 2.7 m and its horizontal transparency is about 20 m.

Behavioural observations on fish were made during daytime with SCUBA gear (Helfman, 1983), and behaviour events were sampled using 'ad libitum', focal-animal, and sequence samplings (Lehner, 1979). Behaviour was recorded on plastic slates, photographed, and video-recorded (Helfman, 1983; Sazima, 1986). Monkeys were observed both from underwater and above water perspectives. Monkey behaviour was recorded in the same way as described for fish, plus terrestrial photographic record.

Results

Schools of up to 30 *B. microlepis* individuals (21-37 cm total length) congregated under overhanging riverbank vegetation, where troops of up to 12 *Cebus apella* individuals foraged for fruits. The monkeys were recorded feeding on fruits of *Guarea* cf. *guidonia* (Meliaceae) and *Zanthoxyllum riedelianum* (Rutaceae). While feeding on fruits (Fig. 2) the monkeys often dropped broken twigs, parts of infrutescences, and whole fruits of the above mentioned plants. The fish were readily attracted to the dropped plant pieces and fed on the fruits (Fig. 2). As the monkeys moved during their foraging on the river bank vegetation, their activity was followed up to 100 m along the water course by the attentive fish.

Discussion

The association between fish and monkeys reported here is clearly related both to the destructive foraging of *Cebus* monkeys (Terborgh, 1983), and the foraging on allochtonous food, especially fruits, by species of *Brycon* (Goulding, 1980). Most schooling characins are diurnal, visually oriented and opportunistic feeders (Lowe-McConnell, 1987; Menezes et al., 1981; Rodríguez & Lewis, 1997) and this is also the case of *B. microlepis*. At our study site this fish consumes mostly fruits and seeds, besides occasional insects fallen from the river bank vegetation (pers. obs.).

In the Amazon, *Brycon* sp. and *B.* cf. *melanopterus* consume fruits or seeds of several plant

Fig. 2. Capuchin monkey, *Cebus apella*, feeding on the fruits of *Zanthoxyllum riedelianum* (upper). Fruits of *Zanthoxyllum* dropped in the water are fed upon by *Brycon microlepis* (lower).

species, which are crushed by their complex dentition (Goulding, 1980). Thus, most species of *Brycon* probably act primarily as seed predators rather than seed dispersers, unless the consumed fruits have very small seeds or are swallowed whole (Goulding, 1980). The seeds of both *Guarea* and *Zanthoxyllum* in our study are relatively large (up to 3.8 mm), and thus are probably masticated during their ingestion by *B. microlepis*. Both these plant species are primarily dispersed by birds (M. Galetti, pers. comm.).

Judging from the foraging pattern of the white uakari, *Cacajao calvus*, another monkey species which causes fruits to fall in the water of the Amazonian flooded forest (Ayres, 1990), it is likely that additional instances of feeding association between fruit-eating characid fish and foraging monkeys will be found there. Francisco A. Machado (pers. comm.) observed a school of *B. microlepis* following a flock of the cuculid bird, *Crotophaga major*, foraging on overhanging riverine vegetation of Cuiabá River, Mato Grosso. The fish fed on insects, mostly katydids, flushed on the water by the birds' activity. At Ipiranga River in São Paulo, southeastern Brazil, we observed an individual of *B.* cf. *opalinus* catching a katydid flushed out by a foraging pair of a passerine bird, *Piranga flava*. Thus, besides benefiting from fruit-feeding activity of monkeys, *Brycon* is able to exploit the foraging activity of birds as well, this time feeding on insects.

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