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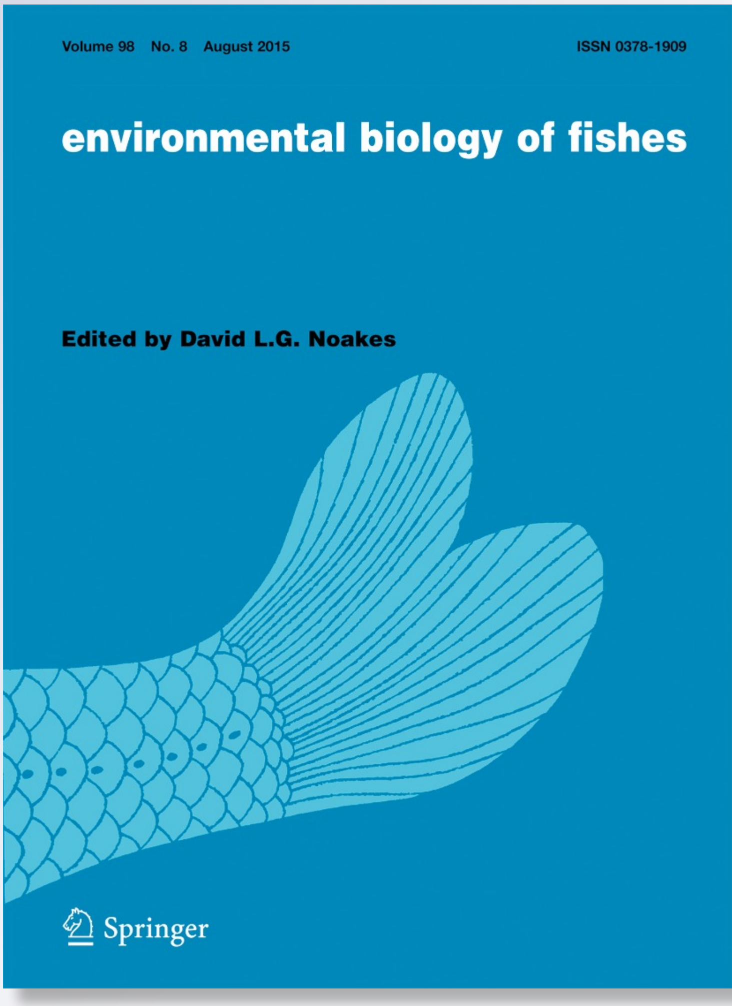
Environmental Biology of Fishes

ISSN 0378-1909
Volume 98
Number 8

Environ Biol Fish (2015) 98:1913-1926
DOI 10.1007/s10641-015-0407-3



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First observations on annual massive upstream migration of juvenile catfish *Trichomycterus* in an Amazonian River

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Received: 7 October 2014 / Accepted: 18 February 2015 / Published online: 6 March 2015

Abstract Following flooding peaks in the Beni River, a massive upstream migration event involving juvenile pencil catfish (*Trichomycterus barbouri*) or chipi chipi is described for the first time. The annual migration begins in the floodplains of the Beni River, where enormous schools of juveniles form to travel upstream through the straits of the last foothills of the Andes into Andean foothill forest streams and rivers. Observations and local knowledge suggest a migration distance of at least 370 km over an average of 32 days in February and March with an average speed of 12 km/day. The migrating juveniles weigh less than 0.38 g and measure less than 33 mm in standard length. As such, considering body length and body weight to distance travelled ratios they are one have one of the greatest migration efforts of any freshwater fish. Local people harvest juveniles across the migration route, but especially in Rurrenabaque, where they are considered a seasonal dish. This scientific revelation highlights the Amazon as a place where natural phenomena are still being discovered, described and documented in an era when hydroelectric infrastructure threatens the ecology of many aquatic ecosystems.

Keywords Migration route · Migration description · Pencil catfish · Juveniles · Foothills · Bolivia

Electronic supplementary material The online version of this article (doi:10.1007/s10641-015-0407-3) contains supplementary material, which is available to authorized users.

G. Miranda-Chumacero (✉) · G. Álvarez · R. B. Wallace · L. Painter
Wildlife Conservation Society, Greater Madidi Tambopata Landscape Conservation Program, La Paz, Bolivia
e-mail: gmiranda@wcs.org

V. Luna
Comunidad de San Miguel, TCO Tacana, La Paz, Bolivia

Introduction

Fish migrations per se are unique and complex phenomena (Brower and Malcolm 1991; Barthem and Goulding 1997; Lucas and Baras 2001; Milner-Gulland et al. 2011). The term migration covers a wide range of collective fish movements (daily, lateral, vertical, annual, cyclical and historical) that reflect corresponding life strategy variation (Lucas and Baras 2001; Zapata and Usma 2014). The majority of collective movements are guided by: a) feeding, b) shelter, c) spawning, and d) colonization and exploration (Lucas and Baras 2001). Migration may also simply respond to spawning, movements upstream because of descending water levels and dispersion (Goulding and Carvalho 1982; Ribeiro 1983; Junk 1984; Barthem and Goulding 1997). The major fish migrations are associated with reproduction and spawning such as the well documented salmon migrations (McGlauflin et al. 2011), where mature adults migrate from floodplains upstream to headwaters to spawn. Dispersion movements have been demonstrated for *Semaprochilodus* juveniles in the Negro River and have been suggested for smaller species (McConnell and Lowe-McConnell 1987). Other types of migration stimuli have been comprehensively systematized by Lucas and Baras (2001), for example, massive movements by individuals seeking shelter or food often associated with juveniles seeking more suitable conditions for development.

Many environment factors are stimuli for fish migrations, but flooding cycles is one the most important (Junk et al. 1989). In environments like the Amazon basin, these cycles are extreme and define the biological cycles of the majority of fish species (McConnell and Lowe-McConnell 1987; Welcomme 1979, 1985).

In the Amazon basin the catfishes *Brachyplatystoma rousseauxii* and *B. filamentosum* have the longest known migration for all fish species in the world. They journey more than 3500 km from the Amazon River estuaries to the Andean foothills (Barthem and Goulding 1997). Although large catfish migration phenomena are well known to local people, especially fishermen, they are still poorly understood (Petrere et al. 2005), especially when the portion of the population migrating are juveniles (Araújo-Lima and Oliveira 1998; De Lima and Araujo Lima 2004; Gomes et al. 2006).

In this study we document a previously undocumented massive juvenile migration of pencil catfish *Trichomycterus* cf. *barbouri* in the Beni River, Bolivia, observed for the first time in 2011 after a flood period. In order to describe this migration we established a network of local observers to record localities for observed schools, help collect specimens, film and photograph the migration, and estimate migration routes and periods. The only registered Trichomycteridae migration are those of the hematophagous parasites or "candiruses" (*Paracanthopoma* and *Vandellia*) that travel attached to the skin or gills of a host, usually a large catfish of the Pimelodidae family such as *Zungaro zungaro* and *Brachyplatystoma vaillanti* (Zuanon and Sazima 2005). Until the research presented herein no Trichomycteridae species was known to truly migrate through its own effort (Burgess 1989).

Methods

Study area

The Beni River is one of the largest rivers in Bolivia with a length of 1010 km, caudal discharge of 2050 m^3/s in the Bala straights, and an estimated sediment discharge of ~192 million tonnes/year in the Rurrenabaque region (Gautier et al. 2006). The Beni River is born as the Tallija River in the Central Cordillera of the Bolivian Andes, becoming the Beni River at the confluence of the Alto Beni and Kaka rivers (Fig. 5). From here it also receives the waters of the Hondo, Quiquibey and Tuichi rivers, before passing the straights of the Bala and Suse escarpments as the last Andean foothills and then opening on to the Amazonian floodplain (Fig. 5). In the floodplain the Beni forms countless meanders that gradually form oxbow lakes characteristic of Amazonian rivers.

Monitoring the migration

After our first observation of migration, in February 2011 following a significant flooding event, we established a surveillance network of seven local observers to report chipi chipi schools in the Tacana communities of Carmen del Emero, Cachichira, Copacabana and San Miguel and the town of Rurrenabaque, all situated along the Beni River. From March 2011 to late 2013 no chipi chipi schools were observed. In early 2014 chipi chipi schools were reported and we tracked the migration between January and March 2014 in different sectors of the Beni River. This monitoring consisted of: a) collating reports from local observers in the Tacana communities of Carmen del Emero, Cachichira, Copacabana and San Miguel and the town of Rurrenabaque situated along the Beni River, and b) characterization of the migration through locating chipi chipi schools between February 26th and March 2nd including filming and photographing schools at each point and describing the size and velocity of the school and behavioral observations. Finally, we georeferenced chipi chipi school observation localities to map the migration route and calculate distances.

Thirty individuals of each school were collected and conserved in 4 % formaldehyde in order to confirm that each school was the same species, take morphological data such as standard length and weight, and examine the stomach contents. Some individuals were preserved in alcohol for future genetic studies. Some live individuals were collected to observe development and behavior in the laboratory.

Stomach contents were qualitatively observed in four individuals after dissection under a stereomicroscope. Travel speeds were estimated in the field and then measured in the laboratory in a circular receptacle of 20 L where 10 individuals were placed and then stimulated to move for complete a lap. Fifteen laps were timed for each individual.

A water level monitoring station exists in Rurrenabaque (14°26′32″S 67°31′42″W) ran by the National Naval Hydrography Service and the ORE-HYBAM program, as well as a meteorology station ran by the National Meteorology and Hydrology Service (SENAMHI) for rainfall and temperature data. These publicly available data were used to relate to migration observations data.

Results

Taxonomic status

Collected individuals were identified as *Trichomycterus barbouri* (Eigenmann 1911, 1918; Fernández 2000) characterized by the presence of a black lateral line extending to the tail. The first pectoral radius is larger than the rest of the radii (Fig. 1) and they possess conical teeth. A voucher was deposited in the Colección Boliviana de Fauna, La Paz, Bolivia (CBF – 13505; CBF – 13506; CBF – 13507; CBF – 13508; CBF – 13509; CBF – 13510; CBF - 13511). In Rurrenabaque this species is called *chipi chipi* meaning "the smallest" in the local indigenous Tacana language. No adults were registered in any of the sample sites. The species was described from 35 specimens of 29 to 40 mm in length from the Beni River (Eigenmann 1911).

Migration description

We determined three zones in the chipi chipi migration according to the geographic characteristics of this region: a) the Beni floodplain zone (180–200 m.a.s.l.), b) the straits zone (200–220 m.a.s.l.) –where fishing is most intensive- and c) the upstream zone (220–400 m.a.s.l.).

a) *Floodplain zone*. Chipi chipi schools were not observed at the Carmen del Emero community, 236 km downstream from Rurrenabaque. Just ~70 km upstream from this community in an area with many oxbow lakes that are connected to the main river during flooding of the wet season, schools were observed in what may be the area where the migration begins. In this zone near the Copacabana community, we observed two schools swimming against the current (Figs. 2 and 5).

b) *Straits Zone*. Just before passing the straits of the Suse escarpment, schools are intensively fished in Rurrenabaque (Fig. 5) along the banks of the Beni River (Fig. 3). In the local region people consume chipi chipi in a popular local dish known as *dunucuavi* that consists of the fish wrapped in patujú leaves (*Heliconia*, Heliconiaceae) and cooked on an open fire, or alternatively prepared in a soup or fried. When the schools pass through Rurrenabaque these fish represent a major but seasonal source of protein for families, with some families gathering up to 50 kg of chipi chipis during the migration (V. Luna, obs. pers., March 2011). After passing through Rurrenabaque the schools are faced with the Suse and Bala straits where the speed and caudal of the river significantly increases. To pass these straits at least some members of the schools climb onto the rocks above the water, adhering to them with their interopercular odontotes (Fig. 4).

c) *Upstream Zone*. Fishing efforts by the team in the tributaries immediately above the straits such as the Hondo, Tuichi and Quiquibey rivers did not yield chipi chipis, rather schools were observed in the Beni River further upstream from the Quiquibey confluence, confirming that the schools travel further upstream. According to observations from local fishermen (Demetrio Tito Abirari and Valentín Luna, San Miguel, TCO Tacana), chipi chipi schools are regularly observed in the Sararía community, near the town of Palos Blancos, on the Alto Beni River, 170 km upstream from Rurrenabaque (Fig. 5).

Characteristics of the schools

Distance traveled Chipi chipi schools are only known from the area 236 km downstream from Rurrenabaque near Carmen del Emero (Fig. 5), although some local fishermen (E. Cabinas, J. Leal. E. Ocampo, March 2014) indicate that chipi chipi schools are observed as far downstream as Monterrey (29 km downstream from

Fig. 1 Example of *Trichomycterus barbouri* (Eigenmann 1911) or chipi chipi captured during migration (32 mm standard length). Photograph: Mileniusz Spanowicz/WCS

Carmen del Emero). In the upstream zone we observed chipi chipi schools further than the Quiquibey River such that the maximum distance between points where chipi chipi schools were observed and photographed or filmed was 73 km. However, taking into account the reported points from communities from Carmen del Emero to Sararía, near Palos Blancos, this distance increases to 373 km ranging from 180 m.a.s.l. to a little more than 400 m.a.s.l..

Number of individuals Observed schools were of different sizes, between 10 and 50 m in length in the floodplains, but extremely challenging to count, and we were unable to sample school size in this study or estimate how many thousands of individuals were in each observed school.

School spread The spread of observed schools was dependent on the movement strategy, with a maximum spread of 30 m observed in the floodplain zone, but much longer and thinner spreads observed in the Suse straits. In the upstream section the schools extended to 50 m.

Riverbank position The migration was observed on both banks moving upstream, but we did not observe schools crossing the river, perhaps suggesting that schools form from individuals from each side of the river coming from oxbow lakes, or the more general floodplain drainage. In the floodplain zone the schools stay near the riverbanks and also close to the surface, forming large clouds of tens of thousands of individuals (Fig. 2). In the straits the schools are further extended but thinner as the chipi chipi individuals pass almost single file on the surface very close to the rocks on the shore and our observations suggest that these schools are continuous (Fig. 4). In the upstream zone where the river is shallower with less volume, schools are more dispersed at the bottom of the river (Fig. 6).

Travel speed Travel speeds depended on the zone but we estimated speeds of 1.08 km/h in the floodplain and just 0.1 km/h in the straits (Table 1), meanwhile in the laboratory speeds varied between 0.49 to 0.75 km/h. Field estimated travel speeds resulted in estimated travel distances of between 2.39 and 25.92 km/day, or between 11.66 to 18.04 km/day using laboratory travel speeds (Table 1).

Individual lengths and weights Standard lengths ranged between 23.36 to 32.88 mm, and weight between 0.08 and 0.38 g. The largest and heaviest individuals were

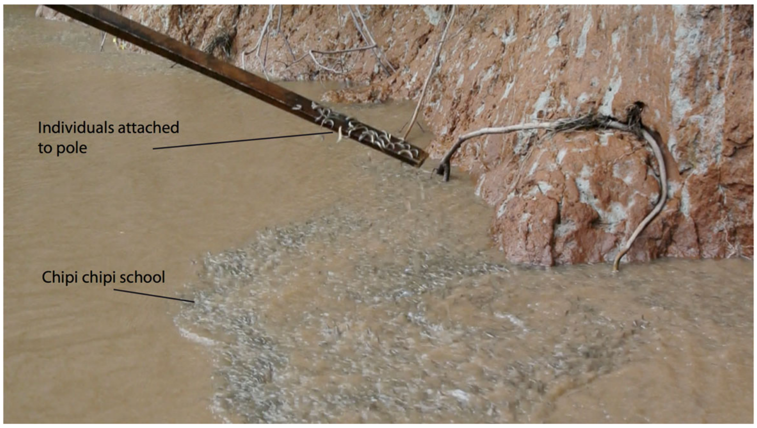

Fig. 2 A *Trichomycterus barbouri* school in the floodplain section of the Beni River: note their clear presence on the surface of the water and along the edge of the river

Fig. 3 Fishing of *T. barbouri* schools in the Rurrenabaque town

collected in the floodplain zone near the Copacabana community (Table 2), but we did not find a relationship between individual sizes and school location along the rivers. The exponential relationship between weight and standard length for all observed schools reveals that individuals attain rapid weight gain as they grow in length (Fig. 7). No adults were registered at any of the sample sites.

Feeding during migration A qualitative examination of stomach contents of some individuals showed only the presence of dipterid larvae, some vegetation, organic material and sediments.

Migration dates The timing of the chipi chipi migration is related with annual flooding events that occur once a year, usually in February and March but occasionally April. Local knowledge actually links chipi chipi school presence as a cue for flooding events ceasing in a given year. Schools were observed in Rurrenabaque for 19 days between February 15th and March 5th. According to observed travel speeds, on average the schools would travel the entire migration route (373 km) in 32 days (Table 1).

Relationship with hydrological cycles

The Beni River is one of rivers that carries most water in the Amazon, its discharge in the Bala straits exceed 2050 m^3/s (Gautier et al. 2006). In Rurrenabaque the river passes through the Suse straits and the flows out on to the floodplain. According to the SNHN data (21st March 2014 report) the 2014 flooding is the highest on record, both in terms of water level and duration. The second highest record was for the 2011 flooding event, but 2014 was significantly greater (Fig. 8) increasing to 3 m above the bank level. Chipi chipi migration events are synchronized with flooding events: in 2011 the flooding peak was the 23rd February and a school was observed in the Suse straits on the 15th March, 20 days after the peak (G. Miranda and G. Álvarez, pers. obsv.). In 2014 the flooding has three peaks between 28th January and 8th February (Fig. 8). The first report of schools in Rurrenabaque was on 15th February, 7 days after the last flooding peak. Schools were observed in Rurrenabaque until the 5th March.

Discussion

Why migrate?

In the case of *T. barbouri* the migration consists of a massive juvenile movement, which occurs along the Beni River from a floodplain zone to the rivers and streams of the Andean foothills. Due to the preliminary nature of this research we cannot confirm individual

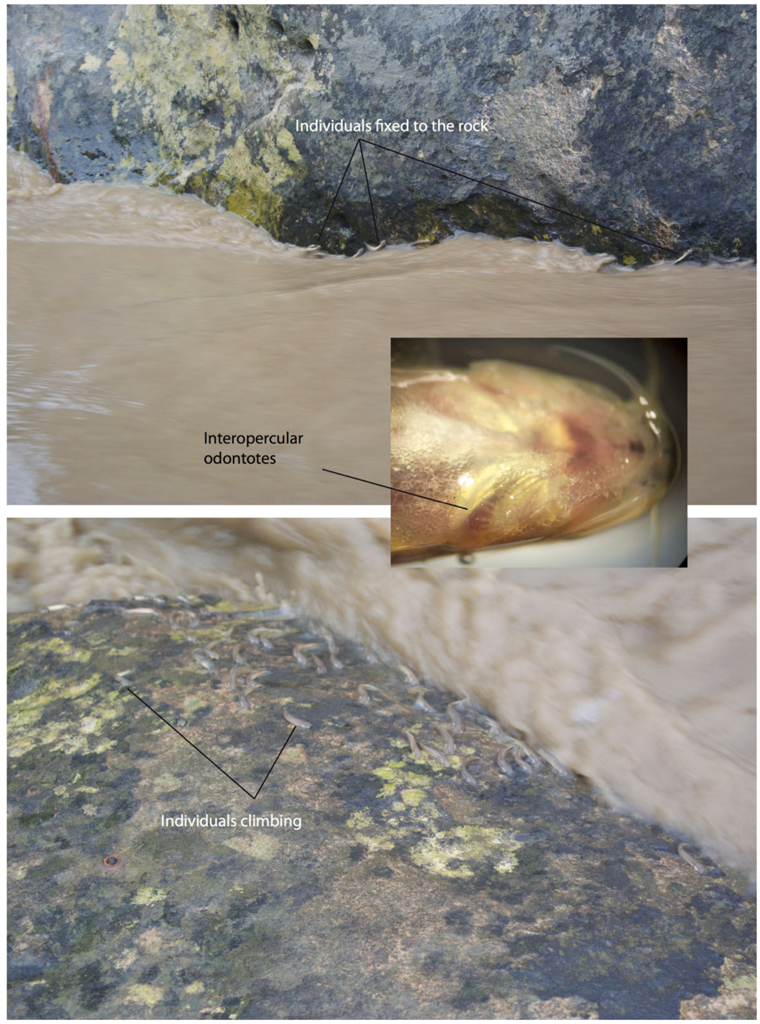

Fig. 4 Chipi chipi fish passing rocks in the straits of the Beni River. The inset shows the tiny interorpercular teeth (odontotes) that are used by the fish to stick to the rocks

distances traveled, however, it seems likely that individual distances encompass floodplain and Andean foothill habitats, and as such individuals observed 236 km downstream from Rurrenabaque would be traveling close to 300 km to access foothill habitat. We suggest that floodplains are maternity sites where eggs and larvae have more space and resources to grow, as occurs with *Arapaima gigas* and *Colossoma macropomum* (Araujo-Lima and Goulding 1997; De Lima and Araujo Lima 2004; Vendel and Chaves 2006). When the flooding events begin to recede individuals leave the floodplain and meet in the main Beni River channel to begin their upstream migration. It remains unclear about what occurs before flooding, as well as what happens when schools reach their destinations in the headwaters of the Beni watershed.

Juvenile migration is a known phenomena for eels (Jellyman 1977), gobies (Yuma et al. 2000), as well as multi-specific migrations described during the construction of hydroelectric dams (Prchalova et al. 2006). In all cases, juveniles leave lakes or floodplains and travel to sites more appropriate for survivorship and development to sexual maturity. A documented strategy to avoid egg predation is to reproduce in the wet season allowing eggs to flow with the current downstream which increases in the wet season (between November and December), thereby considerably reducing predation risk (Araújo-Lima and Oliveira 1998). Assuming this mechanism is relevant for *Trichomycterus barbouri*, upon their arrival to the floodplains, waters disperse across the large tracts of the floodplain (generally in January and February) and a lower density of predators

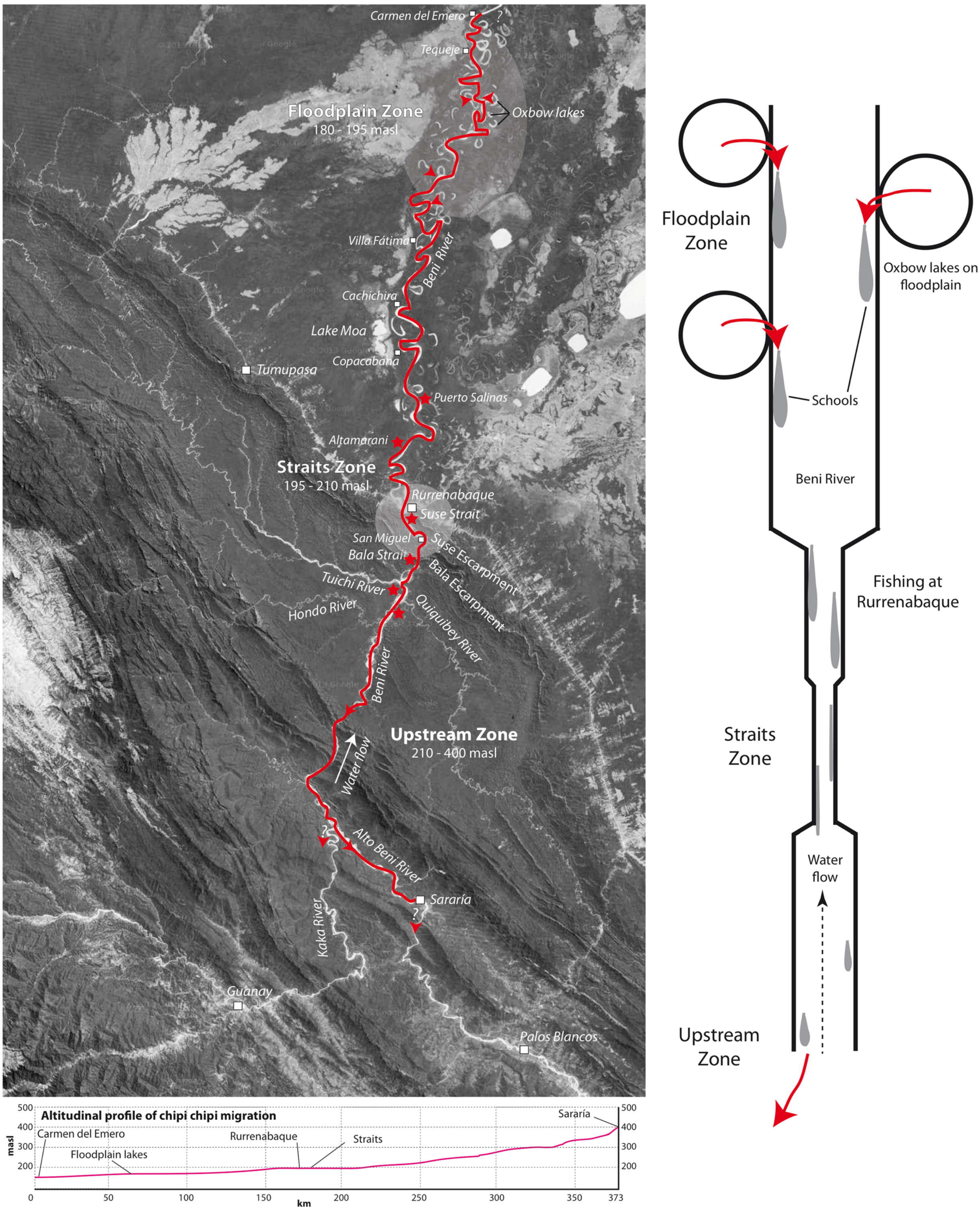

Fig. 5 *Trichomycterus barbouri* migration study area: the solid line represents the known journey of this species. The stars are points where individuals were collected and filmed. The schematic representation shows travel strategies of the schools in each portion of the migration zone and the altitudinal profile of the migration

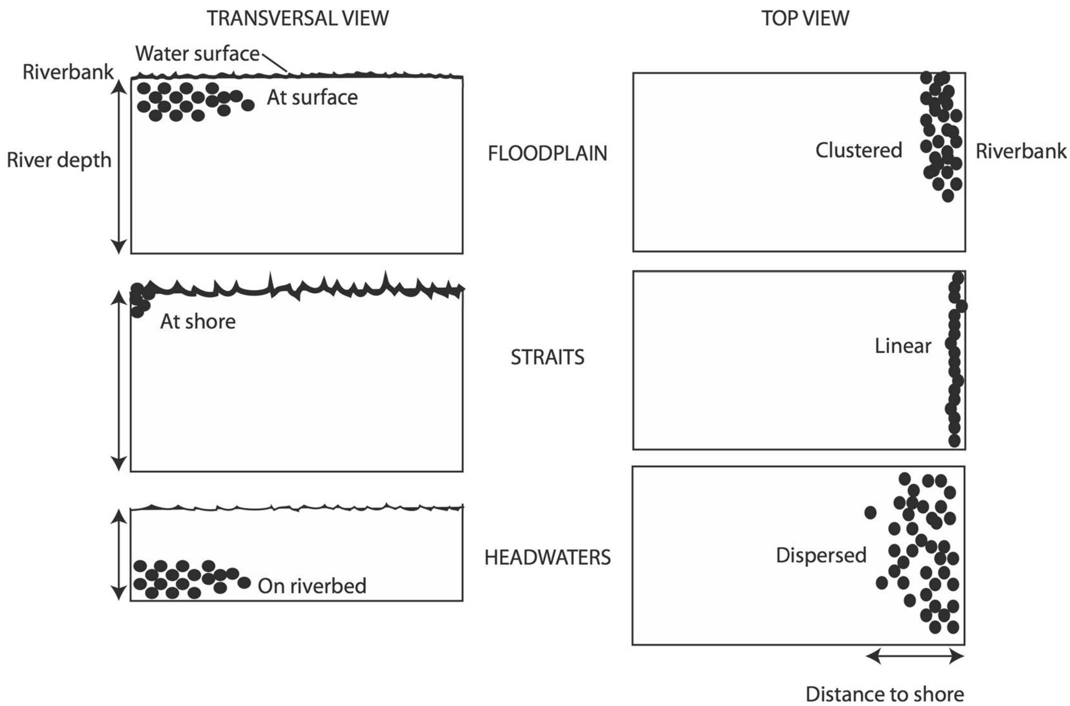

Fig. 6 Vertical and transverse position and shape of chipi chipi schools according to location type

and increased probability of larval survivorship is ensured (De Lima and Araujo Lima 2004). Here, the eggs hatch and larvae develop rapidly in a few weeks while the floodplain is inundated (Fig. 8). When waters recede (March), fish tend to concentrate in water bodies that are disconnected from the main river and become much more vulnerable to predation. To avoid this juveniles group into schools and travel to the main river and then upstream to headwaters, where the density of large predators is much lower (Lucas and Baras 2001) (Fig. 8).

In the floodplain studies in the Beni region adult individuals of *Trichomycterus* have not been reported (Pearson 1924; Miranda-Chumacero 2007; Pouilly et al. 2010). In Andean foothill streams there are reports of *Trichomycterus* adults, but without species identification (Miranda-Chumacero 2007). This observation, together with the fact that the species distribution is concentrated in the foothill forests (Arraya et al. 2009), might support the hypothesis that eggs are released into the flood from foothill forests and that adults do not migrate to the floodplain zones. Further

Table 1 Field and laboratory swimming speeds for *T. barbouri* individuals captured in schools and estimated total travel times considering suspected travel distances

	Field			Laboratory			General
	Min	Mean	Max	Min	Mean	Max	
Swimming speed (km/h)	0.10	0.42	1.08	0.49	0.60	0.75	0.51
Swimming speed (km/day)	2.39	9.98	25.92	11.66	14.30	18.04	12.14
Travel days between floodplain and straights (236 km)	23.66			16.50			20.08
Travels days between straights and upstream (137 km)	13.73			9.58			11.66
Travel days for entire route (373 km)	37.39			26.08			31.74

Table 2 Standard length and weight of individuals captured in schools according to position along the Beni River

School location	Zone	N	Standard length (mm)			Weight		
			Min	Mean	Max	Min	Mean	Max
Copacabana	Floodplain	40	23.36	28.25	32.88	0.08	0.20	0.38
Altamarani	Floodplain	23	24.02	26.71	29.76	0.09	0.13	0.19
Suse	Straits	18	24.29	28.49	31.68	0.10	0.17	0.26
Bala	Straits	16	24.68	27.59	32.68	0.12	0.18	0.34
Tuichi	Upstream	109	23.36	27.02	30.91	0.08	0.16	0.25
Quiquibey	Upstream	54	24.59	26.95	31.91	0.10	0.16	0.33
Grand total		260	23.36	27.30	32.88	0.08	0.16	0.38

sampling of catfish communities in the foothill forests of the Beni watershed may help confirm this hypothesis (Fig. 9).

Economic importance

Some families fish up to 50 kg of chipi chipi during the period that they travel past Rurrenabaque, which according to average weight represents 166,000 individuals. Considering the number of families fishing chipi chipi this amounts to a harvest of millions of individuals representing an important economic value in terms of protein consumption.

The energy costs of migration

The dorado catfish (*Brachyplatystoma rousseauxii*) has the longest known freshwater fish migration of 3,300 km with adults traveling from the nurseries of the Amazonas estuary to the Andean foothills (Barthem and Goulding 1997). Dorado catfish average 52 kg in weight (García Vásquez et al. 2009), although they can reach weights of 80 kg (CIPTA and WCS 2010), in contrast the chipi chipi juveniles weigh 0.3 g, just 0.0003 kg. A gram for gram comparison of the effort of the two species, the effort required for the giant dorado catfish is 63.46 km traveled/kg, but for the chipi chipi the effort is almost 20,000 greater at 1,243,333 km

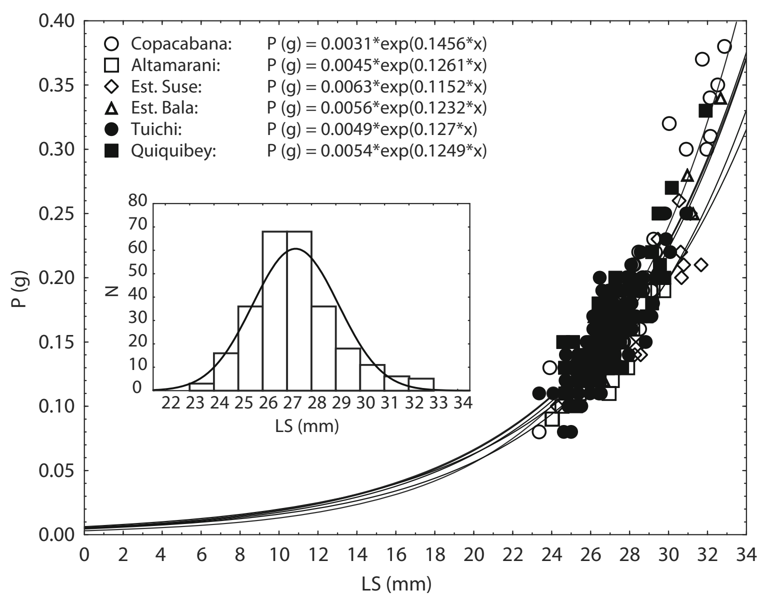

Fig. 7 Exponential relationship between length and weight of individuals captured from schools at differing locations and the proportion of individuals from each size class

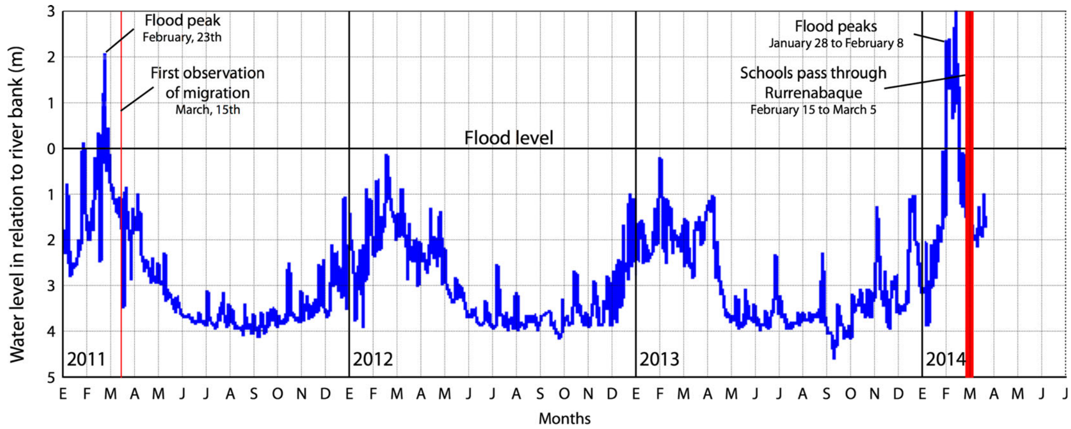

Fig. 8 Observed daily water levels for the Beni River at Rurrenabaque (Modified from SNHN Report 21st March, 2014). Two major flooding events at the beginning of 2011 and 2014 are obvious and their relationship with schools of *T. barbouri* in Rurrenabaque

traveled /kg. As an alternative, if we use body length for both species: the dorado effort is 22 km traveled/cm length and the chipi chipi effort is 116,6 km traveled/cm length, almost 5.3 times greater (Table 3).

Trichomycterus, extreme fish

There are no previous references of migration for this genus, although there are reports of very small movements related to hydrological cycles within the caverns of *T. itacarambiensis* (Trajano 1997). *Trichomycterus* is one of the most fascinating fish genera. Species of this genus have been reported in caverns (Trajano 1997; Miranda and Pouilly 1999; Pouilly and Miranda 2003), thermal waters (Fernández and Miranda 2007; Fernández and Vari 2012), extreme altitudes of above 4000 m.a.s.l. (Arratia 1983; Arratia and Menu Marque 1984; Fernandez 1996), and one of the largest species (*T. rivulatum*) (>20 cm) lives in Lake Titicaca (Eigenmann 1918). *Trichomycterus* is almost a synonym of High Andean streams (McConnell and Lowe-McConnell 1987; Fernandez and Schaefer 2003; Fernández and Vari 2004; Arraya et al. 2009). The fact that this study documents a migration from floodplains to foothill streams is without doubt another stunning example of the ecological plasticity of this genus.

Species distribution

The species were originally described (Eigenmann 1911) from individuals in the Beni watershed obtained by Thomas Barbour. For the sizes of individuals used for Eigenmann (1911) probably the original description was made with juvenile individuals. According to specimens deposited in the Bolivian Faunal Collection the species is recorded in the Beni River, in Amboró National Park, and in the Yacuma River (CBF.07179, CBF.07233, CBF.00007). However, the species is also present in the Suaruro, Pilcomayo, Capararí, Achira, Mizque, Hantahuatana, Limatambo, Wilaqhachy and Waykhu rivers (Arraya et al. 2009), and therefore present in the Amazon and del Plata watersheds. Fernández (2000) indicates that the species is also present in the Cochuna, Medina, Calera, Lules, Potrero de las Tablas, Belén, Segundo and Tala rivers in the del Plata watershed in the Tucumán, Córdoba and Salta provinces in Argentina. It is not known if the migratory behavior described herein occurs in the other rivers and watersheds across the species range.

Body size

The exponential relationship between length and weight (Fig. 7), reflects the characteristic rapid growth rate of juvenile fish (Henderson 2005). The maximum reported size in published studies is 110.02 mm standard length and 128 mm total length (Fernández 2000). In the majority of studies, reported standard length measurements are between 40 and 60 mm (Arraya et al. 2009). The original description was of a 37 mm individual (Eigenmann 1918).

In general, *Trichomycterus* is not frequently captured in the Bolivian Amazon (Miranda and Pouilly 1999; Miranda-Chumacero 1999, 2006; Pouilly et al. 2003, 2006; Arraya et al. 2009; Carvajal-Vallejos and Fernández 2011). Considering the enormous quantity

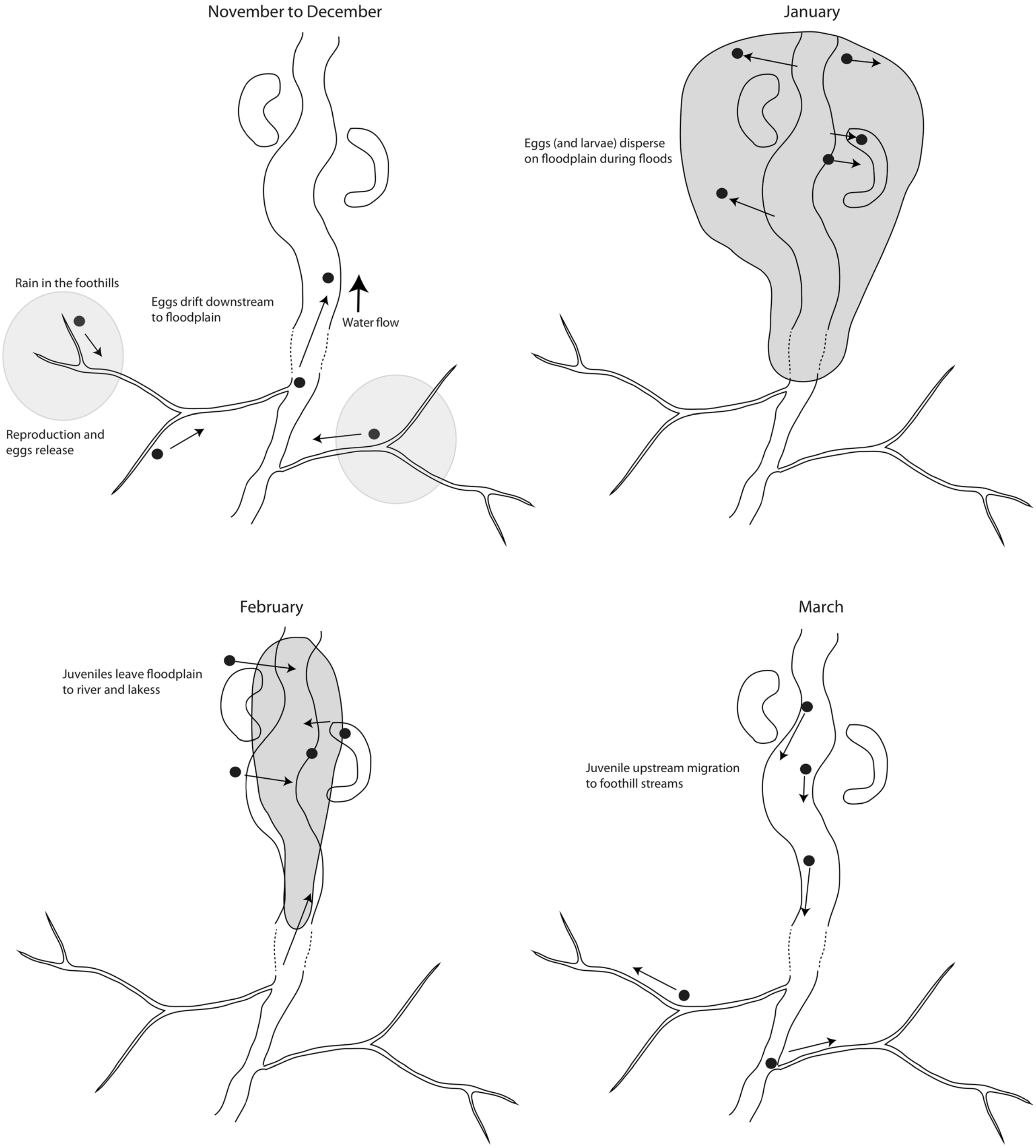

Fig. 9 Hypothetical migration cycle of *T. barbouri* in the Beni River, its tributaries and the floodplain (see text explanation)

of juveniles that migrate upstream it seems probable the survivorship is low, although *Trichomycterus* tends to hide under rocks and debris in the foothill streams, which makes them harder to capture. Capture vulnerability maybe a greater influence on the ability to catch fish in the Andean foothills than abundance, and may also explain the low capture frequency of this group even using electrofishing equipment, a good method to estimate fish abundance in this habitat (Miranda-Chumacero 2006).

Table 3 Comparison of migration effort of *T. barbouri* with the freshwater fish species with the greatest migration distance

Species	Weight (kg)	Length (cm)	Migratory distance (km)	Body weight effort (km/kg)	Body length effort (km/cm)
Brachyplatystoma rosseauxii	52.0000	150.0	~3300	63.46	22.0
Trichomycterus barbouri	0.0003	3.2	~373	1243333.33	116.6
Effort ratio				19592	5.3

Relationship with hydrological cycles

The chipi chipi migration is strongly related to hydrological cycles, specifically with flooding peaks, and as such may constitute a key indicator regarding climate change and its effects on the abundance of migratory species (Carolsfeld et al. 2003; Glantz 2005; Miller and Fluharty 2005). The chipi chipi migration represents the beginning of a series of temporal changes in the composition of the river's fish communities, and therefore if in relatively dry years the relative size of the migration is reduced it may have unknown consequences for the rest of the aquatic community and ecosystem (Carolsfeld et al. 2003; Winemiller and Jepsen 2004; Bauer and Hoye 2014).

Energy and nutrient transfer

Organisms with predictable, seasonal significant movements in large numbers interact with the communities they pass on their travels. This interaction influences trophic web structures, community dynamics and ecosystem functioning through an influx of additional nutrients and energy that increases productivity (Bauer and Hoye 2014). The huge quantity of individuals within *T. barbouri* schools must change the dynamic of the Beni River aquatic communities. Personal observations and comments from local fishermen suggest that the chipi chipi migration is followed by other species such as sábalo ray-finned fish (*Prochilodus nigricans*) and species of Curimatidae also form what is known locally as the *arribada*, or upstream movement. A possible explanation is that both *Trichomycterus* and *Prochilodus* are responding to similar environmental stimuli.

Further analyses and tracking

The sheer density of individuals and their position near the surface of the water makes the chipi chipi migration conspicuous compared to other fish migrations in the region, allowing visual tracking, even in the turbid waters of the Beni River, as opposed to indirect methods such as sonar, telemetry, mark-recapture, etc. This situation represents an opportunity to better understand over time this migration and those of other fish species.

Threats

Some infrastructure projects are planned in the Beni River that could affect the chipi chipi migration as well as other aspects of the aquatic ecosystem. In recent years an increase in the use of gravels from the Beni River near the Rurrenabaque population, has also modified the structure of the main river way, altering the granulometry of the substrate, the geomorphology of the banks, the quantity of dissolved solids, and therefore, the quality of water (G. Miranda, pers. obs.; Y. Delgadillo, pers. comm.). These are determining factors in the passage of chipi chipi schools and changes might affect the migration.

Finally, this chipi chipi migration is an example of how in the Amazon, especially the huge rivers of the basin, there are still many natural phenomena to discover, describe and document.

Acknowledgments The Wildlife Conservation Society through the Greater Madidi Landscape Conservation Program funded this research. We extend our particular thanks to the network of voluntary observers in local communities, without whose interest, curiosity and responsibility this work would not have been possible: Juan "Tonchi" González (Carmen del Emero), Eduardo Cabinas (Cachichira), Crisanto Serato (Copacabana), Constantino Nay (San Miguel), Juan "Masaco" Buchapi and Eddy Ocampo (Rurrenabaque). Fieldwork was also greatly assisted by Gober Serato and Eddy Ocampo and family. We would also like to thank Julio Pinto and Rubén Marín of the Institute of Ecology and Limnology Department for their constant support in the execution of this study and their collaboration for our research was conducted with the correspondent approval of the Biodiversity Authorities (MMAyA-VMABCCGDF-DGBAP - N° 354/2014. Luis Fernández, Luis Pacheco, two anonymous revisers and the editor made valuable suggestions of this manuscript for which we are extremely grateful. This work is dedicated to the Tacana people, in whose territory this phenomenon occurs along with others yet to discover.

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