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Microhabitat use by two silurid species in the Anizacate River (central Argentina)

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A b s t r a c t . Fish species exhibit different preferences and are segregated according to a set of physical habitat conditions. We documented microhabitat preferences on the three dimensions (substrate type, water depth, current velocity) for two native species: the stream catfish, *Trichomycterus corduvense* and the eel catfish, *Heptapterus mustelinus*. The study was conducted on the Anizacate River in a semiarid region of Córdoba Province located in central Argentina. We established one transect perpendicular to flow at the downstream end of each study site with subsequent parallel transects spaced at 5 m intervals throughout the length of the study site. Fish collections and habitat measurements were made in 1 m^2-quadrates at 3 m-intervals along each transect. We quantified available microhabitats and estimated the proportion used by both fish species through suitability curves, niche breadth and Shoener´s overlap formula. Current velocity is the key factor that distinguishes microhabitat use between *T. corduvense* and *H. mustelinus*. The former species is acting as a velocity specialist whereas the latter could be considered as a generalist. In spite of the trophic competition between these species, spatial partitioning may be promoting coexistence of *H. mustelinus* and *T. corduvense* in Anizacate River.

Key words: freshwater, suitability, curves, *Heptapterus mustelinus*, *Trichomycterus corduvense*

Introduction

Natural streams provide a large set of physical habitat conditions supporting diverse aquatic fauna. Fish species exhibit different preferences and segregate according to water velocity, depth and substrate types (B a r r e t & M a u g h a n 1994, R o u s s e l & B a r d o n e t t 1997, G r o s s m a n et al. 1998). The importance of these habitat features to distribution and abundance of stream fishes has been well documented (e.g., R a b e n i & J a c o b s o n 1993, B a r r e t & M a u g h a n 1994, W o o d & B a i n 1995, T o e p f e r et al. 1998). In addition, fisheries managers and researchers have increasingly used stream habitat assessment as a tool to identify, estimate, and predict the effects of habitat alteration on aquatic organisms (W a n g et al. 1996). Interactions between fishes and their environments make the study of individual species interesting from both ecological and evolutionary perspectives (B a l t z 1990).

There is a lack of integrative and systematic research on habitat requirements of the native fish fauna in Argentina. One of the most important watershed of the central region of Argentina is the Xanaes Basin. It flows into Mar Chiquita Lake (one of the largest saline lakes in the world). This lake together with the expansive swamps of the Dulce River on the northern shore and the mouth of Suquía and Xanaes River have been designated as a Ramsar site (Ramsar Convention Bureau, 2002), as it is considered one of the most important wetlands in Argentina in terms of biodiversity in a range of freshwater to very saline environments.

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Two native siluriforms, the stream catfish, *Trichomycterus corduvense* (Weyenbergh, 1877) and the eel catfish, *Heptapterus mustelinus* (Valenciennes, 1840), are recognized as dwelling-bottom species from their morphology and feeding habits (Menni 2004). *T. corduvense* (Trichomycteridae) present elongated body and poorly-developed eyes. It hiding itself between rocks of cold and clear freshwater streams (Pinna 1998). *H. mustelinus* (Pimelodidae) belongs to the subfamily Heptapterinae. This group includes small to medium-sized fishes forming one of the largest radiations of Neotropical catfishes. According to Pinna (1998), some genera seem to be among the most common siluriforms in South American freshwaters. Despite this, the biology of heptapterines in general is poorly-known. Both species are found in the Xanaes Basin, particularly in Anizacate River, one of the most important tributaries of this watershed.

The studies carried out by Dillon & Haro (2002) and Llanos & Haro (2001) demonstrated that both fish species are exclusively insectivorous and indicated a high trophic overlap between *T. corduvense* and *H. mustelinus*. On the other hand, some evidence suggest that salmonid species are affecting native fishes in Tucumán and Córdoba Province, especially *T. corduvense* occurring with *Oncorhynchus mykiss* (Fernández & Fernández 1995, Bistoni & Hued 2002). This salmonid could compete with *T. corduvense* for habitat and food as well as being its predator. On the other hand, there is a lack of knowledge about the biology and habitat requirements of *H. mustelinus*. Despite of living in the same river, our previous observations suggest that *T. corduvense* and *H. mustelinus* do not share the same habitat requirements. Research on habitat requirements of native fishes will help anticipate the effects of habitat alterations as well as the effects of non-native species and other alterations of stream environments.

Investigations of habitat use by stream fishes requires accurate data on physical conditions associated with fish. To understand the habitat use of *T. corduvense* and *H. mustelinus*, we established microhabitat preferences based on the measurement of three principal habitat components: velocity, depth and substrate type. The following questions were examined:

1. Which are the habitat preferences of each fish species?
2. Do *T. corduvense* and *H. mustelinus* display differential microhabitat use?
3. Does microhabitat use vary on size-related basis?
4. Does differential microhabitat use ultimately facilitate coexistence of both species?

Materials and Methods

Our study was carried out in a section of the Anizacate River (31º43' S; 64º 55' W) in a semiarid region of Córdoba Province (Argentina) that covers an area of 465 km^2. The mean annual rainfall is 832 mm and the mean discharge value is 309 mm^3. The rainy season spans from October through March and the dry season from June through September (Vázquez et al. 1979). Maximum water temperatures occur during the rainy season (mean temperature of 20 ºC) whereas the minimum temperatures occur in winter (mean temperature of 8 ºC).

We measured habitat parameters and made fish collection during day light in the dry season from 1999 to 2001. We carried out 2 surveys per year of collection, totalizing 6 surveys. The study was conducted in a 150 m-section of stream sampling representative riffles, runs and pools. Following the method proposed by Barret & Maughan (1994), we established an initial transect perpendicular to the direction of flow at the downstream end of the study site and subsequent transects at 5 m-intervals parallel to the initial transect extending through the length of the study site. Both fish collection and habitat variable

Table 1. Categorization of microhabitat variables registered at the study site on Anizacate River.

Category	Substrate Size (cm)	Depth (cm)	Current Velocity ($m \cdot s^{-1}$)
1	≤ 1	≤ 16	0 – ≤ 0.093
2	1 - ≤ 7	16 - ≤ 28	0.093 – ≤ 0.279
3	7 - ≤ 15	28 - ≤ 39	0.279 – ≤ 0.465
4	15 - ≤ 30	39 - ≤ 51	0.465 – ≤ 0.650
5	30 - ≤ 60	51 - ≤ 62	0.650 – ≤ 0.836
6	> 60	> 62	0.836 – ≤ 1.022

measurements were made in 1 m^2-quadrates at 3 m-intervals along each transect. Adult fish were collected with a backpack electrofisher, identified, counted, measured (standard length) and then released alive into the river. The mean water conductivity was 0.15 $\mu S \cdot cm^{-1}$.

We focused on three major habitat dimensions: substrate type (cm), water depth (cm) and current velocity ($m \cdot s^{-1}$). A Mebflügel – current meter- moulinet (Type C2 "10–50") was used to measured velocities and depths. The current meter was located at 60% of the water depth from the surface. Substrate type was visually estimated as percent within each sampling quadrates. For convenience we subdivided each variable in six categories (Table 1).

We quantified available physical microhabitats and estimated the proportion of microhabitat use by both species. A Kruskal Wallis Tests (Infostat 2003) was used to determine if standard length of captured individuals varied between microhabitat class for each species. Microhabitat selection by each species was estimated through suitability curves using methods of B o v e e (1982).

In order to know the range of resources used by each species in the studied area we estimated the niche breadth using the Shannon-Wiener Index (W a s h i n g t o n 1984). Overlaps in microhabitat use by both species were calculated through S h o e n e r ´ s (1970) overlap formula:

$$1 - 0.5 \sum |P_{xi} - P_{yi}|$$

where P_{xi} is the proportion of the resource category *i* used by species *x* and P_{yi} is the proportion of the same resource category used by species *y*. The result obtained could vary between 0.00 (no overlap) to 1.00 (complete overlap).

Multivariate Analysis of Variance (MANOVA) was applied to determine if fish species use a distinct subset of microhabitat conditions. This method tests the hypothesis that there are no differences in habitat use between two groups: those with a particular species (present) and those without it (absent) (B a i n 1995) with all habitats variables combined and it allows for interactions among them that could be important in defining the microhabitat use by a species. If MANOVA yielded significant results, a one way analysis of variance (ANOVA) was applied to determined which variable can cause the differences observed.

Results

Through three years of monitoring, we collected 131 individuals of six fish species (Table 2). The dominant species was *T. corduvense* (55.73%) following by *H. mustelinus* (19.85%).

Microhabitat availability varied by class (Fig. 1) for all three variables. The dominant habitats had substrate size between 15 and 30 cm (category 4), depth between 16 and 28 cm (category 2), and current velocities from 0.465 and 0.650 ($m \cdot s^{-1}$).

The individual mean size varied according to each fish species. Adults of *T. corduvense* had a mean size of 77.40 ± 8.83 mm whereas *H. mustelinus* averaged 96.30 ± 34.58 mm

standard length. Standard length of each species was not different (Kruskall-Wallis test, p values ranged from 0.10 to 1) between habitat categories indicating that there are no relations between habitat use and fish size.

Table 2. Percentage of abundance of the fish species collected at the study site on Anizacate River.

Fish species	Percentage of Abundance (%)
Parodon cf. *tortuosus*	3.82
Astyanax eigenmanniorum	9.92
Bryconamericus iheringi	5.34
Trichomycterus corduvense	55.73
Heptapterus mustelinus	19.85
Hypostomus cordovae	5.34
Species richness	6

A significant difference was found in habitat characteristics (combinations of depth, velocity and substrate) for *T. corduvense* (MANOVA, $p<0.0001$). This species used a specific set of microhabitat conditions within the available range of habitat characteristics and could be considered as microhabitat specialist. Because no difference were found for *H. mustelinus* we identified this fish as habitat generalist.

The suitability curves for each habitat variable indicated that *T. corduvense* prefers substrate size between 15 and 30 cm (category 4), depth categories 1, 2 and 5 and the highest current velocities (categories 5 and 6; Fig. 2). For *H. mustelinus* the suitability curves indicated the preference for substrate size between 7 and 30 cm (categories 3, 4 and 5), shallow waters (categories 1, 2 and 3) and it presented an indifferent behavior to current velocity variation (Fig. 2).

The niche breadth calculated for current velocity and substrate utilization was significantly different between species while no differences were found in the use of depth categories (Table 3). The Shoeners' Index indicated a high overlap in the use of the different depths and substrate size. On the contrary it was found a low overlap in velocity use. These results indicated the selection of high current velocity microhabitats displayed by *T. corduvense* (Table 4).

Table 3. One-way analysis of variance of Niche Breadth and Shoener's Index for each microhabitat variable between *T. corduvense* and *H. mustelinus* (*$p<0.05$).

Variables	Niche Breadth (Shannon-Wiener Index)			Overlap (Shoeners' Index)
	T. corduvense	*H. mustelinus*		
Substrate	0.519	1.012	*	0.793
Depth	1.155	1.068		0.840
Current velocity	1.207	1.524	*	0.455

Table 4. One way analysis of variance (ANOVA) to determine which microhabitat variable explains the habitat use by *T. corduvense* (*$p<0.05$).

	T. corduvense	
Variables	F	p
Substrate Size	1.32	0.2784
Depth	0.01	0.9273
Current velocity	11.57	0.0050 *

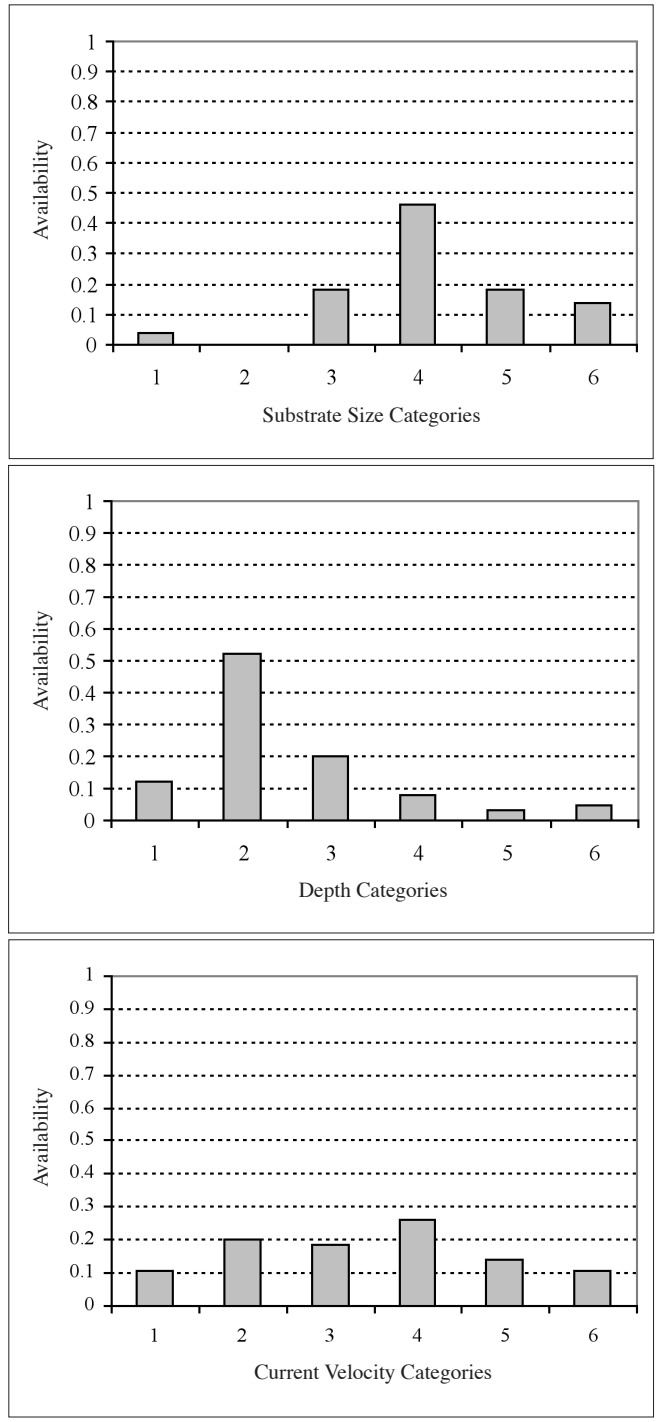

Fig. 1. Frequency distributions (availability) of each habitat variable category in the study section on Anizacate River.

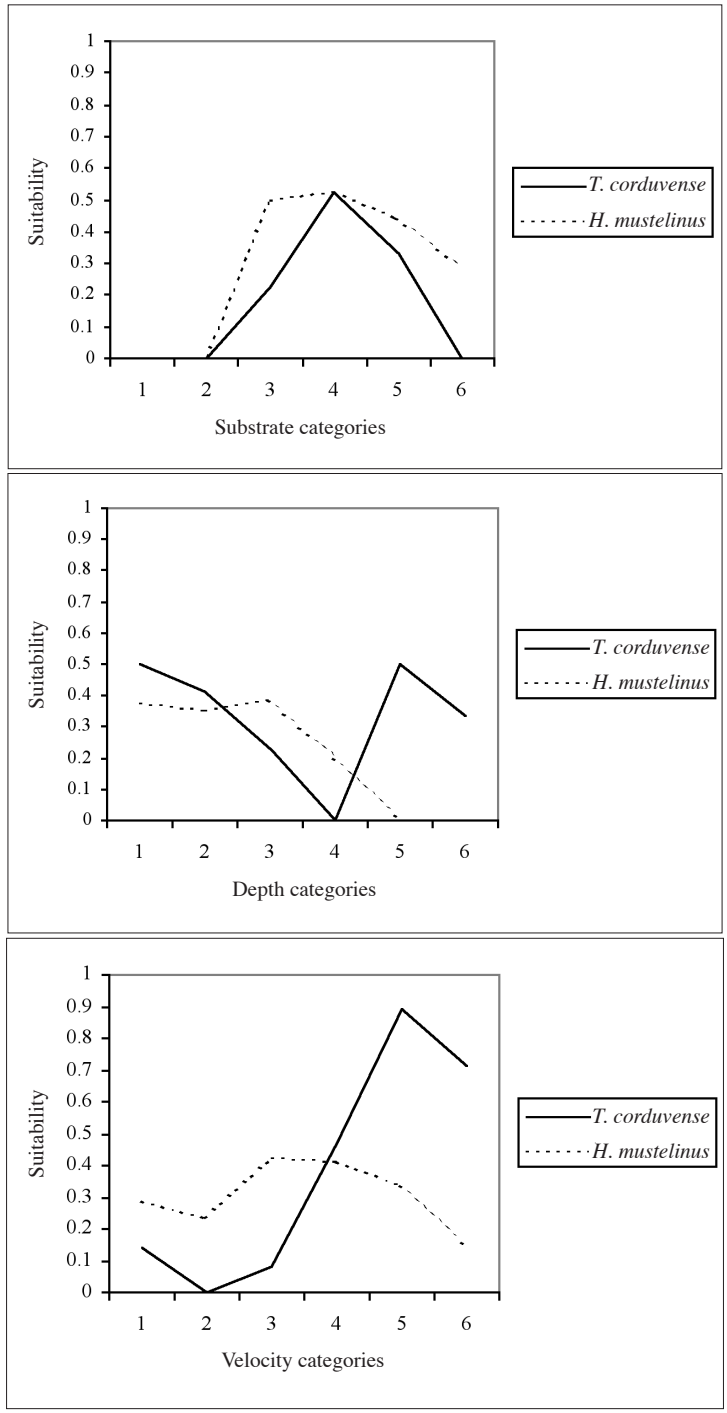

Fig. 2. Substrate size, depth and current velocity suitability curves for *T. corduvense* and *H. mustelinus* (For microhabitat variable categories see Table 1).

Discussion

The present study identified the main habitat types available and described the microhabitat partitioning among two sympatric species in a section of Anizacate River. The two fish species studied displayed different patterns of microhabitat use. *H. mustelinus* presented a generalized pattern of microhabitat use in opposition to the specific selection pattern showed by *T. corduvense*.

The physical environment of running waters has a number of particular features that pose special challenges to the organisms that dwell there (Allan 1995). Rabeni & Jacobson (1993) had indicated that fish distribution and abundance are influenced by depth, velocity, substrate type and cover and they respond to combinations of variables instead variables independently. However, our findings suggest that current velocity is the key factor that determines different microhabitat use by *T. corduvense* and *H. mustelinus* in Anizacate River. The former species is acting as a velocity specialist whereas the latter could be considered a generalist. Layher & Maughan (1987) have hypothesized that habitat specialists could show more uniformity in habitat preferences over space than habitat generalists. This relation has been observed in our study for *T. corduvense* which showed a uniform microhabitat use in the highest velocity sections.

Variability in abundance may be a reflection of species association with only a narrow range of habitats. The degree of habitat specialization among fishes is itself quite variable, with some species being found almost "everywhere" whereas other species are found only in specific locations. Wood & Bain (1995) had pointed out that morphology of fishes is regularly interpreted as a set of physical attributes linked to the use of habitat and food resources. Both species have morphologic characteristics related with river bottom, like naked and mucous skin, slippery body, barbells and sub-terminal mouth. Furthermore they are predators of small bottom invertebrates.

The stream catfish, *T. corduvense*, inhabits fast-flowing, clean and cold waters (Ringuelet et al. 1967) and it is able to resist the current strength hiding itself between the interstitial spaces of substrate. This behavior is due to it slippery body and relatively short body length.

Pinna (1998) pointed out some characteristics that allow *T. corduvense* to live in high water velocities. This author emphasizes the modification of the opercular apparatus into a compact structure with a large ventroposterior platform forming the support of a patch of odontodes. The operculum is also modified as an odontode-bearing structure. He indicated that this profound modification forms a tightly interconnected functional complex, associated with the use of the opercular and interopercular patches of odontodes as devices for anchoring and moving on hard substrate. The Trichomycteridae family has a particular way of resisting and ascending strong currents by means of "elbowing" of their odontode patches, which may explain their presence in most mountain stream in South America. The mentioned characteristics are absent in *H. mustelinus*, which reflects the different habitat use between both fish species.

The most important dimensions of resource partitioning for fish assemblages are habitat and trophic segregations (Ross 1986). According to Llanos & Haro (2001) who performed their study in the same Anizacate River section, there is a high trophic competition between both catfishes (Shoener Index = 0.969). We hypothesize that this trophic competition is an important ecological factor in this river section, thus the spatial partitioning promotes the coexistence of *H. mustelinus* and *T. corduvense* in Anizacate River.

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