ISSN 1517-6770

Food habits of *Triportheus signatus* (Teleostei, Characidae) in a Brazilian semi-arid intermittent river

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Abstract. In Brazilian semi-arid streams coexistence of fish species seems to be enhanced by the highly variable water flow and by the high diversity of aquatic habitat elements available for colonization of fish and their prey. Food resources available to fish play an important role in this dynamics since prey foods are expected to vary in abundance as the habitat changes. This study aims to describe the diet of *Triportheus signatus* (Garman, 1890) in an intermittent river in semi-arid Brazil, and evaluate the changes in diet composition along the river. Dietary composition of *T. signatus* showed a range of food items (26 in total) that could be classified into 5 major classes: Insect, Vegetal matter, Crustacea, Arachnida and Other. Larvae and pupae of Diptera gave the largest contribution in volume with 30.5%, followed by Insect fragments (23.3%). Amongst the Vegetal matter, Seeds were the most important (4.6%), with Unidentifiable vegetal matter contributing a further 8.3%. The study species showed spatial variability in the volumetric contribution of food items to its diet. The results of the present study provide evidence that the dietary composition of *T. signatus* is influenced mostly by the availability and composition of prey items associated with changes in the habitat structure. Despite the relatively large range of food items consumed, the results suggest that study sites show some variability regarding the array of food consumed but a few food items were dominant.

Keywords: fish diet, spatial variability, habitat structure

Resumo. **Habito alimentar de *Triportheus signatus* (Teleostei, Characidae) em um rio intermitente do semiárido brasileiro.** Nos rios intermitentes do semiárido brasileiro a coexistência das espécies de peixes depende do fluxo de água altamente variável e da diversidade de habitats aquáticos marginais disponíveis para a colonização dos peixes e de sua preza. Os recursos tróficos disponíveis para peixes representam importante papel nessa dinâmica uma vez que a abundancia das prezas tende a mudar com as mudanças do habitat. Este estudo descreve a dieta alimentar de *Triportheus signatus* (Garman, 1890) em um rio intermitente do semiárido brasileiro e avalia as mudanças na composição da dieta ao longo do rio. A dieta de *T. signatus* foi composta por um grupo variado de itens (26 ao todo) que pode ser classificado em 5 classes principais: Insetos, Material vegetal, Crustacea, Arachnida e Outros. Larvas e pupas de Diptera apresentaram maior volume (30.5%), seguidos por Fragmentos de inseto (23.3%). Dentre o material vegetal, Sementes foi o item mais representativo (4.6%), com material vegetal não-identificavel contribuindo 8.3%. A espécie estudada apresentou variação espacial na proporção volumétrica dos itens alimentares. Os resultados do presente estudo fornecem evidencias de que a composição alimentar de *T. signatus* é influenciada principalmente pela disponibilidade e composição dos itens alimentares associados a mudanças na estrutura do habitat físico marginal. Apesar de um relativamente amplo espetro alimentar, os resultados sugerem que a composição da dieta varia ao longo do rio e que alguns itens predominam.

Palavras-chave: habito alimentar, variabilidade espacial, estrutura do habitat

Introduction

The intermittency of streams and rivers in semi-arid Brazil is the result of distinctive climatic and edaphic conditions, such as extreme spatial and temporal variations in rainfall and high rates of evapotranspiration (Maltchik & Medeiros, 2006). According to these authors, Brazilian semi-arid streams are disturbance-dominated ecosystems, with a high level of habitat heterogeneity and a relatively diverse biota structured to withstand the high spatio-temporal variability.

In these systems, coexistence of fish species seems to be enhanced by the highly variable water flow (Medeiros & Maltchik, 2001a; 2001b) and by the high diversity of aquatic habitat elements available for colonization of fish and their prey (Medeiros *et al.,* 2006; 2008). Despite that, many aspects of Brazilian semi-arid streams are still unknown, for instance, how such variable systems are able to tropically sustain this diverse fish fauna. Such aspects are of chief concern in the development of conservation policies for the Brazilian semi-arid region. Within this view, the knowledge of resource use (both food and habitat) by fish must be used as a tool for species conservation.

Fish ordinarily make use of a variety of food resources, and these may be from aquatic or terrestrial origin. The importance of terrestrial food items (such as seeds, flowers and terrestrial insects) to the diets of freshwater fish has been reported in many traditional and more recent studies (Welcomme, 1979; Goulding, 1980; Bennemann *et al.,* 2005). Such accounts are frequently associated with large floodplain rivers where the flood pulse and inundation of the vast floodplain are the major drivers of system functioning (Junk *et al*., 1989). As an example, Claro-Jr *et al.* (2004) found seeds and terrestrial insects to be abundant food items in the diets of *Trachelyopterus galeatus* (Auchenipteridae) (Linnaeus, 1766), *Mylossoma duriventre* (Characidae) (Cuvier, 1818) and *Triportheus elongatus* (Characidae) (Günther, 1864) in inundated forests in the Amazon. Alternatively, in Brazilian semi-arid streams flooding is often constrained to the main channel and marginal areas are not commonly inundated. Furthermore, during the dry season, remnant pools frequently lay far from the riparian vegetation (Medeiros *et al.,* 2008). Despite that, studies indicate that fish diets in Brazilian semi-arid aquatic systems may be composed by food items of both terrestrial (vegetal matter, seed and terrestrial insects) and aquatic (fish, algae and aquatic invertebrates) origin (Gurgel *et al.,* 2005).

The species of the genus *Triportheus* inhabit most of the major river drainages of South America in a variety of biotopes, the study species being recorded on the Parnaíba river basin and some Brazilian northeastern coastal drainages (Malabarba, 2004; *Yamamoto et al.*, 2004; Medeiros *et al.*, 2010). This genus reaches moderate sizes (200-240 mm), constituting an ecologically important species. *Triportheus* species have relatively weak dentition and their usual food items include seeds, plankton, and small invertebrates (Malabarba, 2004). Regarding its diet, species of this genus have been described as opportunistic omnivores with a relatively diverse diet comprised of aquatic insects and other invertebrate (Gama & Caramaschi, 2001; Galina & Hahn, 2004). There are important indications of the plasticity of the feeding habits of the genus, as pointed out by Gama & Caramaschi

(2001). These authors observed a shift from a diet based on insects, vegetal matter and seeds to a diet based on terrestrial insects (ants and termites), bees and wasps, associated with the change from lotic to lentic conditions of the environment. This was corroborated by *Yamamoto et al.* (2004) that observed a diverse array of food items (including zooplankton, insects, fruits and seeds, algae and vegetal matter). These authors also report seasonal variation in food items composition.

This study aims to describe the diet of *Triportheus signatus* (Garman, 1890) in an intermittent river in semi-arid Brazil, and to evaluate the changes in diet composition along the river.

Materials and Methods

This study was performed in the Seridó River, located in the Seridó/Borborema region (*sensu* Tabarelli & Silva, 2003) (Fig.1). This area is classified as being of extreme biological importance and was identified as priority area for biodiversity conservation in the Caatinga by Silva *et al.* (2003), because it presents high diversity of species and is rich in endemism. The Seridó/Borborema area is drained mostly by the Piranhas-Açu River basin, with the Seridó River as the main affluent. Average annual temperature is 30.7°C, with the maximum monthly average in October (31.0 °C) and the minimum average in February (29.3 °C) (Amorim *et al.,* 2005). Precipitation is concentrated between January and April, with 350 to 800 mm per year and an annual average of 600 mm (Amorim *et al.,* 2005). Altitude in Seridó/Borborema ranges between 100 and 800 m (Governo do Estado da Paraíba, 1985).

The marginal area of the Seridó River is characterized by scarce or absent riparian vegetation dominated by grass and shrubs. Land use consists mostly of pasture for cattle (Silva, 2008). The aquatic marginal habitat is characterized by the presence

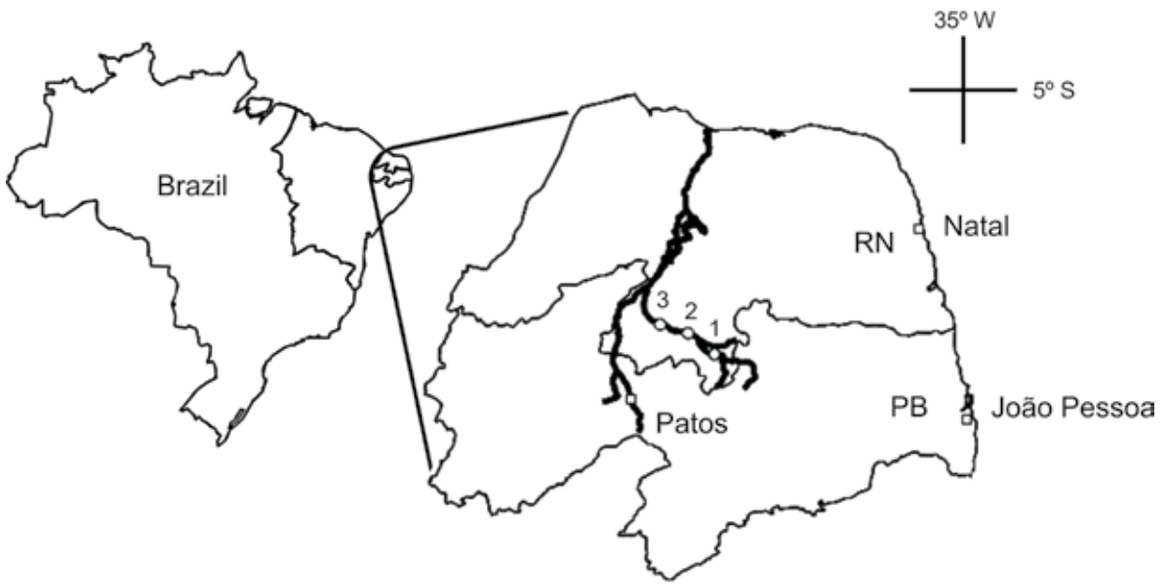

Figure 1. Study sites along the Seridó River in the Brazilian semi-arid region. 1 = Catureré, 2 = Riacho da Serra, 3 = Poço dos Patos.

of macrophytes, grass, filamentous algae and woody debris, whereas the substrate composition is comprised mostly of sand and mud (Medeiros *et al.,* 2008). Average (±SD) water temperature, dissolved oxygen and secchi depths in aquatic systems in the study area are 29.5 (±2.9) °C, 5.8 (±2.0) mg/L and 47.2 (±19.5) cm (Medeiros *et al.,* 2008).

Three locations were sampled along the Seridó River (Catureré, Riacho da Serra and Poço dos Patos) on four occasions (Fig.1). These locations are characterized by muddy to sandy substrate and a diverse array of aquatic and marginal habitat elements (Tab.1). Two sampling occasions were performed during the wet season (April and July 2007) and two during the dry season (October 2007 and January 2008) and the data was pooled to incorporate seasonal variations into the dietary spatial patterns. Fish sampling was performed during day-light hours generally around midday. Samples were collected using one short beach seine net (4 m long, 1.5 m high and 5 mm mesh), one long beach seine net (20 m long, 2 m high and 12 mm mesh), one set of gill nets (30 m long and 1.5 m high equally divided into three 10 m panels of 35, 45 and 55 mm mesh) and one cast net (2.4 m high and 12 mm mesh) (see Medeiros *et al*., 2010). Fish caught were fixed in 4% formalin in the field and later transferred to 75% ethanol. Fish were collected under License No. 032-DIFAP/IBAMA from 23 March 2006.

In the laboratory, each individual fish was measured (cm) for standard and total lengths (SL and TL, respectively) and weighed (g). For the dietary analysis, the stomach of each fish was removed, blotted, placed in a Petri dish and observed with a stereomicroscope for macroscopic analysis of contents. The degree of stomach fullness was estimated through eye by assigning a score between 0 (empty) and 10 (fully distended with food), reflecting the proportion of stomach volume occupied by food (Medeiros & Arthington, 2008a,b). The proportional contribution of each class of food items to the diet of an individual fish was estimated using Hyslop's (1980) indirect volumetric method, where stomach items within each prey category are lumped together and squashed to a uniform depth of 1 mm and the area covered taken to represent the volumetric contribution of that food category to the total stomach contents in mm^3 (Arthington, 1992; Pusey *et al.,* 2000). Items found in the diet of *T. signatus* were grouped into major food categories based on the type of food item. Only stomachs with fullness equal to or greater than 20% were considered in order to prevent bias in the calculation of the proportional contribution of each food category (Pusey *et al.,* 1995). The contribution of each food item to the diet of the species was expressed as the percentage of the mean volumetric contribution made by each dietary item to the stomach contents of individuals in a given site or collection. Frequency of occurrence (%) was calculated as the number of times a food item would occur in the stomachs of *T. signatus* in a given site or collection divided by the total number of stomachs analyzed. The graphical analysis of feeding strategy of Costello (1990) was carried out on major food categories and food items to evaluate the relative importance of ingested items and infer the feeding strategy of the species.

Similarities in diet composition between sampling sites were compared using Morisita-Horn similarity index. Richness, Shannon´s index of diversity and Pielou´s equitability were used to describe general patterns of food items composition. Unidentifiable material was excluded from statistical analysis as its inclusion could bias the results (Pusey *et al.,* 1995). Prior to analysis the effects of fish size on diet composition were evaluated to determine whether comparisons across size classes are reliable. Fourteen fish from the same sampling occasion were classified

Table 1. Proportional (%) marginal cover of habitat descriptors, water quality and morphology averaged (± SD) across sampling occasions for the study sites.

	Catureré	Riacho da Serra	Poço dos Patos
Substrate composition			
Mud	65.4 (±30.5)	15.8	0.2 (±0.3)
Sand	26.4 (±26.9)	69.9 (±18.7)	83.5 (±8.1)
Gravel	4.4 (±3.7)	1.6 (±2.4)	1.9 (±3.0)
Cobbles	0.2 (±0.3)	0.0	3.1 (±3.0)
Rocks	3.6 (±4.6)	12.7 (±12.6)	11.3 (±4.3)
Habitat structure			
Macrophyte	1.4 (±2.8)	95.8 (±12.6)	15.1 (±16.7)
Grass	6.0 (±6.9)	11.4 (±5.4)	0.0
Submerged vegetation	0.0	0.0	0.0
Vegetal cover	0.0	0.4 (±0.8)	0.0
Litter	0.4 (±0.8)	1.7 (±1.2)	0.9 (±1.6)
Algae	1.3 (±1.2)	11.4 (±5.3)	1.3 (±1.0)
Debris	2.7 (±2.7)	2.0 (±2.1)	3.4 (±4.5)
Water quality			
pH	8.8 (±0.4)	7.8 (±0.4)	8.4 (±0.5)
Dissolved oxygen (mg/L)	4.1 (±2.2)	2.5 (±1.1)	4.2 (±2.0)
Conductivity (μS/cμ)	722.1 (±479.5)	506.3 (±180.0)	372.1 (±2.5)
Temperature (°C)	25.9 (±2.7)	26.1 (±1.5)	28.4 (±1.1)
Transparency (cm)	34.1 (±17.9)	136.5 (±38.5)	121.9 (±35.9)
Water velocity (m/s)	0.0	0.2 (±0.1)	0.1 (±0.1)
Morphology			
Elevation (m)	226	168	116
Depth (cm)	61.4 (±10.9)	37.2 (±13.3)	127.3 (±11.1)
Width (m)	19.4 (±7.2)	14.2 (±3.1)	17.6 (±2.1)

into two size classes, size class 1 (six individuals with TL between 9.0-10.5 cm) and size class 2 (eight individuals with TL between 11.0-13.5 cm), and had their diet composition compared.

Results

A total of 81 stomachs were analyzed and 54 had fullness equal to or greater than 20%. Total average (± SD) fullness varied from 40.3 ± 35.4% (in Catureré) to 59.4 ± 37.7% (in Poço dos Patos). Total average fullness in Riacho da Serra was 45.8 ± 29.7% (Tab.2). Total length of the analyzed individuals ranged between 8.5 and 17.0 cm (Tab.1), and was significantly different between the three study sites (ANOVA, df = 2;51; F = 20.5; $p < 0.05$). *Post hoc* comparisons (Tukey HSD) showed that Catureré had significantly smaller individuals when compared to Riacho da Serra and Poço dos Patos ($p < 0.05$), whereas differences in total length between Riacho da Serra and Poço dos Patos were not significant ($p = 0.677$).

Table 2. Summary results for the study sites, showing the number of stomachs analyzed (N Total) and number of stomachs with fullness ≥ 20%, average size of fish with stomach fullness ≥ 20% (total length - TL and standard length -SL) ± standard deviation (SD), and average fullness for all stomachs analyzed and for stomachs with fullness ≥ 20%.

Location	N Total (Fullness ≥ 20%)	TL ± SD (SL ± SD)	Average fullness (total)	Average fullness (≥ 20%)
Catureré	55 (35)	10.8 ± 1.2 (9.0 ±1.1)	40.3 ±35.4	60.7 ±28.3
Riacho da Serra	18 (13)	13.8 ± 3.0 (11.9 ±2.7)	45.8 ±29.7	59.2 ±23.3
Poço dos Patos	8 (6)	14.6 ± 1.1 (12.6 ±1.1)	59.4 ± 37.7	77.5 ±20.2

Evaluation of size classes showed that the diet of *T. signatus* was similar between the two classes of individuals (Morisita-Horn similarity of 0.81), with similar proportions of major food items consumed (Fig.2). Both size classes had large contributions to the stomach content of Digested material (51.0% to smaller and 38.5% to larger individuals), Sand (14.3% to smaller and 22.0% to larger individuals), Unidentifiable vegetal matter (4.8% to smaller and 10.7% to larger individuals) and Insect fragment (28.5% to smaller and 22.9% to larger individuals) (Fig.2). Diversity of food items was also similar between size classes (Shannon diversity index of 1.18 and 1.53, respectively). Nevertheless, richness of food items was greater in size class 2 (12 food items) than in size class 1 (5 food items). Small contributions by aquatic insects (4.3% in total), mostly Diptera, were recorded for larger individuals of *T. signatus* (Fig.2).

Overall, dietary composition of *T. signatus* showed a range of food items (26 in total) that could be

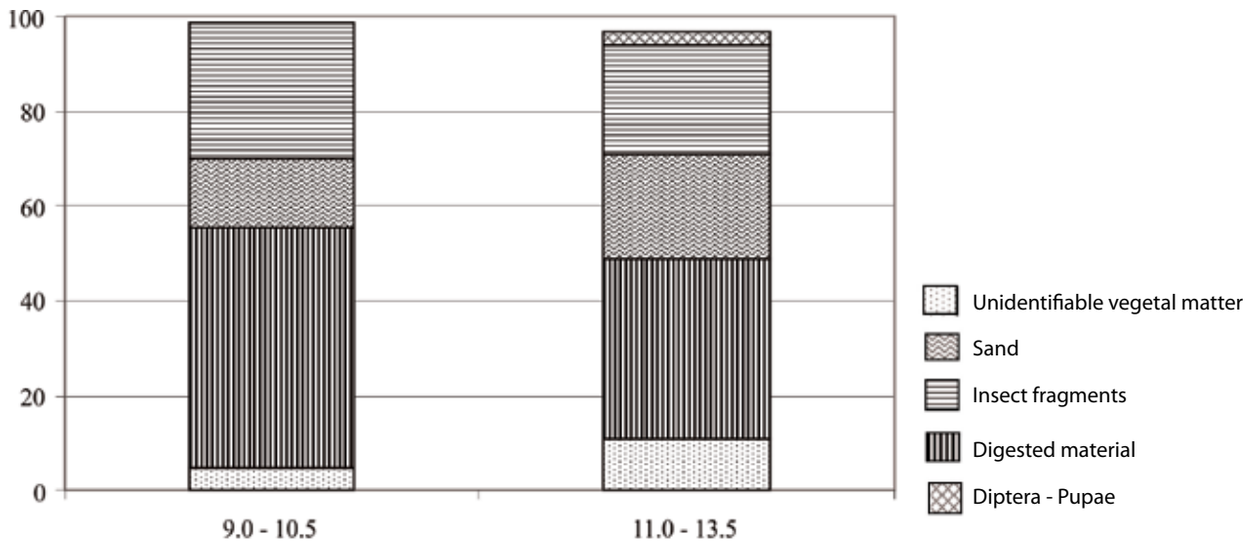

Figure 2. Percentage contribution by volume of food items to two size classes (cm) of *Triportheus signatus* in the Catureré site, Seridó River, Brazil.

classified into 5 major classes: Insect (62.6% of volume and 14 food items), Vegetal matter (12.9% of volume and 2 food items), Crustacea (1.6% of volume and 4 food items) and Arachnida (0.1% of volume and 1 food item). Other food items were grouped into a fifth class which encompassed mostly Digested matter, Fish remains and Sand (Tab.3). Among the insects, larvae and pupae of Diptera gave the largest contribution with 30.5%, followed by Insect fragments (23.3%). Other important insects that *T. signatus* fed upon were ephemeropterans, corixids and coleopterans. Amongst the Vegetal matter consumed, Seeds were the most important (4.6%), with Unidentifiable vegetal matter contributing a further 8.3% (Tab.3).

Table 3. Contribution by percent volume (Vol. %) and frequency of occurrence (FO%) of macroscopic food items found in the diet of *Triportheus signatus* in an intermittent river in semi-arid Brazil.

Item	Vol. %	FO%
Insect	62.58	75.93
Diptera	30.49	42.59
Insect fragment	23.32	61.11
Coleoptera	1.13	12.96
Formicidae	0.35	12.96
Odonata	0.72	7.41
Hymenoptera	0.27	7.41
Ephemeroptera	2.56	5.56
Vespidae	0.39	5.56
Orthoptera	0.80	3.70
Chironomidae	0.01	3.70
Corixidae	2.24	1.85
Naucoridae	0.18	1.85
Notonectidae	0.09	1.85
Mesovelidae	0.03	1.85
Vegetal Matter	12.86	55.56
Unidentifiable vegetal matter	8.30	48.15
Seed	4.56	7.41
Crustacea	1.62	11.11
Argulus	0.01	1.85
Cladocera	1.42	11.11
Copepoda	0.04	5.56
Mysidacea	0.15	3.70
Aracnidae	0.14	11.11
Hydracarinae	0.14	11.11
Other	70.37	70.37
Digested matter	14.52	48.15
Fish remaining	3.75	31.48
Sand	4.27	20.37
Arthropod fragment	0.21	1.85
Nematoda	0.05	1.85
Stomachs analyzed	54	

In general, frequency of occurrence agreed with volumetric data and the most frequent food items were also ingested in greater volume. Exceptions were Unidentifiable vegetal matter, Fish remaining, Sand, Formicidae and Cladocera which, despite lower volumetric contributions, were considerably frequent among the stomachs analyzed. The feeding strategy of the species tended to the generalism, with important contribution of aquatic insects, vegetal matter and fish (the latter being a more rare food item) with some preference or specialization for Diptera (Fig.3).

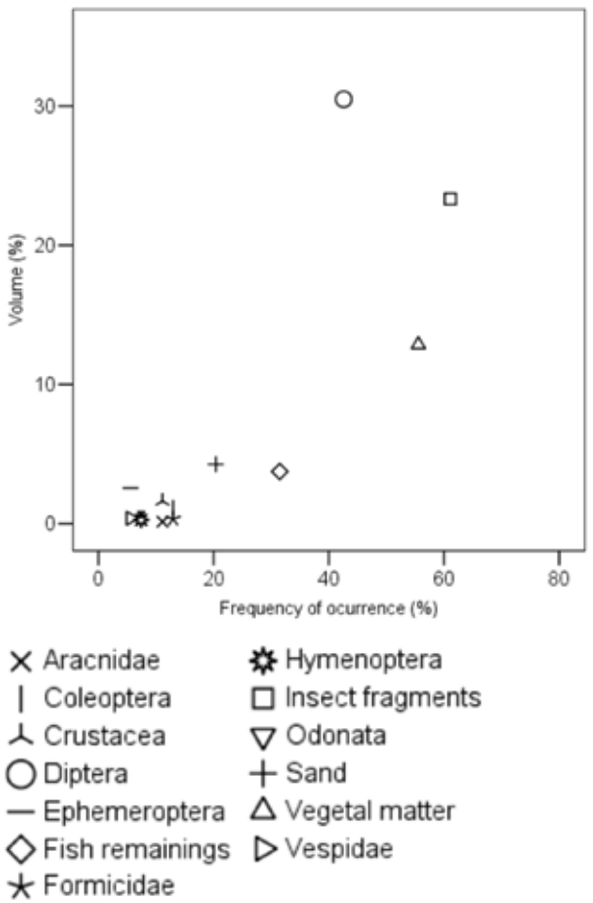

Figure 3. Relative importance of major prey items and categories (as per Table 3) of *Triportheus signatus* in the Seridó River, Brazil.

The study species showed spatial variability in the volumetric contribution of food items to its diet. Both Catureré and Poço dos Patos had the same diversity values (Shannon index = 1.92), despite different richness (11 and 18 food items respectively). Interestingly, Riacho da Serra showed a slightly lower diversity (Shannon index = 1.84), but 17 food items were recorded for the diet of *T. signatus* at this site. Pielou's equitability revealed a greater dominance of a few food items for Riacho da Serra and Poço dos Patos (0.65 and 0.67, respectively), whereas Catureré showed greater evenness in food items consumption (0.80).

Observation of Figure 4 reveals that the dominant food item in the diet of *T. signatus* in Riacho da Serra and Poço dos Patos was Insect fragment. Digested material was also dominant in both study sites. On the other hand, these food items gave smaller volumetric contributions to the diet of the study species in Catureré, which showed a more even volumetric contribution of most food items ingested (Fig.4). In Catureré, Diptera (56.5%), Insect fragment (15.9%), Digested matter (13.0%), Unidentifiable vegetal matter (9.0%), Sand (7.0%) and Fish remainings (6.0%) were the most important food items. In Riacho da Serra, the major food items were Insect fragment, Seed (21.3%), Digested matter (16.2%), Unidentifiable vegetal matter (8.4%), Diptera (8.3%) and Coleoptera (4.8%). In Poço dos Patos, Insect fragment (33.9%), Digested matter (17.9%), Ephemeroptera (14.5%), Corixidae (13.0%), Cladocera (8.3%) and Vegetal matter gave greater contribution to the stomach contents of *T. signatus* (Fig.4). The index of similarity of Morisita-Horn showed that Riacho da Serra and Poço dos Patos were more similar (0.58) when compared to Catureré and Riacho da Serra (0.45) and Catureré and Poço dos Patos (0.36).

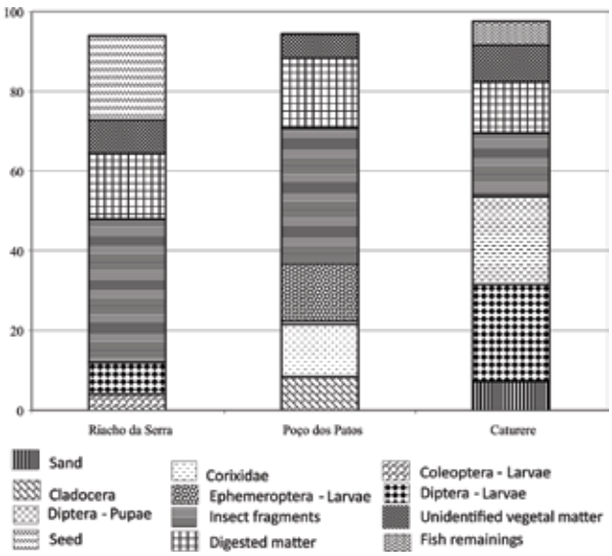

Figure 4. Percentage contribution by volume of food items to the diet of *Triportheus signatus* in an intermittent river in semi-arid Brazil.

Discussion

Feeding habits of *T. signatus* described in the present study indicate an omnivorous/generalist species, with some tendency to insectivory. This is in accordance with other studies for the genus (Gama & Caramaschi, 2001; Galina & Hahn, 2004). The relatively large amounts of digested material in the stomach contents and the low rates of stomach fullness of *T. signatus* indicate that feeding time probably occurred much earlier in relation with the time of sampling. No studies have been performed on feeding chronology of this species, but studies on feeding rhythms of fish in dry regions indicate that prey activity and vulnerability associated to light levels are important factors determining time for feeding activity of fish (Medeiros & Arthington, 2008a). In the present study, it is likely that the study species is feeding early in the morning and late in the afternoon as opposed to midday hours as suggested for omnivores in other dry regions (see for instance Medeiros & Arthington, 2008a), thus the large amounts of digested matter in the stomach contents. Higher temperatures during midday hours are the most likely factor pushing peak feeding activity away from this time of day.

Medeiros & Arthington (2008b) showed significant variations in diet composition across size classes on fish species at different trophic levels in a dryland river. Even though ontogenetic variations in the diet of *T. signatus* have been reported in other studies (Motta & Uieda, 2004; Mazzoni & Costa, 2007), evidence from the present study shows that diet composition was similar between the two sizes classes studied, and therefore fish size is unlikely to have affected the overall results. Yamamoto *et al.* (2004) indicated that variation in diet composition across sizes classes of *Triportheus angulatus* (Spix & Agassis, 1829) was the result of differences in the distribution of fish in the habitat, where smaller individuals would feed more frequently in shallow marginal areas and larger individuals in the deeper areas. In the present study, fish were confined to relatively shallow river-bed pools for most of the time, probably resulting in a very similar range of food resources available. The greater richness of food items observed in larger fish is clearly the result of larger mouth gapes, thus increased potential for ingestion of a greater array of food items (see Pusey *et al.*, 2000).

The diet of *T. signatus* was composed of a range of food items and Insect and Vegetal matter were the most important food items consumed during the study period. Among the insects, larvae and pupae of Diptera gave the largest contributions followed by Ephemeroptera and Corixidae. Insects

and Vegetal matter were also reported as an important part of the diet of species of *Triportheus* (Yamamoto *et al.*, 2004). Galina & Hahn (2003) reported that *Triportheus paranensis* (Günther, 1874) and *Triportheus nematurus* (Kner, 1858) fed mostly on aquatic insects and vegetal matter, with consistent variation depending on the type of habitat (reservoir and floodplain lagoons) or dry/wet season. Terrestrial insects were also consumed mostly associated with the wet season (Galina & Hahn, 2003; Yamamoto *et al.,* 2004).

Insects of terrestrial origin gave little contribution to the diet of *T. signatus* in the present study, suggesting a high dependency on food resources produced within the study aquatic systems. Studies on the habitat structure of water bodies in the Seridó River basin showed that despite a relatively diverse array of submerged structures and substrate types, little overhanging marginal vegetation is present (Medeiros *et al.,* 2008). This may limit the overall input of terrestrial organisms available for fish consumers. Furthermore, flooding in Brazilian semi-arid streams is usually constrained to the main river channel limiting interaction between the aquatic environment and the adjacent riparian zone.

Microcrustaceans, mainly zooplankton, have been reported as important food items to this genus during high flow periods, when their abundance is greater (Galina & Hahn, 2003; Yamamoto *et al.,* 2004). Even though species of *Triportheus* have been reported to present modifications in the branchial apparatus to increase efficiency of capture of zooplankton (see Galina & Hahn, 2003), in the present study, zooplankton (Cladocera and Copepoda) contributed very little to the diet. This is most likely the result of larger size of fish caught and low abundance of this food item, since Brazilian semi-arid streams usually have greater abundances of the small-sized nauplii and Rotifera in the plankton (Noia *et al.,* 2009).

Brazilian semi-arid streams are renowned for their spatial heterogeneity in biological processes (Medeiros *et al.,* 2006) and habitat structure (Medeiros *et al.,* 2008). Coupled with the hydrological disturbances that characterize these systems (Maltchik & Florin, 2002), such variability has been hypothesized as the major driving force structuring communities in these systems (Maltchik & Medeiros, 2001). This study showed some degree of spatial variability in the volumetric contribution of food items to the diet of *T. signatus*. Such variability was mostly related to changes in volume of dominant food items consumed rather than different composition of diet, as shown by equitability and similarity values, and since overall richness and diversity of food items was similar across sampling sites.

A major pattern observed was a greater evenness in volume of food items in Catureré in contrast with higher dominance of insect fragments in Riacho da Serra and Poço dos Patos. Since the dominance of insect fragments was common in both Riacho da Serra and Poço dos Patos these two sites were considered more similar when compared to Catureré. The latter did not show surface water flow during the study period, being a more turbid stretch of the river with a greater contribution of fine muddy sediments to the substrate composition. These characteristics are favorable to the presence of dipterans (see Rosa *et al.,* 2011) which could have led to the greater abundance of this prey to the diet of *T. signatus* at this site, and lower contributions of other food items.

Major differences in diet between Riacho da Serra and Poço dos Patos are represented by the consumption of seeds at the former. This site presented greater abundance of vegetal elements in the sub-aquatic habitat structure (such as macrophytes and algae) and in the margins (such as grass and vegetal cover). Such characteristics associated with greater flow may have enhanced the availability of plant seeds to the diet of the species. In more humid areas, species of this genus have been reported to capitalize on fruits fallen into the water during flow periods (Yamamoto *et al.*, 2004). In the present study, the origin of these seeds was not determined; however the high volume of other vegetal matter and the overall absence of terrestrial insects indicate that the study species may have consumed autochthonous vegetal matter, probably associated with the insects which it fed upon. Results presented are in accordance with other studies that highlighted the importance of the physical habitat to the fish fauna, as the habitat is the framework for colonization by fish and their food resources (Martin-Smith, 1998).

Differences in diversity of habitat elements across variable habitat types have been reported for semi-arid aquatic systems of Brazil (Medeiros *et al.* 2008). In that sense, this study indicates that differences and similarities in resource availability associated with the structure of the habitat may be playing an important role in the use of food resources by fish. Therefore, feeding preferences and the structure of the habitat at stream-reach scale (in the presence of a diverse resource availability) are likely to be important factors determining the food items ingested by *T. signatus*. The results of the present study provide evidence that the dietary composition of *T. signatus* is influenced mostly by the availability and composition of prey items associated with spatial changes in the habitat structure. Despite the relatively large range of food items consumed, the results suggest that study sites show some variability regarding the array of food consumed but a few food items were dominant.

Acknowledgements

The authors are grateful to Telton Pedro Anselmo Ramos and Virginia Dantas Diniz (Universidade Federal da Paraíba) for fieldwork assistance. ESFM is grateful to CNPq/UEPB/DCR for scholarship granted (350082/2006-5). LBM, JATB and MJS are grateful to "Programa de Iniciação Científica da UEPB/CNPq". This research was supported by funds from CNPQ (Edital MCT/CNPq 02/2006 - Universal 477545/2006-8) and received logistical support from "Projeto de Pesquisa em Biodiversidade do Semi-árido (PPBio Semi-árido)".

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Recebido: 08/09/2010

Revisado: 12/08/2011

Aceito: 12/08/2011