Biotemas, 23 (4): 59-64, dezembro de 2010
ISSN 0103 – 1643

doi: 10.5007/2175-7925.2010v23n4p59

Effects of body size on the diet of *Rivulus haraldsiolii* (Aplocheiloidei: Rivulidae) in a coastal Atlantic Rainforest island stream, southern Brazil

Vinícius Abilhoa[1]*
Jean Ricardo Simões Vitule[1,2]
Hugo Bornatowski[1]
Fagner Breda de Lara[2]
Glauco Ubiratan Kohler[2]
Luciana Festti[2]
Wanessa Priscila David do Carmo[2]
Igor Kintopp Ribeiro[1]

[1]Grupo de Pesquisas em Ictiofauna (GPIc), Museu de História Natural Capão da Imbuia (MHNCI), Prefeitura de Curitiba
Rua Prof. Benedito Conceição, 407, CEP 82810-080, Curitiba-PR, Brazil
[2]PPG em Ecologia e Conservação, Setor de Ciências Biológicas
Universidade Federal do Paraná
Caixa Postal 19031, 81531-980, Curitiba-PR, Brazil
*Corresponding author
vabilhoa@uol.com.br

Submetido em 13/04/2010
Aceito para publicação em 26/08/2010

Resumo

Efeito do tamanho corporal na dieta de *Rivulus haraldsiolii* (Aplocheiloidei: Rivulidae) em um riacho litorâneo insular de Floresta Atlântica, sul do Brasil. Foi investigado o efeito do tamanho corporal no hábito alimentar de exemplares de *Rivulus haraldsiolii* coletados em um riacho litorâneo insular de Floresta Atlântica. Amostragens foram realizadas durante uma fase de campo realizada em 13 de julho de 2009, em um riacho de água salobra localizado na porção nordeste da Ilha do Mel, localizada em região meridional de distribuição da Floresta Atlântica no sul do Brasil. A dieta da espécie incluiu insetos imaturos aquáticos (pupas de Diptera e larvas de Chironomidae), insetos aquáticos (Hemiptera – Vellidae), microcrustáceos (Cladocera), ácaros aquáticos (Acarina), gastrópodes (*Pomacea* sp.), insetos terrestres (Coleoptera, Formicidae e Isoptera), fragmentos de insetos e de plantas. A espécie apresentou hábito onívoro, e diferenças na dieta foram relacionadas com as variações no tamanho corporal. Adultos (indivíduos maiores) alimentaram-se principalmente de Formicidae, fragmentos de plantas e ácaros aquáticos, enquanto que jovens (indivíduos menores) alimentaram-se basicamente de larvas aquáticas de insetos (Chironomidae) e ácaros aquáticos.

Unitermos: ecologia alimentar, peixe-anual, peixes de água doce, região neotropical

Abstract

The effect of body size on the feeding habits of the little-known killifish *Rivulus haraldsiolii*, collected in a coastal Atlantic Rainforest island stream, was investigated. Samples were collected during a study trip on

13 July 2009 in a brackish stream located in the northern part of Ilha do Mel Island, one of the most important southern Atlantic Forest areas in southern Brazil. The diet included aquatic immature insects (Diptera pupae and Chironomidae), aquatic insects (Hemiptera – Vellidae), microcrustaceans (Cladocera), aquatic ticks (Acarina), gastropods (*Pomacea* sp.), terrestrial insects (Coleoptera, Formicidae and Isoptera), insect fragments, and plant fragments. The species presented an omnivorous feeding habit, and differences in diet could be related to variations in body sizes. Adults (large individuals) feed mainly on Formicidae, plant fragments and aquatic ticks, whereas juveniles (small individuals) feed basically on aquatic immature insects (Chironomidae) and aquatic ticks.

Key words: feeding ecology, freshwater fish, killifish, Neotropics

Introduction

The Neotropical killifish *Rivulus haraldsiolii* Berkenkamp, 1984 was recently redescribed, and recorded as being endemic to Atlantic Forest coastal drainages in southern Brazil, between Paraná and Santa Catarina states (Costa, 2007). The little-known species of Rivulidae are small-sized forest-dwelling fish that inhabit preferably the shallowest parts of small streams, temporary swamps, flooded areas and man-made drainage ditches (Santos-Filho, 1997). As for any other killifishes, despite the remarkable life cycle (Costa, 2003, Mitcheson and Liu, 2008) and the occurrence in perennial aquatic biotopes and seasonal pools (Costa, 2006), there is scarce information about their natural feeding ecology. Available evidence suggests that the group might have a generalist diet (Taylor, 1992; Shibatta and Rocha, 2001; Shibatta and Bennemann, 2003; Laufer et al., 2009), and differences in the diet richness and prey size are related to variations in body sizes (Santos-Filho, 1997; Laufer et al., 2009).

We describe here the effect of body size on the feeding habits of individuals of *R. haraldsiolii* collected in an Atlantic Rainforest island brackish stream, based on data collected during field studies conducted on 13 July 2009, and related to the field ecology course promoted by the Ecology and Conservation Post Graduation Program of the Federal University of Paraná on Ilha do Mel Island. The study site is considered to be one of the most southern Atlantic Forest areas (Marques and Oliveira, 2004) where freshwater and brackish streams flow directly into the Atlantic Ocean, belonging to the coastal drainages of eastern Brazil province.

Material and Methods

The field work was carried out in a 100m stretch of a brackish stream located in the northern part of the Island (25º31'S 48º18'W) (Figure 1). The study site comprises remaining areas of the coastal Atlantic

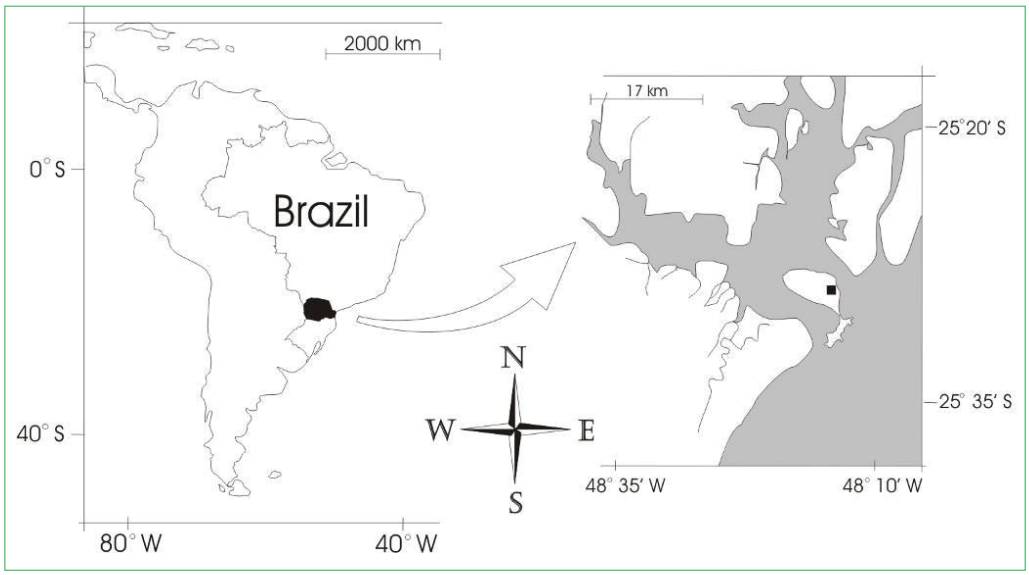

FIGURE 1: Map of South America, showing the Paraná state coast (southern Brazil) and the location of the study site on Ilha do Mel Island (black square).

Rainforest, with floating vegetation and herbaceous riparian vegetation (Figure 2a). All specimens were caught under dead tree branches and leaves in slow-flowing water, with sand on the bottom and a great amount of vegetable debris. Specimens were collected using manual sieves (5mm mesh) and 1.50 x 5.00m seine nets (5mm mesh) (Figure 2b). Captured specimens were fixed in the field in 10% formalin solution and brought to the laboratory of the Centro de Estudos do Mar (CEM-UFPR). Voucher specimens were deposited in the fish collection of the Museu de História Natural Capão da Imbuia (MHNCI 12391). Fishes were collected with IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) authorization 10320.

Because of the lack of information about their life history (size at first maturity, growth, and reproduction), specimens were classified as juveniles and adults according to the size captured, coloration pattern and fin configuration (Santos-Filho, 1997; Costa, 2007). Digestive tracts were removed and their contents analyzed. The food items were grouped in broad taxonomic or ecological categories: aquatic immature insects (Diptera pupae and Chironomidae), aquatic insects (Hemiptera – Vellidae), microcrustaceans (Cladocera), aquatic ticks (Acarina), gastropods (*Pomacea* sp.), terrestrial insects (Coleoptera, Formicidae and Isoptera), insect fragments, and plant fragments.

To evaluate the abundance of food items in the diet of each individual, an adaptation of the Hynes' (1950) method of points was performed: the abundance of each item was interpreted as the number of points (score) that the item covered on grid paper. Abundance data was then investigated using non-metric multidimensional scaling analysis (MDS) with cluster overlay, analysis of similarity (ANOSIM) and similarity percentage (SIMPER) methods performed by the Primer v6 software (Clarke and Gorley; 2006). Significant differences in the diet composition and abundance between juveniles and adults (factors) were assessed by ANOSIM investigation. The SIMPER analysis was used to identify which food item primarily accounted for observed differences between groups. A similarity matrix with the abundance values of food items was generated using the *Bray-Curtis* similarity coefficient.

Results

Eighteen specimens were measured and dissected, ranging from 21.4 to 54.9mm in total length. Five specimens were classified as juveniles (21.4-29.3mm), and thirteen as adults (30.2-54.9mm). Considering the consumption of both animal (mainly aquatic immature dipterans and terrestrial insects) and vegetable (mainly plant fragments) material, the feeding habit of *R. haraldsiolii* seems to be omnivorous. In relation to the origin of the food items, among the autochthonous

FIGURE 2: (a) The study site, a small brackish water stream in the northern part of Ilha do Mel Island, southern Brazil. (b) *Rivulus haraldsiolii*, total length 32.1mm, male.

ones, the most frequent were aquatic ticks (50%) and Chironomidae (27.8%). Formicidae (50%), plant fragments (27.8%), Coleoptera (16.6%) and Isoptera (16.6%) were the most common allochthonous food items.

Diet composition demonstrated differences between juvenile and adult categories as indicated by the ordination resulting from MDS (Figure 3) and the one-way ANOSIM test (Global R=0.485; significance level=1%). SIMPER results showed high dissimilarity between juvenile and adult diets (92.6%), with greater representativeness of Formicidae (63.9%), plant fragments (16.9%) and aquatic ticks (12.8%) for adult categories, and aquatic larvae of Chironomidae (67.6%) and aquatic ticks (27.85) for juveniles (Figure 4).

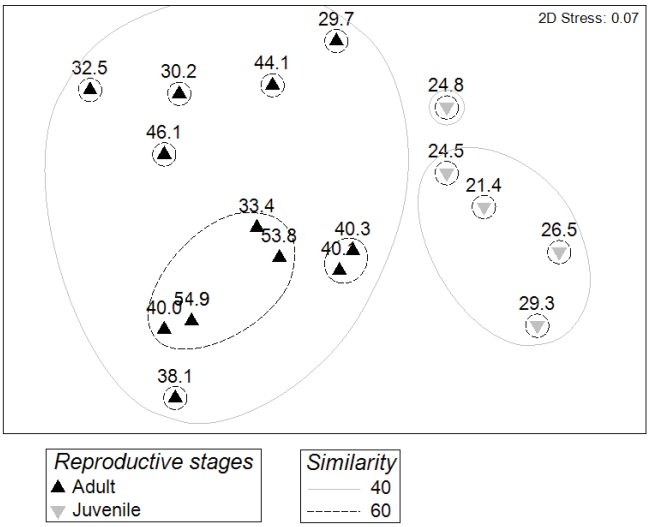

FIGURE 3: Ordination resulting from Nonmetric Multidimensional Scaling Analysis (MDS) with cluster overlay (traces), based on the abundance of food items in juvenile and adult categories (numbers=total length).

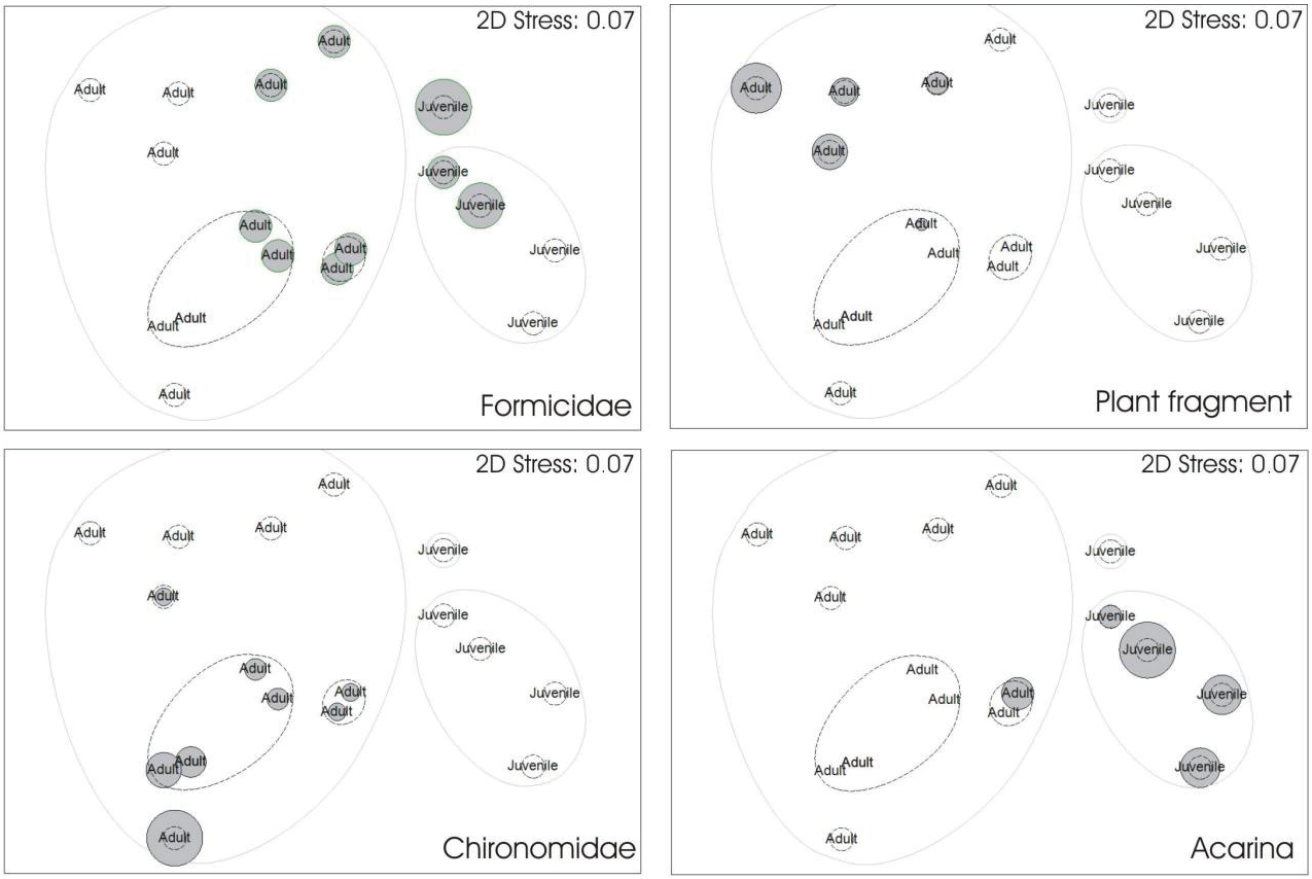

FIGURE 4: Contribution of Formicidae, plant fragments, Chironomidae, and aquatic ticks (Acarina) to the *Rivulus haraldsiolii* diet, according to the ordination resulting from Nonmetric Multidimensional Scaling Analysis (MDS) with cluster overlay (traces). The larger the grey circle (bubble), the greater the abundance value.

Discussion

Despite the fact that this study represents a short-term survey on the feeding ecology of this poorly known killifish, our findings suggest that plants and a variety of terrestrial and aquatic invertebrates form the bulk of *Rivulus haraldsiolii* diet. Davies et al. (1990) and Taylor (1992) studying *Rivulus marmoratus* in Florida mangrove marshes, and Shibatta and Bennemann (2003) studying *Rivulus pictus* in small lakes of Brazilian savanna, also noted that aquatic and terrestrial invertebrates (mostly insects) are considered to be one of the main food items consumed by rivulids.

The food habits changed ontogenetically, which may be a reflection of changes in feeding capabilities (*e.g.* mouth gap, locomotion ability) or habit shifts (Wooton, 1999). Adults (large individuals) feed mainly on Formicidae, plant fragments and aquatic ticks, whereas juveniles (small individuals) feed basically on aquatic immature insects (Chironomidae) and aquatic ticks. A shift in food habits with size increase is well known in fishes (Nikolsky, 1963; Amundsen et al., 2003; Rezsu and Specziár, 2006; Alcaraz and García-Berthou, 2007), and has already been registered for Rivulidae (Laufer et al., 2009), as well as for *R. luelingi* in a laboratory experiment (Santos-Filho, 1997). Generally, larger fish eat larger food and a greater variety of organisms, whereas smaller fish feed on less diverse and smaller sized food items. The feeding habits of *R. haraldsiolii* seem to follow this trend.

The presence of terrestrial insects and the anatomical characteristics of *R. haraldsiolii*, such as the fusiform body shape, large eyes dorsolaterally placed on the head, and upward turned mouth, with the upper and lower jaws moderately protractile (Figure 5), indicate surface picking behavior, by which the fish swims upstream and catches terrestrial items on the water surface (Sazima, 1986), mainly in the marginal areas with slow flowing waters, probably due to a reduced ability for continuous swimming. According to Santos-Filho (1997), *Rivulus* is a visually oriented predator, strongly attracted by prey movement and items that fall into the water from the trees, in a similar way to that observed for several characin species in Atlantic Rainforest streams (Costa, 1987; Casatti and Castro, 1998; Aranha et al., 1998; Abilhoa et al., 2007; 2009).

The relevance of aquatic immature stages of mosquitoes (Diptera), terrestrial insects (Formicidae) and plants to its natural diet highlights the importance of the marginal forest of the Atlantic Rainforest biome to the feeding habits of stream fishes, a result which has also been recorded for several other stream fishes (Sabino and Castro, 1990; Esteves and Lobón-Cerviá, 2001; Costa et al., 1987; Graciolli et al., 2003; Abilhoa et al., 2007; Vitule et al., 2008). In fact, most fish species use food items of allochthonous origin (Lowe-McConnell, 1999) and changes in the riparian vegetation can cause alteration in the feeding habits of freshwater fishes, affecting many links of the trophic chain (Barrela et al., 2000). The present scientific note is the first register on the feeding ecology of *R. haraldsiolii*, an important component of temporary pond communities and stream ecosystems.

Acknowledgements

The authors are grateful to the Ecology and Conservation Post Graduation Program of the Federal University of Paraná and to the Centro de Estudos do

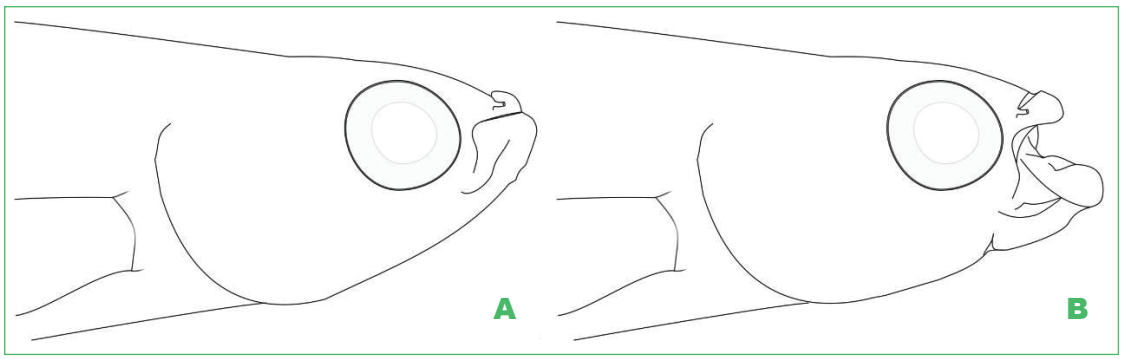

FIGURE 5: Morphological characteristics of *R. haraldsiolii* related with prey detection and ingestion: large eyes, dorsolaterally placed on the head, and the subdorsal mouth (A), with upper and robust lower jaw moderately protractile (B).

Mar (CEM-UFPR) for laboratory facilities. Several papers on Rivulidae biology and ecology were kindly provided by Scott Taylor (Environmentally Endangered Lands Program – Florida).

References

Abilhoa, V.; Bastos, L. P.; Wegbecher, F. 2007. Feeding habits of *Rachoviscus crassiceps* (Teleostei: Characidae) in a coastal Atlantic rainforest stream, southern Brazil. **Ichthyological Exploration of Freshwaters, 18** (3): 227-232.

Abilhoa, V.; Bornatowski, H.; Otto, G. 2009. Temporal and ontogenetic variations on feeding habits of *Hollandichthys multifasciatus* (Teleostei: Characidae) in coastal Atlantic rainforest streams, southern Brazil. **Neotropical Ichthyology, 7** (3): 415-420.

Alcaraz, C.; García-Berthou, E. 2007. Food of an endangered cyprinodont (*Aphanius iberus*): ontogenetic diet shift and prey electivity. **Environmental Biology of Fishes, 78**: 93-207.

Amundsen, P.; Bohn, T.; Popova, O. A.; Staldvik, F. J.; Reshetnikov, Y. S.; Kashulin, N. A.; Lukin, A. A. 2003. Ontogenetic niche shifts and resource partitioning in a subarctic piscivore fish guild. **Hydrobiology, 497**: 109-119.

Aranha, J. M. R.; Takeuti, D. F.; Yoshimura, T. M. 1998. Habitat use and food partitioning of the fishes in a coastal stream of Atlantic Forest, Brazil. **Revista de Biología Tropical, 46** (4): 951-959.

Barrella, W.; Petrere-Júnior, M.; Smith, W. S.; Montag, L. F. A. 2000. As relações entre matas ciliares, os rios e os peixes. In: Rodrigues, R. R. & Leitão-Filho, H. L. (Eds). **Matas ciliares: conservação e recuperação.** Edusp/Fapesp, São Paulo, Brasil, p.187-207.

Casatti, L.; Castro, R. M. C. 1988. A fish community of the São Francisco River headwaters riffles, southeastern Brazil. **Ichthyological Exploration of Freshwaters, 9** (3): 229-242.

Clarke, K. R.; Gorley, R. N. 2006. **PRIMER v6: User Manual/ Tutorial.** PRIMER-E, Plymouth, USA, 190pp.

Costa, W. J. E. M. 1987. Feeding habits of a fish community in a tropical coastal stream, rio Mato Grosso, Brazil. **Studies on Neotropical Fauna and Environment, 22** (3): 145-153.

Costa, W. J. E. M. 2003. Family Rivulidae (South American annual fishes). In: Reis, R. E.; Kullander, S. O. & Ferraris, C. J. (Eds). **Check list of the freshwater fishes of South and Central America.** Edipucrs, Porto Alegre, Brasil, p.526-548.

Costa, W. J. E. M. 2006. Relationships and taxonomy of the killifish genus *Rivulus* (Cyprinodontiformes: Aplocheiloidei: Rivulidae) from the Brazilian Amazonas river basin, with notes on historical ecology. **Aqua Journal of Ichthyology and Aquatic Biology, 11**: 133-175.

Costa, W. J. E. M. 2007. Redescription of *Rivulus luelingi* and *R. haraldsiolii* (Teleostei: Cyprinodontiformes: Rivulidae), two valid killifish species from the Atlantic forest of the coastal plains of southern Brazil. **Ichthyological Exploration of Freshwaters, 18** (2): 175-182.

Davis, W. P.; Taylor, D. S.; Turner, B. J. 1990. Field observations of the ecology and habits of mangrove rivulus (*Rivulus marmoratus*) in Belize and Florida (Teleostei: Cyprinodontiformes: Rivulidae). **Ichthyological Exploration of Freshwaters, 1** (2): 123-134.

Esteves, K. E.; Lobón-Cerviá, J. 2001. Composition and trophic structure of a fish community of a clear water Atlantic rainforest stream in southeastern Brazil. **Environmental Biology of Fishes, 62**: 429-440.

Graciolli, G.; Azevedo, M. A.; Melo, F. A. G. 2003. Comparative study of the diet of Glandulocaudinae and Tetragonopterinae (Ostariophysi: Characidae) in a small stream in southern Brazil. **Studies on Neotropical Fauna and Environment, 38** (2): 95-103.

Hynes, H. B. N. 1950. The food of fresh-water stickle-backs (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. **Journal of Animal Ecology, 19**: 36-57.

Laufer, G.; Arim, M.; Loureiro, M.; Piñeiro-Guerra, J. M.; Clavijo-Baquet, S.; Fagúndez, C. 2009. Diet of four annual killifishes: an intra and interspecific comparison. **Neotropical Ichthyology, 7** (1): 77-86.

Lowe-McConnell, R. H. 1999. **Estudos ecológicos de comunidades de peixes tropicais.** Edups, São Paulo, Brasil, 535pp.

Marques, M. C. M.; Oliveira, P. E. A. M. 2004. Fenologia de espécies do dossel e do sub-bosque de duas Florestas de Restinga na Ilha do Mel, sul do Brasil. **Revista Brasileira de Botânica, 27** (4): 713-723.

Mitcheson, Y. S.; Liu, M. 2008. Functional hermaphroditism in teleosts. **Fish and Fisheries, 9**: 1-43.

Nikolsky, G. V. 1963. **The ecology of fishes.** Academic Press, London, UK, 352pp.

Rezsu, E.; Specziár, A. 2006. Ontogenetic diet profiles and size dependent diet partitioning of ruffe *Gymnocephalus cernuus*, perch *Perca fluviatilis* and pumpkinseed *Lepomis gibbosus* in Lake Balaton. **Ecology of Freshwater Fish, 15**: 339-349.

Sabino, J.; Castro, R. M. C. 1990. Alimentação, período de atividade e distribuição espacial dos peixes de um riacho da floresta Atlântica (sudeste do Brasil). **Revista Brasileira de Biologia, 50** (1): 23-26.

Santos-Filho, P. S. 1997. The effect of body size on prey choice by *Rivulus luelingi* Seegers 1984 (Aplocheiloidei: Rivulidae). **Revista Brasileira de Biologia, 57** (4): 551-562.

Sazima, I. 1986. Similarities in feeding behavior between some marine and freshwater fishes in two tropical communities. **Journal of Fish Biology, 29**: 53-65.

Shibatta, O. A.; Bennemann, S. T. 2003. Plasticidade alimentar em *Rivulus pictus* Costa (Osteichthyes, Cyprinodontiformes, Rivulidae) de uma pequena lagoa em Brasília, Distrito Federal, Brasil. **Revista Brasileira de Zoologia, 20** (4): 615-618.

Shibatta, O. A.; Rocha, A. J. A. 2001. Alimentação em machos e fêmeas do pirá-brasília, *Simpsonichthys boitonei* Carvalho (Cyprinodontiformes, Rivulidae) **Revista Brasileira de Zoologia, 18** (2): 381-385

Taylor, D. S. 1992. Diet of the killifish *Rivulus marmoratus* collected from land crab burrows, with further ecological notes. **Environmental Biology of Fish, 33**: 389-393.

Vitule, J. R. S.; Braga, M. R.; Aranha, J. M. R. 2008. Ontogenetic, spatial and temporal variations in the feeding ecology of *Deuterodon langei* Travassos, 1957 (Teleostei: Characidae) in a Neotropical stream from the Atlantic rainforest, southern Brazil. **Neotropical Ichthyology, 6** (2): 211-222.

Wooton, J. H. 1999. **Ecology of teleost fish.** Kluwer Academic Publishers, Dordrecht, Netherlands, 386pp.