

## Helminth parasites of the pupfish *Cyprinodon meeki* (Pisces: Cyprinodontiformes), an endemic freshwater fish from North-Central Mexico

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### Summary

A total of 21 pupfish *Cyprinodon meeki* was collected from the spring Abraham González, Durango, Mexico. Seven helminth taxa were recovered: *Salsuginus angularis*, *Posthodiplostomum minimum*, *Clinostomum complanatum*, *Bothriocephalus acheilognathi*, *Cyclastera* cf. *ralli*, *Actinorhynchus duranguensis* and *Spiroxys* sp. Among them, *B. acheilognathi* and *A. duranguensis* were the most frequent and abundant species. The remaining species were rare and found at low mean abundance. The observed species richness, individual parasite abundance, and diversity were low at component community and infracommunity levels. These features are in accordance with those recorded for other freshwater fish species in the Nearctic part of Mexico. Host feeding habits, along with its role as intermediate host, are suggested as the main factors in determining the helminth community structure in this fish species.

Key words: Pupfish; *Cyprinodon meeki*; helminth community; Mexico

### Introduction

The pupfish *Cyprinodon meeki* Miller, 1976 is a freshwater species restricted to small springs in the Mezquital River drainage, in the state of Durango, North of Mexico (Espinoza *et al.*, 1993; Miller *et al.*, 2005). It is a generalist feeder and observations of the intestinal content in the studied specimens indicate that their diet mainly consist of algae and insects. This fish species is currently listed as at risk (Miller *et al.*, 2005; World Conservation Monitoring Centre, 2007), and, probably because of its restricted distribution, its helminth fauna is poorly known. The only published record for *C. meeki* is a recently described species of acanthocephalan (Salgado-Maldonado *et al.*, 2005). The aim of this note is to present the helminthological record of the pupfish, *C. meeki* in its current area of distri-

bution, and to describe the helminth community structure of this host species in terms of taxonomic composition, species richness and diversity.

### Material and Methods

A total of 21 adult specimens of *Cyprinodon meeki* (total length 20 to 43 mm) were collected using nets in the spring Abraham González (24°12'45''N; 104°31'48''W). This spring is located in Northern Mexico, few kilometers east of Durango City, State of Durango. The fishes were taken alive to the laboratory and examined within 24 hours after capture using standard procedures. All the external surfaces, mouth, gills, eyes, viscera, including liver, kidney, gut, mesenteries, body cavity and musculature of each host were examined under a stereomicroscope. All helminths found in each fish were counted and then fixed with hot 4 % formalin. Monogeneans, digeneans and cestodes were stained with Mayer's paracarmin or Ehrlich's haematoxylin, dehydrated using a graded alcohol series, cleared in methyl salicylate, and whole-mounted. Nematodes were cleared with glycerin for light microscopy, and stored in 70 % ethanol. Prevalence (percent infected) and mean intensity (mean number of parasites per infected fish) were calculated and used following Bush *et al.* (1997). To determine if sample size was sufficient to produce an accurate estimate of the pool of parasites, a species-richness sample effort curve was used. Helminth species were grouped as dominant (high prevalence and abundance) and rare (low prevalence and abundance) after an Olmstead-Tukey corner test of association (Steel & Torrie, 1981). Numerical dominance was determined using the Berger-Parker dominance index (Southwood, 1978). Infracommunities were described by the mean number of parasite species, the mean number of individual helminths, and the mean value of the Brillouin diversity index. Infracommunities were

compared qualitatively within the locality using the Jaccard similarity index, and quantitatively using the Morisita-Horn index, as calculated in Magurran (1988). Voucher specimens of all taxa were deposited in the Colección Nacional de Helmintos (CNHE), Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City.

## Results

A total of 92 individual helminths were collected. Seven helminth species were recovered: one monogenean, two digeneans, two cestodes, one nematode and one acanthocephalan (Table 1). Four helminth species were recovered as larval stages: *Clinostomum complanatum*, *Posthodiplostomum minimum*, *Cycluster cf. ralli* and *Spiroxys* sp.; the remaining three helminth species were found as adults, with *Atactorhynchus duranguensis* as the only specialist to *C. meeki*. The cestode *Bothriocephalus acheilognathi* was the most abundant species, accounting for about 46 % of the collected worms, followed by *A. duranguensis* which accounted for 17 %. These two species showed the highest levels of infection reaching prevalence values higher than 30 %. However, only *B. acheilognathi* registered a value of mean intensity higher than 2 parasites per infected host. Infection site, number of infected fish, prevalence, a mean intensity of each helminth species are shown in Table 1.

All of the individual hosts were infected, but only 28.5 % of the fishes harbour two or three helminth species. The total number of individual helminths of all species per host varied from 1 to 22, with a mean number of  $4.38 \pm 7.23$  individuals per host. The Olmstead-Tukey test showed that the intestinal worms, *B. acheilognathi* and *A. duranguensis*, were frequent (prevalence > 20.41 %) and abundant (abundance > 0.627). The remaining species have low prevalence and abundance values (Table 1).

The helminth infracommunities were species-poor. Most infracommunities were composed by only one species; four of them had two helminth species, and only two had a maximum of three species. The mean number of species per host was  $1.38 \pm 0.67$ . A large number of hosts (40 %) were parasitized by a single species (the acanthocephalan *A. duranguensis*). The Brillouin index for all infracommunities varied from 0 to 0.682, with a mean diversity value of  $0.132 \pm 0.234$ , while the Berger-Parker dominance index values varied from 0.5 to 1, with a mean of  $0.92 \pm 0.147$ . For comparative purposes, we calculate the Brillouin index for the six infracommunities with at least two species, which varied from 0.189 to 0.682, with a mean diversity value of  $0.462 \pm 0.191$ , and the Berger-Parker dominance index values varied from 0.5 to 0.929, with a mean of  $0.721 \pm 0.139$ . Most of these assemblages were dominated by the cestode *B. acheilognathi*. The helminth infracommunities with at least two species displayed a low

Table 1. Helminth parasites of the pupfish *Cyprinodon meeki* in Abraham González spring, Durango, Mexico (n = 21)

Helminth	Infection site(s)	Number of hosts infected	Prevalence (%)	Mean intensity $\pm$ SD	CNHE No.
Monogenea					
<i>Salsuginus angularis</i>	G	2	9	$1.5 \pm 0.71$	6008
Larval Digenea					
<i>Clinostomum complanatum</i>	Bc, L, M	4	23	$2 \pm 2.39$	6003 – 6005
<i>Posthodiplostomum minimum</i>	L	1	5	13	6006
Cestoda					
<i>Bothriocephalus acheilognathi</i>	I	7	33	$6.14 \pm 7.87$	6002
Larval Cestoda					
<i>Cycluster cf. ralli</i>	M	1	5	1	6007
Larval Nematoda					
<i>Spiroxys</i> sp.	M	4	19	$1.5 \pm 0.58$	6000
Acanthocephala					
<i>Atactorhynchus duranguensis</i>	I	10	48	$1.6 \pm 0.97$	6009

Bc = body cavity; G = gills; I = intestine; L = liver; M = mesentery

level of similarity. The corresponding Jaccard index varied from 0 to 0.667 (mean of  $0.25 \pm 0.192$ ) and the Morisita-Horn index varied from 0 to 0.934 (mean of  $0.302 \pm 0.361$ ).

## Discussion

Most helminth species parasitizing *C. meeki* were larval stages. All these helminths have previously been recorded for diverse freshwater fish species in Central Mexico (Salgado-Maldonado, 2006; Pérez-Ponce de León *et al.*, 2007), and with the exception of *C. cf. ralli*, have also been found parasitizing to *Characodon audax* in the neighbor spring El Toboso (Martínez-Aquino *et al.*, 2007). The remaining helminth species fall into three different categories: one generalist (*Salsuginus angularis*), one introduced (*B. acheilognathi*) and one specialist species (*A. duranguensis*). The monogenean *S. angularis* has been reported in cyprinodontiform fishes of Canada and United States, and has recently been recorded parasitizing goodeid fishes in Mexican waters (Mendoza-Palmero, 2007). The tapeworm *B. acheilognathi* is an introduced species widely distributed in freshwater fishes of Mexico (Gutiérrez-Cabrera *et al.*, 2005; Salgado-Maldonado, 2006). The present record of this parasite in the endemic and endangered pupfish *C. meeki*, as well as in a sympatric population of *Gambusia senilis* (unpublished data, CNHE No. 6001), might be a factor for the conservation of the host, since that some authors consider it as a potential threat for native freshwater fishes, because its abundance and pathogenicity (Salgado-Maldonado and Pineda-López, 2003).

The helminth species herein recorded for *C. meeki* are not very different from the species found in other cyprinodontiform fishes in Central and Northern Mexico (Peresbarbosa-Rojas *et al.*, 1994; Pérez-Ponce de León *et al.*, 2000; Martínez-Aquino *et al.*, 2004, 2007; Sánchez-Nava *et al.*, 2004), and even from other fish species such as the atherinomorphs (Espinosa-Huerta, *et al.*, 1996; Astudillo-Ramos and Soto-Galera, 1997). This can be explained for the nature of the bodies of water where these fishes inhabit, conformed mainly by endorreic springs and lakes were many allogenic species are transported by fish-eating reptiles and birds.

Because of its endangered status, no additional samples of *C. meeki* were taken. For this reason, the helminth community structure described in this work corresponds to a particular point in time and space. The helminth community of *C. meeki* exhibits low values of species richness at both, the component community and infracommunity levels, and it is in accordance to those recorded for other freshwater fishes in the Nearctic part of Mexico as *Allophorus robustus*, *Goodea atripinnis*, *Allotoca diazi*, *Chapalichthys encaustus*, *Characodon audax*, *Chirostoma attenuatum* and *Chirostoma humboldtianum* (Espinosa-Huerta *et al.*, 1996; Astudillo-Ramos and Soto-Galera, 1997; Rojas *et al.*, 1997; Pérez-Ponce de León *et al.*, 2000; Martínez-Aquino *et al.*, 2004, 2007).

A second characteristic shared among the helminth com-

munity of *C. meeki*, and those exhibited by other freshwater fishes occurring in Central and North-Central Mexico, is the numerical dominance by a few numbers of species. However, unlike previous records (Pérez-Ponce de León *et al.*, 2000; Martínez-Aquino *et al.*, 2004, 2007) the generalist larval trematode *P. minimum* was not the dominant species in *C. meeki*. In this study, the specialist acanthocephalan *A. duranguensis* seems to be the only dominant species at both, infracommunity and component community levels.

Except for some cases as the goodeid *Characodon lateralis*, where the poorest helminth communities have been recorded (Mejía-Madrid *et al.*, 2005; Martínez-Aquino *et al.*, 2007), the data suggest that the helminth composition, and the process involved in the structure of helminth communities are common in those fishes occurring in water bodies of Central and Northern Mexico. This work confirms the depauperate and dominated nature of the helminth assemblages of fishes inhabiting in epicontinental waters in the Nearctic part of Mexico (Espinosa-Huerta *et al.*, 1996; Rojas *et al.*, 1997; Choudhury and Dick, 2000; Pérez-Ponce de León *et al.*, 2000; Martínez-Aquino *et al.*, 2004, 2007; Sánchez-Nava *et al.*, 2004), and also suggest that host feeding habits, along with its role as intermediate host for allogenic helminth species, seem to be the main factors determining the helminth community structure. Additional studies for other fish species are necessary to establish patterns and processes involved in the conformation of these helminth assemblages, considering host diet, invasion for exotic helminth species, availability of intermediate hosts and environmental characteristics.

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