

Endohelminth parasites of seven goodein species (Cyprinodontiformes: Goodeidae) from Lake Zacapu, Michoacán, Central Mexico Plateau

Endohelmintos parásitos de siete especies de godeinos (Cyprinodontiformes: Goodeidae) del lago de Zacapu, Michoacán, en la Mesa Central de México

Andrés Martínez-Aquino,^{1,2} Rodolfo Pérez-Rodríguez,^{1,2} David I. Hernández-Mena,^{1,2} Lorena Garrido-Olvera,^{2,3} Rogelio Aguilar-Aguilar⁴ and Gerardo Pérez-Ponce de León¹

¹ Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Apartado Postal 70-153, México, D.F. 04510. México

² Posgrado en Ciencias Biológicas, UNAM. México, D.F. México

³ Instituto de Ecología, UNAM, México, D.F. México

⁴ Departamento de Biología Comparada, Facultad de Ciencias, UNAM, México D.F. México
e-mail: ppdleon@ibiologia.unam.mx

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ABSTRACT

A total of 11 parasitic endohelminth taxa were found in 7 freshwater fish species of the subfamily Goodeinae in Zacapu Lake, Michoacan, Mexico. Six were adults (*Margotrema* cf. *bravoae*, *Phyllodistomum* sp., *Saccocoeloides sogandaresi*, *Rhabdochona lichtenfelsi*, *Bothriocephalus acheilognathi* and Caryophyllidae gen. sp.), while the remaining 5 taxa (*Clinostomum complanatum*, *Posthodiplostomum minimum*, *Tylodelphis* sp., *Eustrongylides* sp. and *Polymorphus brevis*) were larvae. The taxa *S. sogandaresi*, *Tylodelphis* sp., and *R. lichtenfelsi* reached the highest levels of prevalence and mean abundance among all hosts, while the cestodes *B. acheilognathi* and Caryophyllidae gen. sp. showed the lowest values. This study contributes with the inventory of the freshwater fish helminth fauna in Central Mexico Plateau, and particularly with the previous work that has been done with Goodeinae, a subfamily of freshwater fishes endemic to that part of the country.

Key words: Central Mexico Plateau, Goodeinae, helminth parasites.

RESUMEN

En este trabajo se registran 11 taxa de helmintos endoparásitos de 7 especies de peces de la subfamilia Goodeinae del lago de Zacapu, Michoacán, en la mesa central de México. Seis taxa se

registraron en estado adulto (*Margotrema* cf. *bravoae*, *Phyllodistomum* sp., *Saccocoeloides sogandaresi*, *Rhabdochona lichtenfelsi*, *Bothriocephalus acheilognathi* y Caryophyllidae gen. sp.), en tanto que los 5 restantes correspondieron a larvas (*Clinostomum complanatum*, *Posthodiplostomum minimum*, *Tylodelphis* sp. y *Eustrongylides* sp. y *Polymorphus brevis*). Los taxa *S. sogandaresi*, *Tylodelphis* sp. y *R. lichtenfelsi* presentaron los valores más altos de prevalencia y abundancia en los peces estudiados, mientras que los céstodos *B. acheilognathi* y Caryophyllidae gen. sp. presentaron los valores más bajos. Este estudio contribuye al inventario de la fauna helmintológica de peces de agua dulce de la mesa central de México y en particular al que ha sido realizado con Goodeinae, una subfamilia de peces dulceacuícolas endémica de esa parte del territorio nacional.

Palabras clave: Mesa central de México, Goodeinae, helmintos parásitos.

Goodeinae (Cyprinodontiformes: Goodeidae) represents a subfamily of viviparous freshwater fishes, which comprises 20 genera and 43 species, entirely endemic to river drainages and basins of central Mexico (Domínguez-Domínguez *et al.*, 2012). The helminth fauna parasitizing these freshwater fishes has been intensively documented during the last two decades. Some papers have addressed the helminth assemblage in one single species of host

(i.e., Martínez-Aquino *et al.*, 2004, 2007b, 2009; Sánchez-Nava *et al.*, 2004), while some others described the helminth fauna of three or more goodein species within the same locality (e.g., Peresbarbosa-Rojas *et al.*, 1994; Pérez-Ponce de León *et al.*, 2000; Mejía-Madrid *et al.*, 2005; Romero-Tejeda *et al.*, 2008).

Zacapu Lake, located in Central Mexico Plateau, in the state of Michoacán, is a medium-size water body fed by several springs, which shows a relatively low level of environmental degradation, and serves as habitat for diverse freshwater taxa. Because of this, it has been argued that this area is important from a conservational point of view (Medina-Nava *et al.*, 2005; Domínguez-Domínguez *et al.*, 2006; Martínez-Aquino *et al.*, 2007a). The freshwater fish fauna of the lake includes 7 goodein species of which 6 have been partially studied for helminth parasites (Galicia-Guerrero, 2001; Pérez-Ponce de León, 2001; Mejía-Madrid *et al.*, 2005). The aim of this work is to record the endohelminth parasite fauna of all the species of goodeins inhabiting Zacapu Lake, and provide the ecological infection parameters, such as prevalence and abundance.

On July 2009, a total of 161 adult specimens of goodeins belonging to the species *Alloophorus robustus* (Bean, 1892) (n = 17), *Allotoca zacapuensis* Meyer, Radda & Domínguez-Domínguez, 2001 (n = 32), *Goodea atripinnis* Jordan, 1880 (n = 20), *Hubbsina turneri* de Buen, 1940 (n = 20), *Skiffia lermae* Meek, 1902 (n = 19), *Xenotoca variata* (Bean, 1887) (n = 21), and *Zoogoneticus quitzeoensis* (Bean, 1898) (n = 32), were collected in Zacapu Lake (19°49'35" N; 101°47'10" W), using seine nets and electrofishing. Fishes were taken alive to the laboratory, sacrificed by pithing, and individually examined for endohelminth parasites. After dissection, gastrointestinal tract was removed and placed in a Petri dish with 0.65% saline. Other organs (eyes, liver, spleen, gall, swim and urinary bladders), and body cavity, were examined under a stereomicroscope in separate Petri dishes with saline 0.65%. Digeneans, nematodes and cestodes were fixed with 4% (steaming) formalin. Acanthocephalans were placed during 24 hrs in distilled water at 4 °C, and preserved in absolute ethanol. Platyhelminths and acanthocephalans were stained with Mayers paracarmine. Nematodes were cleared with glycerin for light microscopy study. Voucher specimens of all taxa were deposited in the Colección Nacional de Helmintos (CNHE), Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City. The use of prevalence (% infected), and abundance (mean number of parasites of a single species in the sample) follows Bush *et al.* (1997).

In total, 11 endohelminth parasite taxa were collected from the 7 analyzed host species. The endohelminth fauna includes 6 taxa of digeneans (3 adults and 3 larval stages), 2 adult cestodes, 2 nematodes (1 adult and 1 larvae), and 1 acanthocephalan (cystacanth). *Rhabdochona lichtenfelsi* Sánchez-Álvarez, García-Prieto & Pérez-Ponce de León, 1998, *Tylodelphys* sp., and *Polymorphus brevis* (Van Cleave, 1916), were the most widely distributed

taxa among the host species. The adult nematode *R. lichtenfelsi* reached the highest levels of prevalence and mean abundance. *Allotoca zacapuensis* harbored 7 endohelminth taxa, whereas the remaining fish hosts were parasitized by 4-5 endohelminth taxa. Endohelminth parasite taxa, prevalence and abundance, as well as the new host and locality records herein established are shown in Table 1.

Four endohelminth taxa are reported in Zacapu Lake for the first time, and in addition to that, 21 new host records are established in this paper. The endohelminth fauna of *Skiffia lermae* is reported for the first time, meanwhile for the goodeins *Allotoca zacapuensis*, *Hubbsina turneri*, and *Zoogoneticus quitzeoensis*, the known endohelminth parasite fauna was duplicated with respect to previous records. Our study brings the total number of helminth parasites of goodeins in Zacapu Lake to 18 (Galicia-Guerrero, 2001; Pérez-Ponce de León, 2001; Mejía-Madrid *et al.*, 2005). Additionally, with 64.3% of the fish fauna studied thus far for helminth parasites, our data increase the knowledge about the freshwater fish parasite fauna of this locality in 30%.

The endohelminth fauna of goodeins in Zacapu Lake include at least 2 species which have been considered as specialists to Goodeinae, i.e., *Margotrema* cf. *bravoae* Lamothe-Argumedo, 1970, and *Rhabdochona lichtenfelsi* (Pérez-Ponce de León *et al.*, 2000; Mejía-Madrid *et al.*, 2005, 2007; Pérez-Ponce de León & Choudhury, 2005). The adult digenean *Phyllodistomum* sp., could represent a third specialist species; however, this need to be determined once the taxonomic identity of the species is established. Morphologically similar specimens were recently recorded in the goodein fish *Zoogoneticus purhepechus* Domínguez-Domínguez, Pérez-Rodríguez *et al.*, 2008 from a relatively close locality in the lower Lerma River (Martínez-Aquino *et al.*, 2011). These specimens, along with those reported as *Dendrorchis* sp. by Martínez-Aquino *et al.* (2009) have been only recorded in goodeins in central Mexico and may be conspecific. Moreover, they could represent a new species; although until additional taxonomic work based on morphology and molecular markers is carried out, their identities remain uncertain. In contrast, 8 generalist helminth taxa were recorded in the analyzed hosts both as adult or larval stages: *Saccocoeloides sogandaresi* Lumsden, 1963, *Clinostomum complanatum* (Rudolphi, 1819), *Posthodiplostomum minimum* (MacCallum, 1921), *Tylodelphys* sp., *Bothriocephalus acheilognathi* Yamaguti, 1934, Caryophyllidae gen. sp., *Eustrongylides* sp., and *P. brevis*.

For this survey, specimens were collected only in one period during the year, preventing us from establishing a robust comparison of the parasite fauna among analyzed species of hosts, or even between the records we establish in this work, and those previously made for other authors. However, our data correspond with the general pattern described for most species of freshwater fishes occurring in different river basins in central Mexico, i.e., a

Table 1. Number of infected hosts (IH), prevalence (%), abundance (Ab), and infection site of the endohelminth parasites of seven freshwater fish species of goodeins from Zacapu Lake, Michoacán, Central Mexico Plateau.

	<i>Allophorus robustus</i> (n = 17) IH, %, Ab	<i>Allotoca zacapuensis</i> (n = 32) IH, %, Ab	<i>Goodea atripinnis</i> (n = 20) IH, %, Ab	<i>Hubbsina turneri</i> (n = 20) IH, %, Ab	<i>Skiffia lermae</i> (n = 19) IH, %, Ab	<i>Xenotoca variata</i> (n = 21) IH, %, Ab	<i>Zoogoneticus quitzeoensis</i> (n = 32) IH, %, Ab	CNHE No.
Adult Digenea								
<i>Margotrema cf. bravoae</i> (I)		8, 25, 0.44					15, 46.88 0.88φ	7811-12
<i>Phyllostomum</i> sp.# (Ub)		3, 9.38, 0.13φ		2, 10 0.1φ			5, 15.63 0.5φ	7813-15
<i>Saccocoeleoides sogandares</i> # (I)			15, 75 3.15φ					7816
Larval Digenea								
<i>Clinostomum complanatum</i> (Bc)	2, 11.76 0.18φ					1, 4.76 0.05		7817-18
<i>Posthodiplostomum minimum</i> (Bc, L, M)		9, 28.13, 2.03φ	5, 25 0.50		4, 21.05 1.58φ			7819-21
<i>Tylolephthis</i> sp.# (Bc)		2, 6.25, 0.09φ*	2, 10 0.3φ	15, 75 9.7φ	13, 68.42 3.47φ	1, 4.76 0.05φ	2, 6.25 0.06φ	7822-26
Adult Cestode								
<i>Bothriocephalus acheilognathi</i> (I)		1, 3.13 0.03						*
Caryophyllidae gen. sp.# (M)		1, 3.13 0.03φ						7827
Adult Nematode								
<i>Rhabdochona lichtenfelsi</i> (I)	6, 35.29 2.24	21, 65.63 5.03	5, 25 1.25*	15, 75 7.75*	19, 100 4.79φ	15, 71.43 6.76	5, 15.63 0.25	7100, 7102-04, 7107
Larval Nematoda								
<i>Eustrongylides</i> sp. (M)	1, 5.88 0.06φ							7098
Larval Acanthocephalan								
<i>Polymorphus brevis</i> (Bc, M)	1, 5.88 0.06*	3, 9.38 0.16φ		3, 15 0.25φ*	1, 5.26 0.05φ*	4, 19.05 0.29	2, 6.25 0.09φ	7828-30

Infection site: Bc = Body cavity; I = Intestine; L = Liver; M = Mesentery; Ub = Urinary bladder; # = new locality record; φ = new host/locality record; * = No specimens for morphology are available because those were collected for molecular analysis. CNHE No = Catalog number of Colección Nacional de Helminthos.

species-poor helminth fauna, highly dominated by one species of helminth (Pérez-Ponce de León *et al.*, 2000). In particular, ecological parameters of the parasitic infections herein reported coincide with those previously reported for other species of goodeins, i.e., the nematode *Rhabdochona lichtenfelsis*, as well as larval digeneans reach the highest prevalence and abundance values (Martínez-Aquino *et al.*, 2004, 2007b; Romero-Tejeda *et al.*, 2008),

The results we provide in this paper contribute to our understanding of the helminth parasite fauna of goodeins in Central Mexico Plateau, but also further contribute with the inventory of the Mexican freshwater fish parasite fauna.

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