Nematode parasites in the lizards *Salvator rufescens*, *Teius teyou* (Teiidae) and *Homonota underwoodi* (Phyllodactylidae) from the Monte Region in Central-Western Argentina

Studies addressing nematodes in wild animals generate information about the diversity of parasites, contributing to our understanding of the biology and ecology of their hosts (Vieira et al. 2016). Such knowledge is important to reptile conservation because severe parasitosis would compromise the host, causing diminished defenses, higher susceptibility to diseases and poorer performance (Spinelli et al. 1992).

The relationships between nematodes and reptiles have been given little attention. So far, records of parasitic nematodes in lizards of the family Teiidae in Argentina are scarce and lack for the family Phyllodactylidae (Castillo et al. 2019). Most parasitic investigations have been carried out on lizards of the families Liolaemidae, Leiosauridae, and Tropiduridae (Cruz et al. 1998, Ramallo & Díaz 1998, Ramallo et al. 2002, Goldberg et al. 2004, O'Grady & Dearing 2006, Lamas & Zaracho 2006, Ramallo et al. 2016, Ramallo et al. 2017a, Ramallo et al. 2017b, Castillo et al. 2017, Castillo et al. 2018a).

Members of the genus *Salvator* (Teiidae) represent the largest lizards found in South America (Montero et al. 2004). Two species have been recorded in Argentina, the Argentine

Black and White Tegu *Salvator merianae* Duméril & Bibron, 1839 and the Red Tegu *S. rufescens* (Günther, 1871) (Abdala et al. 2012). *Salvator rufescens* is distributed across Argentina, Bolivia and Paraguay (Acosta et al. 2017). The distribution and diet of the species are described in Acosta et al. (2017) and Castillo et al. (2018b). Another Teiidae, the Four-toed Tegu *Teius teyou* Daudin, 1802 is distributed in Bolivia, Brazil, Paraguay and Argentina. It is an active forager, with preference for ants in the Monte region (Castillo & González-Rivas, unpublished data). *Homonota underwoodi* Kluge, 1964 (Phyllodactylidae) is found in Argentina; it is insectivorous (Acosta et al. 2017). With regard to their conservation status in Argentina, these species are categorized as non-threatened (Abdala et al. 2012).

Up to this study, *Diaphanocephalus galeatus* Rudolphi, 1819 (Nematoda: Diaphanocephalidae) is the only recorded nematode of *S. rufescens* in Argentina (Spinelli et al. 1992). The first mention of *Physaloptera retusa* Rudolphi, 1819 in *S. rufescens* was by Sprehn (1932); however, this record corresponds to Bolivia. With regard to *T. teyou* and *H. underwoodi*, to our knowledge, there are no reports of nematodes from these species. The present study enhances our knowledge and provides new parasitological records of nematodes in lizards inhabiting the Monte desert in Argentina.

The sampling area was situated in El Encón, 25 de Mayo District (32°12′56″ S, 67°47′43″ W), San Juan Province, Argentina. This area is represented by the Monte phytogeographic province and encompasses vast arid areas with mean rainfall values < 100 mm/year, including years with no rainfall. Xerophytic plants, adapted to the warm dry climate, are predominant (Fig. 1; Cabrera 1976, Márquez et al. 2016).

In December 2017 and January 2018, using pitfall traps, we collected specimens of *T. teyou* (n=2; male, SVL=145 mm; female, SVL=150 mm), *H. underwoodi* (n=2; males, SVL=50 mm), and *S. rufescens* (n=1; male, SVL=24 cm) that was freshly killed on the road. Individuals were sacrificed by intraperitoneal administration of sodium thiopental, fixed in hot 10% formaldehyde, and preserved in 70% ethanol. All specimens are housed in the Herpetological Collection, Biology Department, School of Exact, Physical, and Natural Sciences, National University of San Juan (*H. underwoodi*: UNSJ 4006, 4007; *T. teyou*: UNSJ 4008, 4009; *S. rufescens*: UNSJ 4309). All applicable national and institutional guidelines for the care and use of animals were followed. In the laboratory, the lizards were dissected through a ventral longitudinal incision from the mouth to the cloaca and examined under a stereoscopic binocular microscope to find nematodes. All nematodes found were kept in 70% ethanol. For their observation, we used the diaphanization by lacto-phenol technique. For identification, we used an Arcano optical microscope and pertinent literature (Rudolphi 1819, Ortlepp 1922, Skrjabin et al. 1960, Vicente et al. 1993, Anderson et al. 2009, Pereira et al. 2012, 2014). Prevalence and mean intensity were estimated following Bush et al. (1997).

We recorded 113 nematodes (Table 1) corresponding to three taxa (*Physaloptera retusa,* n=34; *Physaloptera* sp., n=2; *Pharyngodon* sp., n=77), all of them found in the stomach area. The

Figure 1. Study area at El Encón, 25 de Mayo District, San Juan Province, Argentina.

Pharyngodon sp. could not be further identified without an electron microscope; however, we presume one might be a previously unidentified species.

All collected specimens were deposited in the Parasitological Collection, Biology Department, Faculty of Exact, Physical and Natural Sciences, National University of San Juan, Argentina (*Physaloptera retusa*: UNSJPar 257, *Physaloptera sp.*: UNSJPar 258, *Pharyngodon* sp.: UNSJPar 259).

Physaloptera is a nematode genus that includes approximately 105 species of parasites on reptiles, amphibians, birds, and mammals (Pereira et al. 2012, 2014). In the Neotropics, eight species are known to parasitize the stomach of reptiles: *P. bonnei* Ortlepp, 1922, *P. liophis* Vicente & Santos 1974, *P. lutzi* Cristofaro, Guimaraes & Rodrigues 1976, *P. monodens* Molin, 1860, *P. obtusissima* Molin, 1860, *P. retusa* Rudolphi, 1819, *P. tupinambae* Pereira, Alves, Rocha, Lima & Luque 2012 and *P. bainae* Pereira, Alves, Rocha, Lima & Luque 2014 (Ramallo & Díaz 1998, Goldberg et al. 2004, O'Grady & Dearing 2006, Ávila & Silva 2010, Pereira et al. 2012, 2014, Lamas et al. 2016).

Three species of *Physaloptera* (*P. retusa, P. lutzi* and *P. liophis*) have been recorded for Argentina, parasitizing four lizard genera belonging to four families (Liolaemidae, Tropiduridae, Leiosauridae, and Dipsadidae; Table 2). Most records are of *P. retusa* and *P. lutzi*, with only one record of *P. liophis*. According to our literature review, this is the first record of the genus *Physaloptera* in *H. underwoodi*.

The general morphology of the nematode species recorded in *S. rufescens* matched that of *P. retusa* as it has a vulva in the first portion of the pre-equatorial region of the body, between 20–26% of the total body length. *Physaloptera lutzi* differs from *P. retusa* mainly by having the vulva located near the anus, approximately at 95% of the body length. *Physaloptera retusa* males have 21 caudal papillae that sets them apart from *P. tupinambae* (22 caudal papillae) and

Table 1. Nematode species found in the stomachs of lizards in the Monte region in central-western Argentina. P = Prevalence, I = Intensity, MI = Mean intensity.

Nematode	Host	P	I	MI
Physaloptera retusa	*Salvator rufescens*	100%	34 (31 ♀, 3 ♂)	-
Physaloptera sp.	*Homonota underwoodi*	50%	2 (larvae)	2 (larvae)
Pharyngodon sp.	*Teius teyou*	100%	77 (72 ♀, 5 ♂)	38.5

Table 2. *Physaloptera* spp. previously reported from lizards in Argentina. P = prevalence, MI = Mean intensity. N/A = Not available.

	Host	*Physaloptera* spp.	P	MI	Location	References
Family	Species					
Liolaemidae	*Liolaemus quilmes*	*P. lutzi*	?	?	Salta	[1]
	L. ornatus	*P. lutzi*	?	?	Salta	[1]
	L. alticolor	*P. lutzi*	?	?	Tucumán	[1]
	L. koslowskyi	*P. retusa*	?	?	N/A	[2]
	L. darwinii	*P. retusa*	?	?	N/A	[2]
	L. neuquensis	*P. retusa*	50%	1	Neuquén	[3]
Tropiduridae	*Tropidurus etheridgei*	*Physaloptera* sp.			Salta	[4]
Leiosauridae	*Leiosaurus catamarcensis*	*P. retusa*	100%	2.5	La Rioja	[3]
	L. belli	*P. retusa*	100%	211	Rio Negro	[3]
Dipsadidae	*Xenodon merremi*	*P. liophis*	25%	23	Chaco	[5]

[1] Ramallo & Díaz 1998; [2] O'Grady & Dearing 2006; [3] Goldberg et al. 2004; [4] Cruz et al. 1998; [5] Lamas et al. 2016.

P. bainae (23 caudal papillae) (Pereira et al. 2014).

Pharyngodon is a genus of nematodes parasitizing on amphibians and reptiles (Vicente 1993). Approximately 36 species of *Pharyngodon* have been recorded (Bursey et al. 2008), with four parasite species being mentioned for Neotropic lizards: *P. cesarpintoi* Pereira, 1935, *P. micrurus* Freitas & Ibañez, 1963, *P. travassosi* Pereira, 1935, and *P. yucatanensis* Chitwood 1938 (Bursey & Goldberg 1996). In South America, nematodes of the genus *Pharyngodon* commonly occur in Brazil, parasitizing lizards of the genera *Liolaemus* (Liolaemidae), *Tropidurus* (Tropiduridae), *Ameiva*, *Cnemidophorus* (=*Aurivela*) and *Dicrodon* (Teiidae) (Ávila & Silva 2010). In Argentina, the genus *Pharyngodon* has not previously been mentioned for any reptile species, making our record for a lizard the first.

The different species of *Pharyngodon* are differentiated by the presence or absence of spicule, the morphology of caudal wings, the egg shape, the presence or absence of spines in the tail filament in adults, and the geographic distribution; with their geographic distribution being the major factor for oxyurid speciation in reptiles (Bursey & Godlberg 1996).

The general morphology of the nematodes recorded in the stomach of *T. teyou* allowed identifying them to the genus *Pharyngodon*, family Pharyngodonidae, order Oxyurida. The *Pharyngodon* males recorded were characterized by having a well-developed caudal wing, which forms a genital pouch that envelops all genital papillae; this differentiates them from *Spauligodon* males, whose posterior pair of papillae is located outside the genital pouch, and from *Skrjabinodon* males, which lack a caudal wing (Skrjabin et al. 1960, Anderson et al. 2009). It probably corresponds to a new species and we prefer not to associate it with any currently known species yet.

Differences found in the intensities from the three studied species are likely due to factors such as body size (Ribas et al. 1995) and foraging strategies (Brito et al. 2014). The relationship between lizard SVL (snout vent length) and the intensity of nematode infection suggest that body size is an important determinant of the infection rate (Ribas et al. 1995; Anjos et al. 013). The larger digestive tract of the larger lizards (*T. teyou* and *S. rufescens*), provides more microhabitats suitable for nematode settlement compared to the relatively smaller one of *H. underwoodi*. Additionally, the different foraging behaviors (Ribas et al. 1995) in the lizards (*T. teyou*, *S. rufescens* and *H. underwoodi*), may explain the varying parasitic intensities likely to be recorded in different lizard species, due to their probability of encountering parasites. In addition, the parasite life cycle may also favor higher nematode intensity.

Our study serves to enhance knowledge, contributing new parasitological data on reptiles of Argentina.

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