

**Online Resource ESM1.** *Rhabdias* spp. known from anuran hosts in Central and South America.

<b>Species</b>	<b>Known hosts</b>	<b>Known distribution</b>	<b>Reference</b>
<i>Rhabdias alabialis</i>	<i>Rhinella marina</i> , <i>Scinax boulengeri</i> , <i>Smilisca baudinii</i>	Costa Rica	(Kuzmin <i>et al.</i> , 2007; Burseley and Brooks, 2010)
<i>Rhabdias americanus</i>	<i>Bufo kelloggt</i> , <i>Bufo mazatlanensis</i> , <i>Smilisca baudinii</i>	Mexico	(Goldberg and Burseley, 2002)
<i>Rhabdias androgyna</i>	<i>Pristimantis chiastonotus</i> , <i>Proceratophrys appendiculata</i> , <i>Rhinella margaritifera</i> , <i>Rhinella marina</i>	Brazil, French Guiana, Guyana	(Boquimpani-Freitas <i>et al.</i> , 2001; McAllister <i>et al.</i> , 2010a; Kuzmin <i>et al.</i> , 2015)
<i>Rhabdias breviensis</i>	<i>Leptodactylus fuscus</i> , <i>Leptodactylus macrosternum</i> , <i>Leptodactylus podicipinus</i> , <i>Leptodactylus petersii</i> , <i>Proceratophrys aridus</i> , <i>Rhinella granulosa</i> , <i>Rhinella schneideri</i> , <i>Scinax fuscovarius</i>	Brazil	(Nascimento <i>et al.</i> , 2013; Müller <i>et al.</i> , 2018)
<i>Rhabdias elegans</i>	<i>Hypsiboas lanciformis</i> (= <i>Hyla</i> ), <i>Leptodactylus bufonius</i> , <i>Leptodactylus melanonotus</i> , <i>Odontophrynus americanus</i> , <i>Rhinella arenarum</i> , <i>Rhinella major</i> , <i>Rhinella rubescens</i> (= <i>B. rufus</i> ), <i>Rhinella schneideri</i> , <i>Trachycephalus typhonius</i>	Argentina, Brazil, Ecuador, Mexico, Paraguay, Uruguay	(Kloss, 1971; Goldberg <i>et al.</i> , 2002; Gonzalez and Hamann, 2006, 2008, 2009; McAllister <i>et al.</i> , 2010b; Draghi <i>et al.</i> , 2015; Hamann and Gonzalez, 2015)
<i>Rhabdias fuelleborni</i>	<i>Hypsiboas prasinus</i> , <i>Ischnocnema guentheri</i> (= <i>Eleutherodactylus</i> ), <i>Leptodactylus vastus</i> , <i>Lithobates vaillanti</i> , <i>Rana berlandieri</i> , <i>Rhinella arenarum</i> , <i>Rhinella marina</i> (syn. <i>Bufo marinus</i> ), <i>Rhinella horribilis</i> , <i>Rhinella icterica</i> (syn. <i>Bufo ictericus</i> ), <i>Rhinella jimi</i> , <i>Rhinella limensis</i> , <i>Rhinella schneideri</i> , <i>Rhinella paracnemis</i> , <i>Smilisca cyanosticta</i> , <i>Thoropa miliaris</i>	Argentina, Brazil, French Guiana, Mexico, Peru	(Travassos, 1926; Kloss, 1971, 1974; Galicia-Guerrero <i>et al.</i> , 2000; Goldberg <i>et al.</i> , 2002; Leon-Regagnon <i>et al.</i> , 2005; Luque <i>et al.</i> , 2005; Martins and Fabio, 2005; Anjos <i>et al.</i> , 2008; Gonzalez and Hamann, 2008; Pinhão <i>et al.</i> , 2009; Madelaire <i>et al.</i> , 2012; Santos <i>et al.</i> , 2013; Teles <i>et al.</i> , 2014; Chero <i>et al.</i> , 2015; Kuzmin <i>et al.</i> , 2015; Moretti <i>et al.</i> , 2017)

<i>Rhabdias galactonoti</i>	<i>Adelphobates galactonotus</i>	Brazil	(Kuzmin <i>et al.</i> , 2016)
<i>Rhabdias hermaphrodita</i>	<i>Rhinella crucifer</i>	Brazil	(Kloss, 1971)
<i>Rhabdias kuzmini</i>	<i>Incilius occidentalis</i>	Mexico	(Martínez-Salazar and Leon-Regagnon, 2007)
<i>Rhabdias manantlanensis</i>	<i>Craugastor occidentalis</i>	Mexico	(Martínez-Salazar, 2008)
<i>Rhabdias mucronata</i>	<i>Leptodactylus ocellatus</i>	Argentina	(Schuurmans Stekhoven, 1952)
<i>Rhabdias paraensis</i>	<i>Rhinella marina</i>	Brazil	(Santos <i>et al.</i> , 2011)
<i>Rhabdias peninsularis</i>	<i>Pseudacris hypochondriaca</i>	Mexico	(Martínez-Salazar <i>et al.</i> , 2013)
<i>Rhabdias pseudosphaerocephala</i>	<i>Engystomops pustulosus</i> , <i>Hypsiboas raniceps</i> , <i>Lithobates vaillanti</i> , <i>Rhinella jimi</i> , <i>Rhinella major</i> , <i>Rhinella marina</i> , <i>Rhinella schneideri</i>	Argentina, Brazil, Costa Rica, Mexico*, Nicaragua	(Kuzmin <i>et al.</i> , 2007; Dubey and Shine, 2008; Bursey and Brooks, 2010; Hamann and Gonzalez, 2015; Müller <i>et al.</i> , 2018)
<i>Rhabdias ranae</i>	<i>Leptodactylus melanonotus</i> , <i>Rana magnaocularis</i> , <i>Rana tarahumarae</i> , <i>Smilisca baudinii</i>	Mexico	(Bursey and Goldberg, 2001; Goldberg and Bursey, 2002)
<i>Rhabdias savagei</i>	<i>Agalychnis annae</i> , <i>Agalychnis callidryas</i> , <i>Craugastor crassidigitus</i> , <i>Craugastor gollmeri</i> , <i>Craugastor melanostictus</i> , <i>Craugastor taurus</i> , <i>Diasporus hylaeformis</i> , <i>Eleutherodactylus</i> <i>caryophyllaceus</i> , <i>Engystomops pustulosus</i> , <i>Hylomantis lemur</i> , <i>Isthmohyla tica</i> , <i>Leptodactylus</i> <i>bolivianus</i> , <i>Lithobates forreri</i> , <i>Lithobates taylori</i> , <i>Lithobates vaillanti</i> , <i>Lithobates warszewitschii</i> ; <i>Leptodactylus fragilis</i> , <i>Pristimantis cruentus</i> , <i>Pristimantis caryophyllaceus</i> , <i>Rana berlandieri</i> , <i>Rana vibicaria</i> , <i>Smilisca phaeota</i> , <i>Tlalocohyla</i> <i>loquax</i>	Costa Rica, Mexico	(Bursey and Goldberg, 2005; Leon-Regagnon <i>et al.</i> , 2005; Bursey and Goldberg, 2006, 2007; Goldberg and Bursey, 2008a, b; Bursey and Brooks, 2010; Goldberg and Bursey, 2010; Monroy-Vilchis <i>et al.</i> , 2015)
<i>Rhabdias stenocephala</i>	<i>Leptodactylus macrosternum</i> , <i>Leptodactylus</i> <i>paraensis</i> , <i>Leptodactylus vastus</i>	Brazil	(Kuzmin <i>et al.</i> , 2016; Müller <i>et al.</i> , 2018)
<i>Rhabdias tobagoensis</i>	<i>Hyla microcephala</i>	Mexico	(Goldberg <i>et al.</i> , 2002)
<i>Rhabdias truncata</i>	<i>Telmatobius schreiteri</i>	Argentina	(Schuurmans Stekhoven, 1952)

\* *Rhabdias* specimens originally identified as *R. sphaerocephala* were listed from *R. horribilis* (syn. *Bufo marinus*) in Mexico and Costa Rica, this species is now considered to be *R. pseudosphaerocephala* (Kloss, 1971, 1974; Kuzmin *et al.*, 2007)

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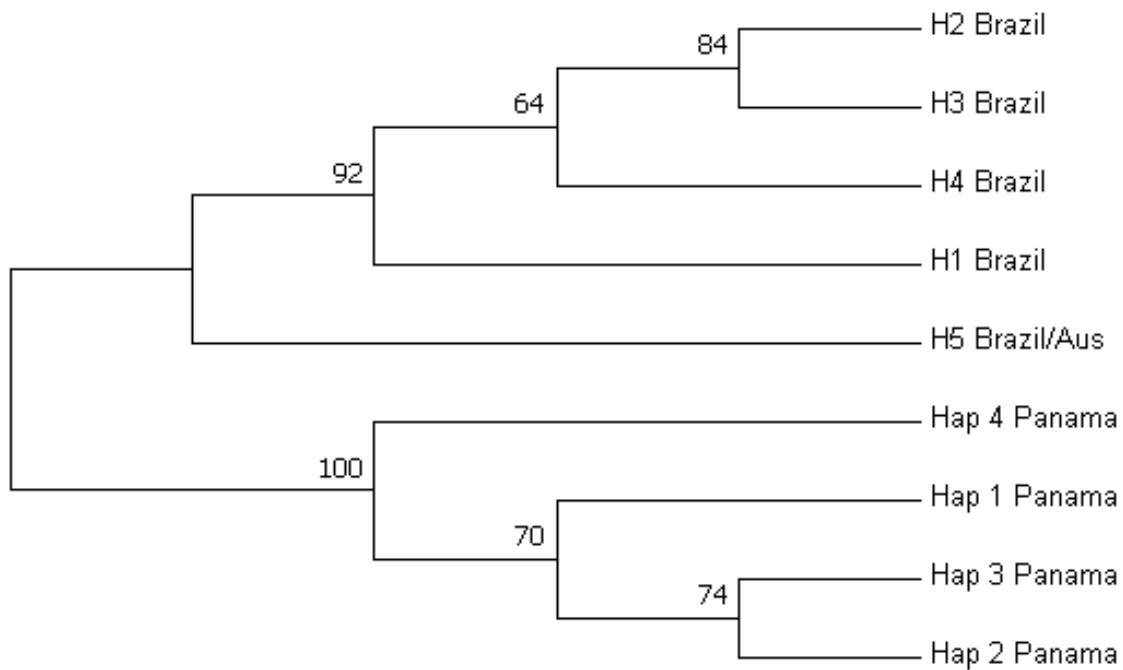
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## Online Resource ESM2

### Morphological characterization of *Rhabdias* (continued)

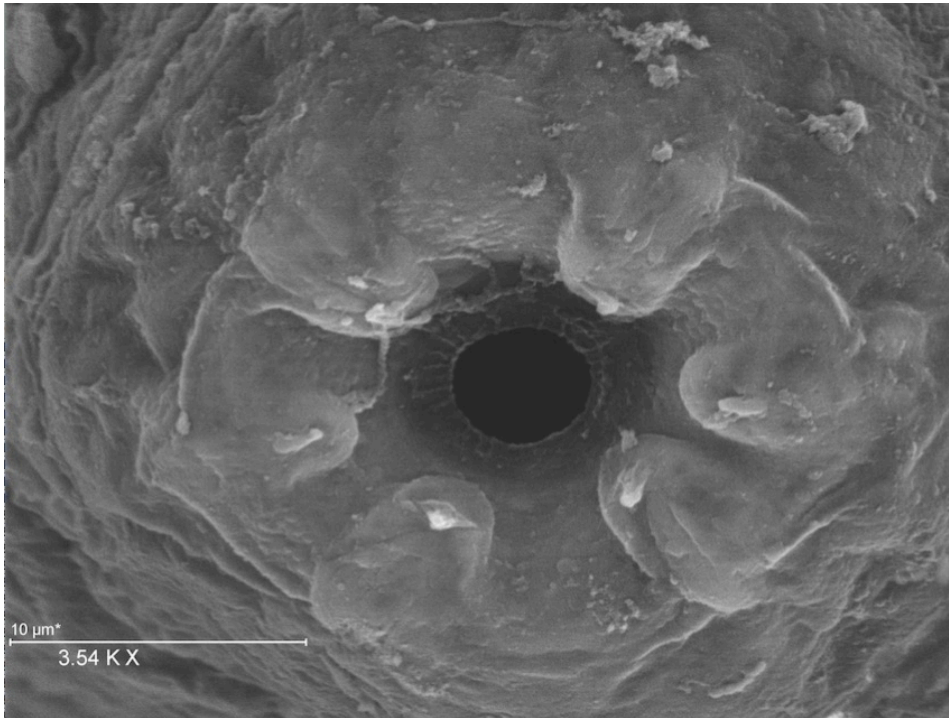
We photographed three of the adult *Rhabdias* removed from the lungs of three adult toads and used as a parasite source for the experimental infections and six of the *Rhabdias* recovered from the lungs of experimentally infected toadlets. We used scanning electron microscopy (SEM) for photographing lip morphology. For the SEM, we fixed nematodes with 4% glutaraldehyde for two hours, and then serially dehydrated them in ethanol (60, 70, 80, 90, 100% for 10 min each). We then placed nematodes into polypropylene baskets (100 µm porosity) and put them into the Critical Point Dryer (Denton CPD-1) to dry. Once dry, we placed each specimen on a stub that was covered with double-sided sticky metallic tape. We covered each specimen with metal (gold:paladium 4:6) using a Sputtering System Hummer VI for five min. Finally, we observed the prepared specimens with a SEM (Zeiss, EVO 40VP) using an acceleration voltage of 20kv (on high vacuum).

**Online Resource ESM3.** Unrooted neighbour joining bootstrap consensus tree of *Rhabdias* cytochrome b sequences. Haplotypes 1-4 Panama originate from this study (Genbank #MG205601- MG205604). Haplotypes H1-H5 originate from Brazil (Genbank #EU836833 - EU836836,EU836839; Dubey and Shine, 2008). Numbers above branches correspond to bootstrap support estimates based on 1000 replicates.



**Online Resource ESM4.** Morphological variation in *Rhabdias* lip morphology.

**A)** Scanning electron micrograph of the lip structure of *Rhabdias* (Haplotype 1) recovered from an experimentally infected *Rhinella horribilis* toadlet. Photo credit: Jorge Ceballos.



**B)** Scanning electron micrograph of the lip structure of *Rhabdias* Haplotype 3 recovered from an experimentally infected *R. horribilis* toadlet. Photo credit: Jorge Ceballos.

