

## GASTROINTESTINAL HELMINTHS FROM EIGHT SPECIES OF *ASPIDOSCELIS* (SQUAMATA: TEIIDAE) FROM MEXICO

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**ABSTRACT.**—Seventy-four representatives of 8 species of whiptail lizards (*Aspidoscelis* spp.), from Mexico were examined for helminths: *Aspidoscelis calidipes* ( $n = 8$ ), *A. communis* ( $n = 10$ ), *A. cozumelae* ( $n = 9$ ), *A. gularis* ( $n = 10$ ), *A. lineattissima* ( $n = 9$ ), *A. motaguae* ( $n = 11$ ), *A. parvisocia* ( $n = 9$ ), and *A. sackii* ( $n = 8$ ). We found one species of Cestoda, *Oochoristica scolopori*, and 7 species of Nematoda, including *Abbreviata terrapenis*, *Parapharyngodon alvarengai*, *Pharyngodon warneri*, *Spauligodon garciaprietoii*, *Spinicauda spinicauda*, *Thubunaea cnemidophorus*, and *Physaloptera* sp. Mean helminth diversity per lizard species was 3.1 (SD 1.8). *Spauligodon garciaprietoii* was present in 6 of 8 (75%) of the lizard species. The specimens we examined were infected by an aggregate of helminths that were either characteristic of *Aspidoscelis* spp. from the United States (North America: *O. scolopori*, *T. cnemidophorus*, *A. terrapenis*, *P. warneri*) or characteristic of *Aspidoscelis* spp. from Mexico (Mesoamerica: *S. garciaprietoii*, *P. alvarengai*, *S. spinicauda*). Twenty-two new host records are reported.

**RESUMEN.**—Setenta y cuatro especímenes representando 8 especies de lagartija cola de látigo, *Aspidoscelis* de México fueron examinados para helmintos: *Aspidoscelis calidipes* ( $n = 8$ ), *A. communis* ( $n = 10$ ), *A. cozumelae* ( $n = 9$ ), *A. gularis* ( $n = 10$ ), *A. lineattissima* ( $n = 9$ ), *A. motaguae* ( $n = 11$ ), *A. parvisocia* ( $n = 9$ ), y *A. sackii* ( $n = 8$ ). Uno especies de Céstoda *Oochoristica scolopori* y 7 especies de Nemátoda, *Abbreviata terrapenis*, *Parapharyngodon alvarengai*, *Pharyngodon warneri*, *Spauligodon garciaprietoii*, *Spinicauda spinicauda*, *Thubunaea cnemidophorus*, y *Physaloptera* sp. fueron encontrados. El número medio de especies de helmintos para cada especie de lagartija fue 3.1 (DE 1.8) (rango 2 a 6). Las susodichas especies de *Aspidoscelis* fueron infectadas por una serie de helmintos, algunos de los cuales eran la característica de *Aspidoscelis* de los Estados Unidos (Norteamérica: *O. scolopori*, *T. cnemidophorus*, *A. terrapenis*, *P. warneri*) contra México (Mesoamerica: *S. garciaprietoii*, *P. alvarengai*, *S. spinicauda*). Se presentan 22 nuevos registros de hospedero.

Of the some 25 species of *Aspidoscelis* known from Mexico (Flores Vilella and Gerez 1994), helminth records are known from *A. tigris* (Goldberg et al. 1998), *A. mexicanus* and *A. deppei* (Jiménez-Ruiz et al. 2003), *A. labialis* (Goldberg et al. 2012), *A. hyperythra* (as *A. hyperythrus*) and *A. maximus* (Goldberg and Bursley 2012). The purpose of this paper is to add to the knowledge of the biodiversity of helminths of 8 species of *Aspidoscelis* lizards of Mexico. We also classify the helminths by their geographic center of distribution and establish the initial helminth lists for *A. calidipes*, *A. communis*, *A. cozumelae*, *A. lineattissima*, *A. motaguae*, *A. parvisocia*, and *A. sackii*.

The following species of *Aspidoscelis* were examined:

*Aspidoscelis calidipes* (Duellman, 1955)—limited to the Tepaltepec-Balsas basin within the states of Michoacan and Guerrero (Ponce-Campos and García Aguayo 2007)

*Aspidoscelis communis* (Cope, 1878)—known from the central plateau of Mexico, from Chihuahua and presumably Nuevo Leon southward to Central Puebla (Uetz and Hosek 2013)

*Aspidoscelis cozumelae* (Gadow, 1906)—known from the island of Cozumel, Quintana Roo, Mexico (Uetz and Hosek 2013)

*Aspidoscelis gularis* (Baird and Girard, 1852)—known in the USA from New Mexico, Texas, and Oklahoma and in Mexico from northeast Coahuila, Nuevo Leon, Tamaulipas, San Luis Potosi, Queretaro, Veracruz, Aguascalientes, Michoacan, and Jalisco (Uetz and Hosek 2013)

*Aspidoscelis lineattissima* (Cope, 1878)—known from the Pacific slopes of Nayarit to Central Guerrero, Colima, Jalisco, Michoacan, Puebla, and Morelos (Uetz and Hosek 2013)

*Aspidoscelis motaguae* (Sackett, 1941)—known from Oaxaca, Mexico, Guatemala, El Salvador, and Honduras (Uetz and Hosek 2013)

*Aspidoscelis parvisocia* (Zweifel, 1960)—restricted to northern Oaxaca and adjacent Puebla Mexico (Canseco-Márquez et al. 2007)

*Aspidoscelis sackii* (Wiegmann, 1834)—known from Central Oaxaca through central Chiapas into central Guatemala (Uetz and Hosek 2013)

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## METHODS

We examined specimens deposited in the herpetology collection of the Natural History Museum (LACM) of Los Angeles County, Los Angeles, California, USA (Appendix 1):

- Rio Tepalcatepec Valley whiptail, *A. calidipes* ( $n = 8$ , mean SVL = 64.1 mm, SD 2.9, range 60–68 mm)
- Colima giant whiptail, *A. communis* ( $n = 10$ , mean SVL = 104.1 mm, SD 6.7, range 94–117 mm)
- Cozumel racerunner, *A. cozumelae* ( $n = 9$ , mean SVL = 59.8 mm, SD 5.5, range 53–71 mm)
- Eastern spotted whiptail, *A. gularis* ( $n = 10$ ), mean SVL = 76.4 mm, SD 11.2, range 63–95 mm)
- Many-lined whiptail, *A. lineatissima* ( $n = 9$ , mean SVL = 79.9 mm, SD 9.3, range 71–98 mm)
- Giant whiptail, *A. motaguae* ( $n = 11$ , mean SVL = 120.0 mm, SD 11.6, range 102–142 mm)
- Mexican pigmy whiptail, *A. parvisocia* ( $n = 9$ , mean SVL = 70.3 mm, SD 4.7, range 63–76 mm)
- Sack's giant whiptail, *A. sackii* ( $n = 8$ , mean SVL = 125 mm, SD 9.6, range 114–142 mm)

The body cavity of each specimen was opened and the gastrointestinal tract excised by cutting across the esophagus and rectum. The esophagus, stomach, and small and large intestines were slit longitudinally and examined separately under a dissecting microscope. Cestodes were stained regressively with hematoxylin, mounted in balsam, studied under a dissecting microscope, and identified. Nematodes were cleared in a drop of lactophenol on a glass slide, cover-slipped, and identified by use of a compound microscope. Parasite terminology follows Bush et al. (1997). Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA (Appendix 2).

## RESULTS

Found were one species of Cestoda, *Oochoeristica scelopori* Voge and Fox, 1957, and 7 species of Nematoda, including *Abbreviata terrapenis* (Hill, 1941); *Parapharyngodon alvarengai* Freitas, 1957; *Pharyngodon warneri* Harwood, 1932; *Spauligodon garaciaprieto* Jiménez-Ruiz, León-Règanon, and Campbell, 2003; *Spinicauda spinicauda* (Olfers, 1819); *Thubunaea cnemidophorus* Babero and Matthias, 1967; and *Physaloptera* sp. We documented total number of helminths, prevalence ([number infected/number examined]  $\times$  100), mean intensity (mean number infected indi-

viduals, 1 SD), and range (helminths within infected individuals; Table 1). All helminth species we found are new host records ( $n = 22$ ).

Mean helminth diversity per lizard species was 3.1 (SD 1.8; range 2–6). *Aspidoscelis communis* and *A. sackii* had the largest number of helminth species (6); *A. calidipes*, *A. cozumelae*, and *A. gularis* each had the fewest number of helminth species (2).

## DISCUSSION

It appears that the species of *Aspidoscelis* we examined were infected by an aggregate of helminths that were either distributed primarily in lizard species in the United States or primarily in species from Mexico, or sometimes characteristic of lizards in both countries. *Oochoeristica scelopori* was distributed in both United States (Telford 1970, Goldberg et al. 1997a) and Mexican lizards (Goldberg et al. 1996). *Abbreviata terrapenis* has been found mainly in lizards from the United States, including the teiids *Aspidoscelis sonora*e and *A. tigris* (Goldberg et al. 1997b). It also has occasionally been reported in North American rattlesnakes (Goldberg et al. 2002), as well as in *Sceloporus jarrovii* (Goldberg et al. 1995). In Mexico, it was found only in *S. jarrovii* (11 *A. terrapenis*) from Tamaulipas (Goldberg et al. 1996) and was absent from the 15 other Mexican states sampled. Hosts for *P. warneri* are summarized in Goldberg et al. (1997b). *Pharyngodon warneri* has been reported in 8 species of *Aspidoscelis* from the United States. The only Mexican *Aspidoscelis* species to harbor *P. warneri* was *A. sackii*. *Thubunaea cnemidophorus* has previously been reported in 4 species of *Aspidoscelis* from the United States (Goldberg et al. 1997b). Its occurrence in the rattlesnakes *Crotalus cerastes*, *C. mitchellii*, and *C. scutulatus*, reported by Babero and Emmerson (1974), may be the result of the snakes ingesting lizards infected with *T. cnemidophorus*. Third-stage larvae of *Physaloptera* sp. (but no adults) are commonly found in species of *Aspidoscelis* and other lizards and anurans (Goldberg et al. 1993). They might be expected in any carnivorous lizards or anurans, which likely serve as paratenic (= transport) hosts.

*Aspidoscelis gularis* merits attention, as McAllister (1990) reported on helminths for this species from both the United States (New Mexico, Oklahoma, and Texas) and northern Mexico

TABLE 1. Total number of helminths, prevalence (% infected in the sample), mean intensity (mean number infected individuals), and range (helminths within infected individuals) for 8 species of *Aspidoscelis* from Mexico: *A. calidipes* (n = 8), *A. communitis* (n = 10), *A. cozumelae* (n = 9), *A. gularis* (n = 10), *A. lineatissima* (n = 9), *A. motague* (n = 11), *A. parvisocia* (n = 9), *A. sacki* (n = 8). All are new host records (n = 22).

Helminth	<i>A. calidipes</i>	<i>A. communitis</i>	<i>A. cozumelae</i>	<i>A. gularis</i>	<i>A. lineatissima</i>	<i>A. motague</i>	<i>A. parvisocia</i>	<i>A. sacki</i>
<i>Cestoda</i>								
<i>Oochoristica scelopori</i>	3 25% 1.5 (SD 0.70) 1-2	—	1 11% 1.0	—	2 22% 1.0	—	—	12 50% 3.0 (SD 3.4) 1-8
<i>Nematoda</i>								
<i>Abbreviata terrapenis</i>	—	—	—	2 20% 1.0	—	172 100% 15.6 (SD 5.6) 3-24	—	55 88% 8.3 (SD 10.1) 1-23
<i>Parapharyngodon alvarengai</i>	—	3 30% 1.0	—	—	—	6 36% 1.5 (SD 1.0) 3-43	—	95 88% 23.8 (SD 17.8)
<i>Pharyngodon warneri</i>	—	—	—	1-3	—	—	—	125 25% 62.5 (SD 70.0) 13-112
<i>Spauligodon garciaprietoi</i>	21 25% 10.5 (SD 5.0) 7-14	1 10% 1.0	—	181 60% 30.2 (SD 23.8) 7-60	—	—	40 11% 40.0	69 13% 69.0
<i>Spinicauda spinicauda</i>	—	2 10% 2.0	—	—	—	—	—	—
<i>Thubumaea cnemidophorus</i>	—	3 10% 3.0	—	—	—	—	—	—
<i>Physaloptera</i> sp.	—	5 20% 2.5 (SD 2.1) 1-4	1 11% 1.0	—	1 11% 1.0	—	1 11% 1.0	—

(Coahuila, Tamaulipas, and Nuevo León). Found were *Oochoristica* sp., *O. bivitellobata*, *Pharyngodon kirbii*, *P. warneri*, *Physaloptera* sp., acanthocephalan cystacanths, and unidentified larval nematodes. He did not separate Mexican records from United States records. Later, McAllister et al. (1995) found the cestode *Oochoristica bivitellobata*, nematodes *Parathelandros texanus*, *P. warneri*, and *Physaloptera* sp., and acanthocephalan cystacanths in *Aspidoscelis gularis septemvittatus* from Texas.

Now we will consider helminth species absent from United States teiids and apparently reaching a northernmost distribution in Mexico. *Parapharyngodon alvarengai* was described by Freitas (1957) from the skink *Mabuia maculata* from Brazil and was also found in the teiid *Ameiva ameiva* from Brazil (Padilha and Faria Duarte 1979). *Spauligodon garciaprietoi* was described from 2 teiid lizards from Mexico, *Aspidoscelis mexicanus* and *A. deppei*, by Jiménez-Ruiz et al. (2003). *Spinicauda spinicauda* is known from the teiid lizards *Ameiva ameiva* from Brazil and the Caribbean (Baker 1987) and *Cnemidophorus gramivagus* from Brazil (Goldberg et al. 2013).

Goldberg et al. (2003) found similar results when they studied helminths from 7 species of sceloporine lizards from Mexico: *Sceloporus formosus*, *S. grammicus*, *S. megalepidurus*, *S. mucronatus*, *S. parvus*, *S. torquatus*, and *S. variabilis*. Four of the 6 adult nematode species—*Atractis penneri*, *Spauligodon giganticus*, *Strongyluris similis*, and *Thubunaea intestinalis*—occur primarily in North American lizards. The cestode *Oochoristica scelopori* and the nematode *Physaloptera retusa* occurred in both the United States and Mexico. Factors responsible for the differences in helminth faunas of North American and Mesoamerican species of *Aspidoscelis* merit further study.

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#### LITERATURE CITED

- BABERO, B.B., AND F.H. EMMERSON. 1974. *Thubunaea cnemidophorus* in Nevada rattlesnakes. *Journal of Parasitology* 60:595.
- BAKER, M.R. 1987. Synopsis of the Nematoda parasitic in amphibians and reptiles. Memorial University of Newfoundland, Occasional Papers in Biology 11:1–325.
- BUSH, A.O., K.D. LAFFERTY, J.M. LOTZ, AND A.W. SHOSTAK. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *Journal of Parasitology* 83:575–583.
- CANSECO-MÁRQUEZ, L., J.A. CAMPBELL, P. PONCE-CAMPOS, A. MUÑOZ-ALONSO, AND A. GARCÍA AGUAYO. 2007. *Aspidoscelis parvisocia*. In: IUCN, compiler, IUCN Red List of Threatened Species. Version 2013.1. Gland, Switzerland; [cited 22 October 2013]. Available from: <http://www.iucnredlist.org>
- FLORES VILLELA, O., AND P. GEREZ. 1994. Biodiversidad y conservación en México: vertebrados, vegetación y uso del suelo. Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad y Universidad Nacional Autónoma de México, Ciudad Universitaria México, D.F. 439 pp.
- FREITAS, J.F.T. 1957. Sobre os gêneros *Thelandros* Wedl, 1862 e *Parapharyngodon* Chatterji, 1933, com descrição de *Parapharyngodon alvarengai* sp. n. (Nematoda, Oxyuroidea). *Memórias Instituto Oswaldo Cruz* 55:21–45.
- GOLDBERG, S.R., AND C.R. BURSEY. 2012. Helminths of the lizards, *Bipes biporus* (Bipedidae), *Callisaurus draconoides*, *Uta stansburiana* (Phrynosomatidae), *Aspidoscelis hyperythrus*, and *Aspidoscelis maximus* (Teiidae) from Baja California del Sur, Mexico. *Comparative Parasitology* 79:68–74.
- GOLDBERG, S.R., C.R. BURSEY, AND J. ARREOLA. 2012. *Aspidoscelis labialis* (Baja California Whiptail). *Endoparasites. Herpetological Review* 43:643–644.
- GOLDBERG, S.R., C.R. BURSEY, AND R.L. BEZY. 1995. Helminths of isolated montane populations of Yarrow's spiny lizards, *Sceloporus jarrovi* (Phrynosomatidae). *Southwestern Naturalist* 40:330–333.
- . 1996. Gastrointestinal helminths of Yarrow's spiny lizard, *Sceloporus jarrovi* (Phrynosomatidae) in Mexico. *American Midland Naturalist* 135:299–309.
- GOLDBERG, S.R., C.R. BURSEY, AND J.L. CAMARILLO-RANGEL. 2003. Gastrointestinal helminths of seven species of sceloporine lizards from Mexico. *Southwestern Naturalist* 48:208–217.
- GOLDBERG, S.R., C.R. BURSEY, AND H. CHEAM. 1997a. Persistence and stability of the component helminth community of the sagebrush lizard, *Sceloporus graciosus* (Phrynosomatidae) from Los Angeles County, California, 1972–1973, 1986–1996. *American Midland Naturalist* 138:418–421.
- . 1997b. Helminths from the Sonoran spotted whiptail, *Cnemidophorus sonorae*, and the western whiptail, *Cnemidophorus tigris* (Sauria: Teiidae), from southern Arizona with comments on *Abbreviata terrapenis* (Nematoda: Physalopteridae). *Great Basin Naturalist* 57:273–277.
- GOLDBERG, S.R., C.R. BURSEY, AND H. GADSEN ESPARZA. 1998. *Cnemidophorus tigris*, *Uta stansburiana* (Western whiptail, side-blotched lizard). *Endoparasites from México. Herpetological Review* 29:237.
- GOLDBERG, S.R., C.R. BURSEY, AND A.T. HOLYCROSS. 2002. *Abbreviata terrapenis* (Nematoda: Physalopteridae): an accidental parasite of the banded rock rattlesnake (*Crotalus lepidus klauberi*). *Journal of Wildlife Diseases* 38:453–456.
- GOLDBERG, S.R., C.R. BURSEY, AND R. TAWIL. 1993. Gastrointestinal helminths of the western brush lizard, *Urosaurus graciosus graciosus*. *Bulletin of the Southern California Academy of Science* 92:43–51.
- GOLDBERG, S.R., C.R. BURSEY, L.J. VITT, AND J. ARREOLA. 2013. Intestinal helminths of the wandering grass

- lizard, *Cnemidophorus gramivagus* (Squamata: Teiidae), from Brazil. *Comparative Parasitology* 80: 301–303.
- JIMÉNEZ-RUIZ, F.A., V. LEÓN-RÉGANON, AND J.A. CAMPBELL. 2003. A new species of *Spauligodon* (Nematoda: Pharyngonidae) parasite of *Cnemidophorus* spp. (Lacertilia: Teiidae) from southern Mexico. *Journal of Parasitology* 89:351–355.
- MCALLISTER, C.T. 1990. Helminth parasites of unisexual and bisexual whiptail lizards (Teiidae) in North America. IV. The Texas spotted whiptail (*Cnemidophorus gularis*). *Texas Journal of Science* 42:381–388.
- MCALLISTER, C.T., J.E. CORDES, AND J.M. WALKER. 1995. Helminth parasites of unisexual and bisexual whiptail lizards (Teiidae) in North America. IX. The plateau spotted whiptail (*Cnemidophorus gularis septemvittatus*). *Texas Journal of Science* 47:83–88.
- PADILHA, T.N., AND M.J. FARIA DUARTE. 1979. Ocorrência de *Parapharyngodon alvarengai* Freitas, 1957 em *Ameiva ameiva* no Estado do Rio de Janeiro (Nematoda, Oxyuroidea). *Atas da Sociedade de Biologia do Rio de Janeiro* 20:21–22.
- PONCE-CAMPOS, P., AND A. GARCÍA AGUAYO. 2007. *Aspidoscelis calidipes*. In: IUCN, compiler, IUCN Red List of Threatened Species. Version 2013.1. Gland, Switzerland; [cited 22 October 2013]. Available from: <http://www.iucnredlist.org>
- TELFORD, S.R., JR. 1970. A comparative study of endoparasitism among some southern California lizard populations. *American Midland Naturalist* 83:516–554.
- UETZ, P., AND J. HOSEK, EDITORS. The reptile database [online]. [Cited 21 October 2013]. Available from: <http://www.reptile-database.org>

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APPENDIX 1. Eight species of *Aspidoscelis* lizards from Mexico deposited in the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, examined for helminths.

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- Aspidoscelis calidipes*: MICHOACAN (LACM 130300, 130302, 130304–130307, 130309, 130310)  
*Aspidoscelis communis*: MICHOACAN (LACM 130321, 130328, 130329, 130334, 130342, 130343, 130345–130347, 130349)  
*Aspidoscelis cozumelae*: QUINTANA ROO (LACM 128385–128393)  
*Aspidoscelis gularis*: TLAXALA (LACM 130616–130625)  
*Aspidoscelis lineatissima*: MICHOACAN (LACM 130407, 130408, 130410, 130412, 130413, 130422, 130423, 130426, 130427)  
*Aspidoscelis motaguae*: CHIAPAS (LACM 130515–130525)  
*Aspidoscelis parvisocia*: OAXACA (LACM 130540, 130543, 130544, 130546–130549, 130552, 130553)  
*Aspidoscelis sackii*: OAXACA (LACM 130560–130567)
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APPENDIX 2. Helminths found in 8 species of *Aspidoscelis* lizards from Mexico. Helminth specimens were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA.

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- Aspidoscelis calidipes*: *Oochoristica scelopori* (USNPC 107401); *Spauligodon garciaprietoi* (USNPC 107402)  
*Aspidoscelis communis*: *Parapharyngodon alvarengai* (USNPC 107403), *Spauligodon garciaprietoi* (USNPC 107404), *Spinicauda spinicauda* (USNPC 107405), *Thubunaea cnemidophorus* (USNPC 107406), *Physaloptera* sp. (USNPC 107407)  
*Aspidoscelis cozumelae*: *O. scelopori* (USNPC 107408), *Physaloptera* sp. (USNPC 107409)  
*Aspidoscelis gularis*: *S. garciaprietoi* (USNPC 107410), *Abbreviata terrapenis* (USNPC 107411)  
*Aspidoscelis lineatissima*: *O. scelopori* (USNPC 107412), *S. garciaprietoi* (USNPC 107413), *Physaloptera* sp. (USNPC 107414)  
*Aspidoscelis motaguae*: *A. terrapenis* (USNPC 107415), *P. alvarengai* (USNPC 107416)  
*Aspidoscelis parvisocia*: *S. garciaprietoi* (USNPC 107417), *Physaloptera* sp. (USNPC 107418)  
*Aspidoscelis sackii*: *O. scelopori* (USNPC 107419), *A. terrapenis* (USNPC 107420), *P. alvarengai* (USNPC 107421), *Pharyngodon warneri* (USNPC 107422), *S. garciaprietoi* (USNPC 107423)
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