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Nematode Parasites of Costa Rican Snakes (Serpentes) with Description of a New Species of *Abbreviata* (Physalopteridae)

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ABSTRACT: Seventy-eight snakes collected in the Area de Conservación Guanacaste, Costa Rica were necropsied: Boidae (1 species), boa constrictor, *Boa constrictor*; Colubridae (21 species), Ecuador sipo, *Chironius grandisquamis*; road guarder, *Conophis lineatus*; South American forest racer, *Dendrophidion percarinatus*; speckled racer, *Drymobius margaritiferus*; mimic false coral snake, *Erythrolamprus mimus*; blunthead tree snake, *Imantodes cenchoa*; western tree snake, *Imantodes inornatus*; banded cat-eyed snake, *Leptodeira annulata*; striped lowland snake, *Leptodrymus pulcherrimus*; Cope's parrot snake, *Leptophis depressirostris*; yellow-bellied racer, *Liophis epinephelus*; neotropical whip snake, *Masticophis mentovarius*; brown vinesnake, *Oxybelis aeneus*; Cope's vine snake, *Oxybelis brevirostris*; green vine snake, *Oxybelis fulgidus*; Cope's false coral snake, *Pliocercus euryzonus*; cloudy snail-eating snake, *Sibon nebulata*; chicken snake, *Spilotes pullatus*; western lyre snake, *Trimorphodon biscutatus*; orange-bellied littersnake, *Urotheca guentheri*; false fer-de-lance, *Xenodon rabdocephalus*; Viperidae (6 species), cantil, *Agkistrodon bilineatus*; jumping pit viper, *Atropoides nummifer*; terciopelo, *Bothrops asper*; cascabel, *Crotalus durissus*; hognosed pit viper, *Porthidium nasutum*; and slender hognose viper, *Porthidium ophryomegas*. Gravid nematodes representing 16 known species, *Aplectana incerta*, *Aplectana itzocanensis*, *Cosmocercoides variabilis*, *Cruzia rudolphi*, *Hastospiculum onchocercum*, *Hexameta boddaertii*, *Kalicephalus costatus*, *Kalicephalus inermis*, *Kalicephalus subulatus*, *Macdonaldius oscheri*, *Ophidascaris arndti*, *Ophidascaris sicki*, *Physaloptera retusa*, *Skrjabinelazia intermedia*, *Terranova caballeroi*, *Travassosascaris araujoi*, 1 new species, *Abbreviata costaricae*, and larvae of a species of *Porrocaecum* were found. Twenty-six new host records and 4 new locality records are reported. The nematode species found in this study are generalist parasites, i.e., infect more than one host species, and a comprehensive review of the hosts of these species is presented.

KEY WORDS: snakes, Costa Rica, Nematoda.

Little information about nematode parasites of Costa Rican snakes is available. The earliest published work on nematodes of Costa Rican snakes was that of Viquez (1935), who reported *Physaloptera obtusissima* in fer-de-lance, *Bothrops atrox* and unidentified species of *Aplectana*, *Ophidascaris*, and *Thelazia* in boa constrictor, *Boa constrictor*. The next reports were those of Brenes and Bravo-Hollis (1960), *Kalicephalus macrovulvus* (currently *Kalicephalus inermis macrovulvus*) in *Bothrops atrox*, and Schad (1962), *Kalicephalus costatus* and *Kalicephalus subulatus* in *Boa constrictor*. More recently, Goldberg and Bursey (2004a, 2005a, 2006a, b, 2009a, b) have reported adults of *Hastospiculum onchocercum*, *Hexameta boddaertii*, *Terranova caballeroi*, and larvae of *Contraecum* sp., *Ophidascaris* sp., and *Porrocaecum* sp. in Costa Rican snakes. Our work on Costa Rican snakes has produced additional hosts as well as a new nematode species, *Abbreviata costaricae*, which we present herein.

MATERIALS AND METHODS

Seventy-eight snakes representing 3 families collected in the Area de Conservación Guanacaste, Costa Rica were necropsied: Boidae: boa constrictor, *Boa constrictor* Linnaeus, 1758 (4); Colubridae: Ecuador sipo, *Chironius grandisquamis* Peters, 1869 (1); road guarder, *Conophis lineatus* (Duméril, Bibron and Duméril, 1854) (1); South American forest racer, *Dendrophidion percarinatus* Cope, 1893 (1); speckled racer, *Drymobius margaritiferus* Schlegel, 1837 (5); mimic false coral snake, *Erythrolamprus mimus* Cope, 1868 (2); blunthead tree snake, *Imantodes cenchoa* Linnaeus, 1758 (5); western tree snake, *Imantodes inornatus* Boulenger, 1896 (1); banded cat-eyed snake, *Leptodeira annulata* Linnaeus, 1758 (4); striped lowland snake, *Leptodrymus pulcherrimus* Cope, 1874 (1); Cope's parrot snake, *Leptophis depressirostris* Cope, 1861 (4); yellow-bellied racer, *Liophis epinephelus* (1); neotropical whip snake, *Masticophis mentovarius* Duméril, Bibron and Duméril, 1854 (1); brown vinesnake, *Oxybelis aeneus* Wagler, 1824 (5); Cope's vine snake, *Oxybelis brevirostris* Cope, 1861 (2); green vine snake, *Oxybelis fulgidus* Daudin, 1803 (3); Cope's false coral snake, *Pliocercus euryzonus* Cope, 1862 (1); cloudy snail-eating snake, *Sibon nebulata* Linnaeus, 1758 (2); chicken snake, *Spilotes pullatus* Linnaeus, 1758 (2); western lyre snake, *Trimorphodon biscutatus* Duméril, Bibron and Duméril, 1854 (7); orange-bellied littersnake, *Urotheca guentheri* Dunn, 1938 (1); false fer-de-lance, *Xenodon rabdocephalus* Wied, 1924 (1); Viperidae: Cantil, *Agkistrodon bilineatus* Günther, 1863

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(2); jumping pit viper, *Atropoides nummifer* Rüppell, 1845 (1); terciopelo, *Bothrops asper* Garman, 1883 (2); cascabel, *Crotalus durissus* Linnaeus, 1758 (11); hognosed pit viper, *Porthidium nasutum* Bocourt, 1868 (1); and slender hognose viper, *Porthidium ophryomegas* Bocourt, 1868 (6).

Snakes had been collected by hand. During necropsy, parasites were separated by taxonomic class and sent to various laboratories for further study and identification. Only nematodes were received at this laboratory. Nematodes had been fixed in glacial acetic acid and preserved and stored in 70% ethanol. For examination and identification, they were cleared in lactophenol and examined by light microscopy. Measurements are given in micrometers unless otherwise stated, with mean \pm 1 SD and range in parenthesis. Drawings were made with the aid of a microprojector (Model 358B, Bausch and Lomb, Rochester, New York). Selected nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland. Snake taxonomy follows Savage (2002).

RESULTS

Gravid nematodes representing 16 known species, *Aplectana incerta* Caballero, 1949, *Aplectana itzacanensis* Bravo Hollis, 1943, *Cosmocercoides variabilis* (Harwood, 1930), *Cruzia rudolphi* Ruiz, 1947, *Hastospiculum onchocercum* Chitwood, 1932, *Hexametra boddaertii* (Baird, 1860), *Kalicephalus costatus* (Rudolphi, 1819), *Kalicephalus inermis* (Molin, 1861), *Kalicephalus sublatus* Molin, 1861, *Macdonaldius oscheri* Chabaud and Frank, 1961, *Ophidascaris arndti* Sprehn, 1929, *Ophidascaris sicki* Freitas, 1951, *Physaloptera retusa* Rudolphi, 1819, *Skrjabinelazia intermedia* (Freitas, 1940), *Terranova caballeri* Barus and Coy Otero, 1966, *Travassosascaris araujo* Sprent, 1978, 1 new species, *Abbreviata costaricae*, and larvae of a species of *Porrocaecum* were found.

Thirty-three of 78 snakes (42%) were infected with a total of 309 nematodes representing 18 species. Nematodes were not found in *Bothrops asper*, *Leptodeira annulata*, or *Pliocercus euryzonus*. No host snake harbored more than 2 nematode species; 22 hosts harbored 1 species, 11 hosts harbored 2 species; there were 1.3 ± 0.5 SD (range 1–2) nematode species per host individual and 9.4 ± 12.9 (range 1–53) nematodes per host. No snake species harbored more than 4 nematode species; there were 1.6 ± 0.8 (range 1–4) nematode species per snake species. Twenty-six new host records and 4 new locality records are reported.

Abbreviata costaricae n. sp.

Figures 1–8

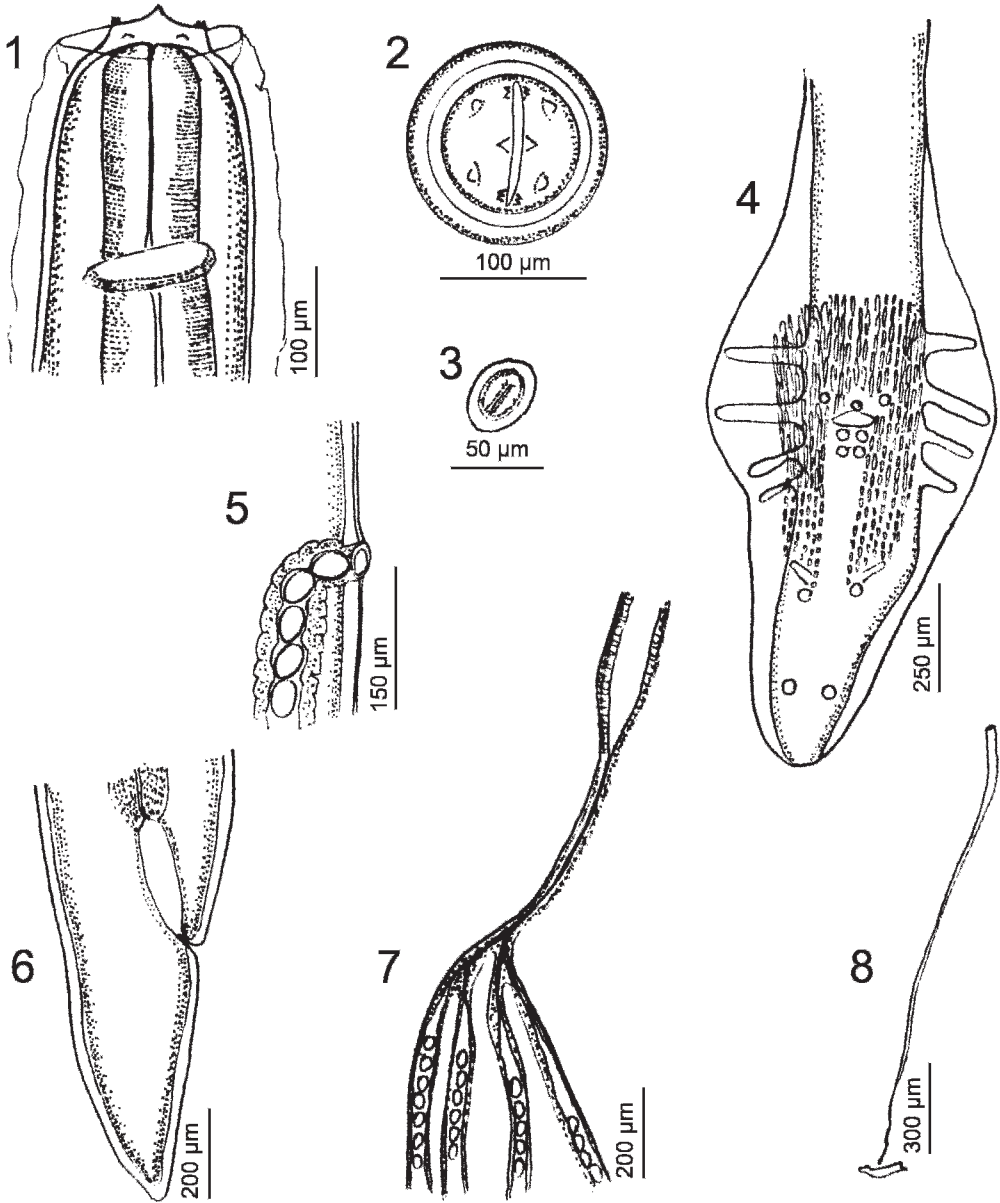
Description

General: Spirurida. Physalopteridae (Railliet, 1893) Leiper, 1908; *Abbreviata* Travassos, 1920. Medium-

sized nematodes, body cylindrical, width similar throughout. Head with two lateral pseudolabia each bearing two small submedian papillae and one amphid. Each pseudolabium armed with a large external tooth and 2 doubled submedian teeth, internolateral tooth and denticles absent. Head with distinct cervical cuticular inflation. Short buccal cavity; esophagus divided into short anterior muscular portion and long posterior glandular portion. Nerve ring slightly anterior to junction of muscular and glandular portions of esophagus. Deirids at level of nerve ring. Inconspicuous excretory pore slightly posterior to junction of muscular and glandular portions of esophagus.

Male (holotype and 2 paratypes): Length 18.17 ± 2.02 mm (16.0–20.0 mm); width at level of esophago–intestinal junction 400 ± 53 (357–459). Vestibule 49 ± 6 (43–55). Esophagus $2,133 \pm 98$ (2,048–2,240) in total length, divided into short muscular portion 236 ± 21 (214–256) in length, glandular portion $1,897 \pm 78$ (1,834–1,984) in length. Nerve ring 248 ± 27 (220–275) from anterior end. Spicules unequal. Right spicule well sclerotized, short, 183 ± 7 (179–191) long; left spicule, less sclerotized, sinuous, $1,505 \pm 159$ (1,326–1,632) in length, approximately 8 times length of right, terminating in fine point. Tail conical with rounded terminus. Caudal bursa well developed; 4 pairs of pendunculate papillae supporting bursal alae, 2 pair precloacal, 2 pairs postcloacal; 11 sessile and 2 mammiliform papillae, 3 sessile papillae precloacal, 1 on midline of anterior cloacal lip, 2 more anterior, positioned at right and left edges of cloaca; 4 sessile papillae in 2 pairs immediately posterior to cloaca, 4 papillae, 2 sessile, 2 mammiliform halfway between cloaca and end of tail; 2 sessile near end of tail. Ventral surface of posterior end with many small ovate verrucae beginning anterior to anteriormost pair of pendunculate papillae and extending posterior to third pair of post anal sessile papillae.

Female (allotype and 4 paratypes): Length 25.10 ± 2.66 mm (22.0–29.0 mm); width at level of esophago–intestinal junction 456 ± 43 (408–510). Vestibule 57 ± 7 (49–66). Esophagus $2,406 \pm 167$ (2,240–2,624) total length; divided into short muscular portion 277 ± 20 (250–305) in length, glandular portion $2,133 \pm 147$ (1,980–2,319) in length. Nerve ring 255 ± 14 (240–275) and vulva $5,184 \pm 239$ (4,864–5,376) from anterior end. Vulva on slight prominence, thin walled vagina directed posteriorly, opening into egg reservoir, then dividing dichotomously to give rise to four uteri. Eggs thick-walled, ovoid, embryonated, 42 ± 4 (37–



Figures 1–8. *Abbreviata costaricae* n. sp. 1. Female, anterior end, lateral view. 2. Female, en face view. 3. Egg. 4. Male, posterior end, ventral view. 5. Female, vulvar region. 6. Female, posterior end. 7. Female, uterine branches. 8. Male, spicules.

49) × 32 ± 3 (27–37). Tail 538 ± 29 (510–587) in length, rounded terminus.

Type locality: Guanacaste Conservation Area, Costa Rica.

Site of infection: Stomach.

Taxonomic Summary

Type host: *Agkistrodon bilineatus* Günther, 1863, cantil, symbiotype UT 03-P-0399, male, collected 25 May 2003.

Type specimens: Holotype male USNPC 103603; allotype female USNPC 103604; paratypes USNPC 103605.

Etymology: The new species is named for its collection locality.

Remarks

Of the known species of *Abbreviata*, only 3 have been reported from the Americas, namely *Abbreviata bahamensis* Moravec, Coy Otero and Barus, 1990 in a lizard, *Leiocephalus* sp. collected on Castle Island, Bahama; *Abbreviata baracoa* Barus and Coy Otero, 1966 in a snake, *Alsophis cantherigerus* collected in Cuba; *Abbreviata terrapenis* (Hill, 1941) Morgan, 1945 in a tortoise, *Terapene ornate* collected in Oklahoma, U.S.A. (Hill, 1941; Barus and Coy Otero, 1966; Moravec et al., 1990). *Abbreviata costaricae* n. sp. is easily differentiated from *A. bahamensis* and *A. baracoa* species by uterine anatomy; both of these species have 2 uterine branches. Females of both *Abbreviata costaricae* n. sp. and *A. terrapenis* possess a uterus with 4 branches; however, the verrucae on the ventral surface of the bursa extend beyond the fifth postcloacal papillae in *A. terrapenis* but end near the third postcloacal papillae in *A. costaricae*.

ASCARIDIDA

Cosmoceroidea (Railliet, 1916, subfam) Travassos, 1925

Cosmocercinae Railliet, 1916

Aplectana incerta Caballero, 1949

(Syn. *Oxysomatium incertum* [Caballero, 1949] Skrjabin, Schikhobalova and Mozgovoi, 1951.)

Hosts and locality: *Chironius grandisquamis* (1): male, UT 03-P-0241, collected 14 March 2003, Rio Mena, Guanacaste Conservation Area; *Conophis lineatus* (1): UT 01-P-0011, collected 4 June 2001, Area Administrative, Guanacaste Conservation Area; *Porthidium nasutum* (1): male, UT 03-P-0400, collected 25 May 2003, San Gerardo, Guanacaste Conservation Area; *Porthidium ophryomegas* (1): female, UT 04-P-0438, collected 14 June 2004, Centeno, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 1 *C. grandisquamis* (100%, 1); 1 of 1 *C. lineatus* (100%, 16); 1 of 1 *P. nasutum* (100%, 34); 1 of 6 *P. ophryomegas* (17%, 1).

Site of infection: Large intestine.

Additional Costa Rican records: Talamanca rocket frog, *Allobates talamancae* (Goldberg and Bursey, 2010); Bransford's robber frog, *Craugastor bransfordii* (Goldberg and Bursey, 2010); Fitzinger's

robber frog, *Craugastor fitzingeri* (Goldberg and Bursey, 2008); black-lined robber frog, *Craugastor melanostictus* (Goldberg and Bursey, 2008); Noble's robber frog, *Craugastor noblei* (Bursey and Brooks, 2010a); rain frog, *Craugastor ranoides* (Goldberg and Bursey, 2008); Gofito robber frog, *Craugastor taurus* (Goldberg and Bursey, 2008); Underwood's robber frog, *Craugastor underwoodi* (Goldberg and Bursey, 2008); Túngara frog, *Engystomops pustulosus* (Bursey and Brooks, 2010a); southern round-gland toad, *Incilius coccifer* (Bursey and Brooks, 2010a); yellow toad, *Incilius luetkenii* (Bursey and Brooks, 2010a); Monte Verden Golden toad, *Incilius periglenes* (Goldberg and Bursey, 2010); southern Gulf Coast toad, *Incilius valliceps* (Bursey and Brooks, 2010a); moustached frog, *Leptodactylus mystacinus* (Bursey and Brooks, 2010a); smoky jungle frog, *Leptodactylus pentadactylus* (Bursey and Brooks, 2010a); Turbo white-lipped frog, *Leptodactylus poecilochilus* (Bursey and Brooks, 2010a); Forrer's grass frog, *Lithobates forreri* (Bursey and Goldberg, 2005; Bursey and Brooks, 2010a); Peralta frog, *Lithobates taylori* (Bursey and Brooks, 2010a); Vaillant's frog, *Lithobates vaillanti* (Bursey and Brooks, 2010a); Warszewitsch's frog, *Lithobates warszewitschii* (Bursey and Goldberg, 2007; Bursey and Brooks, 2010a); strawberry poison frog, *Oophaga pumilio* (Bursey and Brooks, 2010a); Truando toad, *Rhaebo haematiticus* (Bursey and Brooks, 2010a); cane toad, *Rhinella marina* (Bursey and Brooks, 2010a); burrowing toad, *Rhinophrynus dorsalis* (Bursey and Brooks, 2010a); Boulenger's snouted treefrog, *Scinax boulengeri* (Bursey and Brooks, 2010a); Mexican treefrog, *Smilisca baudini* (Bursey and Brooks, 2010a); New Granada cross-banded treefrog, *Smilisca phaeota* (Bursey and Brooks, 2010a); veined treefrog, *Trachycephalus venulosus* (Bursey and Brooks, 2010a).

Type host and locality: *Rhinella marina*, Chiapas, Mexico (reported as *Bufo marinus*, Caballero, 1949).

Other reports: Green toad, *Anaxyrus debilis* (Goldberg, Bursey, Ramos, 1995); Arizona toad, *Anaxyrus microscaphus* (Goldberg, Bursey, Malmos, et al., 1996); Sonoran green toad, *Anaxyrus retiformis* (Goldberg, Bursey, Sullivan, et al., 1996); Woodhouse's toad, *Anaxyrus woodhousii* (Goldberg, Bursey, Malmos, et al., 1996); polymorphic robber frog, *Craugastor rhodopsis* (Goldberg, Bursey, Salgado-Maldonado et al., 2002); Great Plains narrowmouth toad, *Gastrophryne olivacea* (Goldberg et al., 1998a); marbled toad, *Incilius marmoratus* (Galicía-Guerrero

et al., 2000); Sinaloa toad, *Incilius mazatlanensis* (Goldberg and Bursey, 2002a); *Lithobates vaillanti* (Goldberg, Bursey, Salgado-Maldonado et al., 2002; Paredes-Calderon et al., 2004); *Rhinella marina* (Goldberg, Bursey, Salgado-Maldonado et al., 2002); Couch's spadefoot, *Scaphiopus couchii* (Goldberg and Bursey, 1991a, 2005b); *Smilisca baudini* (Goldberg and Bursey, 2002a); Plains spadefoot, *Spea bombifrons* (Goldberg and Bursey, 2002b); western spadefoot, *Spea hammondi* (Goldberg and Bursey, 2002b); Great Basin spadefoot, *Spea intermontana* (Goldberg and Bursey, 2002b); New Mexico spadefoot, *Spea multiplicata* (Goldberg, Bursey, Ramos, 1995).

Geographic range: Costa Rica (Bursey and Goldberg, 2005); Mexico (Caballero, 1949); U.S.A. (Goldberg et al., 1998a).

Specimen deposited: *Chironius grandisquamis*, USNPC 103607; *Conophis lineatus*, USNPC 103608; *Porthidium nasutum*, USNPC 103609; *Porthidium ophryomegas*, USNPC 103610; (vials).

Remarks

This is the first report of *A. incerta* in snakes; previously it was known only from anurans. Species of *Chironius*, *Conophis*, and *Porthidium* are known to feed on frogs and toads (Savage, 2002); thus, the presence of *A. incerta* in these hosts may be a by-product of diet rather than an active infection. *Chironius grandisquamis*, *Conophis lineatus*, *Porthidium nasutum*, and *Porthidium ophryomegas* represent new host records for *A. incerta*.

Aplectana itzacanensis Bravo Hollis, 1943

(Syn. *Oxysomatium itzacanensis* [Bravo Hollis, 1943] Skrzjabin, Schikhobalova and Mozgovi, 1951.)

Hosts and locality: *Drymobius margaritiferus* (1): UT 02-P-0779, collected 23 October 2002, Area Administrative, Guanacaste Conservation Area; *Liophis epinephelus* (1): male, UT 03-P-0184, collected 18 February 2003, Sendero Nacho, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 5 *D. margaritiferus* (20%, 14); 1 of 1 *L. epinephelus* (100%, 4).

Site of infection: Large intestine.

Additional Costa Rican records: Angel robber frog, *Craugastor angelicus* (Goldberg and Bursey, 2010); *Craugastor fitzingeri* (McKenzie, 2007); Fleischmann's robber frog, *Craugastor fleischmanni*

(Goldberg and Bursey, 2010); evergreen robber frog, *Craugastor gollmeri* (Goldberg and Bursey, 2008); *Craugastor ranoides* (Goldberg and Bursey, 2008); *Craugastor taurus* (Goldberg and Bursey, 2008); *Engystomops pustulosus* (Goldberg and Bursey, 2010); *Incilius coccifer* (Bursey and Brooks, 2010a); *Incilius luetkenii* (Bursey and Brooks, 2010a); *Incilius valliceps* (Bursey and Brooks, 2010a); *Lithobates forreri* (Bursey and Goldberg, 2005); *Lithobates vaillanti* (McKenzie, 2007); Rancho Redondo frog, *Lithobates vibicarius* (Bursey and Goldberg, 2006a); *Lithobates warszewitschii* (Bursey and Goldberg, 2007); *Rhaebo haematiticus* (Bursey and Brooks, 2010a); *Rhinella marina* (Brenes and Bravo-Hollis, 1959; Bursey and Brooks, 2010a); *Scinax boulengeri* (Bursey and Brooks, 2010a); Sipurio snouted treefrog, *Scinax elaeochrous* (Bursey and Brooks, 2010a); *Smilisca baudini* (Bursey and Brooks, 2010a); *Smilisca phaeota* (Bursey and Brooks, 2010a); Nicaragua cross-banded treefrog, *Smilisca puma* (McKenzie, 2007; Bursey and Brooks, 2010a); *Trachycephalus venulosus* (Bursey and Brooks, 2010a).

Type host and locality: *Spea multiplicata*, Puebla, Mexico (reported as *Scaphiopus multiplicatus*, Bravo-Hollis, 1943).

Other reports: Mexican leaf frog, *Agalychnis dacnicolor* (Goldberg and Bursey, 2002a); western toad, *Anaxyrus boreas* (Goldberg, Bursey, Hernandez, 1999); Great Plains toad, *Anaxyrus cognatus* (Goldberg and Bursey, 1991a; Goldberg, Bursey, Ramos, 1995); *Anaxyrus debilis* (Goldberg, Bursey, Ramos, 1995); little Mexican toad, *Anaxyrus kelloggi* (Goldberg and Bursey, 2002a); *Anaxyrus microsca-phus* (Goldberg, Bursey, Malmos, et al., 1996); red-spotted toad, *Anaxyrus punctatus* (Goldberg and Bursey, 1991b); *Anaxyrus retiformis* (Goldberg, Bursey, Sullivan, et al., 1996); *Anaxyrus woodhousii* (Goldberg, Bursey, Malmos, et al., 1996); small-headed treefrog, *Dendropsophus microcephalus* (Goldberg et al., 2002); *Gastrophyryne olivacea* (Goldberg et al., 1998a); Sonoran Desert toad, *Incilius alvarius* (Goldberg and Bursey, 1991a; Baker, 1985); *Incilius mazatlanensis* (Goldberg and Bursey, 2002a); *Incilius valliceps* (Espinola-Novelo and Guillen-Hernandez, 2008); Sabinal frog, *Leptodactylus melanonotus* (Goldberg and Bursey, 2002a); Northwest Mexico leopard frog, *Lithobates magnaocularis* (Goldberg and Bursey, 2002a); Pacific chorus frog, *Pseudacris regilla* (Goldberg, Bursey, Gergus, 2001); *Rhinella marina* (Bravo Hollis, 1943; Caballero-Deloya, 1974; Espinoza-Jimenez et al., 2007;

Espinol-Novelo and Guillen-Hernandez, 2008); *Scaphiopus couchii* (Tinsley, 1990; Goldberg and Bursey, 2005b); blue-spotted Mexican treefrog, *Smilisca cyanosticta* (Goldberg, Bursey, Salgado-Maldonado, et al., 2002); northern casquehead frog, *Smilisca fodiens* (Goldberg, Bursey, Galindo, 1999); *Spea bombifrons* (Goldberg and Bursey, 2002b); *Spea multiplicata* (Goldberg, Bursey, Ramos, 1995).

Geographic range: Costa Rica (Brenes and Bravo Hollis, 1959); Mexico (Bravo Hollis, 1943); U.S.A. (Baker, 1985).

Specimen deposited: *Drymobius margaritiferus*, USNPC 103611; *Liophis epinephelus* USNPC 103612; (vials).

Remarks

This is the first report of *A. itzocanensis* in snakes; previously, it was known only from anurans. *Drymobius margaritiferus* and *Liophis epinephelus* feed mainly on frogs and toads (Savage, 2002); thus, the presence of *A. itzocanensis* in these hosts may be a by-product of diet. *Drymobius margaritiferus* and *Liophis epinephelus* represent new host records for *A. itzocanensis*.

***Cosmocercoides variabilis* (Harwood, 1930) Travassos, 1931**

(Syn. *Cosmocercoides dukae* [Holl, 1928] Travassos, 1931, in part; *Oxysomatium variabilis* Harwood, 1930; *Aplectana americana* Walton, 1929; *Oxyuris* sp. of Waitz, 1961; *Oxyuris dubia* Leidy, 1856.)

Hosts and locality: *Crotalus durissus* (1): Female, UT 00-P-0003, collected 23 June 2000 (roadkill), Entrada principal, Guanacaste Conservation Area; *Dendrophidion percarinatus* (1): UT 03-P-0087, collected 16 January 2003, Rio Negro, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 11 *C. durissus* (9%, 4); 1 of 1 *D. percarinatus* (100%, 2).

Site of infection: *C. durissus*, stomach; *D. percarinatus* rectum.

Additional Costa Rican records: Red-eyed treefrog, *Agalychnis callidryas* (Bursey and Brooks, 2010a); *Craugastor fitzingeri* (Bursey and Brooks, 2010a); *Craugastor gollmeri* (Goldberg and Bursey, 2008); litter frog, *Craugastor megacephalus* (Bursey and Brooks, 2010a); *Craugastor ranoides* (Goldberg and Bursey, 2008); Stejneger's robber frog, *Crau-*

gastor stejnegerianus (Bursey and Brooks, 2010a); Isla Bonita tree frog, *Duellmanohyla rufioculus* (Bursey and Brooks, 2010a); evergreen toad, *Incilius coniferus* (Bursey and Brooks, 2010a); *Leptodactylus poecilochilus* (Bursey and Brooks, 2010a); *Lithobates forreri* (Bursey and Brooks, 2010a); *Lithobates taylori* (Bursey and Brooks, 2010a); *Lithobates vaillanti* (Bursey and Brooks, 2010a); *Lithobates warszewitschii* (Bursey and Brooks, 2010a); *Rhinella marina* (Bursey and Brooks, 2010a); copper anole, *Anolis cupreus* (Bursey and Brooks, 2010b); humble anole, *Anolis humilis* (Bursey and Brooks, 2010b); lion anole, *Anolis lionotus* (Bursey and Brooks, 2010b); green basilisk, *Basiliscus plumifrons* (Bursey and Brooks, 2010b); Cope's alligator lizard, *Mesaspis monticola* (Bursey and Goldberg, 2006b); spotted coffee snake, *Ninia maculata* (Goldberg and Bursey, 2006a).

Type host and locality: Gulf Coast toad, *Incilius nebulifer*, Texas (reported as *B. valliceps*, Harwood, 1930).

Other reports: Black salamander, *Aneides flavipunctatus* (Lehmann, 1960); arboreal salamander, *Aneides lugubris* (Lehmann, 1960); long-toed salamander, *Ambystoma macrodactylum* (Waitz, 1961); mole salamander, *Ambystoma talpoideum* (Harwood, 1932); Texas salamander, *Ambystoma texanum* (Harwood, 1930, 1932); marbled salamander, *Dicamptodon ensatus* (Lehmann, 1960); northern dusky salamander, *Desmognathus fuscus* (Odlaug, 1954); large-blotched salamander, *Ensatina eschscholtzii* (Goldberg et al., 1998b); dark-sided salamander, *Eurycea longicauda* (McAllister and Bursey, 2004); black-spotted newt, *Notophthalmus meridionalis* (Harwood, 1930, 1932); red-backed salamander, *Plethodon cinereus* (Bursey and Schibli, 1995); Sequoyah slimy salamander, *Plethodon sequoyah* (McAllister and Bursey, 2004); red-bellied newt, *Taricha rivularis* (Goldberg, Bursey, Dailey, 2009); California newt, *Taricha torosus* (Ingles, 1936); American toad, *Anaxyrus americanus* (Vanderburgh and Anderson, 1987a; Joy and Bunten, 1997; Bolek and Coggins, 2000; Yoder and Coggins, 2007); *Anaxyrus boreas* (Ingles, 1936; Frandsen and Grundmann, 1960; Koller and Gaudin, 1977; Goldberg, Bursey, Hernandez, 1999); *Anaxyrus debilis* (McAllister et al., 1989); Canadian toad, *Anaxyrus hemiophrys* (Bursey and Goldberg, 1998); oak toad, *Anaxyrus quercicus* (Walton, 1938; Hamilton, 1955; Goldberg and Bursey, 1996); southern toad, *Anaxyrus terrestris* (Harwood, 1932); *Anaxyrus wood-*

housii (McAllister et al., 1989); narrow-mouthed toad, *Gastrophryne carolinensis* (Harwood, 1930, 1932; McAllister and Bursey, 2005); Cope's gray treefrog, *Hyla chrysoscelis* (Bolek and Coggins, 1998); squirrel treefrog, *Hyla squirella* (Harwood, 1930, 1932); *Incilius nebulifer* (Harwood, 1932; McAllister et al., 1989); crawfish frog, *Lithobates areolatus* (Harwood, 1930, 1932); Plains leopard frog, *Lithobates blairi* (Goldberg et al., 2000); Carolina gopher frog, *Lithobates capito* (Walton, 1947); bullfrog, *Lithobates catesbeianus* (Walton, 1929; Harwood, 1932; Trowbridge and Hefley, 1934; Brandt, 1936; Ingles, 1936; Rankin, 1945; Lehmann, 1965; Campbell, 1968; Hollis, 1972; Rau et al., 1978; Muzzall, 1991; Andrews et al., 1992; Bursey and DeWolf, 1998; McAlpine and Burt, 1998; Goldberg and Bursey, 2002c); green frog, *Lithobates clamitans* (Harwood, 1932; Odlaug, 1954; Rau et al., 1978; Muzzall, 1991; Bursey and DeWolf, 1998; McAlpine and Burt, 1998); *Lithobates magnaocularis* (Goldberg and Bursey, 2002a); pickerel frog, *Lithobates palustris* (Walton, 1929; Harwood, 1930, 1932; Coggins and Sajdak, 1982; McAllister et al., 1995; Bursey and DeWolf, 1998); northern leopard frog, *Lithobates pipiens* (Odlaug, 1954; Rau et al., 1978; McAlpine and Burt, 1998; Goldberg, Bursey, McKinnell, et al., 2001); southern leopard frog, *Lithobates sphenoccephala* (Harwood, 1930, 1932); wood frog, *Lithobates sylvaticus* (Harwood, 1930; Odlaug, 1954; Muzzall and Peebles, 1991); spotted chorus frog, *Pseudacris clarkii* (McAllister, 1991); spring peeper, *Pseudacris crucifera* (Muzzall and Peebles, 1991); *Pseudacris regilla* (Lehmann, 1965; Koller and Gaudin, 1977); midland chorus frog, *Pseudacris triseriata* (Harwood, 1930, 1932; Odlaug, 1954; Bolek and Coggins, 1998); red-legged frog, *Rana aurora* (Ingles, 1936; Walton, 1947; Lehmann, 1965; Kennedy, 1977); yellow-legged frog, *Rana boylei* (Bursey et al., 2010); Oregon spotted frog, *Rana pretiosa* (Lehmann, 1965); Hurter's spadefoot, *Scaphiopus hurterii* (McAllister et al., 2005); imbricate alligator lizard, *Barisia imbricata* (Goldberg, Bursey, Camarillo-Rangel, 1999); rough teiid, *Echinosaura horrida* (Bursey et al., 2007); northern alligator lizard, *Elgaria coerulea* (Goldberg and Bursey, 1991c); Madrean alligator lizard, *Elgaria kingii* (Goldberg, Bursey, Cheam, 1999); San Lucan alligator lizard, *Elgaria paucicarinata* (Goldberg, Bursey, Beaman, 2004); Texas alligator lizard, *Gerrhonotus liocephalus* (Goldberg, Bursey, Camarillo-Rangel, 1999); Mediterranean house gecko,

Hemidactylus turcicus (Criscione and Font, 2001); slender glass lizard, *Ophisaurus attenuatus* (Harwood, 1930, 1932); five-lined skink, *Plestiodon fasciatus* (Harwood, 1932); northern fence lizard, *Sceloporus undulatus* (Goldberg, Bursey, McAllister, 1995); ground skink, *Scincella lateralis* (Harwood, 1930, 1932; Goldberg, Bursey, McAllister, 1995); cottonmouth, *Agkistrodon piscivorus* (Fontenot and Font, 1996); eastern hognose snake, *Heterodon platyrhinos* (Harwood, 1930, 1932); harlequin coral snake, *Micrurus fulvius* (Harwood, 1930, 1932); brown snake, *Storeria dekayi* (Harwood, 1930, 1932; Rau et al., 1978; Rau and Gordon, 1980); three-toed box turtle, *Terrapene carolina* (Harwood, 1930, 1932; Rausch, 1947); ornate box turtle, *Terrapene ornata* (Harwood, 1930, 1932).

Geographic range: Canada (Vanderburgh and Anderson, 1987a); Costa Rica (Goldberg and Bursey, 2006a); Mexico (Goldberg, Bursey, Camarillo-Rangel, 1999); Panama (Bursey et al., 2007); U.S.A. (Harwood, 1930).

Specimen deposited: *Crotalus durissus*, USNPC 103613; *Dendrophidion percarinatus* USNPC 103614; (vials).

Remarks

Some uncertainty exists for hosts of the 2 American species of *Cosmocercoides*: *Cosmocercoides dukae*, originally *Cosmocerca dukae* Holl, 1928 and *Cosmocercoides variabilis*, originally *Oxysomatium variabilis* Harwood, 1930. Wilkie (1930) established the genus *Cosmocercoides*, and Travassos (1931) included both *C. dukae* and *C. variabilis* in his monograph on the Cosmocercidae. Ogren (1953, 1959) considered *C. variabilis* a synonym of the molluscan parasite *C. dukae* and presumed that amphibians acquired *C. dukae* by ingesting infected molluscs. Vanderburgh and Anderson (1987b) demonstrated that these 2 species were distinct. The major difference in the 2 species is the number of rosette papillae of the male: *C. dukae* with 12 pairs; *C. variabilis* with 14 to 20 pairs. Two males and 2 females were collected in this study and, because the males exhibited 16 pairs of rosette papillae, they are assigned to *C. variabilis*. Ingles (1936) reported *C. dukae* from *Taricha torosa*, *Rana aurora*, and *Bufo boreas* from California but illustrated 16 papillae and, for this reason, his specimens were referred to *C. variabilis*. Anderson (2000) refers all infections of *C. dukae* in toads to *C.*

variabilis. *Cosmocercoides variabilis* has been previously reported from snakes (Harwood, 1930, 1932; Rau et al., 1978; Rau and Gordon, 1980; Fontenet and Font, 1996). *Crotalus durissus* and *Dendrophidion percarinatus* represent new host records for *C. variabilis*.

**Kathlaniidae (Lane, 1914, subfam.)
Travassos, 1918
Cruziinae (Travassos 1917, fam.)
Ortlepp, 1924
Cruzia rudolphi Ruiz, 1947**

Hosts and locality: *Sibon nebulata* (2); UT 01-P-0403 collected 23 June 2001; UT 01-P-0420, 25 June 2001, Buenos Aires, Guanacaste Conservation Area.

Prevalence and intensity: 2 of 2 *S. nebulata* (100%, 13, 36, respectively).

Site of infection: Large intestine.

Additional Costa Rican records: None.

Type host and locality: Aesculapian false coral-snake, *Erythrolamprus aesculapii*, Brazil (Ruiz, 1947).

Other reports: Catesby's snail-eater, *Dipsas catesbyi*, (McAllister et al., 2010); Neotropical snail eater, *Dipsas indica*, (McAllister et al., 2010).

Geographic range: Brazil (Ruiz, 1947); Costa Rica (this study); Ecuador (McAllister et al., 2010).

Specimen deposited: *Sibon nebulatus*, USNPC 103615, 103616; (vials).

Remarks

Sibon nebulatus represents a new host record for *C. rudolphi*; Costa Rica is a new locality record.

**Seuratoidea
Seuratiidae (Hall, 1916) Railliet, 1916
Skrjabinelaziinae Chabaud,
Campana-Rouget and Brygoo, 1959
Skrjabinelazia intermedia (Freitas, 1940)
Chabaud, 1973**

(Syn. *Salobrella intermedia*, Freitas, 1940.)

Hosts and locality: *Oxybelis fulgidus* (1), male, UT 04-P-0431, collected 15 June 2004, Playa Junquillal, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 3 *O. fulgidus* (33%, 1).

Site of infection: Intestine.

Additional Costa Rican records: Lichen anole, *Norops pentaprion* (Goldberg and Bursey, 2004b).

Type host and locality: *Tropidurus spinulosus*, Brazil (Freitas, 1940)

Other reports: *Anolis punctatus* (Bursey et al., 2005); *Cnemidophorus natio* (Menezes et al., 2004); *Stenocercus caducus* (Avila, Souza and da Silva, 2010); *Tropidurus guarani* (Bursey and Goldberg, 2004); *Tropidurus spinulosus* (Vicente, 1981); *Tropidurus torquatus* (Vicente, 1981).

Geographic range: Brazil (Freitas, 1940); Costa Rica (this study); Paraguay (Bursey and Goldberg, 2004); Peru (Bursey et al., 2005).

Specimen deposited: *Oxybelis fulgidus*, USNPC 103617; (vials).

Remarks

Skrjabinelazia intermedia was previously known only from lizards (see host list above). *Oxybelis fulgidus* is known to feed on lizards (Savage, 2002); thus, this occurrence may be a by-product of diet rather than an active infection. *Oxybelis fulgidus* represents a new host record for *S. intermedia*.

**Ascaridoidea
Ascarididae Baird, 1853
Ascaridinae Baird, 1853
Hexametra boddaertii (Baird, 1860)
Sprent, 1978**

(Syn. *Ascaris boddaertii* Baird, 1860; *Ascaris quadrangularis* Schneider, 1866, in part; *Polydelphis hexauterina* Skrjabin, 1916; *Hexametra quadricornis* [Wedl, 1861] sensu Araujo, 1969; *Polydelphis quadrangularis* of Araujo, 1969).

Hosts and locality: *Agkistrodon bilineatus* (1), male, UT 03-P-0399, collected 25 May 2003, Caretera Interamericana, Guanacaste Conservation Area; *Crotalus durissus* (1), UT 02-P-1001, collected 28 December 2002, Area Administrativa, Guanacaste Conservation Area; *Porthidium ophryomegas* (1), female, UT 04-P-0438, collected 14 June 2004, Centro, Guanacaste Conservation Area; *Spilotes pullatus* (1), UT 03-P-0154, collected 30 January 2003, on road to Santa Rosa, Guanacaste Conservation Area; *Trimorphodon biscutatus* (1), UT 03-P-

0329, collected 10 May 2003, Area Administrativa, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 2 *A. bilineatus* (50%, 2); 1 of 11 *C. durissus* (9%, 2); 1 of 1 *P. ophryomegas* (100%, 1); 1 of 2 *S. pullatus* (50%, 53); 1 of 7 *T. biscutatus* (14%, 2).

Site of infection: Intestine, body cavity.

Additional Costa Rican records: *Crotalus durissus* (Bowman, 1984); *Micrurus nigrocinctus* (Goldberg and Bursey, 2004a).

Type host and locality: *Mastigodryas boddaerti*, West Indies (Baird, 1860).

Other reports: *Bothrops* sp. (Skrjabin, 1916; Sprent, 1978); *Crotalus adamanteus* (Sprent, 1978); *Crotalus atrox* (Sprent, 1978; Goldberg et al., 2002); *Crotalus basiliscus* (Goldberg, Bursey, Beaman et al., 2006); *Crotalus cerastes* (Bursey et al., 1995); *Crotalus confluentus* (Sprent, 1978); *Crotalus durissus* (Araujo, 1969; Sprent, 1978; Vicente et al., 1993); *Crotalus viridus* (Bowman, 1984); Baron's racer, *Phylodryas baroni* (Hartdegen and Gamble, 2002); *Philodryas schottii* (Sprent, 1978); *Pseudoboa trigeminal* (Sprent, 1978) *Sistrurus catenatus* (Goldberg, Bursey, Holycross, 2001); immature specimen have been reported in the lizards, *Cnemidophorus ocellifer* (Dias et al., 2005); *Mabuya agilis* (Vrcibradic et al., 2002); *Mabuya macrorhynchia* (Vrcibradic et al., 2001, 2002).

Geographic range: Brazil (Araujo, 1969); Costa Rica (Bowman, 1984); Mexico (Goldberg, Bursey, Beaman et al., 2006); Paraguay (Skrjabin, 1916); West Indies (Baird, 1860); United States: California (Bursey et al., 1995); New Mexico (Goldberg, Bursey, Holycross, 2001).

Specimen deposited: *Agkistrodon bilineatus*, USNPC 103618; *Crotalus durissus*, USNPC 103619; *Porthidium ophryomegas*, USNPC 103620; *Trimorphodon biscutatus*, USNPC 103621; (vials).

Remarks

Agkistrodon bilineatus, *Porthidium ophryomegas*, *Spilotes pullatus*, and *Trimorphodon biscutatus* represent new host records for *H. boddaertii*.

Ophidascaris arndti Sprehn, 1929

(Syn. *Ascaris quadriangularis* Schneider, 1866 in part; *Ophidascaris travassosi* Vaz, 1938; *Ophidascaris sprenti* Araujo, 1969).

Hosts and locality: *Crotalus durissus* (3): UT 02-P-1001, collected 28 December 2002, Area Administrativa, Guanacaste Conservation Area; female, roadkill, UT 04-P-0001, collected 1 June 2004, Paracela Principe, Guanacaste Conservation Area; juvenile, UT 04-P-0461, collected 5 November 2004, Area Administrativa, Guanacaste Conservation Area.

Prevalence and intensity: 3 of 11 *C. durissus* (27%, 5, 1, 2, respectively).

Site of infection: Stomach, mesentery.

Additional Costa Rican records: None.

Type host and locality: Brazilian snake, Berlin Aquarium, Berlin, Germany, identified as *Lachesis lanceolatus* in Sprehn, (1929); currently Martinique lancehead, *Bothrops lanceolatus* (Lacépède, 1789). Perhaps a misidentified host, Lazell (1964) considers *B. lanceolatus* to be restricted to Martinique.

Other reports: *Bothrops atrox* (Vicente et al., 1993); *Bothrops cotiara* (Araujo, 1969); *Crotalus durissus* (Araujo, 1969; Vaz, 1938); *Micrurus lemniscatus* (McAllister et al., 2010); *Porthidium hespere* (Goldberg et al., 2008).

Geographic range: Brazil (Schneider, 1866); Costa Rica (this study); Ecuador (McAllister et al., 2010); Mexico (Goldberg et al., 2008).

Specimen deposited: *Crotalus durissus*, USNPC 103622-103624; (vials).

Remarks

Costa Rica is a new locality record for *O. arndti*.

Ophidascaris sicki Freitas, 1951

(Syn. *Ophidascaris ardti* Sprehn, 1929 sensu Freitas, 1955; *Ophidascaris cretiorum* Freitas, 1968).

Hosts and locality: *Xenodon rabdocephalus* (1): UT 02-P-0870, collected 13 November 2002, on road to Santa Rosa, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 1 *X. rabdocephalus* (100%, 1).

Site of infection: Intestine.

Additional Costa Rican records: None.

Type host and locality: *Waglerophis* (as *Xenodon merremii*, Brazil (Freitas, 1951).

Other reports: *Leimadophis poecilogyrus* (Sprent, 1988); *Micrurus frontalis* (Sprent, 1988); *Philodryas*

patagoniensis (Sprent, 1988); *Pseudoboa cloelia* (Sprent, 1988); *Waglerophis merremii* (Freitas, 1955); *Xenodon newwiedii* (Sprent, 1988); *Xenodon severus* (Freitas, 1951; Vicente et al., 1993).

Geographic range: Brazil (Freitas, 1951); Costa Rica (this study).

Specimen deposited: *Xenodon rabdocephalus*, USNPC 103625; (vials).

Remarks

Xenodon rabdocephalus represents a new host record for *O. sicki*. Costa Rica is a new locality record.

Travassosascaris araujoii Sprent, 1978

(Syn. *Polydelphis quadrangularis* [Schneider, 1866] sensu Araujo, 1969.)

Hosts and locality: *Masticophis mentovarius* (1): UT 03-P-0361, collected 23 May 2003, Interamerican Highway, Guanacaste Conservation Area; *Xenodon rabdocephalus* (1): UT 02-P-0870, collected 13 November 2002, road to Santa Rosa, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 1 *M. mentovarius* (100%, 4); 1 of 1 *X. rabdocephalus* (100%, 1).

Site of infection: Intestine.

Additional Costa Rican records: None.

Type host and locality: *Crotalus durissus terrificus*, Brazil (Araujo, 1969).

Other reports: None.

Geographic range: Brazil (Araujo, 1969); Central America (Sprent, 1978); Costa Rica (this study).

Specimen deposited: *Masticophis mentovarius*, USNPC 103626; *Xenodon rabdocephalus* USNPC 103627; (vials).

Remarks

Masticophis mentovarius and *Xenodon rabdocephalus* represent new host records for *O. sicki*. Costa Rica is a new locality record.

Immature ascaridids (unidentified)

Hosts and locality: *Chironius grandisquamis* (1): male, UT 03-P-0241, collected 14 March 2003, Rio Mena, Guanacaste Conservation Area; *Imantodes inornatus* (1): male, UT 03-P-0442, collected 25 June

2003, Sendero Laguna, Guanacaste Conservation Area; *Leptodrymus pulcherrimus* (1): female, road-kill, UT 04-P-0006, collected 3 June 2004, Santa Elena, Guanacaste Conservation Area; *Oxybelis aeneus* (1): female, UT 02-P-0908, collected 19 November 2002; Laguna Los Jicaros, Guanacaste Conservation Area; *Trimorphodon biscutatus* (1): UT 03-P-0329, collected 10 May 2003, Area Administrativa, Guanacaste Conservation Area

Prevalence and intensity: 1 of 1 *C. grandisquamis* (100%, 10); 1 of 1 *I. inornatus* (100%, 1); 1 of 1 *L. pulcherrimus* (100%, 1); 1 of 5 *O. aeneus* (20%, 1); 1 of 7 *T. biscutatus* (14%, 4).

Site of infection: Intestine, mesentery.

Additional Costa Rican records: Anurans: *Incilius coccifer*, *Incilius luetkenii*, *Leptodactylus pentadactylus*, *Lithobates forreri* (Bursey and Brooks, 2010a).

Other reports: *Microlophus occipitalis* (Peru; Goldberg and Bursey, 2009c); *Drymobius margaritiferus* (Nicaragua; Goldberg and Bursey, 2005a).

Specimen deposited: *Chironius grandisquamis*, USNPC 103628; *Imantodes inornatus*, USNPC 103629; *Leptodrymus pulcherrimus*, USNPC 103630; *Oxybelis aeneus*, USNPC 103631; *Trimorphodon biscutatus*, USNPC 103632; (vials).

Remarks

The structure of the esophagus would allow assignment to the Ascaridinae.

Toxocarinae

Porrocaecum sp. (immature)

Hosts and locality: *Dendrophidion percarinatus* (1): (UT 03-P-0087) collected 16 January 2003, Rio Negro, Guanacaste Conservation Area; *Oxybelis brevirostris* (1): male (UT 03-P-0384) collected 23 May 2003, Quebrada abajo de los Naranjales, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 1 *D. percarinatum* (100%, 11); 1 of 2 *O. brevirostris* (50%, 1).

Site of infection: Stomach.

Additional Costa Rican records: Rusty head snake, *Amastidium veliferum* (Goldberg and Bursey, 2004a); sipo, *Chironius carinatus* (Goldberg and Bursey, 2004a); yellowbelly snake, *Coniophanes fissidens* (Goldberg and Bursey, 2007a); *Dendrophidion percarinatum* (Goldberg and Bursey, 2004a); barred forest racer, *Dendrophidion vinitor* (Goldberg

and Bursey, 2004a); false coral snake, *Erytolampus bizona* (Goldberg and Bursey, 2004a); western tree snake, *Imantodes inornatus* (Goldberg and Bursey, 2009a); northern cat-eyed snake, *Leptodeira septentrionalis* (Goldberg and Bursey, 2009b); yellow-bellied racer, *Liophis epinephalis* (Goldberg and Bursey, 2004a); Central American coral snake, *Micrurus nigrocinctus* (Goldberg and Bursey, 2004a); *Oxybelis brevirostris* (Goldberg and Bursey, 2004a); *Pliocercus euryzonus* (Goldberg and Bursey, 2007a); adorned graceful brown snake, *Rhadinea decorata* (Goldberg and Bursey, 2007a); leaf litter gecko, *Lepidoblepharis xanthostigma* (Goldberg and Bursey, 2008); *Craugastor fitzingeri* (Goldberg and Bursey, 2008); *Lithobates taylori* (Goldberg and Bursey, 2007b); *Lithobates warszewitschii* (Bursey and Goldberg, 2007); Rio San Juan robber frog, *Pristimantis ridens* (Goldberg and Bursey, 2008).

Type host and locality: Adults are parasites of birds.

Other reports: Salmon-bellied racer, *Mastigodryas melanolomus* (Goldberg and Bursey, 2006b); West Coast garter snake, *Thamnophis valida* (Goldberg and Bursey, 2004c); Auber's ameiva, *Ameiva auberi* (Barus and Coy Otero, 1969; Coy Otero, 1970; Coy Otero and Barus, 1979); Allison's anole, *Anolis allisoni* (Coy Otero and Barus, 1979); Buycito anole, *Anolis allogus* (Coy Otero and Barus, 1979); Monte Verde anole, *Anolis alutaceus* (Coy Otero and Barus, 1979); bay anole, *Anolis argillaceus* (Coy Otero and Barus, 1979); Baracoa anole, *Anolis baracoae* (Coy Otero and Barus, 1979); western cliff anole, *Anolis bartschi* (Coy Otero and Barus, 1979); Heradura anole, *Anolis bremeri* (Coy Otero and Barus, 1979); Grand Cayman anole, *Anolis conspersus* (Goldberg, Bursey, Cheam, 1995); crested anole, *Anolis cristatellus* (Goldberg et al., 1998c); knight anole, *Anolis equestris* (Barus and Coy Otero, 1968, 1969; Coy Otero, 1970); Etheridge's anole, *Anolis etheridgei* (Goldberg et al., 1998d); Habana anole, *Anolis homolechis* (Barus and Coy Otero, 1969; Coy Otero, 1970; Coy Otero and Barus, 1979); Cubitas anole, *Anolis jubar* (Coy Otero and Barus, 1979); San Lucian anole, *Anolis luciae* (Goldberg et al., 1997a); cave anole, *Anolis lucius* (Coy Otero and Barus, 1979); white-throated anole, *Anolis luteocularis* (Coy Otero and Barus, 1979); snakescale anole, *Anolis ophiolepis* (Coy Otero and Barus, 1979); Oriente bearded anole, *Anolis porcus* (Coy Otero and Barus, 1979); redbear anole, *Anolis rubriarabatus* (Coy Otero and Barus, 1979); brown anole, *Anolis sagrei*

(Coy Otero and Barus, 1979; Goldberg et al., 1994a); longnose leopard lizard, *Gambelia wislizeni* (McAllister and Bursey, 2007); house gekko, *Hemidactylus mabouia* (Coy Otero and Barus, 1979); northern curly-tailed lizard, *Leiocephalus carinatus* (Barus and Coy Otero, 1969; Coy Otero, 1970; Coy Otero and Barus, 1979; Goldberg, Bursey and Cheam, 1995); Cuban curly-tailed lizard, *Leiocephalus cubensis* (Barus and Coy Otero, 1969; Coy Otero, 1970; Coy Otero and Barus, 1979); Monte Verde curlytail lizard, *Leiocephalus macropus* (Barus and Coy Otero, 1969; Coy Otero, 1970; Coy Otero and Barus, 1979); mountain curlytail lizard *Leiocephalus raviceps* (Coy Otero and Barus, 1979); Cabo corrientes curlytail lizard, *Leiocephalus stictigaster* (Coy Otero and Barus, 1979); American wall gecko, *Tarentola americana* (Coy Otero and Barus, 1979); Condoto stubfoot toad, *Atelopus spurrelli* (Goldberg and Bursey, 2003); polymorphic robber frog, *Craugastor rhodopsis* (Goldberg et al., 2002); El Yungue robber frog, *Eleutherodactylus acmonis* (Coy Otero and Ventosa, 1984); rainfrog, *Eleutherodactylus amplinympha* (Goldberg et al., 1998); Atkins' robber frog, *Eleutherodactylus atkinsi* (Coy Otero and Ventosa, 1984); Juventud robber frog, *Eleutherodactylus cuneatus* (Barus, 1973); black whiskered frog, *Eleutherodactylus dimidiatus* (Barus, 1973; Coy Otero and Ventosa, 1984); Gundlach's robber frog, *Eleutherodactylus gundlachi* (Coy Otero and Ventosa, 1984); Klinikowski's robber frog, *Eleutherodactylus klinikowskii* (Coy Otero and Ventosa, 1984); Martinique robber frog *Eleutherodactylus martinicensis* (Moravec and Kaiser, 1995; Goldberg et al., 1998); greenhouse frog, *Eleutherodactylus planirostris* (Coy Otero and Ventosa, 1984); Ronald's robber frog, *Eleutherodactylus ronaldii* (Coy Otero and Ventosa, 1984); Symington's robber frog, *Eleutherodactylus symingtoni* (Coy Otero and Ventosa, 1984); Thomas' robber frog, *Eleutherodactylus thomasi* (Coy Otero and Ventosa, 1984); Varley's robber frog, *Eleutherodactylus varleyi* (Coy Otero and Ventosa, 1984); Zeus' robber frog, *Eleutherodactylus zeus* (Coy Otero and Ventosa, 1984); Sabinal frog, *Leptodactylus melanonotus* (Goldberg et al., 2002); bullfrog, *Lithobates catesbeianus* (Coy Otero and Ventosa, 1984); Cuban treefrog, *Osteopilus septentrionalis* (Coy Otero and Ventosa, 1984); Cuban long-nosed toad, *Peltophryne longinasus* (Coy Otero and Ventosa, 1984); Tschudi's Caribbean toad, *Peltophryne peltoccephala* (Coy Otero and Ventosa, 1984); Cuban spotted toad, *Peltophryne taladai* (Barus, 1973); Surinam toad, *Pipa pipa* (Bursey et al., 2001);

Charlotteville rain frog, *Pristimantis charlottevillensis* (Goldberg et al., 1998); Grenada rain frog, *Pristimantis euphronides* (reported as *Eleutherodactylus euphronides*, Moravec and Kaiser, 1995).

Geographic range: The genus is cosmopolitan. Immature forms listed above are all Western Hemisphere: Bahamas (Goldberg et al., 1994); British Virgin Islands (Goldberg et al., 1988a); Cayman Islands (Goldberg, Bursey and Cheam, 1995); Colombia (Goldberg and Bursey, 2003); Cuba (Barus and Coy Otero, 1968); Dominica (Moravec and Kaiser, 1995); Grenada (Moravec and Kaiser, 1995); Guadeloupe (Goldberg et al., 1998); Hispaniola (Goldberg et al., 1998d); Marie Galante (Moravec and Kaiser 1995); Mexico (Goldberg et al., 2002); Peru (Bursey et al., 2001); St. Lucia (Goldberg et al., 1997a); Tobago (Goldberg et al., 1998).

Specimen deposited: *Dendrophidion percarinatus* USNPC 103633; *Oxybelis brevirostris*, USNPC 103634; (vials).

Remarks

Eggs passed with feces embryonate to first stage larvae, then molt to second stage; eggs must be ingested by earthworms, in which hatching occurs, and the second stage larvae develop to third stage. Definitive hosts may acquire infection by ingesting infected earthworms directly or by eating infected vermivores (Anderson, 2000). All hosts listed above should be considered paratenic hosts.

Anisakinae Railliet and Henry, 1912 ***Terranova caballeroi* Barus and Coy Otero, 1966**

Hosts and locality: *Erythrolamprus mimus* (1): female, UT 03-P-0257, collected 18 March 2003, Estacion, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 2 *E. minus* (50%, 4).

Site of infection: Stomach.

Additional Costa Rican records: *Liophis epinephalis* (Goldberg and Bursey, 2004a).

Type host and locality: *Alsophis canthigerus*, Cuba (Barus and Coy Otero, 1966).

Other reports: *Alsophis canthigerus* (Barus and Coy Otero, 1978); *Ancistrodon piscivorus* (Sprent, 1979; Fontenot and Font, 1996); *Coluber constrictor* (Sprent, 1979); eastern indigo snake, *Drymarchon corais* (Foster et al., 2000); *Heterodon platyrhinus* (Sprent, 1979); *Nerodia cyclopon* (Sprent, 1979);

Fontenot and Font, 1996); *Nerodia fasciata* (Fontenot and Font, 1996); *Nerodia rhombifera* (Fontenot and Font, 1996); *Nerodia taxispilota* (Sprent, 1979); *Nerodia sipedon* (Sprent, 1979).

Geographic range: Costa Rica (Goldberg and Bursey, 2004a); Cuba (Barus and Coy Otero, 1966); Florida and Louisiana, U.S.A. (Sprent, 1979).

Specimen deposited: *Erythrolamprus mimus*, USNPC 103635; (vials).

Remarks

Erythrolamprus mimus represents a new host record for *T. caballeroi*.

SPIRURIDA

Physalopteroidea

Physalopteridae (Railliet, 1893) Leiper, 1908

Physalopterinae Railliet, 1893

***Abbreviata costaricae* n. sp.**

Hosts and locality: *Agkistrodon bilineatus* (1): male, UT 03-P-0399, collected 25 May 2003, Interamerican Highway, Guanacaste Conservation Area; *Masticophis mentovarius* (1): UT 03-P-0361, collected 23 May 2003, Interamerican Highway, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 2 *A. bilineatus* (50%, 15); 1 of 1 *M. mentovarius* (100%, 1).

Site: Stomach.

Additional Costa Rican records: None.

Type host and locality: *Agkistrodon bilineatus*, Costa Rica (this study).

Other reports: None.

Geographic range: Costa Rica (this study).

Specimen deposited: *Masticophis mentovarius*, USNPC 103606; (vial).

Remarks

See Discussion section above.

***Physaloptera retusa* Rudolphi, 1819**

(Syn. *Spiroptera retusa* Dujardin 1845; *Physaloptera mucronata* Leidy, 1956; *Physaloptera largada* Sprehn, 1932.)

Hosts and locality: *Drymobius margaritiferus* (1): UT 02-P-0779, collected 23 October 2002, Area

administrative, Guanacaste Conservation Area; *Oxybelis fulgidus* (1), male, UT 04-P-0431, collected 15 June 2004, Playa Junquillal, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 5 *D. margaritiferus* (20%, 1); 1 of 3 *O. fulgidus* (33%, 1).

Site: Large intestine.

Additional Costa Rican records: *Anolis cupreus* (Goldberg and Bursey, 2004d; Bursey and Brooks, 2010b); *Anolis humilis* (Bursey and Brooks, 2010b); *Anolis lionotus* (Bursey and Brooks, 2010b); common basilisk, *Basiliscus basiliscus* (Bursey and Brooks, 2010b); yellow-headed gecko, *Gonatodes albogularis* (Bursey and Brooks, 2010b); common house gecko, *Hemidactylus frenatus* (Bursey and Brooks, 2010b); rosebelly lizard, *Sceloporus variabilis* (Bursey and Brooks, 2010b).

Type host and locality: Golden tegu, *Tupnambis teguixin*, Brazil (Rudolphi, 1819).

Other reports: Common lesser toad, *Rhinella granulosa* (Goncalves et al., 2002); South American common toad, *Rhinella margaritifera* (Goncalves et al., 2002); giant ameiva, *Ameiva ameiva* (Poinar and Vaucher, 1972; Cristofaro et al., 1976; Ribas et al., 1998a; Bursey et al., 2005; Bursey et al., 2007); Middle American ameiva, *Ameiva festiva* (Goldberg and Bursey, 2009d); rainbow ameiva, *Ameiva undulata* (Caballero, 1951); red worm lizard, *Amphisbaena alba* (Molin, 1860); brown-eared anole, *Anolis fuscoauratus* (Goldberg, Bursey, Vitt, 2006); Amazon green anole, *Anolis punctatus* (Bursey et al., 2005); canyon spotted whiptail, *Aspidoscelis burti* (Goldberg and Bursey, 1989a); imbricate alligator lizard, *Barisia imbricata* (Goldberg, Bursey, Camarillo-Rangel, 1999); zebra-tail lizard, *Callisaurus draconoides* (Telford, 1970); sand dune lizard, *Cnemidophorus abaetensis* (Dias et al., 2005); rainbow whiptail, *Cnemidophorus lemniscatus* (Caballero and Vogelsang, 1947; Diaz-Ungria, 1964; Diaz-Ungria and Gallardo, 1968); green tail lizard, *Cnemidophorus littoralis* (Vrcibradic et al., 2000); Laurent's whiptail, *Cnemidophorus murinus* (Specian and Whittaker, 1980); no common name, *Cnemidophorus nativo* (Menezes et al., 2004); Spix's whiptail, *Cnemidophorus ocellifer* (Ribas et al., 1995); southern alligator lizard, *Elgaria multicarinata* (Telford, 1970); San Lucan alligator lizard, *Elgaria paucicarinata* (Goldberg, Bursey, Beaman, 2004); western skink, *Eumeces skiltonianus* (Telford, 1970); long-nose leopard lizard, *Gambelia wislizenii* (Telford,

1970); Texas alligator lizard, *Gerrhonotus liocephalus* (Goldberg, Bursey, Camarillo-Rangel, 1999); yellow headed gecko, *Gonatodes albogularis* (Bursey et al., 2007); green iguana, *Iguana iguana* (Diaz-Ungria and Gallardo, 1968; Bursey et al., 2007); no common name, *Kentropyx altamazonicus* (Bursey et al., 2005); striped forest whiptail, *Kentropyx calcarata* (Goldberg et al., 2007; Avila and da Silva, 2009); forest whiptail, *Kentropyx pelviceps* (Bursey et al., 2005); Bell's anole, *Leiosaurus belli* (Goldberg, Bursey, Morando, 2004); no common name, *Leiosaurus catamarcensis* (Goldberg, Bursey, Morando, 2004); no common name, *Leposoma rugiceps* (Bursey et al., 2007); *Liolaemus boulengeri* (O'Grady and Dearing, 2006); *Liolaemus darwini* (O'Grady and Dearing, 2006); *Liolaemus koslowskyi* (O'Grady and Dearing, 2006); Lutz's tree iguana, *Liolaemus lutzae* (Rocha, 1995); no common name, *Liolaemus nequensis* (Goldberg et al., 2004); *Liolaemus umbrifer* (O'Grady and Dearing, 2006); no common name, *Mabuya agilis* (Ribas et al., 1998b); two-striped mabuya, *Mabuya bistrata* (Molin, 1860; Bursey et al., 2005); Paraguay mabuya, *Mabuya dorsivittata* (Rocha et al., 2003); *Mesaspis monticola* (Bursey and Goldberg, 2006b); *Microlophus koepckeorum* (Goldberg and Bursey, 2009c); *Microlophus peruvianus* (Goldberg and Bursey, 2009c); *Microlophus stolzmanni* (Goldberg and Bursey, 2009c); *Microlophus tigris* (Goldberg and Bursey, 2009c); tree runner, *Plica plica* (Bursey et al., 2005; Goldberg, Bursey, Vitt, 2009); blue-lipped tree lizard, *Plica umbra* (Bursey et al., 2005; Goldberg, Bursey, Vitt, 2009); *Polychrus gutturosus* (Bursey et al., 2007); common stream lizard, *Potamites ecleopus* (Goldberg et al., 2007); Bocourt's spiny lizard, *Sceloporus acanthinus* (Caballero, 1951); Clark's spiny lizard, *Sceloporus clarkii* (Goldberg et al., 1994b); blue spiny lizard, *Sceloporus cyanogenys* (Goldberg, Bursey, McAllister, 1995); emerald spiny lizard, *Sceloporus formosus* (Goldberg et al., 2003); sagebrush lizard, *Sceloporus graciosus* (Woodbury, 1934; Goldberg and Bursey, 1989b; Goldberg et al., 1997b); graphix spiny lizard, *Sceloporus grammicus* (Goldberg et al., 2003); Yarrow's spiny lizard, *Sceloporus jarrovi* (Goldberg and Bursey, 1990; Bursey and Goldberg, 1991, 1994; Goldberg, Bursey, McAllister, 1995; Goldberg, Bursey, Bezy, 1996); desert spiny lizard, *Sceloporus magister* (Pearce and Tanner, 1973; Walker and Matthias, 1973; Goldberg et al., 1994b; Goldberg, Bursey, McAllister, 1995); canyon lizard, *Sceloporus merriami* (Goldberg, Bursey, McAllister, 1995); southern crevice lizard, *Scelo-*

porus mucronatus (Goldberg et al., 2003); western fence lizard, *Sceloporus occidentalis* (Grundmann, 1959; Telford, 1970; Pearce and Tanner, 1973; Goldberg et al., 1998e); Texas spiny lizard, *Sceloporus olivaceus* (Goldberg Bursey, McAllister, 1995); granite spiny lizard, *Sceloporus orcutti* (Telford, 1970); bluebelly lizard, *Sceloporus parvus* (Goldberg et al., 2003); crevice spiny lizard, *Sceloporus poinsettii* (Goldberg et al., 1993; Goldberg Bursey, McAllister, 1995); rough-scaled lizard, *Sceloporus serrifer* (Goldberg Bursey, McAllister, 1995); crevice swift, *Sceloporus torquatus* (Goldberg et al., 2003); eastern fence lizard, *Sceloporus undulatus* (Morgan, 1943; Pearce and Tanner, 1973; Goldberg et al., 1994b; Goldberg, Bursey, McAllister, 1995); *Sceloporus variabilis* (Goldberg, Bursey, McAllister, 1995; Goldberg et al., 2003); striped plateau lizard, *Sceloporus virgatus* (Goldberg et al., 1994b); rose whorltail iguana, *Stenocercus roseiventris* (Bursey et al., 2005); turniptail gecko, *Thecadactylus rapicauda* (Bursey et al., 2005); black lava lizard, *Tropidurus melanopleurus* (Roca, 1997); spiny lava lizard, *Tropidurus spinulosus* (Vicente, 1981); Amazon lava lizard, *Tropidurus torquatus* (Vicente and Santos, 1967; Cristofaro et al., 1976; Vicente, 1981; Ribas et al., 1998a; Vrcibradic et al., 2000); no common name, *Tupinambis longilineus* (Avila, dos Anjos, Silva et al., 2010); black spotted tegu, *Tupinambis nigropunctatus* (Morgan, 1943); red tegu, *Tupinambis rufescens* (Sprehn, 1932); *Tupinambis teguixin* (Molin, 1860; Ortlepp, 1922; Lent and Freitas, 1948; Schuurmans-Stekhoven, 1950); thornytail iguana, *Uracentron flaviceps* (Goldberg and Bursey, 2007c); side-blotched lizard, *Uta stansburiana* (Telford, 1970).

Geographic range: Argentina (Goldberg, Bursey, Morando, 2004); Brazil (Rudolphi, 1819); Colombia (Goldberg and Bursey, 2009d); Costa Rica (Goldberg and Bursey, 2004a); Mexico (Caballero, 1951); Netherlands Antillels (Specian and Whittaker, 1980); Panama (Bursey, Goldberg, Telford, 2007); Peru (Bursey et al., 2005); Venezuela (Diaz-Ungaria and Gallardo, 1968); U.S.A. (Grundmann, 1959).

Specimen deposited: *Drymobius margaritiferus*, USNPC 103636; *Oxybelis fulgidus*, USNPC 103637; (vials).

Remarks

Seven species of *Physaloptera* have been described from reptiles of the Americas, namely *P. abjecta* Leidy, 1856, *P. liophis* Vincente and Santos 1974, *P. lutzi* Cristofaro, Guimaraes and Rodrigues,

1976, *P. monodens* Molin, 1860, *P. obtusissima* Molin, 1860, *P. retusa*, and *P. squamatae* Harwood, 1932. *Physaloptera monodens* is considered a synonym of *P. obtusissima* by Morgan (1943). The 6 species are separated by the position of the vulva or based on the shape of the spicule and pattern of caudal sessile papillae. The vulva is near the anus in *P. lutzi*; in the other 5 species, it occurs in the first third of the body. *Physaloptera retusa* possesses a bent right spicule; in the remaining 4 species, the spicule is not curved. *Physaloptera abjecta* has 3 pairs of postcloacal sessile papillae; the remaining 3 species have 5 pairs. In *P. liophis*, the first 2 pairs of postcloacal papillae are in tandem; in the remaining 2 species, the first 2 pairs of postcloacal papillae form a single line near posterior cloacal lip. In *P. obtusissima*, the third pair of sessile papillae is between the fourth pair of stalked papillae; in *P. squamatae*, the third pair of sessile papillae is posterior to the fourth pair of stalked papillae. We have assigned our specimens to *P. retusa* because the right spicule is strongly curved. With the exception of occurrences in the toads *Rhinella granulosa* and *R. margaritifera* reported by Goncalves et al. (2002), *Physaloptera retusa* is known only from lizards. Both *Drymobius margaritiferus* and *Oxybelis fulgidus* are known to feed on lizards (Savage, 2002). Because *P. retusa* is a stomach worm and was found in such low numbers (1, 1), and in the intestines of these snakes, it most likely is present due to diet. *Drymobius margaritiferus* and *Oxybelis fulgidus* represent new host records for *P. retusa*.

Diplotrienoidea

Diplotrienoidea (Skrjabin, 1916)

Anderson, 1958

Dicheilonematinae Wehr, 1935

Hastospiculum onchocercum Chitwood, 1932

Hosts and locality: *Boa constrictor* (1): male, UT 02-P-0746, collected 16 August 2002, Area Administrative, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 4 *B. constrictor* (25%, 1).

Site of infection: Surface of stomach.

Additional Costa Rican records: *Dendrophidion pericarinatus* (Goldberg and Bursey, 2004a); *Dendrophidion vinitor* (Goldberg and Bursey, 2004a).

Type host and locality: *Boa constrictor*, zoo (Chitwood, 1932).

Other reports: *Boa constrictor* (Caballero, 1947; Chitwood, 1932); *Crotalus durissus* (Desportes, 1941; Caballero, 1947; Araujo, 1970; Vicente et al., 1993); *Epicrates cenchria* (Everard, 1975); *Philodryas aestivus* (Vicente et al., 1993); *Spilotes pullatus* (Vicente and Jardim, 1980).

Geographic range: Brazil (Desportes, 1941); Costa Rica (Goldberg and Bursley, 2004a); Mexico (Caballero, 1947); Trinidad (Everard, 1975).

Specimen deposited: *Boa constrictor*, USNPC 103638; (vial).

Remarks

This is the third report of *H. onchocercum* in *Boa constrictor*.

Filarioidea
Onchocercidae (Leiper, 1911)
Onchocercinae Leiper, 1911
***Macdonaldius oschei* Chabaud and Frank, 1961**

Hosts and locality: *Boa constrictor* (1): UT 02-P-0685, collected 16 August 2002, Interamerican Highway between Santa Rosa and Poco, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 4 *B. constrictor* (25%, 18).

Site of infection: Mesentery.

Additional Costa Rican records: None.

Type host and locality: *Python molurus*, Stuttgart Zoological Garden, Germany (Chabaud and Frank, 1961a).

Other reports: *Boa constrictor* (Frank, 1964a, b, c; Telford, 1965).

Geographic range: Costa Rica (this study); Mexico (Telford, 1965).

Specimen deposited: *Boa constrictor*, USNPC 103639; (vial).

Remarks

Macdonaldius oschei was described by Chabaud and Frank (1961a) from specimens taken from the major arteries of *Python molurus bivittatus* from India and *Python reticulatus* from Indonesia that had died in the Zoological Garden in Stuttgart, Germany. It was subsequently found in *Boa constrictor* in the same zoo and microfilariae were

described (Chabaud and Frank, 1961b). Frank (1962, 1964a, b) reported that microfilariae invaded and developed in the Malpighian tubules of the New World argasid tick *Ornithodoros talaju*, which had been introduced to the zoo. Frank (1964c) concluded that *M. oschei* was normally a parasite of New World reptiles, and its appearance in other hosts in the Stuttgart Zoological Garden was the result of the introduction of suitable vectors along with infected reptiles. To our knowledge, Telford (1965) is the only previous report of wild-caught snakes harboring *M. oschei*. Costa Rica is a new locality record.

STRONGYLIDA

Diaphanocephaloidea

Diaphanocephalidae Travassos 1920
***Kalicephalus costatus* (Rudolphi, 1819)**
Yorke and Mapleston, 1926
***K. costatus costatus* (Rudolphi, 1819)**

(Syn. *Strongylus costatus* Rudolphi, 1819; *Kalicephalus strumosus* Molin, 1861; *Kalicephalus mucronatus* Molin, 1861; *Scelerostomum kalicephalium* Stossich, 1899; *Kalicephalus philodryadus* Ortlepp, 1923.)

Hosts and locality: *Imantodes cenchoa* (1): female, UT 03-P-0263, collected 24 March 2003, Rio Negro, Guanacaste Conservation Area; *Leptophis depressirostris* (2): male, UT 01-P-0322, collected 22 June 2001 Rio Negro, Guanacaste Conservation Area; female, UT 03-P-0193, collected 24 February 2003, Rio Cucaracho, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 1 *I. cenchoa* (100%, 1); 2 of 4 *L. depressirostris* (50%, 1, 6, respectively).

Site of infection: Large intestine.

Additional Costa Rican records: *Boa constrictor* (Schad, 1962).

Type host and locality: *Coluber* sp., Brazil (Rudolphi, 1819). No species of *Coluber* is currently listed for Brazil.

Other reports: *Antillophis andreae* (Barus and Coy Otero, 1978); *Bothrops alternatus* (Fernandes and Artigas, 1978); *Bothrops atrox* (Schad, 1962; Diaz-Ungria, 1964); *Bothrops cotiara* (Fernandes and Artigas, 1978); *Bothrops jararaca* (Schad, 1962; Fernandes and Artigas, 1978); *Bothrops jararacussu* (Fernandes and Artigas, 1978); *Bothrops pradoi* (Fernandes and Artigas, 1978); *Chironius carinatus*

Table 1. Costa Rican snake nematodes by reference: 1. this paper; 2. Viquez, 1935; 3. Brenes and Bravo-Hollis, 1960; 4. Schad, 1962; 5. Goldberg and Bursey, 2004a; 6. Goldberg and Bursey, 2006a.

	Nematode							
	<i>Abbreviata costaricae</i>	<i>Aplectana incerta</i>	<i>Aplectana itzacanensis</i>	<i>Cosmocercooides variabilis</i>	<i>Cruzia rudolphi</i>	<i>Hastospiculum onchocercum</i>	<i>Hexametra boddaertii</i>	<i>Kalicephalus costatus</i>
Boidae:								
<i>Boa constrictor</i>	—	—	—	—	—	1	—	4
Colubridae:								
<i>Chironius grandisquamis</i>	—	1	—	—	—	—	—	—
<i>Conophis lineatus</i>	—	1	—	—	—	—	—	—
<i>Dendrophidion percarinatus</i>	—	—	—	1	—	5	—	—
<i>Dendrophidion vinitor</i>	—	—	—	—	—	5	—	—
<i>Drymobius margaritiferus</i>	—	—	1	—	—	—	—	—
<i>Erythrolamprus mimus</i>	—	—	—	—	—	—	—	—
<i>Imantodes cenchoa</i>	—	—	—	—	—	—	—	1
<i>Imantodes inornatus</i>	—	—	—	—	—	—	—	—
<i>Leptodeira annulata</i>	—	—	—	—	—	—	—	—
<i>Leptodrymus pulcherrimus</i>	—	—	—	—	—	—	—	—
<i>Leptophis depressirostris</i>	—	—	—	—	—	—	—	1
<i>Liophis epinephelus</i>	—	—	1	—	—	—	—	—
<i>Masticophis mentovarius</i>	1	—	—	—	—	—	—	—
<i>Nina maculata</i>	—	—	—	6	—	—	—	—
<i>Oxybelis aeneus</i>	—	—	—	—	—	—	—	—
<i>Oxybelis brevirostris</i>	—	—	—	—	—	—	—	—
<i>Oxybelis fulgidus</i>	—	—	—	—	—	—	—	—
<i>Phiocercus euryzonus</i>	—	—	—	—	—	—	—	—
<i>Sibon nebulatus</i>	—	—	—	—	1	—	—	—
<i>Spilotes pullatus</i>	—	—	—	—	—	—	1	—
<i>Trimorphodon biscutatus</i>	—	—	—	—	—	—	1	—
<i>Urotheca guentheri</i>	—	—	—	—	—	—	—	—
<i>Xenodon rabdocephalus</i>	—	—	—	—	—	—	—	—
Elapidae:								
<i>Micrurus nigrocinctus</i>	—	—	—	—	—	—	5	—
Viperidae:								
<i>Agkistrodon bilineatus</i>	1	—	—	—	—	—	1	—
<i>Atropoides nummifer</i>	—	—	—	—	—	—	—	—
<i>Bothrops atrox</i>	—	—	—	—	—	—	—	—
<i>Bothrops asper</i>	—	—	—	—	—	—	—	—
<i>Crotalus durissus</i>	—	—	—	1	—	—	1	—
<i>Porthidium nasutum</i>	—	1	—	—	—	—	—	—
<i>Porthidium ophryomegas</i>	—	1	—	—	—	—	1	—

(Schad, 1962); *Chironius sexcarinatus* (Schad, 1962); *Crotalus durissus* (Schad, 1962; Fernandes and Artigas, 1978); *Cromicus angulifer* (Schad, 1962); *Erythrolamprus venustimimus* (Schad, 1962); *Eudryas bifossatus* (Schad, 1962); *Lachesis muta* (Schad, 1962); *Liophis miliaris* (Schad, 1962; Fernandes and Artigas, 1978); *Lystrophis semicinctus* (Schad, 1962); *Mastigodryas bifossatus* (Fabio and Rolas, 1974); *Philodryas patagoniensis* (Fernandes and Artigas, 1978); *Philodryas schotti* (Schad, 1962); *Philodryas serra* (Schad, 1962); *Phrynosoma sulphuraceus*

(Schad, 1962); *Thalerophis ahaetulla* (Schad, 1962); *Thalerophis occidentalis* (Schad, 1962); *Thalerophis richardi occidentalis* (Schad, 1964); *Waglerophis merremii* (Fernandes and Artigas, 1978); *Xenodon guentheri* (Fernandes and Artigas, 1978); *Xenodon newwedii* (Fernandes and Artigas, 1978).

Geographic range: Brazil (Schad, 1962); British Guiana (Schad, 1962); Costa Rica (Schad, 1962); Cuba (Barus and Coy Otero, 1978); Ecuador (Schad, 1964).

Table 1. Extended.

Nematode									
<i>Kalicephalus inermis</i>	<i>Kalicephalus subblatus</i>	<i>Macdonaldius oscheri</i>	<i>Ophidascaris arndti</i>	<i>Ophidascaris sicki</i>	<i>Physaloptera obtusissima</i>	<i>Physaloptera retusa</i>	<i>Skrjabinelazia intermedia</i>	<i>Terranova caballeroi</i>	<i>Travassoscaris araujoii</i>
—	1, 4	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	5	—
—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	1	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—
3	—	—	—	—	2	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—

Specimen deposited: *Imantodes cenchoa* USNPC 103640; *Leptophis depressirostris*, USNPC 103641, 103642; (vials).

cenchoa and *Leptophis depressirostris* represent new host records for *K. costatus*.

Remarks

Schad (1962) divided *K. costatus* into 4 subspecies based upon locality: *K. costatus costatus*, South and Central America; *K. costatus parvus*, North America; *K. costatus micrurus*, Tropical and South Africa; *K. costatus indicus*, Orient and Australasia. We have only listed hosts for *K. costatus costatus*. *Imantodes*

***Kalicephalus inermis* Molin, 1861
K. inermis macrovulvus Caballero, 1954**

(Syn. *Kalicephallus macrovulvus* Caballero, 1954).

Hosts and locality: Atropoides nummifer (1): female, UT 04-P-0590, collected 21 November 2004, Estación, Guanacaste Conservation Area; *Leptophis depressirostris* (1): UT 05-P-0304 col-

lected 26 September 2005, Brasilia, Guanacaste Conservation Area; *Porthidium nasutum* (1): male, UT 03-P-0400, collected 25 May 2003, San Gerardo, Guanacaste Conservation Area; *Urotheca guentheri* (1): female, UT 03-P-0290, collected 9 April 2003, Volcan Santa Maria, Guanacaste Conservation Area.

Prevalence and intensity: 1 of 1 *A. nummifer* (100%, 5); 1 of 4 *L. depressirostris* (25%, 1); 1 of 1 *P. nasutum* (100%, 1); 1 of 1 *U. guentheri* (100%, 3).

Site of infection: Large intestine.

Additional Costa Rican records: *Bothrops atrox* (Brenes and Bravo-Hollis, 1960).

Type host and locality: *Agkistrodon bilineatus*, Guatemala (Caballero, 1954).

Other reports: *Chironius multiventris* (McAllister et al., 2010); *Lachesis muta* (Schad, 1962); *Thalerophis occidentalis* (Schad, 1962).

Geographic range: Costa Rica (Brenes and Bravo-Hollis, 1960); Ecuador (McAllister et al., 2010); Guatemala (Caballero, 1954); Trinidad (Schad, 1962).

Specimen deposited: *Atropoides nummifer*, USNPC 103643; *Leptophis depressirostris* USNPC 103644; *Porthidium nasutum*, USNPC 103645; *Urotheca guentheri*, USNPC 103646; (vials).

Remarks

Schad (1962) erected an "inermis group" by reducing *Kalicephalus inermis* Molin, 1861, *Kalicephalus macrovulvus* Caballero, 1954, and *Kalicephalus coronellae* Ortlepp, 1923 to subspecies (geographic race) status: *K. inermis inermis* in Brazil; *K. inermis macrovulvus* in northern South America and Central America; and *K. inermis coronellae* in Mexico and North America. Fernandes and Artigas (1978) considered these subspecies to be valid species, but Baker (1987) retained the subspecies designation. *Atropoides nummifer*, *Leptophis depressirostris*, *Porthidium nasutum*, and *Urotheca guentheri* represent new host records for *Kalicephalus inermis*.

***Kalicephalus subulatus* Molin, 1861**

(Syn. *Ankylostoma boae* Blanchard, 1886; *Strongylus boae* MacCallum, 1921; *Kalicephalus chitwoodi* Caballero, 1954).

Hosts and locality: *Boa constrictor* (2): UT 02-P-0685 collected 16 August 2002, Interamerican Highway, Guanacaste Conservation Area; female,

UT 05-P-0011, collected 25 May 2005, Camino a Naranjo, Guanacaste Conservation Area.

Prevalence and intensity: 2 of 4 *B. constrictor* (50%, 19, 2, respectively).

Site of infection: Large intestine.

Additional Costa Rican records: *Boa constrictor* (Schad, 1962; Rodriguez-Ortiz et al., 2003).

Type host and locality: *Boa constrictor*, Brazil (Molin, 1861).

Other reports: *Boa constrictor* (Caballero and Vogelsand, 1950; Caballero, 1954; Ubelaker and Dailey, 1966; Everard, 1975; Fernandes and Artigas, 1975); *Corallus caninus* (Fernandes and Artigas, 1975); *Epicrates cenchria* (Fernandes and Artigas, 1975); *Lachesis muta* (Goncalves et al., 2002).

Geographic range: Brazil (Molin, 1861); Costa Rica (Schad, 1962) Guatemala (Caballero, 1954); Trinidad (Everard, 1975); Venezuela (Caballero and Vogelsand, 1950).

Specimen deposited: *Boa constrictor*, USNPC 103647, 103648; (vials).

Remarks

In his monograph, Schad (1962) restricted the name *Kalicephalus subulatus* to species occurring in the *Boa constrictor*. More recently, Fernandes and Artigas (1975) and Goncalves et al. (2002) have determined additional hosts. This is the third report of *K. subulatus* from Costa Rica.

DISCUSSION

Of the 133 snake species found in Costa Rica (Savage, 2002), 40 (30%) have so far been found to harbor nematodes. One additional record of nematodes in Costa Rican snakes should be noted: Goldberg and Bursey (2004a) reported larvae of *Contracaecum*, a bird parasite, in *Erytrolampus bizona* and *Micurus alleni*. Table 1 lists the currently known species of nematodes from Costa Rican snakes; we have not included undetermined species or larval forms in the table. The current information is too sparse to draw general conclusions, but it would appear that 3 categories of nematodes are present: those that parasitize snakes *sensu stricto*, namely *Abbreviata costaricae*, *Cruzia rudolphi*, *Hastospiculum onchocercum*, *Hexametra boddaertii*, *Kalicephalus costatus*, *K. inermis*, *K. subulatus*, *Macdonaldius*

oscheri, *Ophidascaris arndti*, *O. sicki*, *Physaloptera obtusissima*, *Terranova caballeroi*, *Travassosascaris araujoi*; those present as a by-product of diet and not parasites sensu stricto (we are hesitant to use the terms "accidental" or "incidental" because we were unable to determine if these nematodes were alive within the intestine of the host), *Aplectana incerta*, *Aplectana itzocanensis*, *Cosmocercoides variabilis* *Physaloptera retusa*, *Skrjabinelazia intermedia*; and those using snakes as paratenic hosts, *Contraecaeum*, *Porroecaeum*. Further examination of Costa Rican snakes will be necessary before categorization of the helminth community can be made.

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