

Helminths from 9 Species of Geckos (Squamata: Gekkonidae) from Sri Lanka

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ABSTRACT: Nine species of geckos from Sri Lanka were examined for helminths: *Calodactylodes illingworthorum*, *Cnemaspis kandiana*, *Cnemaspis scalpensis*, *Cnemaspis tropidogaster*, *Gehyra mutilata*, *Hemidactylus parvimaaculatus*, *Hemidactylus depressus*, *Hemidactylus frenatus*, and *Hemidactylus leschenaultii*. Species found include 1 species of Digenea, *Mesocoelium monas*; 2 species of Cestoda, *Cylindrotaenia philauti* and *Oochoristica paurenensis*; 8 species of Nematoda, *Parapharyngodon maplestoni*, *Pharyngodon gekko*, *Pharyngodon oceanicus*, *Physaloperoides dactyluris*, *Skrjabinelazia hemidactyli*, *Spauligodon hemidactylus*, *Thamugadia hemidactyla*, and Acuariidae gen sp. (larva in cysts); and 1 species of Acanthocephala, *Acanthocephalus serendibensis*. Mean number of helminth species per infected gecko was 1.3 ± 0.5 (range 1–3). Nineteen new hosts and 7 new locality records are reported.

KEY WORDS: helminths, Digenea, Cestoda, Nematoda, Acanthocephala, geckos, Sri Lanka.

There have been few reports of helminths in Sri Lankan geckos: von Linstow (1906) described a nematode, *Oxyuris megaloon* (currently *Parapharyngodon* species inquirenda), from *Hemidactylus leschenaultii*; Crusz and Ching (1975) reported the acanthocephalan *Acanthocephalus serendibensis* in *Cnemaspis kandiana*; Breckenridge and Nathanael (1983) studied the morphology of acanthocephalans obtained from *Cnemaspis kandiana*; Crusz (1984) found a digenean, *Paradistomum* sp., in *Hemidactylus parvimaaculatus*; and de Silva et al. (2004) reported unidentified strongyloid nematodes in *Calodactylodes illingworthorum* and *Hemidactylus maculatus*.

Herein, we report helminths in 9 species of geckos from Sri Lanka. Six of these species are Sri Lankan endemics: Sri Lankan golden gecko, *Calodactylodes illingworthorum* Deraniyagala, 1953, a large lizard found in rocky outcrops of the dry zone of Sri Lanka; Kandyan gecko, *Hemidactylus depressus* Gray, 1842, a rupicolous gecko that occurs on the plains; spotted house gecko, *Hemidactylus parvimaaculatus* Deraniyagala, 1953, a widely distributed species common in disturbed habitats; and three morphospecies of the genus *Cnemaspis*, which we refer to as the Kandy day gecko, *Cnemaspis kandiana* (Kelaart, 1852), Ferguson's day gecko, *Cnemaspis scalpensis* (Ferguson,

1877), and the rough-bellied gecko *Cnemaspis tropidogaster* (Boulenger, 1885). Manamendra-Arachchi et al. (2007) recently described many new species, restricted the application of the names *C. kandiana* and *C. scalpensis* to specimens from limited geographic areas within the island, and considered the provenance of *C. tropidogaster* sensu stricto to be uncertain. Both the geographic distribution and range of morphological variability of most of the newly described taxa remain incompletely known, and it is probable that our samples of *Cnemaspis* are composite under their interpretation. Only our Central Province *C. kandiana* specimens are unambiguously assignable to the named species as narrowly construed. The remaining specimens cannot confidently be assigned to species within the framework of Manamendra-Arachchi et al. (2007), but they are consistent with the names as used in the literature prior to 2007 (e.g., Das and de Silva, 2005). The other species have wider distribution patterns: stump-tailed gecko, *Gehyra mutilata* Wiegmann, 1834, ranging from India east to Myanmar, Indo-China, the Malay Peninsula, and Indonesia to Oceania; common house gecko, *Hemidactylus frenatus* (Duméril and Bibron, 1836), which is widespread in Sri Lanka and southern and Southeast Asia, and has been introduced into almost every part of the tropics and subtropics; and Leschenault's leaf-toed gecko, *Hemidactylus leschenaultii* Duméril and Bibron, 1836, which occurs in the dry zones of Sri Lanka

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Table 1. Number (N), prevalence (%), and mean intensity of infection (mean [M] ± standard deviation [SD]) for helminths in 9 species of Sri Lankan gekkonid lizards.

	<i>Calodactyloides illingworthorum</i>			<i>Cnemaspis kandiana</i>			<i>Cnemaspis scalpensis</i>			<i>Cnemaspis tropidogaster</i>		
	N	%	M ± SD	N	%	M ± SD	N	%	M ± SD	N	%	M ± SD
Digenea												
<i>Mesocoelium monas</i>	–			3	8	3	–			–		
Cestoda												
<i>Cylindrotaenia philauti</i>	–			–			–			2	9	1 ± 0
<i>Oochoristica paurensis</i>	–			–			–			–		
Nematoda												
<i>Parapharyngodon maplestoni</i>	–			–			–			–		
<i>Pharyngodon gekko</i>	4	33	4	–			–			1	5	1
<i>Pharyngodon oceanicus</i>	–			–			–			–		
<i>Physalopteroides dactyluris</i>	3	33	3	–			3	25	3	2	5	2
<i>Skrjabinelazia hemidactyli</i>	1	33	1	9	46	1.5 ± 1.2	–			3	14	1 ± 0
<i>Spauligodon hemidactylus</i>	–			–			–			–		
<i>Thamugadia hemidactyla</i>	–			–			–			1	5	1
Acuariidae gen sp. (larva in cysts)	–			–			–			10	9	5 ± 4
Acanthocephala												
<i>Acanthocephalus serendibensis</i>	–			–			–			1	5	1

but is widespread in southern Asia from eastern Pakistan to peninsular India (Das and de Silva, 2005).

MATERIALS AND METHODS

Seventy-six individuals representing the following 9 species of geckos from Sri Lanka collected in 2002 were examined for helminths: *Calodactyloides illingworthorum* ($n = 3$, mean snout-vent length (SVL) = 76.3 mm ± 18.5 SD, range = 55–88 mm); *Cnemaspis kandiana* ($n = 13$, mean SVL = 29.7 mm ± 2.6 SD, range = 24–33 mm); *Cnemaspis scalpensis* ($n = 4$, mean SVL = 33.8 mm ± 1.7 SD, range = 32–36 mm); *Cnemaspis tropidogaster* ($n = 22$, mean SVL = 30.9 mm ± 3.7 SD, range = 23–38 mm); *Gehyra mutilata* ($n = 4$, mean SVL = 48.0 mm ± 7.5 SD, range = 38–56 mm); *Hemidactylus parvimaclatus* ($n = 12$, mean SVL = 43.5 mm ± 7.3 SD, range = 33–54 mm); *Hemidactylus depressus* ($n = 7$, mean SVL = 68.0 mm ± 4.8 SD, range = 59–73 mm); *Hemidactylus frenatus* ($n = 8$, mean SVL = 49.2 mm ± 3.9 SD, range = 45–54 mm); and *Hemidactylus leschenaultii* ($n = 3$, mean SVL = 81.0 ± 1.4 SD, range = 80–82 mm).

Geckos were collected by hand, euthanized within 12 hr of capture, preserved in 10% formalin, and stored in 70% ethanol. The body cavity was opened by a longitudinal incision, and the digestive tract was removed and opened. The esophagus, stomach, small intestine, and large intestine were examined for helminths under a dissecting microscope. Nematodes and acanthocephalans were placed on a glass slide in a drop of glycerol, a coverslip was added, and identification was made from these temporary wetmounts. Digeneans and cestodes were regressively stained in hematoxylin, mounted in balsam, and examined. Locality data are given in Appendix 1. Geckos were deposited in the herpetology collection of the National Museum of Sri Lanka, Colombo, Sri Lanka. Helminths were deposited in the United States National Parasite Museum, Beltsville, Maryland (Appendix 2).

RESULTS

We found 1 species of Digenea (*Mesocoelium monas* [Rudolphi, 1819] Freitas, 1957), 2 species of Cestoda (*Cylindrotaenia philauti* Cruz and Sanmugasunderam, 1971 and *Oochoristica paurensis* Malhotra and Capoor, 1984), 8 species of Nematoda (*Parapharyngodon maplestoni* Chatterji, 1933; *Pharyngodon gekko* [Chakravarty and Bhaduri, 1948] Petter and Quentin, 1976; *Pharyngodon oceanicus* Bursey & Goldberg, 1999; *Physalopteroides dactyluris* [Karve, 1938] Chabaud and Brygoo, 1960; *Skrjabinelazia hemidactyli* Shamim and Deshmukh, 1982; *Spauligodon hemidactylus* Bursey and Goldberg, 1996; *Thamugadia hemidactyla* Deshmukh and Ali, 1966; Acuariidae gen sp. [larva in cysts]), and 1 species of Acanthocephala (*Acanthocephalus serendibensis* Cruz and Mills, 1970). Number of helminths, prevalence (%), and mean intensity ± SD are presented in Table 1. Parasite terminology is in accordance with Bush et al. (1997).

In total, 192 helminths were found: 47 (24.5%) digeneans; 3 (1.5%) cestodes; 141 (73.5%) nematodes, and 1 (0.5%) acanthocephalan. Mean number of helminths per infected host was 6.2 ± 13.7. Of the helminths found, 10 (5%) were larval forms not capable of completing their life cycle in geckos. Twelve species of helminths were found; however, no individual host harbored more than 3 species. Thirty one (40%) of 77 geckos were infected. Of these, 26 (84%) each harbored 1 helminth species; 38 (13%)

Table 1. Extended.

<i>Gehyra mutilata</i>			<i>Hemidactylus parvimaculatus</i>			<i>Hemidactylus depressus</i>			<i>Hemidactylus frenatus</i>			<i>Hemidactylus leschenaultii</i>		
N	%	M ± SD	N	%	M ± SD	N	%	M ± SD	N	%	M ± SD	N	%	M ± SD
—			—			—			44	13	44	—		
—			—			—			—			—		
—			1	8	1	—			—			—		
—			1	8	1	—			—			11	100	3.0 ± 2.7
—			—			—			—			—		
—			—			2	14	2	—			—		
—			3	17	1.5 ± 0.7	—			—			7	66	3.5 ± 3.5
2	25	2	—			—			—			—		
—			—			76	28	38 ± 41	4	13	4	—		
—			—			—			—			—		
—			—			—			—			—		
—			—			—			—			—		

harbored 2 helminth species each; and 1 (3%) harbored 3 species (mean number of helminth species per infected gecko was 1.3 ± 0.5 ; range 1–3). Mean number of helminth species per host species was 2.6 ± 1.8 (range 1–7).

DISCUSSION

Mesocoelium monas is cosmopolitan in distribution and requires a mollusk intermediate host (Kennedy et al., 1987). It is known from fishes, amphibians, and reptiles; records are summarized in Burse et al. (2007). *Mesocoelium monas* has previously been found in *H. frenatus* from Indonesia (Killick and Beverley-Burton, 1982; Kennedy et al., 1987). *Cnemaspis kandiana* represents a new host record for *M. monas*. Other hosts from Sri Lanka include *Polypedates eques*, *Polypedates maculatus*, *Ichthyophis glutinosus*, *Ichthyophis pseudangularis*, and *Nessia burtonii* (Fernando, 1933; Crusz and Santiapillai, 1982; Crusz and Daundasekera, 1988).

Cylindrotaenia philauti was originally described from the rhacophorid frog *Philautus* (currently *Pseudophilautus variabilis*, collected in Sri Lanka (Crusz and Sanmugasunderam, 1971). It apparently has not been reported since its discovery. Our specimens were not well preserved, but they do fit the original description. *Cnemaspis tropidogaster* represents a new host record for *C. philauti*.

Oochoristica pauriensis was described from *Hemidactylus brooki* and *Hemidactylus flaviviridis*, both from India (Malhotra and Capoor, 1984). To our knowledge, it has not been reported since its discovery. Sri Lanka is a new locality record for *O. pauriensis*, and *H. parvimaculatus* (recently resurrected from the synonymy of *H. brooki*; Bauer et al., 2010) is a new host record.

Parapharyngodon maplestoni was originally described from the intestine of an agamid lizard, *Calotes versicolor*, collected in Burma by Chatterji (1933). Additional hosts include the agamid *Bronchocela cristatella*; the anguid *Pseudopus apodus*; the gekkonids *Cyrtodactylus louisianensis*, *Hemidactylus flaviviridis*, and *H. frenatus*; and the scincids *Emoia longicauda*, *Emoia nigra*, *Emoia obscura*, *Emoia pallidiceps*, *Lipinia noctua*, *Prasinohaema virens*, *Sphenomorphus emigrans*, and *Sphenomorphus jobiensis* (Burse et al., 2005a, b; Goldberg et al., 2008, 2010). Of these, Baylis (1936) lists *C. versicolor* and *H. flaviviridis* as hosts from Sri Lanka for *P. maplestoni*; however, Crusz and Daundasekera (1988) considered Sri Lanka a doubtful locale for *P. maplestoni*. *Hemidactylus parvimaculatus* and *Hemidactylus leschenaultii* represent new host records for *P. maplestoni*. Baylis's (1936) record of *H. flaviviridis* probably actually pertains to the somewhat similar *H. leschenaultii*, because *H. flaviviridis* does not occur in Sri Lanka (Somaweera and Somaweera, 2009).

Table 2. Reported helminths from 11 species of geckos from Sri Lanka.

Helminth	Gecko										
	<i>Calodactylodes illingworthorum</i>	<i>Cnemaspis kandiana</i>	<i>Cnemaspis scalpenis</i>	<i>Cnemaspis tropidogaster</i>	<i>Gehyra mutilata</i>	<i>Hemidactylus parvimaculatus</i>	<i>Hemidactylus depressus</i>	<i>Hemidactylus frenatus</i>	<i>Hemidactylus flaviviridis</i>	<i>Hemidactylus leschenaultii</i>	<i>Hemidactylus maculatus</i>
<i>Mesocotyle monas</i>	-	1*	-	-	-	-	-	1	-	-	-
<i>Paradissomum</i> sp.	-	-	-	-	-	2	-	-	-	-	-
<i>Cylindrotaenia philauti</i>	-	-	-	1	-	-	-	-	-	-	-
<i>Oochoristica paurensis</i>	-	-	-	-	-	1	-	-	-	-	-
<i>Parapharyngodon maplestoni</i>	-	-	-	-	-	1	-	-	3	1	-
<i>Parapharyngodon megaloon</i>	-	-	-	-	-	-	-	-	-	4	-
<i>Pharyngodon gekko</i>	1	-	-	1	-	-	-	-	-	-	-
<i>Pharyngodon oceanicus</i>	-	-	-	-	-	-	1	-	-	-	-
<i>Physaloperoides dactyluris</i>	1	-	1	1	-	1	-	-	-	1	-
<i>Skrijabinelazia hemidactyli</i>	1	-	-	1	1	-	-	-	-	-	-
<i>Spatuligodon hemidactylus</i>	-	-	-	-	-	-	1	1	-	-	-
<i>Thamugadia hemidactyla</i>	-	-	-	1	-	-	-	-	-	-	-
Acuariidae gen. sp.	-	-	-	1	-	-	-	-	-	-	-
Strongyloidea gen. sp.	5	-	-	-	-	-	-	-	-	-	5
<i>Acanthocephalus serendibensis</i>	-	6	-	1	-	-	-	-	-	-	-

* 1. This study; 2. Cruz (1984); 3. Baylis (1936); 4. von Linstow (1906); 5. de Silva et al. (2004); 6. Cruz and Ching (1975).

Pharyngodon gekko, originally *Neopharyngodon gekko*, was described from specimens taken from the large intestine of *Gekko gekko* collected in Calcutta, India, by Chakravarty and Bhaduri (1948) and reassigned by Petter and Quentin (1976). It apparently has not been reported since its discovery. *Calodactylodes illingworthorum* and *Cnemaspis* aff. *tropidogaster* represent new host records for *P. gekko*; Sri Lanka is a new locality record. *Pharyngodon oceanicus* was described from the gecko *Gehyra oceanica* from the Cook and Society Islands by Bursey and Goldberg (1999). There is an additional report of *P. oceanicus* in *G. oceanica* collected in Moorea (Goldberg et al., 2000). *Hemidactylus depressus* represents a new host record for *Pharyngodon oceanicus*; Sri Lanka is a new locality record.

Physalopteroides dactylurus, originally *Thubunaea dactyluris*, was described from specimens taken from *Hemidactylus flaviviridis* and *Calotes versicolor* by Karve (1938) and reassigned to *Physalopteroides* by Chabaud and Brygoo (1960). Additional hosts include *H. frenatus* and a viperid snake, *Echis carinatus*, from India and a skink, *Eumeces* (currently *Eurylepis*) *taeniolatus*, from Turkmenistan (Baker, 1987). *Calodactylodes illingworthorum*, *Cnemaspis* aff. *scalpensis*, *C.* aff. *tropidogaster*, *H. parvimaculatus*, and *H. leschenaultii* represent new host records for *P. dactylurus*; Sri Lanka is a new locality record.

Skrjabinelazia hemidactyli was described from specimens taken from *Hemidactylus brookii* collected in Marathwada, Maharashtra, India, by Shamim and Deshmukh (1982). It, to our knowledge, has not been reported since its discovery. *Calodactylodes illingworthorum*, *C. tropidogaster*, and *H. leschenaultii* represent new host records for *S. hemidactyli*; Sri Lanka is a new locality record.

Spauligodon hemidactylus was described from *H. frenatus* from 11 islands in Oceania by Bursey and Goldberg (1996). It has been reported in the gekkonids *Cosymbotus* (currently *Hemidactylus*) *platyurus*, *Gehyra mutilata*, *Hemidactylus garnotii*, *Hemiphyllodactylus typus*, and *Lepidodactylus lugubris* (Goldberg and Bursey, 2001, 2002). *Hemidactylus depressus* represents a new host record for *S. hemidactylus*; Sri Lanka is a new locality record.

Thamagudia hemidactylia was described from specimens taken from subcutaneous tissues of *Hemidactylus giganteus* collected in India by Deshmukh and Ali (1966). It apparently has not been reported since its description. *Cnemaspis tropidogaster* represents a new host record for *T. hemidactylia*; Sri Lanka is a new locality record.

Acuariid nematodes inhabit the gizzard of terrestrial birds; insects are intermediate hosts (Anderson, 2000). Lizards presumably are paratenic (transport) hosts, and development does not go beyond the larval stage. This is the first report of acuariid larvae in Sri Lankan geckos.

Acanthocephalus serendibensis was originally described from specimens taken from the agamid *Ceratophora stoddarti*, collected in Sri Lanka by Cruz and Mills (1970), and was redescribed from specimens taken from the same host, as well as the gekkonid *Cnemaspis* aff. *kandiana*, both host species collected in Sri Lanka (Cruz and Ching, 1975). *Cnemaspis* aff. *tropidogaster* represents a new host record for *A. serendibensis*.

Bush et al. (1997) presented a hierarchy of parasite community terms, including infracommunity (helminths in a single host), component community (helminths of a host species are presented in Table 1), and supracommunity (helminths in sympatric hosts). For this discussion, we will consider the supracommunity to be Sri Lankan geckos. Helminths have been classified as core and secondary species according to their prevalence (P): Species with prevalences >30% are deemed core species (Roca, 1993); species with 10–30% prevalence are considered secondary species (Hanski, 1982; Roca, 1993). Within the supracommunity, no helminth species was found to represent a core species; *Skrjabinelazia hemidactyli* represents a secondary species (P = 14). However, for the various component communities, the following species represent core species: *Pharyngodon gekko*, *Physalopteroides dactylurus*, and *Skrjabinelazia hemidactyli* in *C. illingworthorum*; *Skrjabinelazia hemidactyli* in *C. kandiana*; and *P. maplestoni* in *H. leschenaultii* (see Table 1 for P). The following species represent secondary species within component communities: *Physalopteroides dactylurus* in *C. scalpensis*; *Skrjabinelazia hemidactyli* in *G. mutilata*; *Spauligodon hemidactylus* in *H. depressus*; and *Physalopteroides dactylurus* in *H. leschenaultii* (see Table 1 for P).

At this point in time, one generalization can be made: Sri Lankan geckos are infected by generalist helminth species, that is, species capable of infecting two or more host species (Table 2). One question that remains to be answered is: Why do differential rates of infection occur within these hosts? Is it related to the small sample of hosts examined or are there ecological or physiological factors at work? A second question is: Will the remaining species of geckos, when examined, harbor the same species of helminths so far reported?

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LITERATURE CITED

- Anderson, R. C.** 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxon, U.K. 650 pp.
- Baker, M. R.** 1987. Synopsis of the Nematoda parasitic in amphibians and reptiles. Memorial University of Newfoundland Occasional Papers in Biology 11:1–325.
- Bauer, A. M., T. R. Jackman, E. Greenbaum, A. de Silva, V. B. Giri, and I. Das.** 2010. Molecular evidence for the taxonomic status of *Hemidactylus brookii* group taxa (Squamata: Gekkonidae). The Herpetological Journal 20:129–138.
- Baylis, H. A.** 1936. The Fauna of British India, including Ceylon and Burma. Nematoda. Vol. I. Taylor and Francis, London, U.K. 408 pp.
- Breckenridge, W. R., and S. Nathanael.** 1983. Cement glands in *Acanthocephalus serendibensis* Crusz and Mills, 1970 (Acanthocephala: Palaeacanthocephala: Echinorhynchidae). Journal of Helminthology 57: 255–258.
- Bursey, C. R., and S. R. Goldberg.** 1996. *Spauligodon hemidactylus* n. sp. (Nematoda: Pharyngodonidae) from *Hemidactylus frenatus* (Reptilia: Gekkonidae) from Oceania. Journal of Parasitology 82:299–301.
- Bursey, C. R., and S. R. Goldberg.** 1999. *Pharyngodon oceanicus* sp. n. (Nematoda: Pharyngodonidae) from the oceanic gecko, *Gehyra oceanica* (Sauria: Gekkonidae) of the Pacific Islands. Journal of the Helminthological Society of Washington 66:37–40.
- Bursey, C. R., S. R. Goldberg, and F. Kraus.** 2005a. New genus, new species of Cestoda (Anoplocephalidae), new species of Nematoda (Cosmocercidae) and other helminths in *Cyrtodactylus louisianensis* (Sauria: Gekkonidae) from Papua New Guinea. Journal of Parasitology 91:882–889.
- Bursey, C. R., S. R. Goldberg, and F. Kraus.** 2005b. Endoparasites in *Sphenomorphus jobiensis* (Sauria: Scincidae) from Papua New Guinea with description of three new species. Journal of Parasitology 91:1385–1394.
- Bursey, C. R., S. R. Goldberg, and S. R. Telford, Jr.** 2007. Gastrointestinal helminths of 14 species of lizards from Panama with descriptions of five new species. Comparative Parasitology 74:108–140.
- 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.
- Chabaud, A. G., and E.-R. Brygoo.** 1960. Nématodes parasites de caméléons malgaches. Memoires de l'Institut Scientifique de Madagascar: Série A. Biologie Animale 14:125–159.
- Chakravarty, G. K., and N. V. Bhaduri.** 1948. An oxyurid nematode *Neopharyngodon gekko* gen. et sp. nov. from the Indian lizard *Gekko gekko* (Linn.). Proceedings of the Zoological Society of Bengal 1:103–107.
- Chatterji, R. C.** 1933. On a new nematode, *Parapharyngodon maplestoni* gen. nov., sp. nov., from a Burmese lizard. Annals of Tropical Medicine and Parasitology 27:131–134.
- Crusz, H.** 1984. Parasites of endemic and relict vertebrates: a biogeographical review. Pages 321–351 in C. H. Fernando, ed. Ecology and Biogeography in Sri Lanka. Dr. W. Junk Publishers, The Hague, Netherlands.
- Crusz, H., and C. C. Ching.** 1975. Parasites of the relict fauna of Ceylon. VI. More new helminths from amphibians and reptiles, a new host-record and redescription of *Acanthocephalus serendibensis* Crusz and Mills 1970. Annales de Parasitologie Humaine et Comparée 50:531–538.
- Crusz, H., and M. A. K. Daundasekera.** 1988. Parasites of the relict fauna of Ceylon. IX. Helminths from burrowing scincine lizards. Annales de Parasitologie Humaine et Comparée 63:439–447.
- Crusz, H., and E. V. Mills.** 1970. Parasites of the relict fauna of Ceylon. I. *Acanthocephalus serendibensis* sp. nov. from the Ceylon horn-nosed lizard, *Ceratophora stoddarti* Gray. Annales de Parasitologie Humaine et Comparée 45:13–19.
- Crusz, H., and V. Sanmugasunderam.** 1971. Parasites of the relict fauna of Ceylon. II. New species of cyclophyllidean cestodes from small hill-vertebrates. Annales de Parasitologie Humaine et Comparée 46: 575–588.
- Crusz, H., and A. Santiapillai.** 1982. Parasites of the relict fauna of Ceylon. VIII. Helminths from *Ichthyophis* spp. (Amphibia: Gymnophiona). Annales de Parasitologie Humaine et Comparée 57:317–327.
- Das, I., and A. de Silva.** 2005. A Photographic Guide to Snakes and Other Reptiles of Sri Lanka. Ralph Curtis Books, Sanibel Island, Florida. 144 pp.
- Deshmukh, P. G., and S. M. Ali.** 1966. On a new species of the genus *Thamagudia* from the wall lizard, *Hemidactylus giganteus*. Indian Journal of Helminthology 18(supplement):83–85.
- de Silva, A., R. P. V. J. Rajapakse, A. M. Bauer, W. M. J. De Silva, C. C. Austin, S. Goonewardene, Z. Hawke, V. Vanneck, A. Drion, and M. M. Goonasekera.** 2004. First report of parasites of *Hemidactylus maculatus hunae* & *Calodactylodes illingworthorum* (Reptilia: Gekkonidae) inhabiting the Nigala Fire Savannah, Sri Lanka. *Lyriocephalus* (Special Issue 2004) 5:199–205.
- Fernando, W.** 1933. Contributions to Ceylon helminthology. 3. *Mesocoelium burti*, sp. nov., *Mesocoelium marsi*, sp. nov., and *Haplochis pearsoni*, sp. nov. Ceylon Journal of Science 18:9–18.
- Goldberg, S. R., and C. R. Bursey.** 2001. Gastrointestinal helminths of gekkonid lizards (Sauria: Gekkonidae) from the Philippine Islands and Thailand. Comparative Parasitology 68:138–142.
- Goldberg, S. R., and C. R. Bursey.** 2002. Gastrointestinal helminths of seven gekkonid lizard species (Sauria: Gekkonidae) from Oceania. Journal of Natural History 36:2249–2264.

- Goldberg, S. R., C. R. Bursey, and H. Cheam.** 2000. Gastrointestinal helminths of four lizard species from Moorea, French Polynesia. *Comparative Parasitology* 67:118–121.
- Goldberg, S. R., C. R. Bursey, and F. Kraus.** 2008. Gastrointestinal helminths of eleven species of *Eomoia* (Squamata: Scincidae) from Papua New Guinea. *Journal of Natural History* 42:1923–1935.
- Goldberg, S. R., C. R. Bursey, and F. Kraus.** 2010. Metazoan endoparasites of 14 species of skinks (Squamata: Scincidae) from Papua New Guinea. *Journal of Natural History* 44:447–467.
- Hanski, I.** 1982. Dynamics of regional distribution: the core and satellite species hypothesis. *Oikos* 38:210–221.
- Karve, J. N.** 1938. Some nematode parasites of lizards. Pages 251–258 in *Livro Jubilar do Professor Lauro Travassos, editado para Commemorar o 25 Aniversario de suas Atividades Cientificas (1913–1938)*. Typographia do Instituto Oswaldo Cruz, Rio de Janeiro, Brazil.
- Kennedy, M. J., L. M. Killick, and M. Beverley-Burton.** 1987. Life cycle studies on two Digenea, *Paradistomum geckonum* (Dicrocoeliidae) and *Mesocoelium sociale* (Mesocoeliidae), in geckonid lizards from Indonesia. *Canadian Journal of Zoology* 65:2491–2497.
- Killick, L. M., and M. Beverley-Burton.** 1982. Observations on digeneans from lizards (Sauria) in Indonesia (*Paradistomum geckonum*, *Mesocoelium sociale*, and *Postorchigenes ovatus*) with a revision of *Paradistomum* Kossack, 1910 (Dicrocoeliidae). *Canadian Journal of Zoology* 60:2093–2106.
- Malhotra, S. K., and V. N. Capoor.** 1984. On a new reptilian cestode *Oochoristica pauiensis* n. sp. from *Hemidactylus brooki* (Gray) and *Hemidactylus flaviviridis* (Rüppell) from Garhwal Hills, U.P., India. *Korean Journal of Parasitology* 22:99–101.
- Manamendra-Arachchi, K., S. Batuwita, and R. Pethiyagoda.** 2007. A taxonomic revision of the Sri Lankan day-geckos (Reptilia: Gekkonidae; *Cnemaspis*) with description of new species from Sri Lanka and southern India. *Zeylanica* 7:9–122.
- Petter, A. J., and J. C. Quentin.** 1976. Keys to the genera of the Oxyuroidea. Pages 1–30 in R. C. Anderson, A. G. Chabaud, and S. Willmott, eds. *CIH Keys to the Nematode Parasites of Vertebrates*. Commonwealth Agricultural Bureaux, Farnham Royal, Slough, U.K. 30 pp.
- Roca, V.** 1993. Helminthofauna dels reptiles. *Monografies de la Societat d'Història Natural de les Balears* 2:273–292.
- Shamim, S., and P. G. D. Deshmukh.** 1982. *Skrjabinelazia hemidactylus* n. sp. from a reptilian host *Hemidactylus brooki*. *Rivista di Parassitologia* 43:469–472.
- Somaweera, R., and N. Somaweera.** 2009. *Lizards of Sri Lanka: a Colour Guide with Field Keys*. Edition Chimaira. Frankfurt am Main, Germany. 303 pp.
- von Linstow, O.** 1906. Helminths from the collection of the Colombo Museum. *Spolia Zeylanica* 3:163–188.
- C. Austin. All specimens have been deposited in the National Museum of Sri Lanka, Colombo (registration numbers pending).
- Calodactylodes illingworthorum* ($n = 3$): AMB 7414, 7421, Uva Province, Monaragala District, Serawa, Pitakumbura (07°15'50"N; 81°21'25"E); AMB 7434 Eastern Province, Ampara District, Aran-telawa east of Maha Oya (07°31'59"N; 81°26'23"E).
- Cnemaspis kandiana* ($n = 13$): AMB 7422, 7423, Uva Province, Monaragala District (06°56'00"N; 81°17'17"E); AMB 7431, Uva Province, Monaragala District, Rathatakanda Butlele (06°46'00"N; 81°15'43"E); AMB 7448, 7451, North Central Province, Anuradhapura District, Mihintale (08°21'08"N; 80°30'48"E); AMB 7471, 7472, Central Province, Kandy District, Kandy (07°15'36"N; 80°37'11"E); AMB, 7476–7479, 7484, Central Province, Matale District, Matale (07°31'48"N; 80°37'39"E); AMB 7486, Central Province, Kandy District, Gampola (07°09'05"N; 80°33'05"E).
- Cnemaspis scalpensis* ($n = 4$): AMB 7446, 7447, North Central Province, Anuradhapura District, Ritigala (08°07'06"N; 80°39'51"E); AMB 7417, 7418, Uva Province, Monaragala District, Serawa, Pitakumbura (07°15'50"N; 81°21'25"E).
- Cnemaspis tropidogaster* ($n = 24$): AMB 7470, Central Province, Kandy District, Kandy (07°15'36"N; 80°37'11"E); AMB 7488–7490, 7492, 7493, Central Province, Kandy District, Helboda (07°05'37"N; 80°39'26"E); AMB 7494, Central Province, Nuwara Eliya District, Kondagala, Labookellie (07°02'12", 80°42'29"E); AMB 7496, 7497, 7499–7501, Central Province, Nuwara Eliya District, Upcot (06°47'07"N; 80°37'37"E); AMB 7502, Central Province, Nuwara Eliya District, Fairlawn Tea Estate (06°46'10"N; 80°37'18"E); AMB 7510–7513, Sabargamuwa Province, Ratnapura District, Rakwana-Deniyaya Road (06°27'04"N; 80°37'37"E); AMB 7526, Southern Province, Galle District, Udugama (06°12'53"N; 80°20'23"E); CCA 2460–2462, Southern Province, Galle District, Kottawa (06°05'52"N; 80°18'40"E); CCA 2463 Southern Province, Galle District, 5 km south of Kottawa (06°04'48"N; 80°17'36"E); AMB 7522, Southern Province, Galle District, Bataganwilla (06°02'20"N; 80°13'17"E); AMB 7525, Southern Province, Galle District, Kitulampitiya (06°04'00"N; 80°13'00"E).
- Gehyra mutilata* ($n = 4$): AMB 7419, Uva Province, Monaragala District, Rathagala (07°18'02"N; 81°23'11"E); AMB 7506, Central Province, Nuwara

APPENDIX 1

Location by district and province for 9 species of geckos from Sri Lanka found to harbor helminth parasites. Collection acronyms: AdS = Anselm de Silva, AMB = Aaron M. Bauer, CCA = Christopher

Eliya District, Upcot (06°47'07"N; 80°37'37"E); AMB 7515, Southern Province, Galle District, Nimalawa (06°03'08"N; 80°25'55"E); AMB 7527, Southern Province, Galle District, Haycock (06°18'48"N; 80°18'55"E).

Hemidactylus parvimaculatus ($n = 12$): AdS 36, Eastern Province, Ampara District, Kartivu (07°21'52", 81°51'16"E); AMB 7413, Uva Province, Monaragala District, Pidenipitiya (07°13'27"N; 81°02'17"E); AMB 7426, 7427 Uva Province, Monaragala District, Gonaganara (06°36'53"N; 81°16'13"E); AMB 7432, Eastern Province, Ampara District, Tapataya (07°35'26"N; 81°25'38"E); AMB 7438, North Central Province, Polonnaruwa District, Dimbulagala (07°52'24"N; 81°09'09"E); AMB 7454, North Central Province, Anuradhapura District, Poonewa (08°33'51"N; 80°37'39"E); AMB 7466, Northwestern Province, Puttalam District, Mamburiya (07°59'38"N; 79°44'33"E); AMB 7480, Central Province, Matale District, Matale (07°31'48"N; 80°37'39"E); AMB 7516, Southern Province, Galle District, Nimalawa (06°03'08"N; 80°25'55"E); AMB 7520, 7521, Southern Province, Galle District, Boosa (06°04'19"N; 80°09'46"E).

Hemidactylus depressus ($n = 7$): AdS 69, Uva Province, Monaragala District, Kuruwekotha (07°05'55"N; 81°13'03"E); AMB 7440, 7441, North Central Province, Polonnaruwa District, Dimbulagawa (07°52'24"N; 81°09'09"W); AMB 7445 North Central Province, Anuradhapura District, Ritigala (08°07'06"N; 80°39'51"E); AMB 7481 Central Province, Matale District, Matale (07°31'48"N; 80°37'39"E); AMB 7524, Southern Province, Galle District, Kitulampitiya (06°04'00"N; 80°13'00"E); AMB 7528 Southern Province, Galle District, Haycock (06°18'48"N; 80°18'55"E).

Hemidactylus frenatus ($n = 6$): AdS 16-A, Central Province, Kandy District, Gompola (07°09'05"N; 80°33'05"E); AMB 7411, Uva Province, Monaragala District, Pidenipitiya (07°13'27"N; 81°02'17"E); AMB 7420, Uva Province, Monaragala District, Rathagala (07°18'02"N; 81°23'11"E); AMB 7452, North Central Province, Anuradhapura District, Mihintale (08°21'08"N; 80°30'48"E); AMB 7455, North Central Province, Anuradhapura District, Poonewa (08°33'51"N; 80°28'50"E); AMB 7518, Southern Province, Galle District, Kandewatte (06°02'24"N; 80°12'39"E).

Hemidactylus leschenaultii ($n = 3$): AdS 12, North Central Province, Polonnaruwa District, Yakkure (07°49'00"N; 81°01'00"E); AMB 7443, North Central Province, Polonnaruwa District, Polonnaruwa (07°55'59"N; 81°00'29"E); AMB 7444, North Central Province, Polonnaruwa District, Minneriya (08°02'48"N; 80°54'35"E).

APPENDIX 2

Helminths from 9 species of geckos from Sri Lanka were deposited in the United States National Parasite Museum (USNPC), Beltsville, Maryland.

Calodactylodes illingworthorum: *Pharyngodon gekko* (USNPC 101127), *Physalopteroides dactyluris* (USNPC 101128), *Skrjabinelazia hemidactyli* (USNPC 101129).

Cnemaspis kandiana: *Mesocoelium monas* (USNPC 101130), *Skrjabinelazia hemidactyli* (USNPC 101131).

Cnemaspis scalpensis: *Physalopteroides dactyluris* (USNPC 101132).

Cnemaspis tropidogaster: *Pharyngodon gekko* (USNPC 101136), *Physalopteroides dactyluris* (USNPC 101137), *Skrjabinelazia hemidactyli* (USNPC 101138), *Thamugadia hemidactyla* (USNPC 101139), acuariid larvae (USNPC 101140), *Acanthocephalus serendibensis* (USNPC 101141).

Gehyra mutilata: *Skrjabinelazia hemidactyli* (USNPC 101142).

Hemidactylus parvimaculatus: *Oochoristica pauriensis* (USNPC 101143), *Parapharyngodon maplestoni* (USNPC 101144), *Physalopteroides dactyluris* (USNPC 101145).

Hemidactylus depressus: *Pharyngodon oceanicus* (USNPC 101146), *Spauligodon hemidactylus* (USNPC 101147).

Hemidactylus frenatus: *Mesocoelium monas* (USNPC 101148), *Spauligodon hemidactylus* (USNPC 101149).

Hemidactylus leschenaultia: *Parapharyngodon maplestoni* (USNPC 101150), *Physalopteroides dactyluris* (USNPC 101145).