

Nematodes from northern Australian reptiles

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Abstract

Twenty-one species of nematode were identified from the gastrointestinal tract or body cavity of 131 individual lizards and snakes comprising 26 species. In 13 host species, only a single individual specimen was available, and the aquatic Keelback snake (*Tropidonophis mairii*) comprised almost half the specimens examined. In general, nematode intensity was low, and only a single adult nematode specimen was present in most of the reptiles examined. Most nematode species showed specificity to one host family, except for *Abbreviata bancrofti*, which was recovered from six species across four families. A total of 21 new host-parasite records and one new locality record are listed, with a number of reptile species reported as a host for a nematode for the first time.

Introduction

Nematode parasites are widespread in snakes and lizards in Australia (Pichelin *et al.* 1999). Gastrointestinal nematodes of varanid lizards and of pythons have been relatively well studied from northern Australia, revealing that these reptiles support a rich nematode fauna, some species showing marked host specificity and geographical range limitations (Jones 1979, 1988; Mulder & Smales 2015). A recent study on the nematodes of the Keelback snake (*Tropidonophis mairii*) showed very high infection prevalence with the spirurid nematode *Tanqua anomala* but with limited negative impacts on the health of the host (Mayer *et al.* 2015). Little is known, however, of nematodes found in other reptile groups in northern Australia. During the course of various projects undertaken on reptiles in this area over many years, reptiles were dissected, and any helminths found were removed for subsequent study. For this paper we examined previously unstudied nematodes dissected from host specimens in the collections of the Museum and Art Gallery of the Northern Territory, the Queensland Museum, and the Australian Museum, as well as from the personal collections of the authors. These nematodes were identified, host specificity and associations between species investigated, and the host habitat and geographical range noted.

Methods

Preservation of nematode specimens varied, depending on host source (dissections of fresh road-killed specimens or previously preserved museum specimens) and the collector of the nematodes. Thus, some specimens were initially preserved in 10% formaldehyde whereas others were preserved in 70% ethanol; all specimens were subsequently stored in 70% ethanol. Before examination, the nematodes were cleaned then cleared in chlorolactophenol and examined under a BA series Olympus microscope.

Museum reference numbers and infections of every individual reptile examined in this study are given in Table 1. The listed intensity of infection data needs to be treated with caution, especially for records from museum host specimens. Many of these specimens were difficult to dissect due to preservation shape (for example, snake specimens are coiled into jars), the inability to complete a full dissection to preserve the host specimen intact as much as possible, and in many cases, prior dietary studies conducted on the specimens had removed or emptied the contents of their stomach. Accurate records for uninfected snakes sourced from other studies were unavailable, thus prevalence data presented here are incomplete and should also be treated with caution.

Results

A total of 131 individual host specimens, comprising 26 species across 9 families were found to be infected with nematodes (Table 1). The hosts were lizards of the families Agamidae (3 species), Carphodactylidae (1), Diplodactylidae (2), Gekkonidae (1), Scincidae (2) and Varanidae (3), and snakes of the families Boidae (4), Colubridae (2) and Elapidae (8). Twenty-two reptile species were represented by five or less individuals. The samples were dominated by the aquatic colubrid snake *Tropidonophis mairii*, which accounted for almost half of the host specimens examined.

Species identified

At least 21 nematodes (excluding larvae) were identified from the reptiles examined in this study (Table 2); 13 were identified to species, 6 were identified to genus and 2 could only be identified to family level. Larval and immature stages were also reported (Table 1). Eleven new host-parasite records were observed: *Physalopteroides filicauda* in the Eastern Water Skink (*Eulamprus quoyii*); *Abbreviata hastaspicula* in the Woma (*Aspidites ramsayi*); *Tropidonophis mairii* in Spencer's Monitor (*Varanus spenceri*); *Abbreviata bancrofti* in *Tropidonophis mairii*, the Lesser Black Whipsnake (*Demansia vestigiata*) and the Eastern Brown Snake (*Pseudonaja textilis*); *Tanqua tiara* in the Northern Death Adder (*Acanthophis praelongus*); *Dracunculus mulbus* in *Tropidonophis mairii* and the Black-headed Python (*Aspidites melanocephalus*); and *Maxvachonia brygooi* in the Asian House Gecko (*Hemidactylus frenatus*). In addition, the following genera were recorded for the first time from these hosts: *Ophidascaris* sp. 1 in the Coastal Taipan (*Oxyuranus scutellatus*); *Ophidascaris* sp. in the Orange-Naped Snake (*Furina ornata*); *Pharyngodon* sp. in the Chameleon Gecko (*Carphodactylus laevis*); *Skerjabinodon* sp. and *Pharyngodonidae* sp. in the Northern Velvet Gecko (*Oedura castelani*); and *Kalicephalus* sp. in the Slatey-grey Snake (*Stegonotus cuellatus*),

Tropidonophis mairii and *Acanthobhis praelongus*. The presence of immature *Eustrongylides* sp. in *Tropidonophis mairii* and larval Physalopteridae in the Zigzag Velvet Gecko (*Amalosa rhombifer*) and the Eastern Barred Wedgenout Ctenotus (*Ctenotus straubii varius*) are new host records. The report of *Parapharyngodon maplestoni* in *Hemidactylus frenatus* is a new locality record.

Intensity of infection

For most of the nematode species, the intensity of infection was low. Additionally, for a large number of records, only one individual of each host species was examined. Thus the true range of intensity of infection remains unknown. In skinks and geckoes, all of which were physically small, the intensity of infection, primarily by pharyngodonids, was generally less than five individuals. However, in snakes, intensity of infection was often greater than 10 individuals, although where more than one species of nematode was present, one was usually present in much higher levels than the other. The parasites with highest intensity were: *Tanqua tiara* in the Yellow-spotted Monitor (*Varanus panoptes*) (intensity over 400); *Abbreviata hastaspicula* in *Varanus spenceri* (Spencer's Monitor) (intensity of 250) and the Sand Monitor (*Varanus gouldii*) (intensity ranging from 35 to more than 100); and *Abbreviata bancroftii* from *Demansia vestigiata* at a mean intensity of 48 (27–69) for the two Northern Territory specimens and at 17 (1–50) for the six northern Queensland specimens. However, for all of these host species, less than 10 specimens and often only one specimen, were examined. For the most represented host in this study, *Tropidonophis mairii*, the nematode *Tanqua anomala* was recovered at a mean intensity of 31 (1–201). This would be a truer reflection of the range of intensity of infection in this host species as the snakes were specifically examined for infection levels as part of the study by Mayer *et al.* (2015).

Host specificity

Pharyngodonid nematodes and physalopterid larvae occurred only in the smaller skinks and geckoes. *Maxvachonia brygooi* was only found in the introduced gecko *Hemidactylus frenatus*. *Strongyluris paronai* only occurred in the agamid lizards. *Kalicepbalus* sp., Spiruridae sp., *Eustrongylides* sp. and adults of *Ophidascaris* spp. were all reported only from snakes. *Tanqua anomala* was reported only from *Tropidonophis mairii*, whereas *Tanqua tiara* was reported from a range of snakes and varanids. The various species of *Abbreviata* were found to infect a range of hosts across the major families; for example *Abbreviata bancroftii* was recovered from six species of reptile, across four families.

Discussion

Most reports of nematode infections in reptiles in Australia are anecdotes associated with the descriptions of new species of nematodes. However, a few recent studies have reported aspects of the ecological relationship between nematodes and their hosts (Barton 2015; Mayer *et al.* 2015; Mulder & Smales 2015). Although a wide range of hosts were examined in this study, just one species, *Tropidonophis mairii*, dominated the study and it is the only host for which good ecological data can be presented.

It is unfortunate that many of the specimens of nematodes collected in this study were not in an optimal condition, being poorly preserved, incomplete, immature, or having only one sex available. And in many cases, only a single individual nematode was recovered. For this reason, full identification to species level was often not possible. However, this study has reported at least nine new host-parasite records and one new locality record, as well as increasing the knowledge of nematodes of many species of reptiles in northern Australia. This is especially true for the Northern Territory, an area that has been severely under-represented in previous studies. *Carphodactylus laevis*, *Oedura castelnani*, *Amalosa rhombifer*, *Ctenotus strauchii varius*, *Stegonotus cucullatus*, *Acanthophis praelongus*, *Furina ornata*, *Demansia vestigiata* and *Oxyuranus scutellatus* are all reported as hosts for a nematode parasite for the first time.

In this study, representatives of the nematode genus *Ophidascaris* were recovered from a number of snakes as well as from a single varanid lizard. As discussed above, many of the specimens collected could only been identified to the genus *Ophidascaris*. Both *Ophidascaris moreliae* and *Ophidascaris robertsi* have previously been identified in the Children's Python (*Antaresia childreni*), *Aspidites melanocephalus* and the Carpet Python (*Morelia spilota*), with its congener *Ophidascaris robertsi* reported only from *Aspidites ramsayi* (Mawson 1955; Sprent & Mines 1960; Sprent 1969; Jones 1979). Differentiation of these two closely-related species depends on several characters, including the form of the lips, the presence or absence of a post-oesophageal caecum, cervical alae, and pitting on the surface of the eggs. Identification of specimens to *Ophidascaris moreliae/robertsi* was only possible for nematodes collected from a single *Morelia spilota* from an unknown collection location in northern Queensland. However, the quality of the specimens did not allow for identification to one or the other of the species.

Ophidascaris pyrribus was originally described from a Red-bellied Black Snake (*Pseudechis porphyriacus*) originating from the central New South Wales coast (Johnston & Mawson 1942). It has subsequently been reported from a number of other elapid snakes from across Australia (Jones 1980; Pichelin *et al.* 1999). *Ophidascaris pyrribus* was only found in one snake (a specimen of *Pseudechis porphyriacus* from northern Queensland) in the present study as an encysted larval stage.

Two males and one female of a species of *Ophidascaris* were recovered from *Oxyuranus scutellatus* from northern Queensland, in which the male copulatory spicules were abnormally long, being more than 10 mm in length, which is twice the length of those reported in *Ophidascaris pyrribus* (Johnston & Mawson 1942). This suggests that the specimens collected belong to a different, possibly new, species of *Ophidascaris*. However these specimens were not in a sufficiently good condition to compare other morphological features. Nematodes are commonly found in *Oxyuranus scutellatus* (Hoser 2008), but none has previously been identified to species. Further collections of *Oxyuranus scutellatus* from northern Queensland, as well as other locations, are required for the collection of more nematodes to allow for accurate species identification.

The life cycle for most members of the genus *Ophidascaris* remains unknown, however, a mammalian intermediate host is required for development of *Ophidascaris moreliae* to an infective third stage larva (Sprent 1969), whereas *Ophidascaris pyrribus* is thought to use lizards as its intermediate host (Sprent 1988). The diet of the snakes *Morelia spilota* and *Oxyuranus scutellatus* are both dominated by mammals, whereas the snakes *Antaresia childreni*, *Aspidites ramsayi*, the Rough-scaled Snake (*Tropidechis carinatus*) and *Pseudonaja textilis* have a more varied diet, with 30–50% being mammals, and *Pseudechis porphyriacus* has a diet dominated by reptiles and amphibians (Shine 1991). Interestingly, none of the colubrid snakes examined in this study were infected with any *Ophidascaris* species. The diet of *Tropidonophis mairii* is almost exclusively amphibians, whereas *Stegonotus cucullatus* has a reptile-dominated diet (Shine 1991), but as only two *Stegonotus cucullatus* were examined in this study, this needs to be treated with caution. *Strongyluris paronai* appears to be restricted to members of the Agamidae (Pichelin *et al.* 1999), and it was reported from both the Frill-neck Lizard (*Chlamydosaurus kingii*) and a Bearded Dragon (*Pogona* sp.) in this study. Previous reports of *Strongyluris paronai* are mainly from the Kimberley region in northern Western Australia (Jones 1986, 1994), with one study of the seasonality of infection in *Chlamydosaurus kingii* in Kakadu National Park (Griffiths *et al.* 1998). Due to the patterns of observation of larval and adult nematodes in *Chlamydosaurus kingii* by Griffiths *et al.* (1998), it is assumed that *Strongyluris paronai* has a direct life cycle, although Anderson (2000) suggested that insects might be utilised as transport hosts, with no development of the parasite within. Both *Chlamydosaurus kingii* and *Pogona* species are known to feed extensively on insects (Cogger 2014).

Representatives of the genus *Maxvachonia* have been reported from a number of lizards, mostly agamids, in Australia, with one dubious report from an elapid snake (Mawson 1972). Species of *Maxvachonia* have also been reported from a few skinks and varanids (Pichelin *et al.* 1999). Further examination of the specimens reported in Barton (2015) collected from *Hemidactylus frenatus* allowed for the specific identification to *Maxvachonia brygooi*. This represents a new host record for *Maxvachonia brygooi*. The life cycle of *Maxvachonia* has not been studied, but other members of the family Cosmocercidae have a direct life cycle, with the infective larva penetrating the host via the mouth or skin (Anderson 2000). As with *Strongyluris paronai*, described above, this nematode may utilise insects as transport hosts, although this has yet to be shown.

Members of the Pharyngodonidae are strictly monoxenous, with direct transmission through the ingestion of infective larvae within eggs (Anderson 2000). Members of the Pharyngodonidae are exclusively found in lizards, especially skinks (Pichelin *et al.* 1999). Pharyngodonids were only collected from geckoes in this study, however all other groups of lizards were only represented by one to three specimens. The vast majority of infections were of *Spauligodon hemidactylus* in *Hemidactylus frenatus*, as reported previously in Barton (2015).

Parapharyngodon maplestoni has previously been reported from *Hemidactylus frenatus* in various locations outside of Australia (South-East Asia and Oceania; Barton 2015),

but this is the first published record of this parasite in Australia. As with *Spauligodon hemidactyli* (Barton 2015), it is assumed that *Parapharyngodon maplestoni* has been introduced to Australia with its host. Further research will be required to determine if this species has spread to other native Australian reptiles.

A number of *Pharyngodon* species have been reported from a range of skinks and geckoes across Australia (Pichelin *et al.* 1999). The presence of a species of *Pharyngodon* in *Carphodactylus laevis* is a new host record.

A small number (seven) of species of *Skryabinodon* have been reported from skinks and geckoes in Australia (Pichelin *et al.* 1999; Jones 2013). The presence of a species of *Skryabinodon* in *Oedura castelnaui* is a new host record.

Dracunculus mulbus was originally reported from the tissues surrounding the organs in the body cavity of the Water Python (*Liasis fuscus*) from Fogg Dam, Northern Territory (Jones & Mulder 2007). *Dracunculus mulbus* occurs in the tissues or body cavity of its host and the true intensity of infection as well as potential range of host species may have been higher. Both *Tropidonophis mairii* and *Aspidites melanocephalus* are new host records, with both species collected from close to the type locality.

It is assumed that *Dracunculus mulbus* has an aquatic-based life cycle, as other members of the genus release larvae into the water from a blister in the skin, and the larvae develop to the infective stage within copepods before being ingested by a paratenic host, such as a tadpole (Anderson 2000). Thus, the aquatic snakes here could be infected via infected frogs, with *Tropidonophis mairii* known to feed primarily on them, although *Liasis fuscus* and *Aspidites melanocephalus* are not known to eat them, preferring either mammals or reptiles (Shine 1991).

The two species of *Tanqua* identified in this collection, *Tanqua tiara* and *Tanqua anomala*, were described by Linstow (1879, 1904) and both were redescribed by Baylis (1916), the former from species of *Varanus* and other aquatic and semi-aquatic reptiles in the Old World tropics, and the latter from the Checkered Keelback (*Xenochrophis piscator*) (previously known as *Tropidonophis piscator*) in Sri Lanka. *Tanqua tiara* occurred in high numbers in the single specimen of *Varanus panoptes* examined, and has been recorded at moderately high prevalence (25% to greater than 50%), at intensities of up to 120, in three species of *Varanus* from northern Australia (Jones 1988). *Tanqua anomala* occurred exclusively in the aquatic colubrid *Tropidonophis mairii*, with a mean intensity of 31 from the snakes examined in this study. Mayer *et al.* (2015) reported a mean intensity of 35 nematodes (0–243) for 93 *Tropidonophis mairii* examined from Fogg Dam; it is from these snakes that the nematodes examined in this study were taken.

The cases of *Tanqua tiara* infections reported in this study were from the Darwin and Fogg Dam region. Additionally, only in the Northern Territory was *Tropidonophis mairii* infected with *Tanqua anomala*, with none of the four *Tropidonophis mairii* collected from Queensland infected with any species of *Tanqua*. The collection location of *Tropidonophis*

mairii in Queensland is an area affected by tidal intrusion, thus the required intermediate hosts may not be able to survive in this area; however, further collections of snakes from other areas of northern Queensland are required to determine if this parasite does occur there or is restricted to the Northern Territory.

Physalopterid nematodes are the dominant gastric nematode in a number of Australian reptile families (Jones 1991, 2014). Adults of *Abbreviata* are the dominant genus in the larger reptiles (Jones 1991, 2014). The high intensities of *Abbreviata hastaspicula* in species of *Varanus* have been previously documented by Jones (2014). Physalopterid nematodes possess a two host life cycle, with an arthropod intermediate host and a paratenic host where the larva is found coiled within a cyst in the stomach wall (Jones 1991, 2014), as was found often in this study in the smaller species of reptiles examined. Identification of these larvae to species cannot be done through morphology alone (Jones 1991). It is unknown whether this cyst stage is a prerequisite for final maturity or whether there is some physiological clue in the (usually) larger final host for development to occur to adult (Jones 1991). Adult physalopterids were thought to be absent in colubrid snakes, with the exception of an unpublished report in Jones (2014). Reports from boid snakes were considered spurious, with nematodes found thought to actually have been infections in the prey items (Jones 2014). This study, however, confirms the presence of *Abbreviata* species in members of both these families in Australia.

Abbreviata bancroftii has a widespread distribution, and had been reported from 21 species across three families (Jones 2014). The colubrid *Tropidonophis mairii* is confirmed as a host species, as well as the additional elapids *Demansia vestigiata* and *Pseudonaja textilis*. The boids *Aspidites melanocephalus* and *Morelia spilota* are also reported as hosts in this study with infection levels similar to those found in the 'usual' hosts, which would tend to confirm that they are true hosts for these parasites. *Abbreviata bancroftii* is found in regions along the coastal eastern and southern fringe of Australia as well as the northern tropics in areas with higher rainfall levels (Jones 2014).

Abbreviata hastaspicula is predominantly found in drier areas and the northern tropics where the mean annual temperature is greater than 18°C (Jones 2014). *Abbreviata hastaspicula* had been exclusively reported from varanid lizards (see Jones 2014); this study reports the snakes *Aspidites ramsayi*, *Stegonotus cucullatus* and *Tropidonophis mairii* as hosts, although at much lower levels of infection than that reported for varanids.

Most of the reports for *Abbreviata* spp. were for immature specimens which were unable to be identified to species due to the lack of required taxonomic characters.

Physalopteroides filicanda was originally described from the Smooth Knob-tail Gecko (*Nephrurus laevissimus*) (Jones 1985) and has subsequently been reported from a variety of lizards across all families, with the majority of records from Western Australia (Pichelin *et al.* 1999; Goldberg & Burse 2012).

Members of the genus *Kalicephalus* have been reported from a small number of snakes across Australia (Pichelin *et al.* 1999). Unfortunately, none of the specimens collected in this study was suitable for providing a species identification, although they were considered closest to *Kalicephalus australiensis*. The life cycle of *Kalicephalus*, like other strongylids, is considered direct via ingestion of the infective larva, although the use of paratenic hosts cannot be ruled out (Anderson 2000). All of the infected snakes in this study came from Fogg Dam and all are new host records for members of this genus of nematode in Australia.

There are two previous records of *Eustrongylides* in Australia: *Eustrongylides acrochordi* (immature female) from the stomachs of two (out of eight) Arafura File Snakes (*Acrochordus arafurae*) (Jones 1978), an aquatic fish-eating snake, plus encysted in the livers of water pythons (*Liasis fuscus*) (Mulder & Smales 2015). Nematodes in the genus *Eustrongylides* usually have two intermediate hosts, with fishes being the usually recorded second intermediate host (Anderson 1992). Species of *Eustrongylides* mature in the proventriculus of fish-eating aquatic birds, and it is likely that *Acrochordus arafurae*, *Liasis fuscus* and *Tropidonophis mairii* were paratenic or accidental hosts (Jones, 1978; Mulder & Smales 2015; present study).

The host-specificities of nematodes recovered during this study correspond with those of previous studies (Jones 1980, 1983, 1988). The low host specificity of *Abbreviata bancrofti* has been noted previously (Jones 2014). The habitat range of this nematode's hosts is exemplified by its high prevalence and intensity in *Demansia vestigiata*, which normally inhabits drier habitats (Cogger 2014), and it was the second most common nematode in the aquatic *Tropidonophis mairii*. In 16 host species, only a single adult nematode specimen was recovered (Table 2). The intensity of most nematodes was low, and this finding in several host species accords with the conclusions of Mulder & Smales (2015) for infections in the python *Liasis fuscus*. In some cases however the finding of a single nematode may have been the result of accidental infection, the nematode having been ingested within the prey.

This study, therefore, confirms previous observations on host specificities and intensities of infection, and extends the known hosts of several species. Further studies with larger samples would provide a fuller picture of the nematode fauna of reptiles in northern Australia. Such basic data is needed to monitor possible faunal changes with both the advance of the Cane Toad (*Rhinella marina*) and changes in climate.

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Table 1. Individual reptile hosts of nematodes examined in this study, separated into A) lizards and B) snakes. Sources of hosts are listed as those dissected from the collections of the Museum and Art Gallery of the Northern Territory (NTM), the Queensland Museum (QM) and the Australian Museum (AM) and from specimens donated to DPB by staff of the University of Sydney Tropical Ecology Research Facility (TIERF) or dissected by DPB at James Cook University, Townsville (JCU). The host registration number for museum specimens, where applicable, is listed; registration numbers for the collected nematodes is provided in the last column. Unreg denotes an unregistered specimen; unk denotes unknown information.

A. LIZARDS

Host Family	Host Species	State Collected	Location Collected	Source	Identification	Stage	Location in host	No.	Parasite Museum Deposit Number
Agamidae	<i>Chlamydosaurus kingii</i>	NT	Elcho Island	JCU	<i>Strongylaris parvum</i>	Adult	Stomach	1	NTM D1810
	<i>Intellagama leweni</i>	Qld	Tully Rd/1andstone Rd, Tully	JCU	<i>Abreviata</i> spp.	Adult	Intestine	1	NTM D1778
Carpophacetylidae	<i>Pigeona</i> sp.	Qld	No collection data	JCU	<i>Strongylaris parvum</i>	Adult	Intestine	6	NTM D1809
	<i>Carpophacetylus laevis</i>	Qld	Iron Range	JCU	<i>Pharyngodon</i> sp.	Adult	Intestine	2	N/A
Diplodactylidae	<i>Amalosa thombijer</i>	NT	Cape Fourcroy, Bathurst Island	NTM R7889	Physalopteridae sp.	Larva	Wall of Stomach	1	NTM D1812
	<i>Oedura castelhami</i>	Qld	Ayr District	NTM R7969	Physalopteridae sp.	Larva	Wall of Stomach	1	N/A
Gekkonidae	<i>Hemidactylus frenatus</i>	NT	Ayr District	JCU	Pharyngodontidae sp.	Adult	Rectum	1	NTM D1828
			Beatrice Hill	NTM R1640	<i>Skeptimodon</i> sp.	Adult	Rectum	1	NTM D1798
			Berry Springs Reserve	NTM R6346	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	3	NTM D1648
			Black Point	NTM R20939	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	NTM D1631
			Crocker Is. Mindjilang Community	NTM R20409	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	NTM D1639
			Darwin	NTM R19816	<i>Macrachoania brygool</i>	Adult	Intestine	1	NTM D1819
				NTM R25671	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	NTM D1638
				NTM R25980	<i>Parapharyngodon mplectoni</i>	Adult	Rectum	5	NTM D1641
				NTM R0010	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	NTM D1822
				NTM R19815	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	10	NTM D1625
Scincidae	<i>Ctenodus strouchii varius</i>	NSW	Katherine	NTM R8142	<i>Spaulligodon hemidactylus</i>	Adult	Intestine	1	NTM D1632
			New Year Island	NTM R7687	Physalopteridae sp.	Larva	Wall of Stomach	1	N/A
			T. Tree	NTM R6564	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	NTM D1829
			Christmas Island	NTM R19503	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	N/A
			No collection data	NTM R3566	<i>Spaulligodon hemidactylus</i>	Adult	Rectum	1	NTM D1628
			Sturt National Park	AM R151609	Physalopteridae sp.	Larva	Intestine	1	AM W49136
				AM R152920	Physalopteridae sp.	Larva	Intestine	1	AM W49137
	AM R152957	Physalopteridae sp.	Larva	Intestine	1	AM W49138			

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Host Family	Host Species	State Collected	Location Collected	Source	Identification	Stage	Location in host	No.	Parasite Museum Deposit Number
			Nelly Bay, Magnetic Island	JCU	<i>Abbreviata bancrofti</i>	Adult	Intestine	1	NTM D1776
			Tomoulin (near Ravenshoe)	JCU	<i>Ophidascaris</i> spp.	Adult	Stomach	3	NTM D1802
			No collection data	JCU	<i>Ophidascaris moreliae/ robertsi</i>	Adult	Stomach	9	NTM D1800
Colubridae	<i>Sigamantis cucullatus</i>	NT	Fogg Dam	TERF	<i>Abbreviata hastaspicula</i>	Adult	Intestine	1	NTM D1768
					<i>Tanqua tiana</i>	Adult	Intestine	1	N/A
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	1	NTM D1745
				TERF	<i>Kalcephalus</i> sp.	Adult	Intestine	1	NTM D1814
				TERF	<i>Unenyon</i>	Larva	Mesenteries	1	NTM Unreg
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	1	NTM D1714
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	20	NTM D1670
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	10	NTM D1720
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	135	NTM D1682
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	7	NTM D1742
				TERF	<i>Draconculis multibis</i>	Adult	Intestine	1	NTM D1815
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	7	NTM D1707
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	21	NTM D1722
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	145	NTM D1687
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	135	NTM D1705
				TERF	<i>Eastrogyliodes</i> sp.	Larva	Intestine	1	NTM D1787
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	45	NTM D1691
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	2	NTM D1737
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	12	NTM D1674
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	4	NTM D1710
				TERF	<i>Eastrogyliodes</i> sp.	Larva	Intestine	1	NTM D1792
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	1	NTM D1732
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	22	NTM D1658
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	32	NTM D1715
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	21	NTM D1698
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	3	NTM D1731
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	54	NTM D1692
				TERF	<i>Abbreviata</i> spp.	Larva	Intestine	3	NTM D1736
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	24	NTM D1659
				TERF	<i>Kalcephalus</i> sp.	Adult	Intestine	1	NTM D1793

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Host Family	Host Species	State Collected	Location Collected	Source	Identification	Stage	Location in host	No.	Parasite Museum Deposit Number
					<i>Tanqua anomala</i>	Adult	Intestine	4	NTM D1699
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	8	NTM D1709
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	60	NTM D1669
					<i>Abbreviata bancrofti</i>	Adult	Intestine	6	N/A
					<i>Abbreviata</i> spp.	Adult	Intestine	5	NTM D1741
					<i>Kalcephalus</i> sp.	Adult	Intestine	1	NTM D1794
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	201	NTM D1690
					<i>Abbreviata bancrofti</i>	Adult	Intestine	2	NTM D1718
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	50	NTM D1678
					<i>Abbreviata hastaspicula</i>	Adult	Intestine	1	NTM D1746
					<i>Tanqua anomala</i>	Adult	Intestine	37	NTM D1673
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	2	NTM D1708
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	2	NTM D1752
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	3	NTM D1740
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	54	NTM D1696
					<i>Abbreviata bancrofti</i>	Adult	Intestine	17	NTM D1734
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	26	NTM D1695
				TERF	<i>Abbreviata bancrofti</i>	Larva	Intestine	1	NTM D1719
					<i>Eustrongylides</i> sp.	Larva	Intestine	1	NTM D1791
					<i>Tanqua anomala</i>	Adult	Intestine	10	NTM D1683
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	1	NTM D1738
					<i>Tanqua anomala</i>	Unk	Intestine	4	NTM D1703
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	54	NTM D1676
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	8	NTM D1733
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	56	NTM D1660
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	17	NTM D1667
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	1	NTM D1743
					<i>Eustrongylides</i> sp.	Larva	Intestine	4	NTM D1789
					<i>Kalcephalus</i> sp.	Larva	Intestine	1	NTM D1795
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	1	NTM D1702
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	21	NTM D1675
					<i>Abbreviata hastaspicula</i>	Adult	Intestine	1	NTM D1744
					<i>Tanqua anomala</i>	Adult	Intestine	10	NTM D1684
				TERF	<i>Eustrongylides</i> sp.	Larva	Intestine	2	NTM D1790
					<i>Tanqua anomala</i>	Adult	Intestine	9	NTM D1677
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	26	NTM D1751
					<i>Eustrongylides</i> sp.	Larva	Intestine	1	NTM D1788

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Host Family	Host Species	State Collected	Location Collected	Source	Identification	Stage	Location in host	No.	Parasite Museum Deposit Number
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	7	NTM D1784
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	2	NTM D1713
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	20	NTM D1701
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	11	NTM D1766
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	10	NTM D1783
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	34	NTM D1749
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	6	NTM D1721
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	12	NTM D1689
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	2	NTM D1729
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	19	NTM D1688
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	1	NTM D1724
				TERF	<i>Dacnalcata</i> sp.	Adult	Tissues	1	NTM D1816
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	20	NTM D1672
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	19	NTM D1716
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	15	NTM D1680
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	1	NTM D1717
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	8	NTM D1668
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	1	NTM D1735
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	13	NTM D1661
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	5	NTM D1711
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	5	NTM D1704
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	8	NTM D1727
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	25	NTM D1693
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	1	NTM D1666
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	6	NTM D1657
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	65	NTM D1706
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	3	NTM D1748
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	23	NTM D1785
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	6	NTM D1750
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	1	NTM D1761
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	22	NTM D1726
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	16	NTM D1686
				TERF	<i>Abbreviata bancrofti</i>	Adult	Intestine	7	NTM D1730
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	10	NTM D1656
				TERF	<i>Abbreviata</i> spp.	Adult	Intestine	1	NTM D1739
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	9	NTM D1663
				TERF	<i>Tanqua anomala</i>	Adult	Intestine	10	NTM D1662

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Order	Family	Identification	Host Family	Host Species	State Collected	Prevalence	Intensity		
Physalopteridae	Physalopteridae	<i>Abbreviata hameroffi</i>	Boidae	<i>Aspidites melanacrophalus</i>	NT	1/2	6		
			Colubridae	<i>Moresia spilata</i>	Qld	2/2	8–9 (8.5)		
			Colubridae	<i>Tropidonophis mairii</i> *	Qld	1/5	1		
			Colubridae	<i>Tropidonophis mairii</i> *	NT	30/54	1–32 (8.9)		
			Colubridae	<i>Tropidonophis mairii</i> *	Qld	3/4	1–5 (3.3)		
			Elapidae	<i>Domania vestigiata</i> *	NT	2/2	27–69 (48)		
			Elapidae	<i>Pseudonaja textilis</i> *	Qld	6/7	1–50 (17.2)		
			Elapidae	<i>Pseudonaja textilis</i> *	NT	1/1	1		
			Varanidae	<i>Varanus gouldii</i>	Qld	1/2	27		
			Varanidae	<i>Varanus gouldii</i>	NT	2/3	9–10 (9.5)		
			Boidae	<i>Aspidites ramseyi</i> *	NT	4/5	1–26 (10.5)		
			Colubridae	<i>Stegonotus acallatus</i>	NT	1/2	1		
			Varanidae	<i>Tropidonophis mairii</i> *	NT	2/54	1		
Varanidae	<i>Varanus gouldii</i>	NT	3/3	35–105 (63.7)					
Agamidae	<i>Abbreviata spp.</i>	Agamidae	<i>Varanus spenceri</i> *	NT	1/1	250			
		Agamidae	<i>Intelligama kesnerii</i>	Qld	1/1	1			
		Boidae	<i>Aspidites melanacrophalus</i>	Unk	1/1	1			
		Boidae	<i>Aspidites ramseyi</i>	NT	1/5	1			
		Colubridae	<i>Stegonotus acallatus</i>	Qld	1/2	3			
		Colubridae	<i>Stegonotus acallatus</i>	NT	1/2	1			
		Colubridae	<i>Tropidonophis mairii</i>	NT	8/54	1–7 (2.9)			
		Colubridae	<i>Tropidonophis mairii</i>	Qld	1/4	4			
		Elapidae	<i>Domania vestigiata</i>	Qld	1/7	2			
		Elapidae	<i>Pseudochis anstralis</i>	NT	1/1	10			
		Varanidae	<i>Pseudochis porphyreus</i>	Qld	1/1	1			
		Varanidae	<i>Varanus gouldii</i>	Qld	1/1	1			
		Gekkonidae	<i>Physalopteridae sp.</i>	Gekkonidae	<i>Hemidactylus frenatus</i>	NT	1/12	1	
Gekkonidae	<i>Oedura rhombifer</i> *			NT	2/2	1			
Gekkonidae	<i>Oedura rhombifer</i> *			NT	2/2	1			
Gekkonidae	<i>Crenatus strachani varius</i> *			NSW	3/3	1			
Gekkonidae	<i>Eulamprus quoyi</i> *			Qld	1/1	1			
Colubridae	<i>Tropidonophis mairii</i>			Qld	1/4	5			
Colubridae	<i>Stegonotus acallatus</i> *			NT	1/2	1			
Colubridae	<i>Tropidonophis mairii</i> *			NT	3/54	1			
Elapidae	<i>Acanthophis praelongus</i> *			NT	1/3	1			
Colubridae	<i>Tropidonophis mairii</i>			NT	1/61	1			
Elapidae	<i>Acanthophis praelongus</i>			NT	1/3	1			
Strongylida	Spiruridae			<i>Physalopteroides filicanda</i>	Scincidae				
				<i>Spiruridae sp.</i>	Colubridae				
		<i>Kaliophthalmus sp.</i>	Colubridae						
Unknown	Unknown	Unknown	Elapidae						
		Unknown	Colubridae						