HELMINTH PARASITES OF THE LACE MONITOR
VARANUS VARIUS (REPTILIA: VARANIDAE) IN EASTERN AUSTRALIA.

HUGH I. JONES*

*Discipline of Microbiology and Immunology, School of Biomedical, Biomolecular and Chemical Science, University of Western Australia, Nedlands, Western Australia 6009.

Phone: (08)9346-1270 or (08)9386-6140. Email: hjones@cyllene.uwa.edu.au

Summary

Six species of gastrointestinal nematode, one tissue-dwelling nematode and one species of cestode were recovered from 63 specimens of *Varanus varius* (White, ex Shaw), examined from throughout their range in eastern Australia. *Abbreviata confusa* (Johnston & Mawson, 1942) Chabaud, 1956 was the predominant species, occurring in 42.9% of lizards at a mean intensity of 20. *A. antarctica* (Linstow, 1899) Schulz, 1927 occurred in 9.8% of lizards, *Raillietascaris varani* (Baylis & Daubney, 1922) Sprent, 1985 in 11.5% and the cestode *Kapsulotaenia tidswelli* (Johnston, 1909) Freze, 1965 in 14.3% of hosts examined. Other nematode infections (*Tanqua tiara* (Blanchard, 1904), *Strongyluris paronai* (Stossich, 1902)) were with one or two specimens only. Infection with *Piratuboides* sp. (Mackerras, 1962) Bain & Sulahian, 1974 was confirmed from this host for the first time. This parasite fauna is discussed in relation to the geographical environment and ecology of the host.

Keywords: Reptile helminths, Australia, *Varanus varius*, *Abbreviata*, *Raillietascaris*, *Tanqua*, *Piratuboides*, *Kapsulotaenia*

Introduction

The lace monitor, *Varanus varius* (White, ex Shaw), was the first Australian monitor lizard to be described (White 1790). It is one of the largest lizards in Australia, attaining a length of almost two metres (Weavers 2004). It occurs from northern Queensland to eastern South Australia, extending west to central New South Wales (Cogger 1992). *Varanus varius* is a largely arboreal lizard which occupies a variety of habitats, including lowland open forest and woodland, and, in the lowland northern parts of its range, forests with denser canopy cover. West of the Great Dividing Range, this monitor is found in narrow fringes of woodland along margins of rivers and lakes (Weavers 2004). In some parts of its range it occurs sympatrically with *V. gouldii* (Gray) and *V. rosenbergi* Mertens.

Several species of nematode and two species of cestode have been identified from the gastrointestinal tract of this well-known lizard, but hitherto there have been no studies to determine prevalence, intensity of infection or geographical range of these parasites. This study was undertaken to remedy this lack of information, and to compare the nematode fauna with that of other large species of *Varanus* in Australia.

Materials and Methods

Gastrointestinal tracts were examined from 61 specimens preserved in the Australian Museum (N: 27), Victorian Museum (N: 17), South Australian Museum (N: 5), Australian National Wildlife Collections at CSIRO Sustainable Ecosystems, Canberra (N: 9) and the Queensland Museum (N: 3). Nematodes were also examined from two *V. varius* from Queensland and forwarded by Leigh Owens and John Mines. In total, findings are reported from 6 lizards in Queensland, 35 from New South Wales, 17 from Victoria and five from South Australia. Size (snout-vent length, SVL), collection date and locality, and food residues in the stomachs were noted for all hosts. Worms recovered were cleaned, stored in 70% ethanol with 10% glycerol, cleared in chlorolactophenol, and examined with an Olympus BA series microscope. In addition, nematodes were examined from eight *V. varius* held in the Australian Helminth Collection (AHC). All specimens have been returned to their respective institutions.
PARASITIC HELMINTHS IN *VARANUS VARIUS*

**Results**

**Helminths recovered.** Six species of gastrointestinal nematode were identified (Table 1): *Abbreviata confusa* (Johnston and Mawson, 1942) Chabaud, 1956, *A. antarctica* (Linstow, 1899) Schultz, 1927, *A. hastaspicula* Jones, 1979, *Raillietascaris varani* (Baylis and Daubney, 1922), Spret, 1985, *Tanqua tiara* (Blanchard, 1904) and *Strongylurus paronai* (Stossich, 1902) Railliet & Henry, 1914. In addition, one immature female *Piratuboides sp.* Mackerras, 1962 was recovered from the body cavity of a lizard from Eungella Range, Queensland. In all, 33/63 (52.4%) of *V. varius* were infected with gastrointestinal nematodes. Two hosts contained larval *Abbreviata* sp. only. No cysts containing physalopterid larvae were seen on or within any internal organs. Nine hosts (14.3%) contained the cestode *Kapsulotaenia tidswelli*. Nematodes taken from six of the eight *V. varius* in the AHC were identified as *A. confusa*, one contained *A. antarctica* and one contained larval *Abbreviata* only.

**Table 1.** Helminth species recovered from 63 specimens of *Varanus varius*

| Helminth                       | Prevalence | Intensity (range and mean) |
|-------------------------------|------------|---------------------------|
| *Abbreviata confusa*          | 25 (42.9%) | 1-88; 20.4;               |
| *Abbreviata antarctica*       | 6 (9.8%)   | 1-35; 13.3;               |
| *Abbreviata hastaspicula*     | 2 (3.3%)   | 2, 5.                     |
| *Raillietascaris varani*      | 7 (11.5%)  | 1-32; 11.7;               |
| *Tanqua tiara*                | 1 (1.6%)   | 1-                        |
| *Strongylurus paronai*        | 1 (1.6%)   | 1-                        |
| *Piratuboides sp.*            | 1 (1.6%)   | 1-                        |
| *Kapsulotaenia tidswelli*     | 9 (14.3%)  | ?                         |

**Prevalence, intensity and distribution.** *Abbreviata confusa* was the most frequently encountered nematode, occurring in 27 (42.9%) of lizards examined (Fig. 1). Seventeen of these lizards (63.0%) contained single-species infections. Fourteen of all infected lizards (51.8%) contained <10 worms. Both intensity and prevalence of infection were higher in lizards from within about 100 km of the coast; nine of thirteen lizards infected with >10 *A. confusa* were from east of the Great Dividing Range. Three of six *A. antarctica* occurred concurrently with *A. confusa* (Fig. 2). The only two infections with *A. hastaspicula* were from mid-central to west New South Wales. Six of seven *R. varani* occurred concurrently with *A. confusa* and/or *A. antarctica*. *R. varani* occurred from just south of Sydney northwards, east of the Great Dividing Range (Fig. 3). *R. varani* were found most frequently in the stomachs, in some cases with the anterior ends buried in the host gastric tissues, with a small number in the upper portions of the intestine. All infections with *K. tidswelli* were in the lower portions of the hosts’ intestines. One infection with this cestode was from Gippsland in Victoria, one from northern Queensland, and the remaining seven from locations in New South Wales; all but one were from east of the Great Dividing Range (Fig. 4).

**Host size and food residues.** No nematode infections were found in hosts with an SVL of <380mm; above that size, there was no relation to host SVL. Less than one half of stomachs (47.5%) had no food residues; 26% contained arthropod remains, 13% contained mammal, 9.8% reptile, 3.3% bird and 1.6% amphibian remains. The vertebrate remains (27.7%) included a bandicoot, possum (? greater glider *Petauroides volans* (Kerr)), an echidna *Tachyglossus aculeatus* (Shaw) (represented by a few spines), a medium-sized snake, and a medium to large *V. varius*, as well as scavenged lamb chops and chicken eggs.

**Discussion**

Johnston (1909) recorded *Physaloptera* sp. as possibly *P. varani* (=*Abbreviata*) from *V. varius*, but admitted that he had not seen Parona’s description of this worm, and gave no details. In three subsequent publications Johnston (1912a, 1912b, 1916) records *A. varani* with a query. *Abbreviata varani* was more fully described by Ortlepp (1922) from five specimens from two different varanid host species from India and Sri Lanka.
H.I. Jones

His description of *A. varani* differs from that of either *A. antarctica* or *A. confusa*, principally in the very long left spicule, and it is likely that Johnston’s specimens were one of the two more common species above. The occurrence of *A. varani* in Australian reptiles therefore cannot yet be confirmed. *Abbreviata antarctica* was described from the western blue-tongued lizard *Cyclodus (=Tiliqua) occipitalis* (Peters) and from the death adder *Acanthophis antarcticus* (Shaw & Nodder) from South Australia by Linstow (1899). Irwin-Smith (1922) subsequently gave a fuller description from specimens removed from the eastern blue-tongued lizard *T. scincoides* (White ex Shaw) and from an un-named lizard. It was first reported from *V. varius* by Johnston & Mawson (1941) from Kangaroo Island (possibly a host or locality error, as *V. varius* is not known to occur on Kangaroo Island; Cogger 1992, Weavers 2004). *Abbreviata confusa* was described from many tiger snakes *Notechis scutatus* (Peters) from South Australia by Johnston & Mawson (1942), who distinguished it from *A. antarctica*. They postulated that *A. confusa* was confined to snakes. *Abbreviata hastaspicula* was described from the black-headed python *Aspidites melanocephalus* (Krefft) by Jones (1979), and has subsequently been found to be widespread in drier areas of Australia, principally in species of *Varanus*.

Figure 1. (LHS). Geographical distribution of *Abbreviata confusa* infection in *Varanus varius*. ○ no infection; ● infection with *A. confusa* (small circles, <20 specimens, large circles, >20 specimens). ■ *A. confusa* identified from AHC and two other collections. (Locality of one specimen too imprecise to include). Dotted line indicates approximate distribution of *V. varius*.

Figure 2. (RHS). Geographical distribution of *Abbreviata antarctica* (●) and *Abbreviata hastaspicula* (▲) in *Varanus varius*. Results from two other collections denoted thus by a square (□).

The present study shows that *A. confusa* is the predominant species of gastrointestinal nematode in *V. varius*, occurring throughout its range, and being more common in higher rainfall areas nearer the coast. However, less than half the lizards examined were infected, and intensity of infection was low in most cases. This contrasts with the situation in three partly-sympatric large varanid lizards; 52/56 (93%) *V. rosenbergi* were infected with *A. antarctica*, at a mean intensity of 57 worms (Jones 2005); and 31/42 (74%) *V. gouldii* (sensu...
stricto) and 9/9 (100%) *V. panoptes* were infected with *A. hastaspicula* at a mean intensity of 101 and 154 respectively (Jones 1983); these three lizard host species were also infected with five other species of *Abbreviata*. Life-cycles have not been elucidated for any species of *Abbreviata* in Australia. Tenebrionid beetles, gryllid crickets, acridid and tettigonid grasshoppers (Orthoptera), and mantids (Dictyoptera), were experimentally or naturally-infected intermediate hosts for *A. kazachstanica* Markov and Paraskiv, 1956, and frogs and geckos could act as paratenic hosts (Kabilov and Siddikov 1978, Kabilov 1980), and there is indirect evidence that termites may have a role in transmission of *Abbreviata* spp. in arid Australia (Jones 1995). *Varanus varius* takes larger prey (more than a quarter of animals in the present study contained vertebrate remains) and carrion may dominate the diet, at least in one location (Lake Burrendong, NSW), though diet clearly varies with both season and locality (Guarino 2001, Weavers 1989). In the absence of knowledge of either intermediate or paratenic hosts for *A. confusa*, the significance of such factors as large size, large summer home range (Guarino 2002) and diet in this host cannot yet be assessed.

Intensity of *A. confusa* in *V. varius*, though less than that of other *Abbreviata* species in other varanid hosts, indicates that it is the most salient nematode parasite in this host. *Abbreviata confusa* occurs commonly in a number of other varanid hosts, *V. glauerti* Mertens, *V. glebopalma* Mitchell, *V. tristis* (Schlegel) and *V. scalaris* Mertens, and in other species at lower mean intensity, and often concurrently with other congeneric species (Jones 1988). The presence of infections with *A. antarctica* (two hosts with >20 worms) and low numbers of *A. hastaspicula* is evidence that *V. varius* can support other species of *Abbreviata*, and that infection is more likely to be ecologically rather than physiologically determined (Jones 1988). It is significant that the two hosts infected with *A. hastaspicula* were from drier and hotter areas of mid-central

Figure 3. (LHS). Geographical distribution of *Raillietascaris varani* in *Varanus varius*. Results from two other collections denoted by a square (■).

Figure 4. (RHS). Geographical distribution *Kapsulotaenia tidswelli* in *Varanus varius*. Results from two other collections denoted by a square (■).
New South Wales; four *V. gouldii* obtained from the same area as one of these *V. varius*, Gundabooka National Park, each contained >200 *A. hastaspicula* (Jones unpublished). Apart from a single *K. tidswelli* from central New South Wales, all infections of *A. antarctica*, *R. varani*, and *K. tidswelli* occurred east of the Great Dividing Range. *Tanqua tiara* was described (as *Ascaris tiara*) from species of *Varanus* from Africa and Asia by Linstow (1879), and first reported in *V. varius* by Johnston & Mawson (1948).

The single infection in the present study was from north Queensland. It is common in other Australian species of *Varanus* (e.g., *V. mertensi*, *V. panoptes*, *V. gouldii* and *V. indicus* (Daudin)) in the tropics (Jones 1988, 2004). *Ophidascaris varani* was described by Johnston & Mawson (1947) from *V. varius* from southern Queensland, and subsequently Thomas (1959) described *Amplicaecum mackerrasae* from the same host species and from the same locality. Sprent (1985) reduced these, and four other described ascaridoid nematodes, to synonymy, naming them *Raillietascaris varani*. This nematode has not hitherto been recorded in other species of *Varanus* in Australia. Its distribution in *V. varius* indicates that it is confined to warmer areas with higher rainfall; the life-cycle has not been elucidated, but it probably involves an intermediate host (Sprent 1985); the higher prevalence of vertebrates in this host’s food may be significant in this regard, though whether as paratenic or intermediate hosts is not known. Sprent (1985) considers that this species had a recent origin in the Old World tropics, and that it dispersed from India. Several specimens were attached to the gastric mucosa by their anterior ends but none were found threaded through the gastric tissues as is often the case in *Ophidascaris pyrurus* in elapid snakes. *Strongylurus paronai* occurs primarily in agamid lizards in Australia (*Chlamydosaurus kingii*, *Pogona microlepidota*), predominantly from higher rainfall areas (Johnston and Mawson 1942; Jones 1986, 1994), and has not been recorded previously from other species of *Varanus*. The single male found in this study was therefore probably derived from ingested prey. The single specimen of *Piratuboides* was a female with infertile eggs. Johnston & Bancroft (1920) recovered a ‘large filaria’ from *V. varius*; Mackerras (1962) described two similar species of *Piratuba* (=*Piratuboides*) from *V. tristis*, *P. queenslandensis* from several sites in Queensland and *P. varanicola* from north Queensland. Specimens collected from near Brisbane and identified as *P. queenslandensis* may have been from *V. varius* (Mackerras 1962). Otherwise, there have been no other records of filarial nematodes from this host.

Two species of cestode have been reported from *V. varius*; Johnston (1909) described the cestode *Acanthotaenia tidswelli* (= *Kapsulotaenia tidswelli* Freze, 1965) from Bathurst, New South Wales, and subsequently (1912a) identified it from the same host species in southeast Queensland. Johnston (1913) described *Bothridium parvum* from this host in north Queensland. Specimens collected in the present study were readily identified as *K. tidswelli* by the form of the scolex, though the minute cuticular spines on the scolex and neck described by Johnston were only visible in patches – perhaps an artifact of poor preservation.

**Conclusion**

This study illustrates that a widespread species of *Abbreviata, A. confusa*, is the predominant gastrointestinal nematode in *V. varius*. However, it occurs at lower prevalence and intensity than other species of *Abbreviata* in other large congeneric varanid species. In the absence of a fuller understanding of the biology of *Abbreviata* spp. nematodes, possible reasons for this remain speculative. Two other species of *Abbreviata* were also recorded; *A. antarctica* appears to be more common in *V. rosenbergii*, and *A. hastaspicula* from more arid and hotter inland areas, as in the two infected lizards in the present study. These observations lend further support to the importance of ecological factors in determining intensity and prevalence of *Abbreviata* infections in Australian varanid lizards (Jones 1988).

**Acknowledgments**

I thank Ross Sadlier, Australian Museum, Dianne Bray, Museum Victoria, Mark Hutchinson, South Australian Museum, Patrick Couper, Queensland Museum, and Dave Spratt, CSIRO Sustainable Ecosystems, for letting me examine lizards in their care, and for providing examination facilities and collection data. Leigh Owens and John Mines kindly forwarded nematodes which they had collected, and the late P. M. Mawson lent nematode specimens from the Australian Helminth Collection.
PARASITIC HELMINTHS IN *VARANUS VARIUS*

References

Cogger, H.G. (1992) “Reptiles and Amphibians of Australia”. (Reed Books, Chatswood).

Guarino, F. (2001) Diet of a large carnivorous lizard, *Varanus varius*. *Wildlife Research* 28, 627-630.

Guarino, F. (2002) Spatial ecology of a large carnivorous lizard, *Varanus varius* (Squamata: Varanidae). *Journal of the Zoological Society of London* 258, 449-457.

Irwin-Smith, V. (1922) Notes on nematodes of the genus Physaloptera. Pt. iii. The Physaloptera of Australian lizards. *Proceedings of the Linnaean Society of New South Wales* 47, 232-244.

Johnston, T.H. (1909) On a new reptilian cestode. *Journal of the Royal Society of New South Wales* 43, 103-116.

Johnston, T.H. (1912a). A census of Australian reptilian haematozoa. *Proceedings of the Royal Society of Queensland* 23, 233-249.

Johnston, T.H. (1912b). Notes on some entozoan. *Proceedings of the Royal Society of Queensland* 24, 63-91.

Johnston, T.H. (1913) Cestoda and Acanthocephala. Report of the Australian Institute of Tropical Medicine 1911-1913, 75-96.

Johnston, T.H. (1916). A census of the endoparasites recorded as occurring in Queensland, arranged under their hosts. *Proceedings of the Royal Society of Queensland* 28, 31-79.

Johnston, T.H. & Bancroft M. J. (1920). Experiments with certain Diptera as possible transmitters of bovine onchocerciasis. *Proceedings of the Royal Society of Queensland* 32, 31-57.

Johnston, T.H. & Mawson, P.M. (1941) Some parasitic nematodes in the collection of the Australian Museum. *Records of the Australian Museum* 21, 9-16.

Johnston, T.H. & Mawson, P.M. (1942) Some new and known Australian parasitic nematodes. *Proceedings of the Linnaean Society of New South Wales* 67, 90-94.

Johnston, T.H., & Mawson, P.M. (1947) Some nematodes from Australian lizards. *Transactions of the Royal Society of South Australia* 71, 22-27.

Johnston, T.H. and Mawson, P.M. (1948) Some new records of nematodes from Australian snakes. *Records of the South Australian Museum* 9, 101-106.

Jones, H. I. (1979) Gastrointestinal nematodes, including three new species, from Australian and Papua New Guinean pythons. *Proceedings of the Helminthological Society of Washington* 46, 1-14.

Jones, H.I. (1983) *Abbreviata* (Nematoda: Physalopteroidea) in lizards of the *Varanus gouldii* complex (Varanidae) in Western Australia. *Australian Journal of Zoology* 31, 285-298.

Jones, H.I. (1986). Gastrointestinal nematodes in the lizard genus *Pogona* Storr (Agamidae) in Western Australia. *Australian Journal of Zoology* 34, 689-705.

Jones, H.I. (1988) Nematodes from nine species of *Varanus* (Reptilia) from tropical northern Australia, with particular reference to the genus *Abbreviata* (Physalopteridae). *Australian Journal of Zoology*. 36, 691-708.

Jones, H.I. (1994). Gastrointestinal nematodes of the frillneck lizard, *Chlamydosaurus kingii* (Agamidae), with particular reference to *Skjrabinoptera goldmanae* (Spirurida: Physalopteridae). *Australian Journal of Zoology* 42, 371-377.

Jones, H.I. (1995). Gastric nematode communities in lizards from the Great Victorian Desert, and an hypothesis for their evolution. *Australian Journal of Zoology* 43, 141-164.

Jones, H.I. (2004) Gastric nematodes, including a new species of *Abbreviata* (Nematoda: Physalopteridae) from the mangrove monitor *Varanus indicus* (Reptilia: Varanidae). *Transactions of the Royal Society of South Australia* 128, 53-59.

Jones, H.I. (2005) Gastrointestinal nematodes of *Varanus rosenbergi* (Reptilia: Varanidae) and the effects of habitat change in southern Australia, with particular reference to the genus *Abbreviata* (Physalopteroidea). *Records of the Western Australian Museum* 22, 259-263.
Kabilov, T.K. (1980) The life cycle of *Abbreviata kazachstanica* (in Russian). *Parazitologiya* **14**, 263-270.

Kabilov, T.K., & Siddikov, B.Kh. (1978). Finding the intermediate host of *Abbreviata kazachstanica* Markov et Paraskiv, 1956 (in Russian). *Doklady Akademii Uzbekskoi SSR*, **2**, 67-68.

Linstow, O. von (1899) Nematoden aus der Berliner Zoologischen Sammlung. *Mitteilungen aus der Zoologischen Sammlung des Museums für Naturkunde in Berlin* **1** (2), 1-28 (+ 6 plates).

Mackerras, M.J. (1962). Filarial parasites (Nematoda: Filarioidea) of Australian animals. *Australian Journal of Zoology* **10**, 400-457.

Ortlepp, R.J. (1922) The nematode genus *Physaloptera* Rud. *Proceedings of the Zoological Society of London* 999-1107.

Sprent, J.F.A. (1985) Ascaroid nematodes of Amphibians and Reptiles: Raillietascaris n. g. *Annales de Parasitologie Humaine et Comparée* **60**, 601-611.

Thomas, P.M. (1959) Some nematode parasites from Australian hosts. *Transactions of the Royal Society of South Australia* **82**, 151-162.

Weavers, B.W. (1989) Diet of the lace monitor *Varanus varius* in south-eastern Australia. *Australian Journal of Zoology* **25**, 83-85.

Weavers, B. (2004) *Varanus varius* pp. 499-515 In: “Varanoid Lizards of the World”, Pianka, E. R., King, D. R. and King, R. A. (Eds). (Indiana University Press, Bloomington and Indianapolis).

White, J. (1790) “Journal of a Voyage to New South Wales”. (Debrett, London).