Morulaimus gigas (Nematoda: Belonolaiminae) in southern and eastern Australia

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Abstract. This paper reports the first detections of *Morulaimus gigas* outside Western Australia in turf samples from South Australia, Victoria, New South Wales and Queensland. New infestations were also found in turf samples from Western Australia. Approximately 7% of turf samples tested between 1996 and 2008 contained *M. gigas* with 87% of these above the damage threshold. *M. gigas* was associated with turf decline in bent grass, *Agrostis tenuis* – a new addition to the previously recorded hosts.

The family Belonolaimidae, as defined by Siddiqi (2000), is a group of migratory ectoparasites commonly known as sting nematodes. All four genera in the family have been recorded from Australia (McLeod *et al.* 1994; Hodda and Nobbs 2008), but *Belonolaimus* Steiner 1949 has been found mainly in North America, *Ibipora* Monteiro and Lordello 1977 has been found mainly in Central and South America and *Carphodorus* Colbran 1965 and *Morulaimus* Sauer 1966 are generally restricted to Australia and New Zealand (Siddiqi 2000). This group of genera is listed as the subfamily Belonolaiminae by Fortuner and Luc (1987) and Hodda (2007). *Morulaimus gigas* Nobbs and Eyres 1992 was described in association with declining couch grass turf (*Cynodon dactylon*) from Western Australia. This paper presents data indicating a widespread distribution of *M. gigas* in Australia.

From 1996–2008, 3812 turf samples were submitted to Crop Health Services, Department of Primary Industries (DPI) Victoria, Australia by greenkeepers and turf consultants for diagnosis and assessment of plant-parasitic nematodes suspected to be associated with turf decline and/or as part of routine golf course and bowling green management programs.

The samples, received throughout each year from coastal and inland areas, exhibited symptoms similar to those caused by other plant-parasitic nematodes, including yellow and brown patches, and reduced vigour. The soils were typically sandy and roots were discoloured, short and stubby with few feeder roots.

Nematodes were extracted from the soil by using the Whitehead tray method (Whitehead and Hemming 1965). Different stages of the nematodes, including juveniles, males and females were recovered from the samples. Nematode specimens were fixed in formalin-acetic fixative 4:1 (Hooper 1970) to harden, and then transferred through a series of glycerol-ethanol solutions (Seinhorst 1959) to pure glycerol.

M. gigas was the only species present in the 80% of submitted samples containing plant-parasitic nematodes. Population densities were variable and ranged from 6–2976/200 mL soil. Although other plant-parasitic nematodes were extracted from some samples, symptoms of decline were only associated with population densities of *M. gigas* exceeding the damage threshold for sting nematodes (20/200 mL soil in couch turf (Robinson *et al.* 1994)). *M. gigas* was detected above this damage threshold in 228 of the 262 samples in which it was found.

Table 1. Permanent microscope slides of *Morulaimus gigas* from five Australian states deposited in the Victorian Plant Pathology Herbarium (VPRI)

States	Number of slides	VPRI voucher numbers
South Australia	8	34 295–34 302
Victoria	8	26 008, 34 303–34 309
New South Wales	66	25 743–25 746, 29 225, 29 226, 29 229, 29 230, 29 377–29 381, 29 385–29 388, 29 698–29 703, 29 705, 29 706, 33 651–33 653, 33 658–33 661, 33 681, 33 701–33 703, 33 710, 33 714, 33 717, 33 718, 33 722, 33 735, 33 737, 33 774, 33 826–33 829, 34 089–34 093, 34 096–34 100, 34 024–34 031
Queensland	4	34 290–34 292, 34 310
Western Australia	11	25 765–25 767, 25 780, 25 781, 25 798–25 800, 25 801, 34 293, 34 294

In the present study, turf samples from 48 locations in Australia were found to contain *M. gigas* (Fig. 3) with new detections in Western Australia, South Australia, Victoria, New South Wales and Queensland. These are the first records of *M. gigas* in eastern and southern Australia. *M. gigas* was also found for the first time in bent grass (*Agrostis tenuis*). It is possible that *M. gigas* has a wider host range than previously known and this requires further investigation.

A total of 97 permanent microscope slides of *M. gigas* were deposited in the Victorian Plant Pathology Herbarium (VPRI)

Fig. 1. (a) *Morulaimus gigas* with four distinct lateral lines and outer bands areolated. (b) Aerolated outer band and tail elongated, cylindrical with rounded and annulated terminus of *M. gigas*.

DPI Victoria, Australia (Table 1) with 8 from South Australia, 8 from Victoria, 66 from New South Wales, 4 from Queensland and 11 from Western Australia.

The nematodes were identified as being in the genus *Morulaimus* by having submedian lobes in the head region not separated by deep grooves; four distinct lines in the lateral field; the outer bands areolated (Fig. 1a and b); conspicuous epiptygma (Fig. 2); an elongated labial disc and an elongated, cylindrical tail with rounded, annulated terminus (Fig. 1b). These are key taxonomic criteria defining the genus *Morulaimus* (Table 2).

There are eight species in the genus *Morulaimus*, all described from Australia (Siddiqi 2000). The specimens from the turf samples in the present study had the following diagnostic characters: long body (2180–2479 μm), long stylet (108–113 μm), vagina vera heavily sclerotised (Fig. 2) and tail elongated, cylindrical with rounded, annulated terminus (Fig. 1b). All these characters are diagnostic for *M. gigas* (Nobbs and Eyres 1992). The measurement ranges found in the different localities are slightly smaller than that recorded in the original description. This variation is expected considering diverse locations from which the specimens were obtained.

Fortuner and Luc (1987) considered the genus *Ibipora* synonymous with *Belonolaimus*, rejecting the number of lateral lines as diagnostic and ignoring the other differentiating character (dorsoventral position of dorsal oesophageal gland) (Sauer *et al.* 1980); without these differentiating characters, *M. gigas* comes close to *B. lolii*. However, Siddiqi (2000)

Fig. 2. Female *Morulaimus gigas* with conspicuous epiptygma and heavily sclerotised vagina vera.

Table 2. Key characters differentiating four genera of sting nematodes recorded from Australia (Sauer *et al.* 1980)

Genera	Submedian lobes	Lateral field	Epiptygma	Labial disc shape
<i>Morulaimus</i>	No distinct grooves	4 distinct incisures, outer bands areolated	Present	Elongated
<i>Ibipora</i>	4 distinct grooves	4 distinct incisures, outer bands areolated	Absent	Rounded
<i>Belonolaimus</i>	4 distinct grooves	Single groove-like incisure	Present	Rounded
<i>Carphodorus</i>	No distinct grooves	2 distinct incisures	Absent	Rounded

Fig. 3. Distribution map of *Morulaimus gigas* in Australia with ▲ indicating previous detections in Western Australia and ■ indicating the most recent detections from this research.

considered lateral lines, epiptygma and position of oesophageal glands as valid generic differentiating characters within Belonolaiminae. If these characters are valid, then *M. gigas* is not synonymous with *B. loli*. In this paper the latest view that *M. gigas* is distinct is accepted, but note that the possible synonymy is being investigated, with results presented elsewhere.

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