Eight known species of *Aphelenchoides* nematodes with description of a new species from Manipur, India

L. Bina Chanu · N. Mohilal · L. Victoria ·
M. Manjur Shah

Received: 25 April 2013 / Accepted: 27 May 2013 / Published online: 20 June 2013
© Indian Society for Parasitology 2013

Abstract Study of *Aphelenchoides* nematodes from different localities of Manipur were conducted for their documentation. During the study eight known and a new species were identified. *Aphelenchoides aerialis* sp. nov. differed from all other species of *Aphelenchoides* in having a tail without bifurcation and strong ventral mucro with single ventrosublateral caudal papillae in male. The known species along with the new species are described in the present study.

Keywords Nematode · *Aphelenchoides* · New species · Manipur · India

Introduction

Aphelenchoides spp. leads a mycetophagous lifestyle. However, the genus does contain a few species which are of greater or lesser importance as ecto and endoparasites of plants. Some species have been shown to parasitize higher plants and yet feed and reproduce on a variety of fungi. The major plant-parasitic species include *A. besseyi* Christie (1942) which causes ‘white tip’ disease of rice. *A. fragariae* (Ritzema Bos 1890; Christie 1932) and *A. ritzemabosi* (Schwartz 1911; Steiner 1932) which attack a wide variety of plants and *A. arachidis* Bos (1977); a species of restricted distribution, attacking groundnut. Uniquely amongst the Aphelenchida, two species have been reported from the marine littoral habitat (Timm and Franklin 1969) tolerating wide differences in salinity. There are a total of 138 species of identified *Aphelenchoides* spp. world-wide

and 54 species were collected from India. In Manipur also a survey for *Aphelenchoides* nematodes was conducted in different localities and hosts of Manipur for their documentation. Eight known species and a new species, *A. aerialis* sp. nov. were identified during the study. All the species along with the new species are illustrated herewith.

Materials and methods

The collected samples were processed through Cobb’s (1918) decanting and sieving method followed by modified Baermann’s funnel technique. The extracted nematodes were killed in warm F.A (4:1) and processed by the glycerol–ethanol method of Seinhorst (1959). After slides preparation, measurements were taken using an ocular micrometer and diagrams were drawn under a camera lucida. Photomicrographs were taken using a 200X Meiji VT Series Inverted Microscope.

Results and discussions

Aphelenchoides aerialis sp. nov. (Figs. 1, 2)

Dimension Refer Table 1

Descriptions

Female Body mirror image of S- shaped upon fixation. Cuticular striation fine. Lateral field with two incisures. Cephalic region low, set off by constriction. Cephalic sclerotisation weak. Stylet 15.3 µm long with very small basal thickenings. Median oesophageal bulb at 59.5 µm from anterior end, oblong, valvular apparatus in the middle of the bulb. Oesophageal glands overlap the intestine, 129.2 µm long, occupying less than half the body width. Nerve rings a bit far behind oesophago–intestinal

L. B. Chanu (✉) · N. Mohilal · L. Victoria · M. M. Shah
Parasitology Section, Department of Life Sciences, Manipur
University, Canchipur 795003, Manipur, India
e-mail: bina.chanu@gmail.com

Fig. 1 Camera lucida drawings of *Aphelenchoides aerialis* sp. nov. **a** Female, anterior body, **b** male, entire body, **c** female, entire body, **d** male, anterior body, **e** male, posterior body showing mono ventro—sublateral caudal papillae, **f** female, tail region

junction, excretory pore opposite to base of oesophageal median bulb and above nerve ring. Vagina directed forward and sphincter highly developed; vulval lips raised. Gonad monoprodelfic and outstretched, oocytes arranged in a single row. Sphincter present at oviduct—uterine junction, spermatheca packed with round sperms. Post-vulval uterine sac short, 28.9 μ m long. Tail conical 42.5–48.2 μ m long and provided with a single small smooth mucro.

Male Body curved ventrally but more curved at tail region. Testis long and outstretched. Spicules typical of the genus. Dorsal limb 23.8 μ m in length without knob—tipped and ventral limb 11.9 μ m in length. Capitulum and rostrum very well developed. Post anal genital papillae one pair situated above tail terminus. Tail terminating into a long spine—like mucro.

Type habitat and locality Bark of *Pinus roxburghii* Sarg from Nongpok Sekmai with 24.76384 Latitude and 93.85574 Longitude, Thoubal District, Manipur.

Type species Collected in March, 2007. Holotype female on slide LV₂₇₁/1-♀ *A. aerialis* sp. nov. paratype females on the slides LV₂₇₁/2- 4 -♀ *A. aerialis* sp. nov. and paratype male on slide LV₂₇₁/1 - ♂ *A. aerialis* sp. nov., deposited in the parasitology Laboratory, Department of Life Sciences, Manipur University, Canchipur—795003, Manipur.

Etymology The species was designated based on the location of the nematode which is the above ground level of host plant.

Differential diagnosis The species differed from all other species of *Aphelenchoides* in having a tail without bifurcation with strong ventral mucro with single ventro-sublateral caudal papillae in male.

Aphelenchoides aerialis sp. nov. comes close to *A. pinusi* Bajaj and Walia (1999); *A. saprophilus* Franklin (1957) and *A. fragariae* (Ritzema Bos 1890; Christie 1932). However, it differs from *A. pinusi* in having smaller body, excretory pore above nerve ring, opposite to base of the median oesophageal bulb; shorter post—vulval uterine sac and shorter spicules without knob—tipped dorsal limb; post anal genital papillae one pair at tail terminus ($L = 0.56$ – 0.80 mm, post vulval uterine sac = 34–60 μ m, dorsal limb of spicules = 25–30 μ m with knob tipped; ventral limb = 12–15 μ m, tail terminating into a long spine—like mucro, three pair of genital papillae, 1st slightly post anal, 2nd near middle of tail and 3rd near tail terminus in *A. pinusi*). *Aphelenchoides aerialis* sp. nov. differs from *A. saprophilus* in having two lateral lines, smaller and more slender body, spicules without knob—tipped dorsal limb ($L = 0.54$ mm, $a = 20$, lateral lines = 4, dorsal limb of spicule = 23 μ m with knob—tipped in *A. saprophilus*). The new species also differs from *A. fragariae* in having longer stylet with very small basal thickening, excretory pore above nerve ring, more robust body, highly developed sphincter at vagina, longer spicules ($a = 45$ – 60 , stylet = 10 μ m with distinct knobs, excretory pore opposite to nerve ring, absence of sphincter at vagina, spicule = 14–17 μ m in *A. fragariae*).

Aphelenchoides aligarhiensis Siddiqi et al. (1967)

Dimension Refer Table 2

Descriptions

Female Body slightly curved upon fixation. Cuticle with very fine striae, about 1.7 μ m apart near mid—body. Lip region rounded, offset from body. Lateral fields with four incisures, 1/4th as wide as body. Stylet slender, 10.2 μ m long, basal thickening of stylet weakly developed. Excretory pore situated at 52.7 μ m from anterior end of body opposite to nerve ring. Ovary long, outstretched, oocytes in a single row except for a few in region of multiplication. Spermatheca oblong, packed with discoidal spermatozoa. Uterine sac measuring almost five times body width,

Fig. 2 Photomicrograph of *Aphelenchoides aequalis* sp. nov. **a** Female, anterior body, **b** female, genital branch, **c** female, posterior body, **d** male, entire body, **e** male, anterior end, **f** male, posterior end

extending to more than half the vulva- anus distance. Tail elongate-conoid, ventrally arcuate, tapering to a rounded terminus, armed with a mucronate spine.

Male Not found.

Habitat and locality Soil around rhizospheric region of *Pinus kesiya* Royle from Khuga Dam with 24.30000 Latitude and 93.14999 Longitude, Churchandpur District, Manipur.

Remarks The present specimen agrees in all dimensions and morphological characters with those described by Siddiqi et al. (1967) except some variation in body length.

Aphelenchoides baguei Maslen (1979)

Dimension Refer Table 3

Description

Table 1 Morphometric data of *Aphelenchoides aeralis* sp. nov

Characters	Holotype ♀	Paratype ♀	Paratype ♂
<i>n</i>	1	5	3
L	0.46	0.46–0.51 (0.48 ± 0.025)	
a	33.8	32.1–33.8 (32.78 ± 0.832)	29–29.41 (29.13 ± 0.19)
b	6.15	6.15–7.2 (6.64 ± 0.47)	5.9–6.92 (6.58 ± 0.48)
b'	3.66	3.66–4.1 (3.86 ± 0.19)	3.4
c	10.7	9.8–10.7 (10.3 ± 0.41)	8.7
c'	5	5–6.4 (5.72 ± 0.54)	4.2
V or T	66.7	66.7–68.2 (67.56 ± 0.58)	46.71–47.8 (47.43 ± 0.5)
G ₁	26.9	26.9–28.2 (27.4 ± 0.5)	–
Lip width	5.1	5.1	5.1
Lip height	3.4	3.4	3.4
Stylet	15.3	15.3	15.3
Oesophagous	125.8	125.8–127.5 (126.7 ± 0.76)	129.2–133.3 (131.93 ± 1.93)
Median bulb	61.2	61.2–63.5 (62.24 ± 0.90)	57.09–59.5 (58.69 ± 1.13)
Nerve ring	68	68–69.7 (69.08 ± 0.69)	69.7–70.93 (70.12 ± 0.593)
Excretory pore	62.9	62.9–67.5 (65.48 ± 0.69)	69.7–72.66 (71.67 ± 1.39)
Max. body width	13.6	13.6–15.3 (14.46 ± 0.76)	15.3–17.3 (16.63 ± 0.94)
Tail	42.5	42.5–48.2 (45.94 ± 2.03)	51.0–55.36 (52.45 ± 2.05)
ABD	8.5	8.5–10.2 (9.29 ± 0.67)	11.9–13.84 (13.19 ± 0.914)
VA dist.	110.5	110.5–112.6 (111.66 ± 0.88)	–
Spicule	–	–	23.8–25.95 (25.23 ± 1.01)
Spicule head	–	–	8.5–10.38 (9.75 ± 0.88)

All measurements in µm except
L in mm

Table 2 Morphometric data of female species of *A. aligarheinsis*

Characters	<i>A. aligarheinsis</i> (Siddiqi et al. 1967)
<i>n</i>	3
L	0.42–0.61 (0.53 ± 0.08)
a	25.1–30.2 (27.7 ± 2.08)
b	6.1–8.1 (7.0 ± 0.81)
c	11.4–16.1 (14.3 ± 2.02)
c'	2.5–3 (2.7 ± 0.02)
V	64.2–71.8 (68.6 ± 3.24)
G ₁	30.6–34.8 (32.6 ± 1.71)
Stylet	10.2
Oesophagous	73.1–81.6 (77 ± 3.49)
Excretory pore	52.7
PUS	35.7–39.1 (37.4 ± 1.38)
Tail	35.7–39.1 (37.4 ± 1.38)
ABD	11.9–15.3 (13.6 ± 1.38)

All measurements in µm except L in mm

Female Body slightly curved ventrally upon fixation. Cuticle with fine striations, about 1.7 µm apart in mid body region. Lateral fields with four incisures throughout body length. Cephalic framework flattens, set off from body contour, 4.2–5.6 (4.9 ± 0.5) µm wide and 8.2–2.7 (10.3 ± 1.6) µm high. Stylet 10.2–12.8 µm long with

small basal thickenings. Guiding ring situated just behind junction of conical part and shaft. Oesophagus typically aphelenchoid, 146.4–152 µm long, glands overlapping intestine. Excretory pore at 82.4–94.2 µm from anterior end of body and posterior to nerve ring.

Mono—prodelphic reproductive system and out-stretched ovary. Vulva a transverse slit with slightly protruding lips. Oocytes arranged in a single row. Post vulval uterine sac 92.4–96.4 µm or about five vulval body widths long. Tail 38.4–46.2 µm long or about 3.8–4.4 times anal body widths long, terminus with a small ventral mucro which is multi—papillate almost to its tips.

Male Not found.

Habitat and locality

- (1) *Morus alba* Linnaeus from Naorem Leikai, Kakwa with 24.767934073905717 Latitude and 93.937579 39338684 Longitude, Imphal West District
- (2) *Pinus kesiya* Royle from Keibul Lamjao with 24.500000 Latitude and 93.76666669 Longitude, Bishnupur District, Manipur.

Remarks The morphological details and dimensions of the present specimen conform well with those described by Maslen (1979) though some variations are found in body and tail lengths which may be due to intraspecific variations.

Aphelenchoides confusus Thorne and Malek (1968)**Dimension** Refer Table 3**Description**

Female Body cylindrical tapering gradually near extremities. Cuticle finely striated, 1.7 μm apart in mid—body region. Lateral fields marked by 4 very fine lines, about 1/8 body width. Cephalic framework set off by constriction. Spear 10.2–17 μm long, its muscles attached to refractive band at base of cephalic framework. Corpus of oesophagus set off from bulb by narrow constriction. Bulb filling neck cavity with massive valvular apparatus. Isthmus a slender hyaline tube shorter than neck width, set off from bulb by constriction. Nerve ring $\frac{1}{2}$ body width behind bulb. Excretory pore opposite nerve ring at 86.7–115.6 μm from the base of anterior end of body. Hemizonid more than a body width posterior to excretory pore. Basal oesophageal lobes extending dorsally, 5 or 6 body widths long.

Vulva with protuberant labia. Vagina extending slightly forward. Uterus with massive spheroid-shaped, spermatheca almost filling body cavity, filled with sperms, ovary outstretched, sometimes extending to median bulb. Eggs twice as long as body width. Post uterine sac collapsed extending $\frac{1}{3}$ – $\frac{1}{2}$ distances back to anus. Tail conoid, 20.4–25.5 μm in length and with phasmids almost terminal.

Male Not found.

Habitat and locality *Morus alba* Linnaeus from Matai Garden with 24.861421600000 Latitude and 93.9166176 9999960000 Longitude, Imphal East District, Manipur.

Remarks The morphological characteristics and dimensions of the present species conform well with those described by Thorne and Malek (1968) though some variations are found in the length of body and tail which may be due to intraspecific variations.

Aphelenchoides minor Seth and Sharma (1986)**Dimension** Refer Table 3**Description**

Female Body straight to curve slightly ventrally upon fixation, small, slender body, tapering at both ends. Lateral field with three incisures. Cephalic framework set off from body without annulations. Stylet with indistinct basal thickenings, 4.8–8.2 μm long. Procorpus with a narrow lumen, followed by prominent muscular, squarish median bulb with a flat base and crescentic wave. Oesophageal glands lying dorsally along intestine about three body-widths long. Nerve ring 48.2 μm from anterior end of body. Excretory pore situated just below nerve ring. Tail narrowing after anal opening, 22.4–30.8 μm long, rounded terminus with ventral mucro. Distinct anal opening. Outstretched ovary with a single row of cells, three times body width long behind the end of oesophageal overlapping lobe. Vulva a transverse slit with small and slightly prominent lips. Well-developed post—vulval uterine sac, 3.4–5.1 (3.9 $\pm$ 0.8) % of body width long.

Male Not found.

Habitat and locality *Morus alba* Linnaeus from Kalika village, Irilbung with 24.76389 Latitude and 93.85579 Longitude, Kyamgei with 24.8206 Latitude and 93.9029

Table 3 Morphometric data of the females of three species of *Aphelenchoides*

Characters	<i>A. baguei</i> (Maslen 1979)	<i>A. confusus</i> (Thorne and Malek 1968)	<i>A. minor</i> (Seth and Sharma 1986)
<i>n</i>	6	10	10
Length	0.58–0.74 (0.68 $\pm$ 0.06)	0.48–0.79 (0.62 $\pm$ 99.3)	0.28–0.56 (0.43 $\pm$ 0.1)
<i>a</i>	35.2–38.2 (36.8 $\pm$ 1)	28.6–46.6 (36.5 $\pm$ 5.8)	18.2–26.2 (21.8 $\pm$ 3)
<i>b</i>	5.2–7.2 (6.4 $\pm$ 0.8)	2.5–4.4 (3.5 $\pm$ 0.6)	4.8–7.2 (6 $\pm$ 0.8)
<i>b'</i>	3.6–4.2 (3.9 $\pm$ 0.2)	–	2.4–4.4 (3.1 $\pm$ 0.7)
<i>c</i>	14.2–16.2 (15.2 $\pm$ 0.8)	23.8–38.8 (30.4 $\pm$ 4.8)	12.2–16.2 (14.4 $\pm$ 1.4)
<i>c'</i>	3.8–4.4 (4.1 $\pm$ 0.2)	2–2.4 (2.2 $\pm$ 0.2)	2.2–2.6 (2.4 $\pm$ 0.1)
<i>V</i>	62.8–68 (65.4 $\pm$ 1.7)	76.8–78.6 (77.7 $\pm$ 0.7)	66.4–72.2 (69.2 $\pm$ 2.2)
Stylet	10.2–12.8 (11.4 $\pm$ 1)	10.2–17 (15 $\pm$ 2.2)	4.8–8.2 (6.6 $\pm$ 1.4)
<i>G</i> ₁	42.4–48.6 (45.7 $\pm$ 2.3)	29–42.6 (34.4 $\pm$ 5.1)	48.2–56.2 (52.1 $\pm$ 2.9)
<i>G</i> ₂	14–16.2 (15.2 $\pm$ 0.8)	4.3–18.2 (12.6 $\pm$ 3.2)	4.2–5.2 (4.7 $\pm$ 0.3)
Oesophagous	146.4–152 (149.2 $\pm$ 2.1)	134.7–241.4 (176.9 $\pm$ 3.9)	98.8–114.2 (106.6 $\pm$ 6.9)
Nerve ring	–	90.1–119 (103.3 $\pm$ 11)	–
Excretory pore	82.4–94.2 (88.2 $\pm$ 4.5)	86.7–115.6 (95.2 $\pm$ 11)	47.6–54.6 (50.7 $\pm$ 2.6)
PUS	92.4–96.4 (94.6 $\pm$ 1.4)	20.4	–
Tail	138.4–46.2 (41.8 $\pm$ 2.7)	8.5–10.2 (9.3 $\pm$ 0.8)	22.4–30.8 (27.3 $\pm$ 3)

All measurements in μm except Length in mm

Table 4 Morphometric data of the females of *A. swarupi* and *A. vigor*

Characters	<i>A. swarupi</i> (Seth and Sharma 1986)	<i>A. vigor</i> (Thorne and Malek 1968)
<i>n</i>	12	7
Length	0.52–0.68 (0.60 ± 0.05)	0.44–0.49 (0.46 ± 0.02)
<i>a</i>	34.4–42.4 (38 ± 3)	24.8–29.3 (26.7 ± 1.8)
<i>b</i>	5.8–8.2 (6.8 ± 0.9)	2.7–4.8 (3.5 ± 0.8)
<i>b</i> ₁	–	5.6–8.6 (7 ± 1.2)
<i>c</i>	12.2–16.2 (14.4 ± 1.4)	12.4–30.3 (19.9 ± 7.5)
<i>c'</i>	2.2–2.6 (2.4 ± 0.1)	1.5–3.5 (2.6 ± 0.3)
<i>V</i>	66.4–72.2 (69.2 ± 2.2)	69.2–88.6 (75.7 ± 9)
Stylet	8.2–10.2 (9.4 ± 0.8)	11.9–13.6 (12.3 ± 0.7)
<i>G</i> ₁	32.4–36.4 (34.4 ± 1.6)	33.5–45.9 (40.7 ± 5.2)
<i>G</i> ₂	–	10.5–13.3 (11.7 ± 1.1)
Oesophagous	–	102–164.9 (136 ± 25.9)
Nerve ring	–	74.8–88.4 (77.3 ± 10.5)
Excretory pore	–	61.2–78.2 (69.7 ± 8.5)
Rectum	–	17
Tail	32.8–37.4 (35.5 ± 1.9)	15.3–35.7 (28 ± 7.7)
ABD	8.5–12.4 (10.3 ± 1.4)	10.2

All measurements in µm except Length in mm

Longitude and Khongman with 24.777750 Latitude and 93.96021999 Longitude, Imphal East District; C.I. College ground mulberry farm, Bishnupur with 24.60633 Latitude and 93.79441 Longitude, Bishnupur District; Govt. Silk-farm, Wangbal with 24.62306 Latitude and 94.00896 Longitude, Thoubal District and Regional Tasar Research Station, Chingmeirong with 24.32004050 Latitude and 93.93429530 Longitude, Imphal West District; Manipur.

Remarks The morphological characters and dimensions of the present species conform well with those described by Seth and Sharma (1986) except some variation in length of stylet. This may be considered as intraspecific variations.

Aphelenchoides swarupi Seth and Sharma (1986)

Dimension Refer Table 4

Description

Female Body straight to slightly curved upon fixation, cylindrical, tapering at both ends. Lateral fields prominent with three incisures. Cephalic framework slightly offset, without annulations. Stylet 8.2–10.2 µm long with basal thickenings. Procorpus with well-marked lumen and muscular median bulb with valve in anterior half of bulb. Oesophageal glands lying dorsally along intestine and about three body-widths long. Nerve ring 72.8 µm from anterior end of body. Excretory pore ventrally placed opposite to nerve ring. Tail tapering gradually to a blunt rounded terminus with a ventral mucro. Distinct anus with

outstretched ovary. Vulva a transverse slit with slightly prominent vulval lips. Post vulval uterine sac extends less than half the distance between vulva and anus.

Male Not found.

Habitat and locality

- (1) *Morus alba* Linnaeus from Regional Tasar Research Station, Chingmeirong with 24.32004050 Latitude and 93.93429530 Longitude, Imphal West District; Lameidong with 24.51606 Latitude and 94.0056 Longitude, Mayang Imphal Konchak Makha Leikai with 24.57956 Latitude and 93.89665 Longitude, Thoubal District
- (2) *Morus indica* Linnaeus from Bishnupur ward no. 4, Bishnupur with 24.60633 Latitude and 93.79442 Longitude, Bishnupur District and
- (3) *Pinus roxburghii* Sarg from Nongpok Sekmai with 24.76384 Latitude and 93.85574 Longitude, Thoubal District, Manipur.

Remarks The morphological details and dimensions of the present species conform well with those described by Seth and Sharma (1986) except some variations in body, stylet and tail lengths. These variations may be due to intraspecific variations.

Aphelenchoides vigor Thorne and Malek (1968)

Dimension Refer Table 4

Description

Female Body cylindrical except toward extremities upon fixation. Striae of coarse granules, being about 1.7 µm apart at mid-body. Lateral fields a plain band of about 1/6th body width, usually with two exceedingly minute incisures. Cephalic framework set off by constriction. Spear 11.9–13.6 µm long with slight but distinct knobs. Nerve ring at 74.8–88.4 µm from base of anterior end and excretory pore at 61.2–78.2 µm. Hemizonid obscure, about one body width behind pore. Intestinal cells each with single nucleus, sometimes very small and grouped closely in region of vulva. Vulva sclerotized, overlapping with jointed flap.

Ovary outstretched sometimes reflexed. Posterior uterine sac a broad tubular sac usually filled with sperms. Terminal cells of intestine without granules. Tail slightly arcuate with blunt terminal projection, 15.3–35.7 µm in length.

Male Not found.

Habitat and locality *Morus indica* Linnaeus from Bishnupur Maning Leikai, Bishnupur with 24.60633 Latitude and 93.79441 Longitude, Bishnupur district, Manipur.

Remarks The morphological details and dimensions of the present specimen conform well to those described by

Table 5 Morphometric data of females of *A. dhanachandi* and *A. neoechinocaudatus*

Characters	<i>A. dhanachandi</i> (Chanu et al. 2012)	<i>A. neoechinocaudatus</i> (Chanu et al. 2012)
<i>n</i>	12	4
Length	0.37–0.50 (0.53 ± 39.8)	0.53–0.60 (0.56 ± 32.2)
a	25.2–36.1 (28.4 ± 2.6)	25.5–28.6 (27.1 ± 1.5)
b	6.6–7.7 (7.0 ± 0.2)	8.3–9.0 (8.6 ± 0.3)
b'	3.3–7.4 (4.5 ± 1.4)	4.5–5.0 (4.7 ± 0.2)
c	5.3–7.4 (6.0 ± 0.5)	11.0–11.7 (11.3 ± 0.3)
c'	6.6–9.2 (6.0 ± 0.5)	5.3–5.4 (5.3 ± 0.1)
DGO	27.2–37.4 (30.29 ± 2.69)	34.0–40.8 (37.4 ± 3.4)
O	23.6–30.1 (25.9 ± 2.0)	27.7–34.2 (30.9 ± 3.2)
V	57.9–62.9 (59.9 ± 1.3)	64.4–64.9 (64.6 ± 0.2)
G ₁	24.4–45.3 (33.5 ± 6.7)	26.2–40.6 (33.4 ± 7.2)
MB	39.3–49.9 (33.5 ± 6.7)	45.7–45.8 (45.7 ± 0.05)
m	37.5–50.0 (47.7 ± 4.8)	49.6
Median bulb	13.6–17.0 (15.3 ± 1.0)	13.6
PUS	3 VBD	3½ VBD
Anterior end to valves of median bulb	50.9–61.1 (54.8 ± 3.7)	57.8–59.5 (58.6 ± 0.8)
Oesophagus	95.2–129.0 (114.5 ± 10.4)	119.0–122.4 (120.7 ± 1.7)
Stylet	13.6–15.3 (14.0 ± 0.7)	11.9
Head width	5.1	5.1
Head height	3.4	1.7
Anterior end to vulva	221.0–309.4 (262.3 ± 26.2)	348.8–387.6 (368.2 ± 19.4)
Vulva-anus dist.	93.5–122.4 (102.3 ± 11.0)	142.8–159.8 (151.3 ± 8.5)
Vulva	11.9–17.0 (14.5 ± 1.6)	17.0
Excretory pore	61.2–85.0 (73.0 ± 7.8)	62.9–64.6 (63.7 ± 0.8)
Nerve ring	56.1–73.1 (63.8 ± 5.2)	66.3–68.0 (67.1 ± 0.8)
Body width	13.6–17.0 (15.3 ± 1.3)	21.0
Tail	62.9–85.0 (71.4 ± 7.1)	45.9–54.4 (50.1 ± 4.2)
ABD	8.5–10.2 (9.2 ± 0.8)	8.5–10.2 (9.3 ± 0.8)
Oesophago-intestinal junction/cardia	56.1–68.0 (61 ± 3.8)	64.6–76.5 (70.5 ± 5.9)

All measurements in µm except
Length in mm

Thorne and Malek (1968) except some variation in body lengths which may be due to intraspecific variations.

Aphelenchoides dhanachandi Chanu et al. (2012)

Dimension Refer Table 5

Description

Female Body characteristically curved ventrally upon fixation. Body slender and tapering at both ends, 0.37–0.50 mm long. Lateral fields prominent and narrow, marked by three incisures. Body cuticle finely annulated. Cephalic region clearly set—off, 5.1 µm wide and 3.4 µm high. Stylet slender and with indistinct basal swellings, 13.6–15.3 µm long. First region of oesophagus with well-marked lumen followed by prominent muscular, elongated tamarind seed—shaped median bulb, 13.6–17.0 µm long with conspicuous valve in posterior region located 39.1–47.6 µm from anterior end. Nerve ring situated just behind median bulb,

59.5–69.0 µm long from anterior cephalic region. Excretory pore on ventral surface opposite to nerve ring, about four and half body width, 61.2–80.7 µm long from anterior region of body. Oesophageal glands lying dorsally along intestine, oesophagus extending 95.2–129.2 µm from anterior region of body. The oesophago—intestinal junction 3.7–5.0 body-widths, posterior to base of median bulb.

Female reproductive system monoprodelphic and out-stretched, consisting of a single row of cell. Anterior gonad 91.8–217.6 µm long. Post vulval uterine sac 49.3–56.4 µm long, about three vulval body widths. Vulva sometimes protruding in some specimen. Tail long, wide with distinct anus, highly curved ventrally and tapers gradually to a pointed terminus, 62.9–98.0 µm long or about 7–8 anal body widths long. **Male** Not found.

Habitat and locality *Morus indica* Linnaeus from Yurembam Rose Garden, Yurembam with 24.75767 Latitude and 93.89597 Longitude, Imphal West District, Manipur.

Table 6 Checklist of known species *Aphelenchoides* nematodes from Manipur, India

Species	♂/♀ Ratio	Host and locality	Remark
<i>A. aligarheinsis</i> (Siddiqi et al. 1967)	Male absent	<i>Pinus kesiya</i> , Khuga Dam	Dimensions and morphological details similar to original sp.
<i>A. baguei</i> (Maslen 1979)	Male absent	<i>Morus alba</i> , <i>Pinus kesiya</i> ; Kakwa, Keibul Lamjao & Sunu Siphai	Variation in body and tail length from original sp.
<i>A. Confusus</i> (Thorne and Malek 1968)	Male absent	<i>Morus alba</i> , Matai village	Variation in body and tail length from original sp.
<i>A. minor</i> (Seth and Sharma 1986)	Male absent	<i>Morus alba</i> ; kalika village, Irilbung, Kyamgei, Khongman, Bishnupur, Wangbal, Chingmeirong	Variation in stylet length
<i>A. swarupi</i> (Seth and Sharma 1986)	1:1	<i>Morus alba</i> , <i>Morus indica</i> , <i>Pinus kesiya</i> , <i>Pinus roxburghii</i> ; Chingmeirong, Lameidong, Mayang Imphal, Thoubal, Nongpok Sekmai, Bishnupur	Variation in body, tail and stylet length from original sp.
<i>A. vigor</i> (Thorne and Malek 1968)	Male absent	<i>Morus indica</i> , Bishnupur	Variation in body length
<i>A. dhanachandhi</i> (Chanu et al. 2012)	Male absent	<i>Morus indica</i> , Yurembam Rose Garden	Dimensions and morphological details similar to original sp.
<i>A. Neoechinocaudatus</i> (Chanu et al. 2012)	Male absent	<i>Morus indica</i> , Yurembam Rose garden	Dimensions and morphological details similar to original sp.

Remarks The present specimen conforms well in dimensions and morphological details to those described by Chanu et al. (2012).

Aphelenchoides neoechinocaudatus Chanu et al. (2012)

Dimension Refer Table 6

Description

Female: Body small and slender, almost straight upon fixation and tapering at both ends, 0.5–0.6 mm long. Lateral field marked by three incisures. Cephalic region slightly set-off, 5.1 µm wide and 1.7 µm high, without any annulation. Stylet slender with indistinct or without basal swellings, 11.9 µm long. Anterior part of oesophagus with well-marked lumen and muscular median bulb with valve in posterior half of the bulb. Median bulb elongated pear-shaped 13.6 µm long, located at 47.6–49.3 µm from cephalic region. Nerve ring located behind base of median bulb, at half-body width, 66.3–68.0 µm from anterior end. Excretory pore conspicuous, on the ventral surface opposite nerve ring, 62.9–64.6 (63.7 ± 0.8) µm long, about thrice body widths. Oesophageal glands lying dorsally along intestine, oesophagus extending 119.0–122.4 µm from anterior base. The oesophago-intestinal junction 64.6–76.5 µm from anterior end, 3.0–3.6 body widths posterior to median bulb.

Female reproductive system monoprodelphic and outstretched, consisting of a single row of cells, anterior gonad about 141.1–244.8 µm long, post uterine sac 51.0–69.7 (60.3 ± 9.3) µm long, about three and half vulval body width long. Tail short, pointed posteriorly with a strong

ventrally pointed mucro, 45.9–54.4 µm long or about five and half anal body width long.

Male Not found.

Type host and locality *Morus indica* Linnaeus from Yurembam Rose Garden, Yurembam with 24.75767 Latitude and 93.89597 Longitude, Imphal West, Manipur.

Remarks The present specimens conform well in dimensions and morphological details to those described by Chanu et al. (2012).

Acknowledgments The authors are thankful to HOD, Department of Life Sciences, Manipur University, Canchipur for providing necessary laboratory facilities. The corresponding author is also thankful to Department of Science & Technology, New Delhi for the financial assistance in the form of Fast Track—Young Scientist fellowship.

References

- Bajaj HK, Walia RK (1999) Three new species of *Aphelenchoides* Fisher 1894 (Aphelenchina: Nematoda) from India along with a compendium of Indian species. Indian J Nematol 29(2):154–170
- Bos WS (1977) *Aphelenchoides arachidis* n. sp. (Nematoda: Aphelenchoidea) an endoparasite of the testa of groundnut in Nigeria. Zeitschrift für Pflanzenkrankheiten (Pflanzenpathologie) und Pflanzenschutz 84: 95–99
- Chanu LB, Mohilal N, Shah MM (2012) Two new species of *Aphelenchoides* (Nematoda: Aphelenchida: Aphelechoidea: Aphelenchidae) from Manipur. India Biologia 67(3):530–534. doi: 10.2478/s11756-012-0042-9
- Christie JR (1932) Recent observations on the strawberry dwarf nematode in Massachusetts. Plant Dis Rep 16:113–114
- Christie JR (1942) A description of *Aphelenchoides besseyi* n. sp., the summer—dwarf nematode of strawberries, with comments on the identity of *Aphelenchoides subtenuis* (Cobb 1926) and

- Aphelenchoides hodsoni* Goodey 1936. Proc Helminthol Soc Wash 9:82–84
- Cobb NA (1918) Estimating the nema population of the soil with special reference to sugar—beet and root—gall nemas, *Heterodera radicola* (Greef) Muller and with a description of *Tylencholaimus aequalis* n. sp. Agric Tech Circular no.1, USA, Bureau of Plant Industry, U.S. Department of Agriculture, p 48. ISBN: B00089rt7k
- Franklin MT (1957) *Aphelenchoides composticola* n. sp. and *A. saprophilus* n. sp. from mushroom compost and rotting plant tissues. Nematologica 2:306–313
- Maslen NR (1979) Six new nematode species from the maritime Antarctic. Nematologica 25:288–308
- Ritzema Bos J (1890) De bloemkoolziekte der aarbeiien, veroorzaakt door *Aphelenchus fragariae* nov. spec. (Voorloopige mededeeling). Maandblad Natuurwetensch 16:107–117
- Schwartz M (1911) Die Aphelenchen der Veilchengallen und Blattflecken an Farnen und *Chrysanthemum*. Arb Kaiserl Boil Anstalt Land Forstwirtschaft 8:303–334
- Seinhorst JW (1959) A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. Nematologica 4:67–69
- Seth A, Sharma NK (1986) Five new species of genus *Aphelenchoides* (Nematoda: Aphelenchida) infesting mushroom in Northern India. J Soil Biol Ecol 5:14–19
- Siddiqi MR, Hussain SI, Khan AM (1967) *Seinura propora* n. sp. and *Aphelenchoides aligarhensis* n. sp. (Nematoda: Tylenchida). Syst Parasitologie 4:257–262
- Steiner G (1932) Notes on nematode diseases. Plant Dis Rep 16:2–3
- Thorne G, Malek RB (1968) Nematodes of the Northern Great Plains. Part I. Tylenchida (Nemata: Secernentea). Techn Bull S. D. Agric Exp Stn 41:1–120
- Timm RW, Franklin MT (1969) Two marine species of *Aphelenchoides*. Nematologica 15:370–375