Aporcelaimidae (Nematoda: Dorylaimida) from the Kruger National Park

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This paper deals with Aporcelaimidae from the central part of the Kruger National Park. Five new species are described, viz. *Aporcelaimus pseudospiralis* n.sp., *Aporcelaimellus adriaani* n.sp., *Aporcelaimellus micropunctatus* n.sp., *Aporcelaimellus parapapillatus* n.sp. and *Tubixaba minima* n.sp. Two further species are recorded and their biometric data tabulated: *Makatinus macropunctatus* Heyns, 1967 and *Tubixaba parva* Pretorius, Kruger & Heyns 1987.

Key words: Aporcelaimidae, *Aporcelaimus*, *Aporcelaimellus*, *Tubixaba*, *Makatinus*, taxonomy, Nematoda, Kruger National Park.

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Introduction

In a previous paper (Botha & Heyns 1990) we reported on various Dorylaimoidea obtained from soil samples taken at several localities in the central part of the Kruger National Park. The present paper deals only with the Aporcelaimidae from the above-mentioned samples. All measurements except the total body length are given in μm in the tables as well as in the text. Curved structures, e.g. spicules, were measured along the curved median line. The specimens used for scanning electron microscopy were hydrated in distilled water, fixed in TAF at 5 °C, dehydrated in an ethanol distilled water series, put in the critical point dryer, mounted on aluminium SEM-studs and sputter coated.

All specimens have been deposited in the collection of the Department of Zoology, Rand Afrikaans University.

Descriptions

Aporcelaimellus adriaani n.sp.

(Fig. 1 A-G, Fig. 2 A-C). Morphometric data in Table 1.

Female

Relatively small nematode, with robust body. Heat relaxed body slightly ventrally curved, slightly more curved posteriorly (Fig. 1G). Cuticle relatively thin: 2-3 μm on the neck, 3-4 μm at mid-body, and 7-9,5 μm around the tail tip. Transverse striae in exocuticle rather more prominent towards lip region and around tail. Lateral chord about one tenth body diameter at base of oesophagus, with small cells. Lateral, ventral and dorsal body pores obscure.

Lip region set off by a constriction; about one third as wide as body at base of oesophagus (Fig. 1C). Lips angular. Amphid obscure. Length of odontostyle slightly less than lip region width. Stylet aperture three fifths stylet length. Stylet width one fifth stylet length. Odontophore distinct, rod-like, slightly thickened at its base. Guiding ring single, unsclerotized. Hemizonid situated anterior to nerve ring. Wall of posterior part of guiding sheath, which surrounds odontophore, appearing slightly sclerotized. Cardia conoid, varying in length (Fig. 1A, B and E). Oesophageal gland nuclei sometimes obscure. Position of oesophageal gland nuclei and their openings

Fig. 1. *Aporcelaimellus adriaani* n.sp.: A. Anterior body region of female; B. Dorsoventral view of oesophagus of female; C. Dorsoventral view of head; D. Lateral view of head; E. Cardiac region; F. Posterior body region of female; G. Heat-relaxed body posture of two females.

Fig. 2. *Aporcelaimellus adriaani* n.sp.: A. Reproductive system of female; B. Posterior branch of reproductive system of female, with two eggs; C. Dorsoventral view of anterior branch of reproductive system of female.

Table 1
Morphometric characters of *Aporcelaimellus adriaani* n.sp.

	Holotype	Paratypes
<i>n</i>	1 ♀	6 ♂
L(mm)	1,24	1,3 (1,23-1,49)
a	29	28 (23-30)
b	3,4	3,9 (3,5-4,1)
c	54	51,5 (42-58)
c'	0,9	0,94 (0,79-1,07)
V %	57	55 (53-57)
Width of lip region	13,5	13 (12-15)
Odontostyle	15	15 (14-16)
Width of odontostyle	3	3 (3-3,5)
Odontophore	23,5	24 (21,5-26)
Total stylet length	38,5	39 (37,5-41)
Stylet aperture	9	8 (7,5-9)
Stylet aperture as % of stylet length	60	56 (50-60)
Guiding ring from anterior end	7	6 (5-7,5)
Length of oesophagus	365	344 (320-380)
Body width	43,5	47 (41,5-53,5)
Distance from head to vulva	71	72 (66,5-81)
Tail length	23	25,5 (21,5-30)
Anal body diameter	25	27 (25-29,5)
Length of rectum	31	28 (26-30)
Length of prerectum	134	97 (63,5-179)

as follows ($n = 2$): DO = 56 and 56; DN = 61 and 61; S₁O₁ = 69,8 and 69,8; S₁N₁ = 69 and 69,5; S₁O₂ = 77,8 and 77,5; S₁N₂ = 78 and 78; S₂O₁ = 85,6 and 85,7; S₂N₁ = 84,8 and 84; S₂O₂ = 86 and 86; S₂N₂ = 85 and 84,9.

Intestinal cells large, packed with brown granules. Prerectum varying in length, 2,4-6,9 times anal body diameter. Sphincter at junction of prerectum and rectum mostly obscure. Rectum length equal to anal body diameter. Tail conoid and bluntly rounded (Fig. 1F). Three pairs of caudal pores present.

Female didelphic, amphidelphic (Fig. 2A-C). Ovaries reflexed dorsally. *Pars dilatata oviductus* and *pars dilatata uteri* separated by a sphincter muscle. Ovejector not clearly differentiated. Vagina muscular, reaching 27-48 % of corresponding body diameter. Vulva a transverse slit without sclerotized lips. One or two eggs at a time in reproductive system, measuring 70-97 x 26-49 μ m ($n = 4$).

Male unknown.

Diagnosis

Aporcelaimellus adriaani n.sp. is related to *A. laevis* Tjepkema, Ferris & Ferris 1971. It differs from *A. laevis* by its narrower lip region (12-15 μ m versus 17,6 μ m), thicker cuticle at mid-body (3-4 μ m versus 2,5 μ m), narrower lateral chord (4,5 μ m versus 8 μ m), shorter odontostyle (14-16 μ m versus 18 μ m), shorter rectum (26-31 μ m versus 37 μ m) and vulva without sclerotized lips versus lips sclerotized in *A. laevis*. *A. adriaani* n.sp. can be further distinguished from *A. laevis* by the sclerotization of the wall of the posterior part of the guiding sheath which surrounds the odontophore. *A. adriaani* n.sp. corresponds with *A. laevis* in body length, body width, length of oesophagus, tail length and width, and the absence of an oesophago-intestinal disc.

Type locality and habitat

Holotype and six paratype females collected by J. Heyns in August 1988 among roots of unidentified grasses near the Tsokwane picnic area.

Fig. 3. *Aporcelaimellus micropunctatus* n.sp.: A. Anterior body region of female; B. Lateral view of head; C. Shape of cardia and oesophago-intestinal disc; D. Posterior branch of reproductive system of female; E-F. Variation in the posterior body region of female; G. Heat-relaxed body posture of three females.

Type specimens

Holotype female on slide 4152; paratypes on slides 4143, 4152, 4153, 4157 and 4161.

Aporcelaimellus micropunctatus n.sp.

(Fig. 3A-G, 4A-D). Morphometric data in Table 2.

Female

Relatively robust nematode, of medium length. Heat relaxed body slightly to strongly

ventrally curved in the shape of the letter "C" (Fig. 3G). Cuticle relatively thick: 3-4 μm on the neck, 4,5-8 μm at mid-body, 6-9 μm around the tail tip. Cuticle consisting of a thin outer layer, slightly thicker middle layer and thick inner layer of which only the inner two layers are shown in the figures. Transverse striae in exocuticle faint; mesocuticle with distinct radial striae (appearing as punctations when seen *en face*), rather more prominent towards lip region and around tail (Fig. 3B, E and F).

Fig. 4. *Aporcelaimellus micropunctatus* n.sp.: A. Lateral view of head (bar equals 3 μm); B. Anterior-lateral view of head (bar equals 3,5 μm); C. Vulva area (bar equals 1 μm); D. Posterior body region of female (bar equals 10 μm).

Table 2
Morphometric characters of *Aporcailimellus micropunctatus* n.sp.

n	Holotype Skukuza	Paratypes			
		Skukuza	Tshokwane picnic area	Engelhard Dam	Letaba area
L (mm)	1 ♀ 2,09	5 ♀♀ 1,93 (1,72-2,11)	3 ♀♀ 2,25 (2,17-2,31)	5 ♀♀ 1,92 (1,81-2,07)	3 ♀♀ 1,94 (1,82-2,05)
a	24	25 (23-28)	25 (22-28)	27,0 (25-29)	28 (26-30)
a'	35	29,5 (29-30) [‡]	35 (33-38)	35,5 (35-36) [‡]	33 (31-35)
b	3,9	3,6 (3,3-3,9)	3,8 (3,6-4,0)	3,5 (3,1-3,8)	4,0 (3,8-4,4)
c	54	49 (45-51)	75 (57-85)	57 (50-64)	59 (47-71)
c'	0,9	0,95 (0,8-1,05)	0,7 (0,6-0,9)	0,8 (0,72-0,96)	0,9 (0,7-1,1)
V %	57	54 (51-59)	56 (55-57)	55 (54-56)	54 (53-56)
Width of lip region	18	18,5 (17,5-19,5)	20 (19-20)	19 (18-20)	18 (18-19)
Odontostyle	23	21 (20-22)	20 (19-21)	20 (19-21)	21,5 (20-22,5)
Width of odontostyle	4,5	4 (4-4,5)	4 (4-4,5)	4 (3,5-4)	4
Odontophore	35,5	38 (37-40)	42 (39-44)	37 (35-39)	35,5 (34,5-36,5)
Total stylet length	58,5	59 (57-61,5)	62 (59-65)	57 (55-59)	57 (54,5-58,5)
Stylet aperture	13	13 (12-13,5)	14 (13-14)	13 (12-13)	13 (12-13,5)
Stylet aperture as % of stylet length	59	61 (57-65)	69 (65-74)	63 (62-65)	60 (55-65)
Guiding ring from anterior end	10,5	10 (8-11,5)	11 (10-11,5)	10 (9-11)	11 (10,5-11,5)
Amphid aperture	9,5	9 (9-9,5)	10	9,5 (9-10,5)	9 (8-9,5)
Length of oesophagus	540	541 (501-557)	592 (557-610)	530 (505-545)	489 (440-515)
Body width	86	77 (69-83,5)	92 (83-102)	72 (65,5-84)	69 (65,5-72,5)
Distance from head to vulva	120	105 (98-111)	127 (120-131)	105 (98,5-112)	105 (97-114,5)
Tail length	39	39 (33,5-43)	31 (26,5-38)	34 (30-36)	34 (26-41)
Anal body diameter	42,5	41 (38-43)	42 (41-43)	41 (35,5-45,5)	38 (35-40)
Length of rectum	56	54 (48-56)	48 (44-50)	54 (48-56)	48 (41-52)
Length of preectum	91	111 (92-151)	190,5 (159-222) [‡]	83 (62-113)	104 (73-146)

[‡] n=2

Lateral chord about one tenth body diameter at base of oesophagus. Lateral, dorsal and ventral body pores distinct. Lateral pores 64-77 distributed over entire body length (17-23 to base of oesophagus, 14-20 between oesophagus and vulva, and 27-40 between vulva and anus), starting as a single row behind the lip region and gradually diverging into two rows opposite the base of the oesophagus, with more pores in the latero-subdorsal than in the latero-subventral rows. Dorsal pores varying from 5-8, limited to oesophageal region. Ventral pores 37-47, distributed over entire body (12-16 to base of oesophagus, 10-16 between oesophagus and vulva, and 14-19 between vulva and anus).

Lip region distinctly set off by a constriction (Fig. 4A & B), about one fifth as wide as body at base of oesophagus. Lips angular. Amphid stirrup-shaped, in lateral view appearing to be divided into two parts (Fig. 3B); aperture about one half width of lip region. Length of odontostyle equal to or slightly greater than lip region width. Stylet aperture more than half stylet length. Stylet width about one fifth stylet length. Guiding ring single, unsclerotized. Rudimentary excretory pore situated near nerve ring. Hemizonid situated anterior to nerve ring. Thin oesophago-intestinal disc present, sometimes not clearly visible. Cardia conoid, varying in length (Fig. 3A and C). Position of oesophageal gland nuclei and their openings as follows ($n = 10$): DO = 55 (52-58); DN = 58 (55-60); S₁O₁ = 70 (68,1-70,9); S₁N₁ = 69,5 (68,2-71,4); S₁O₂ = 77 (76,3-78,8); S₁N₂ = 77,2 (75,9-78,8); S₂O₁ = 87,8 (87-88,2); S₂N₁ = 86,6 (85,6-88,7); S₂O₂ = 88,5 (87,9-90); S₂N₂ = 87,1 (86,5-87,9).

Intestinal cells packed with brownish granules. Junction between intestine and prerectum distinct. Prerectum varying in length, from two to five times anal body diameter. Distinct sphincter at junction of prerectum and rectum. Rectum length one to one and a

half times anal body diameter. Tail convex-conoid, bluntly rounded (Fig. 3E and F). Three pairs of caudal pores present.

Female didelphic, amphidelphic (Fig. 3D). Ovaries reflexed dorsally. *Pars dilatata oviductus* and *pars dilatata uteri* separated by a sphincter muscle. Ovejector not clearly differentiated. Vagina muscular, reaching 30-50 % of the corresponding body diameter. Vulva a transverse slit with sclerotized lips. No sperm cells observed. One female found with an egg in each uterus, measuring 105-107 x 46 µm.

Male unknown.

Diagnosis

Aporcelaimellus micropunctatus n.sp. is very similar to *A. punctatus* Altherr, 1972, *A. porcus* Thorne, 1974 and *A. obscurus* (Thorne & Swanger, 1936) Heyns, 1965. It can be distinguished from *A. punctatus* by the sclerotized lips of the vulva and the absence of males. It differs from *A. porcus* in the more posterior position of the vulva (51-59 % versus 46 %) and the thinner cuticle on the neck. It can be distinguished from *A. obscurus* by the presence of more distinct radial striae over the entire body, versus very weak radial striae in the cuticle of *A. obscurus* as well as by the apparent absence of males, although males are also very rare in *A. obscurus*. In the possession of prominent radial striae, which appear like punctations when viewed *en face*, *A. micropunctatus* n.sp., *A. punctatus* and *A. porcus* relate somewhat to the genus *Makatinus* Heyns, 1965.

Type locality and habitat

Holotype and five paratypes from the Skukuza Camp, three paratypes from the Tshokwane picnic-area, five paratypes from the look-out near Engelhard Dam and three paratypes from the look-out near the Letaba River, north of the Letaba Camp, all collected among the roots of unidentified grasses by J. Heyns in August 1988.

Type specimens

Holotype female from Skukuza Camp on slide 4194; paratypes from Skukuza Camp on slides 4195, 5197, 4198 and 4203; paratypes from the look-out near Engelhard Dam on slides 4162, 4168 and 4190; paratypes from the Tshokwane picnic area on slides 4149 and 4150 and paratypes from Letaba on slide 4216.

Aporcelaimellus parapapillatus n.sp.

(Fig. 5A-H, 6A-C). Morphometric data in Table 3.

Female

Relatively robust nematode, of medium length. Head relaxed body ventrally curved in the shape of the letter "C" (Fig. 5H). Cuticle relatively thick: 3.5 μm on the neck; 5 μm at mid-body; 8-10 μm around the tail tip. Cuticle consisting of a thin outer layer, thicker middle layer and thick inner layer of which only the inner two layers are shown in the figures. Exocuticle with transverse striae. Lateral chord about one seventh the body diameter at the base of the oesophagus, with small cells. Lateral, ventral and dorsal body pores indistinct. Lateral pores 103-113 and distributed over entire length of body (29-35 to base of oesophagus, 30-32 between oesophagus and vulva, and 44-46 between vulva and anus), starting as a single row behind the lip region and gradually diverging into two rows at the base of the oesophagus, with more pores in the latero-subdorsal than in the latero-subventral row. Dorsal pores 13-14 and limited to oesophageal region. Ventral pores 84-94, distributed over the entire body (23-27 to base of oesophagus, 22-29 between oesophagus and vulva and 34-42 between vulva and anus).

Lip region distinctly set off by a constriction; about one quarter as wide as body at base of oesophagus (Fig. 5B). Lips angular. Amphid stirrup-shaped, in lateral view appearing to be divided into two parts (Fig. 5C). Amphid aperture about one half lip region width. Length of odontostyle equal to lip region

width. Stylet aperture more than one half stylet length. Stylet width about one quarter stylet length. Odontophore distinct, rod-like, slightly thickened at its base. Guiding ring single and unsclerotized. Rudimentary excretory pore situated near nerve ring. Hemizonid situated anterior to rudimentary excretory pore. Anterior part of oesophagus, which surrounds the odontophore, muscular and slightly thickened. Oesophago-intestinal disc absent. Cardia conoid and varying in size (Fig. 5A and D). Position of oesophageal gland nuclei and their openings as follows ($n = 1$): DO = 52; DN = 54; S₁O₁ = 65; S₁N₁ = 66; S₁O₂ = 76.6; S₁N₂ = 76.7; S₂O₁ = 87.7; S₂N₁ = 86.5; S₂O₂ = 87.9; S₂N₂ = 86.8.

Intestinal cells small and packed with brownish granules. Junction between intestine and prerectum distinct. Prerectum length about four times anal body diameter. Distinct sphincter at junction of prerectum and rectum. Rectum length about equal to anal body diameter. Tail convex-conoid, somewhat bluntly rounded (Fig. 5G), with three pairs of caudal pores.

Female didelphic, amphidelphic (Fig. 5E). Ovaries reflexed. *Pars dilatata oviductus* separated from *pars dilatata uteri* by a sphincter muscle. Ovejektor not clearly differentiated. Vagina muscular, reaching 33 % of the corresponding body diameter. Vulva a transverse slit without sclerotized lips. No sperm cells observed in reproductive system.

Male

Male similar to female except posterior part of body more strongly ventrally curved, in the shape of the figure "6" (Fig. 5H). Diorchic, testes opposed; posterior and anterior testes 427- 495 μm and 441- 453 μm respectively. Sperm cells ovoid. Spicules long and slender, each with a distinctly wrinkled area in the spicular sheath (Fig. 5F). One pair of adanal supplements situated anterior to cloacal opening (Fig. 6C), plus a series of 15-17 contiguous ventromedian supplements.

Fig. 5. *Aporcelaimellus parapapillatus* n.sp.: A. Anterior body region of female; B. Lateral view of female head; C. Shape and position of amphid; D. Shape of cardia; E. Posterior branch of reproductive system of female; F. Male tail; G. Posterior body region of female; H. Heat-relaxed body posture of female and male.

Table 3
Morphometric characters of *Aporcelaimellus parapapillatus* n.sp.

	Holotype	Paratypes		
n	1 ♀	2 ♀♀	3 ♂♂	
L(mm)	2,51	2,11	2,40	2,36 (2,27-2,38)
a	33	32	29	32 (30-24)
a'	45	36	40	38 (36-42)
b	4,4	3,9	4,9	4,4 (4,2-4,5)
c	71	62	75	62 (60-64)
c'	0,92	0,98	0,86	0,97 (0,95-0,98)
V %	52	55	56	—
Width of lip region	19,5	20	20	19 (18-20)
Odontostyle	19	18	18	17 (16-18,5)
Width of odontostyle	4,5	5	4,5	4,5 (4-5)
Odontophore	32	32	32	32 (26,5-36)
Total stylet length	51	50	50	50 (44-54,5)
Stylet aperture	13	12	12	12 (11-12,5)
Stylet aperture as % of stylet length	68	67	67	68,5 (68-69)
Guiding ring from anterior end	9,5	10,5	9	9 (8-10)
Amphid aperture	9	9	9	9,5 (9-10)
Length of oesophagus	570	530	490	548 (540-555)
Body width	76	65	83,5	74 (67,5-79)
Distance from head to vulva	131	115,5	13	—
Tail length	35,5	33,5	32	37 (36-37,5)
Anal body diameter	38,5	34	27	38
Length of rectum	48	46	47	62 [‡]
Length of prerectum	173	136	147	139 [‡]
Length of spicules	—	—	—	83,5 (80-88)
Length of lateral guiding pieces	—	—	—	21 (19-23)
Number of supplements	—	—	—	15,17,17

[‡]n=1

Diagnosis

Aporcelaimellus parapapillatus n.sp. is very similar to *A. papillatus* (Bastian, 1865) Baqri & Khera, 1975. It can be distinguished from *A. papillatus* by the position of the vulva (52-56 % versus 49 %) and the number of ventromedian supplements (15-17 versus 8).

Type locality and habitat

Holotype and five paratypes collected by J. Heyns in August 1988 among roots of unidentified grasses near the look-out at Engelhard Dam.

Type specimens

Holotype on slide 4168, paratypes on slides 4160, 4162, 4189 and 4190.

Aporcelaimus pseudospiralis n.sp.

(Fig. 7 A-H). Morphometric data in Table 4.

Female

Relatively large, fairly slender nematode. Heat relaxed body ventrally curved in the shape of the letter "C" (Fig. 7H). Cuticle relatively thick: 4,5-5 µm on the neck, 9-9,5 µm at mid-body, 10,5-11,5 µm around the tail tip. Cuticle with criss-cross lines on the surface of the outer layer and with faint radial striae in the mesocuticle, prominent in the tail region (Fig. 7G). Lateral chord about one fifth body diameter at base of oesophagus, with relatively conspicuous cells. Lateral, ventral and dorsal body pores distinct. Lateral pores 192-225, distributed over entire body length (39-48 to base of oesophagus, 58-75 between oesophagus and vulva, 92-102 between vulva

Fig. 6. *Aporcelaimellus parapapillatus* n.sp.: A. Lateral view of head (bar equals 5 μm); B. Ventromedian supplements of male (bar equals 1 μm); C. Posterior region of male tail, with distinct adanal supplements (bar equals 6 μm).

and anus). The lateral pores start as a single row behind the lip region and diverge gradually into two rows at the base of the oesophagus, with more pores in the latero-subdorsal than in the latero-subventral rows. Dorsal pores about 19, limited to oesophageal region. Ventral pores 86-126, distributed over entire body length (31-50 to base of oesophagus; 40-45 between oesophagus and vulva, 27-31 between vulva and anus).

Lip region distinctly set off by a constriction, about one fifth as wide as body at base of oesophagus. Lips rather angular in outline (Fig. 7C). Amphid stirrup-shaped, the aperture situated in the constriction. In a lateral view, each amphid appears to be divided into two parts. Length of odontostyle equal to lip region width. Aperture of odontostyle large, about three quarters of the stylet length (Fig. 7B). Stylet width about one fifth stylet length. Odontophore distinct, rod-like, not thickened at its base. Guiding ring single, unsclerotized. Rudimentary excretory pore situated anterior to nerve ring. Hemizonid situated anterior to excretory pore. Anterior part of oesophagus not thickened. Posterior part of oesophagus surrounded by a distinct muscular sheath. Oesophago-intestinal disc absent. Cardia small, conoid. Position of oesophageal gland nuclei and their openings as follows ($n = 1$): $DO = 50,7$; $DN = 53,9$; $S_1O_1 = 60,7$; $S_1N_1 = 60,4$; $S_1O_2 = 65,4$; $S_1N_2 = 65,9$; $S_2O_1 = 87,3$; $S_2N_1 = 85,2$; $S_2O_2 = 87,6$; $S_2N_2 = 85,8$.

Intestinal cells packed with brownish granules. Junction between intestine and prae-rectum distinct. Distinct sphincter at junction of prae-rectum and rectum. Rectum length 1-1,5 times anal body diameter. Prae-rectum length 4 times anal body diameter. Tail convex-conoid, bluntly rounded (Fig. 7G). Three pairs of caudal pores present.

Female didelphic, amphidelphic (Fig. 7F). Ovaries reflexed. *Pars dilitata oviductus* and *pars dilitata uteri* separated by a sphincter muscle. Ovejector not clearly differentiated.

Vagina strongly muscular, reaching 55-61 % of the corresponding body diameter. Vulva a transverse slit without sclerotized lips. No sperm cells or eggs observed in reproductive system.

Male unknown.

Diagnosis

Aporcelaimus pseudospiralis n.sp. is placed in the genus *Aporcelaimus* Thorne & Swanger, 1936 because of the relatively large body length ($L = 3,64 - 4,41$ mm), relatively slender body ($a = 31-35$), large stylet aperture in relation to stylet length (75-77 %) and the criss-cross lines on the outer surface of the outer cuticle layer.

Aporcelaimus pseudospiralis n.sp. is very similar to *A. spiralis* (Cobb, 1893) Thorne & Swanger, 1936. It can be distinguished from *A. spiralis* by difference in lip height (the lip height of *A. pseudospiralis* n.sp. is typical of the genus, whereas in *A. spiralis* the lip region is exceptionally low). The amphid of *A. pseudospiralis* n.sp. is horizontally divided into two parts whereas in *A. spiralis* it is vertically divided. Finally *A. pseudospiralis* n.sp. has a smaller "c" value ($c = 58-73$ versus $c = 83$).

Type locality and habitat

Holotype and three female paratypes collected by J. Heyns in August 1988 among the roots of unidentified grasses in the Skukuza camp.

Type specimens

Holotype on slide 4195, paratypes on slide 4192.

Makatinus macropunctatus Heyns, 1967 (Fig. 8, 9A-D). Morphometric data in Table 5.

The description of *Makatinus macropunctatus* was based on specimens from soil collected among the roots of plants in the veld

Fig. 7. *Aporcelaimellus pseudospiralis* n.sp.: A. Anterior body region of female; B. Stylet; C. Lateral view of head; D. Vulva area showing glands; E. Abnormal anterior branch of female reproductive system; F. Normal posterior branch of female reproductive system; G. Female tail; H. Heat-relaxed body posture of two females.

Table 4
Morphometric characters of *Aporcelaimus pseudospiralis* n.sp.

	Holotype		Paratypes
<i>n</i>	1 ♀		3 ♀♀
L (mm)	3,98	4,1	(3,64 ; 4,42 ; 4,24)
a	31	34	(32 ; 35 ; 34)
a'	39	43	(40 ; 48 ; 41)
b	4,6	4,8	(4,5 ; 5 ; 5,1)
c	58	70	(64 ; 73 ; 72)
c'	1,15	1,0	(0,93 ; 1,08 ; 1,0)
V %	53	51	(52 ; 51 ; 50)
Width of lip region	25,5	25	(23,5 ; 27 ; 25,5)
Odontostyle	26	25	(25,5 ; 26,5 ; 23,5)
Width of odontostyle	6	6	(5,5 ; 6,0 ; 6,0)
Odontophore	52	48	(46,6 ; 49,5 ; 48,5)
Total stylet length	78	73	(72 ; 76 ; 72)
Stylet aperture	20	19	(19,5 ; 20 ; 18)
Stylet aperture as % of stylet length	77	76	(76 ; 75 ; 77)
Guiding ring from anterior end	15,5	14	(13,5 ; 15 ; 13)
Amphid aperture	11	10	(10 ; 10 ; 11)
Length of oesophagus	860	842	(810 ; 880 ; 835)
Body width	130	123	(117 ; 125 ; 126)
Distance from head to vulva	209	187	(119 ; 227 ; 214)
Tail length	68	59	(57 ; 60,5 ; 59)
Anal body diameter	59	59	(61 ; 57 ; 59)
Length of rectum	74	74	(65 ; 84,5 ; 73)
Length of prerectum	274	248	(245 ; 219 ; 280)

near Tshokwane (Heyns 1967). The present specimens of *M. macropunctatus* match the description of *M. macropunctatus* Heyns, 1967, except that the amphid appears to be divided into three parts when seen laterally (Fig. 8A), whereas Heyns (1967) described it as undivided. However, examination of the type specimens revealed the same amphid structure as in the present specimens.

Locality and habitat

One male and one female collected by J. Heyns in August 1988 among the roots of grasses near the Letaba River at a look-out north of the Letaba Camp. Specimens on slides 4229 and 4231.

Tubixaba minima n.sp.

(Fig. 10A-H). Morphometric data in Table 6.

Female

Medium-sized nematodes with relatively robust bodies. Heat relaxed body slightly ventrally curved in the shape of the letter "C" (Fig. 10H). Cuticle relatively thick; 3-3,5 µm on the neck, 5-7 µm at mid-body, 7,5-9,5 µm around the tail tip. Cuticle consisting of a thin outer layer, thicker middle layer and thick inner layer of which only the inner two layers are shown in the figures. Exocuticle with transverse striae; radial striae in mesocuticle. Lateral chord about one tenth the body diameter at the base of the oesophagus with conspicuous cells. Lateral and ventral pores distinct, dorsal pores obscure. Lateral pores 75-94, distributed over entire length of body (18-24 to base of oesophagus, 18-29 between oesophagus and vulva, 33-47 between vulva and anus). The lateral pores start as a single row behind the lip region and diverge into two rows just anterior to the anus. Ventral pores 41-53, distributed over the entire length of

Fig. 8. *Makatinus macropunctatus* Heyns, 1967. A. Shape of amphid of specimens from Letaba River; B. Shape of amphid of holotype.

25 μ m A,B

Table 5
Morphometric characters of *Makatinus macropunctatus* Heyns, 1967 and *Tubixaba parva* Pretorius, Kruger & Heyns, 1987

Species	<i>Makatinus macropunctatus</i>		<i>Tubixaba parva</i>	
<i>n</i>	1 ♀	1 ♂	1 ♀	1 ♂
L (mm)	2,83	2,71	3,67	3,77
a	34	41	44	40
b	4,3	4,1	7,8	5,1
c	105	90	115	92
c'	0,61	0,86	0,7	0,82
V %	57	—	56	—
Width of lip region	24	22,5	19	18
Odontostyle	29	27	18	18
Width of odontostyle	5,5	5	4,5	4,5
Odontophore	46	43	33	33
Total stylet length	75	70	51	51,5
Odontostyle aperture	13	11	5	5
Stylet aperture as % of stylet length	45	41	28	28
Guiding ring from anterior end	13	13,5	11,5	12,5
Amphid aperture	11	12	—	13
Length of oesophagus	660	665	470	740
Body width	82,5	66,5	83	93,5
Distance from head to vulva	162	—	207	—
Length of vagina	24,5	—	38	—
Vagina length as % of body width	15	—	46	—
Tail length	27	30	32	41
Anal body diameter	44	34,5	45	50
Length of rectum	50	—	54	—
Length of prerectum	120	—	365	—
Cuticle thickness: at the neck	4	4	3	3,5
: at mid-body	8,5	9	7,5	—
: at the tail	11,5	9,5	13	11
: at the tail tip	11	10	10	10
Length of spicules	—	68	—	113
Length of crurae	—	19	—	17,5
Number of ventromedian supplements	—	14	—	14

Fig. 9. *Makatinus macropunctatus* Heyns, 1967: A. Anterior-lateral view of male head (bar equals 5,6 μm); B. Lateral view of female head (bar equals 6,5 μm); C. Cuticle with punctations (bar equals 0,8 μm); D. Posterior body region of male (bar equals 10 μm).

Table 6
Morphometric characters of *Tubixaba minima n.sp.*

	Holotype Tshokwane picnic area	Tshokwane picnic area	Paratypes Skukuza	Letaba
<i>n</i>	1 ♀	10 ♀♀	2 ♀♀	1 ♀
L(mm)	2,08	1,95 (1,72-2,12)	1,95 ; 1,92	1,92
a	34	32 (29-34)	29 ; 32	29
b	4,1	4,1 (3,8-4,7)	3,6 ; 4,0	4,2
c	69	75 (63-91)	67 ; 62	77
c'	0,77	0,72 (0,57-0,81)	0,74 ; 0,87	0,7
V %	53	51 (47-55)	51 ; 48	53
Width of lip region	16,5	16 (15,5-17,5)	16,5 ; 16	17
Odontostyle	18	17 (16,5-18,5)	16,5 ; 17,5	19
Width of odontostyle	4,5	4,7 (4-5)	5 ; 5	5
Odontophore	31,5	31 (30-32,5)	33 ; 32,5	33,5
Stylet aperture	7	7 (6,5-7,5)	6 ; 7	6,5
Stylet aperture as % of stylet length	39	40,5 (39-41)	36 ; 40	34
Guiding ring from anterior end	6,5	7 (6-7,5) ‡	6 ; 7	7
Amphid aperture	10	10 (9-10)	9 ; 10,5	10
Length of oesophagus	505	426 (390-510)	540 ; 570	460
Body width	60,5	60 (55-64) ‡	67 ; 59,5	67
Distance from head to vulva	111	101 (93,5-117,5)	99 ; 92	101
Tail length	30	26,5 (23-28)	29 ; 31	25
Anal body diameter	39	37 (32-40,5)	30 ; 35,5	36
Length of rectum	39	36 (27-41)	42,5 ; 39	38,5
Length of prerectum	152	143 (118-170)	131 ; 114	132

‡ *n*=9

body (12-15 to base of oesophagus, 10-14 between oesophagus and vulva, 18-24 between vulva and anus).

Lip region distinctly set off by a constriction; about one quarter as wide as body at base of neck. Lips rounded, sometimes slightly angular. Amphid stirrup-shaped, the aperture slightly more than half the lip region width, situated in the constriction (Fig. 10B). Amphid when viewed laterally appearing to be divided into two parts. Length of odontostyle equal to or slightly greater than lip region width.

Stylet aperture about two fifths stylet length. Stylet width about one quarter stylet length. Odontophore distinct. Guiding ring single, unsclerotized. Rudimentary excretory pore situated near nerve ring. Hemizonid situated anterior to nerve ring. One pair of endolids

situated anterior to nerve ring (Fig. 10C). Oesophago-intestinal disc absent. Cardia conoid, variable in length (Fig. 10A and D). Position of oesophageal gland nuclei and their openings as follows (*n* = 3): DO = 51 (49,9-52,6); DN = 54,5 (53,6-56); S₁O₁ = 66,6 (65,3-67,9); S₁N₁ = 66,8 (65,7-69); S₁O₂ = 71,4 (70-72,7); S₁N₂ = 70,9 (69,8-72,3); S₂O₁ = 81 (79,1- 83,2); S₂N₁ = 78,3 (77,1-79,8); S₂O₂ = (79,5-83,6); S₂N₂ = 79,6 (77,8- 82,2).

Intestinal cells packed with transparent brown and yellowish granules. Junction between intestine and prerectum obscured by dense granules. Distinct sphincter at junction of prerectum and rectum. Rectum length equal to anal body diameter. Prerectum length about four times the anal body diameter. Tail convex-conoid, bluntly rounded (Fig. 10G). Caudal pores variable in number and position, from two to four pairs occurring on tail.

Fig. 10. *Tubixaba minima* n.sp.: A. Anterior body region of holotype female; B. Shape and position of amphid; C. Endolids in lumen of oesophagus; D. Cardiac region; E-F. Variation in female reproductive system; G. Female tail; H. Heat-relaxed body posture of female.

Female didelphic, amphidelphic (Fig. 10E and F). Ovaries reflexed. *Pars dilatata oviductus* separated from *pars dilatata uteri* by a sphincter muscle. Ovejector not clearly differentiated. Vagina reaching about 39-59 % of the corresponding body diameter, strongly muscular. Vulva a transverse slit without sclerotized lips. No sperms cells or eggs observed in reproductive system.

Male unknown.

Diagnosis

Tubixaba minima n.sp. can be compared with *T. parva* Pretorius, Kruger & Heyns, 1987 and *T. tswanorum* Nell & Heyns, 1987, the only *Tubixaba* species known from southern Africa. It can be distinguished from *T. parva* by the less conspicuous radial striae in the neck, longer odontostyle (16,5-19 µm versus 14-17 µm), more robust body (a = 29-34 versus 39-53,4), smaller "b" value (3,8-4,7 versus 5,1-7,9), fewer lateral and ventral pores (75-94 versus 360 and 41-52 versus 120 respectively). *T. minima* n.sp. can be distinguished from *T. tswanorum* by its smaller size (L = 1,72-2,12 mm versus 4,34-4,59 mm), more robust body (a = 29-34 versus 49,4-54,6), shorter tail (23-31 µm versus 30-35 µm) and smaller anal body diameter (32-40,5 µm versus 47-53 µm). From the type species, *T. tuxaua* Monteiro & Lordello, 1980, it can be separated very easily by its smaller size (1,72-2,12 mm versus 10,75-11,66 mm), smaller "a" value (29-34 versus 61-70), smaller "b" value (3,8-4,7 versus 6,4-7,6), smaller "c" value (63-91 versus 157-179), thinner cuticle (3-9,5 µm versus 13-20 µm) and shorter odontostyle (16,5-19 µm versus 31-33 µm).

Type locality and habitat

Holotype and ten paratypes from Tshokwane picnic area, two paratypes from Skukuza

Camp and one paratype from the look-out near the Letaba River, north of the Letaba Camp, all collected by J. Heyns in August 1988 among the roots of grasses.

Type specimens

Holotype female from Tshokwane picnic area on slide 4156; paratypes from Tshokwane picnic area on slides 4149, 4155, 4156, 4160 and 4161; paratypes from Skukuza Camp on slides 4196 and 4200 and paratype from Letaba on slide 4228.

Tubixaba parva Pretorius, Kruger & Heyns, 1987. Morphometric data in Table 5

Tubixaba parva was described from specimens collected in 1986 by J. Heyns and A. Coomans among the roots of grasses and *Acacia* trees next to the parking area outside the Malelane Gate of the Kruger National Park. The present specimens, one male and one female (slide 4164), which are in perfect agreement with the type population, were collected by J. Heyns in August 1988 among the roots of grasses at the look-out near the Engelhard Dam.

Acknowledgements

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