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Some species of *Helicotylenchus* Steiner, 1945 from South Africa (Nematoda: Hoplolaimidae)

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Summary – A total of 49 populations of the genus *Helicotylenchus* Steiner, 1945 from various localities in South Africa were studied. *H. delanus* sp. n., collected from the rhizosphere of *Pinus patula* is described. The species is characterized by the posterior position of the vulva (V = 73-76%), reduced posterior genital branch (25-44 µm), and position of phasmids (five annuli posterior to anus) in females and by body length (497-629 µm), position of excretory pore (85-94 µm from anterior end), stylet length (22-26 µm), spicule length (18-23 µm), and gubernaculum length (6-8 µm) in males. *H. krugeri* Van den Berg & Heyns, 1975 is synonymized with *H. martini* Sher, 1966. *H. paracanalis* Sauer & Winoto, 1975 and *H. variabilis* Philips, 1971 are new recordings for South Africa. The male of *H. indicus* Siddiqi, 1963 is described for the first time and *H. brevis* (Whitehead, 1958) Fortuner, 1984, *H. exallus* Sher, 1966, and *H. vulgaris* Yuen, 1964 are redescribed. © Orstom/Elsevier, Paris

Résumé – ***Quelques espèces d'*Helicotylenchus *Steiner, 1945 provenant d'Afrique du Sud (Nematoda: Hoplolaimidae)*** – Un total de 49 populations du genre *Helicotylenchus* Steiner, 1945 provenant de différentes localités d'Afrique du Sud ont été étudiées. *H. delanus* sp. n. récolté dans la rhizosphère de *Pinus patula* est décrit. Cette espèce est caractérisée par la position postérieure de la vulve (V = 73-76 %), la branche génitale postérieure réduite (25-44 µm), la position des phasmides (cinq anneaux en arrière de l'anus) chez la femelle ; la longueur du corps (497-629 µm), la position du pore excréteur (à 85-94 µm de l'avant), les longueurs du stylet (22-26 µm), des spicules (18-23 µm) et du gubernaculum (6-8 µm). *H. krugeri* Van den Berg & Heyns, 1975 est synonymisé avec *H. martini* Sher, 1966. *H. paracanalis* Sauer & Winoto, 1975 et *H. variabilis* Philips, 1971 sont signalés pour la première fois en Afrique du Sud. Le mâle de *H. indicus* Siddiqi, 1963 est décrit pour la première fois ; *H. brevis* (Whitehead, 1958) Fortuner, 1984, *H. exallus* Sher, 1966 et *H. vulgaris* Yuen, 1964 sont redécrits. © Orstom/Elsevier, Paris

Keywords: *Helicotylenchus*, nematodes, SEM, South Africa, taxonomy.

The cosmopolitan genus *Helicotylenchus* Steiner, 1945 is common throughout South Africa and is found in all biomes. Fifteen of the 29 species found in South Africa were also reported from other African countries (Kleynhans *et al.*, 1996).This article is the result of an ongoing investigation on this genus in South Africa. Seventeen populations from Mpumalanga, fourteen from the Eastern Cape, five from KwaZulu-Natal, seven from the Western Cape, five from the Northern Cape, and one each from the North-West and Northern Provinces were studied (Table 1). Some populations showed such pronounced interspecific variability that no reliable characteristics could be found to separate the species. Scanning electron micrographs are given for the first time for six of the species.

Extraction and handling procedures were similar to those given by Marais (1993). All the specimens studied are housed in the National Collection of Nematodes, ARC-Plant Protection Research Institute, Pretoria, South Africa and the Muséum National d'Histoire Naturelle, Paris, France.

*Helicotylenchus delanus** sp. n. = *H. intermedius apud* Kleynhans *et al.*, 1996

(Figs 1,2)

MEASUREMENTS

See Table 2.

DESCRIPTION

Female: Habitus straight (44%) to C-shaped (56%). Lip region not offset, with five to six lip annuli. Labial disc not visible in lateral view, rectangular in *en face* view. Labial framework strongly developed, its outer margin extending posteriorly over three to four annuli from basal plate. Cephalids not seen. Stylet knobs posteriorly rounded and varying anteriorly from flattened (28%) to indented (72%). Median bulb shape varying from oblong to nearly round. Overlap of oesophageal lobe 20 ± 6.4 (15-29) µm long; two specimens with dorsal oesophageal overlap. Excretory pore located from posterior part of median bulb to opposite middle of oesophageal lobe. Hemizonid two

* A cryptogram from the name of the type locality, Elandshoogte.

Table 1. *Distribution of the populations studied.*

Species	Code	Province	Locality*	Associated plants	Longitude	Latitude	pH	% Clay	% Silt	% Sand
H. martini	KP739	Eastern Cape	Aliwal North	Natural vegetation	31.08 S	26.48 E	-	-	-	-
H. brevis	KP941	Western Cape	Knysna	Indigenous forest	34.02 S	23.23 E	-	-	-	-
H. exallus	KP982	Eastern Cape	Tsitsikamma National Park	Indigenous forest	33.59 S	23.47 E	-	-	-	-
H. exallus	KP985	Eastern Cape	Tsitsikamma National Park	Indigenous forest	34.01 S	23.53 E	-	-	-	-
H. martini	KP1132	Northern Cape	Petrusville	Natural vegetation	30.18 S	24.34 E	-	-	-	-
H. exallus	KP1171	Western Cape	Wilderness National Park	*Pelargonium cucullatum* (L.) L'Hérit.	33.59 S	22.42 E	5.8	0	5	95
H. exallus	KP1184	Western Cape	Kraaifontein	*Psidium guajava* L.	33.44 S	18.50 E	7	0	5	95
H. martini	KP1189	Eastern Cape	Oviston	Natural vegetation	30.46 S	25.44 E	6.8	8	20	72
H. vulgaris	KP1243	Northern Cape	Upington	*Olea europaea* var. *europaea* L.	28.27 S	21.19 E	8	10	3	87
H. martini	KP1270	Northern Cape	Kanoneiland	*Juglans regia* L.	28.38 S	21.07 E	7.4	4	0	96
H. vulgaris	KP1289	Northern Cape	Upington	*Vitis* L. spp.	28.36 S	21.08 E	7.7	14	17	69
H. vulgaris	KP1293	Northern Cape	Upington	*Phoenix dactylifera* L.	28.35 S	21.09 E	7.6	14	10	76
H. martini	KP1343	Eastern Cape	Sterkstroom	Natural vegetation	31.34 S	26.33 E	6.7	1	4	95
H. exallus	KP1350	Western Cape	Heroldsbaai	Natural vegetation	34.03 S	22.24 E	6.1	6	8	86
H. exallus	KP1413	Western Cape	Dangerpoint	Fynbos	34.37 S	19.17 E	8.2	4	5	91
H. martini	KP1505	Western Cape	Wilderness	Natural vegetation	33.45 s	22.41 E	6.4	5	3	92
H. exallus	KP1520	Western Cape	Wilderness	Natural vegetation	33.54 S	22.42 E	5	4	21	75
H. exallus	KP1533	Eastern Cape	Tsitsikamma National Park	Indigenous forest	34.01 S	23.53 E	4.7	4	6	90
H. exallus	KP1537	Eastern Cape	Tsitsikamma National Park	*Agapanthus praecox* Willd. subsp. *minimus* (Lindl.) Leighton	34.01 S	23.53 E	4.2	4	0	96
H. brevis	KP1544	Eastern Cape	Tsitsikamma National Park	*Dietes iridioides* (L.) Sweet *ex* Klatt	34.01 S	23.53 E	4.8	11	10	79
H. brevis	KP1545	Eastern Cape	Tsitsikamma National Park	Indigenous forest	34.01 S	23.53 E	4.9	9	0	91
H. brevis *H. exallus*	KP1549	Eastern Cape	Tsitsikamma National Park	Indigenous forest	34.01 S	23.53 E	5.9	6	8	86
H. brevis	KP1553	Eastern Cape	Tsitsikamma National Park	*Argyrolobium collinum* Eckl. & Zeyh.	34.01 S	23.53 E	5.4	10	19	71
H. brevis	KP1563	Eastern Cape	Tsitsikamma National Park	*Chlorophytum* sp. Ker-Gawl.	34.01 S	23.54 E	4.6	5	9	86
H. brevis	KP1565	Eastern Cape	Tsitsikamma National Park	*Crassula* sp.	34.01 S	23.54 E	5.6	5	9	86
H. exallus	KP1567	Eastern Cape	Tsitsikamma National Park	Indigenous forest	34.01 s	23.54 E	5.9	11	23	66
H. brevis	N474	KwaZulu-Natal	Port Edward	*Musa* sp.	31.02 S	31.13 E	-	-	-	-
H. brevis	N475	KwaZulu-Natal	Umtentwini	*Hyphaene coriacea* Gaertn.	30.42 S	30.29 E	-	-	-	-
H. brevis	N480	KwaZulu-Natal	Trafalgar	Dune vegetation	30.58 S	30.26 E	-	-	-	-
H. martini	N624	KwaZulu-Natal	Newcastle	Natural vegetation	27.52 S	29.44 E	-	8	12	80

End of Table 1 next page

Table 1. *(continued).*

Species	Code	Province	Locality*	Associated plants	Longitude	Latitude	pH	% Clay	% Silt	% Sand
H. indicus	OVS323	KwaZulu-Natal	Retief's Pass	Grass	28.32 S	29.07 E	5.1	0	14	86
H. exallus	TVL702	North West	Rustenburg	*Vangueria* sp.	25.33 S	27.17 E	-	-	-	-
H. martini	TVL1255	Mpumalanga	Carolina	*Populus* sp.	26.02 S	30.04 E	6.4	5	15	80
H. exallus	TVL1277	Mpumalanga	Warburton	*Quercus* sp.	26.14 S	30.31 E	5.1	10	20	70
H. martini	TVL1284	Mpumalanga	Warburton	*Zantedeschia aethiopica* (L.) Spreng.	26.15 S	30.33 E	4.8	15	8	77
H. indicus	TVL1288	Mpumalanga	Warburton	Natural vegetation	26.15 S	30.33 E	5.8	15	10	75
H. martini	TVL1314	Mpumalanga	Badplaas	Indigenous forest	25.50 S	30.29 E	5	15	18	67
H. indicus	TVL1346	Mpumalanga	Ngodwana	*Pinus elliottii* Engelm.	25.37 S	30.33 E	4.6	35	25	40
H. martini	TVL1349	Mpumalanga	Nelspruit	Natural vegetation	25.31 S	30.57 E	6.1	5	10	85
H. martini	TVL1353	Mpumalanga	Nelspruit	*Vellozia equisetoides* (Bak.) Bak.	25.32 S	30.57 E	6.6	3	20	77
H. martini	TVL1364	Mpumalanga	Barberton	Natural vegetation	25.46 S	30.57 E	5.5	5	10	85
H. martini	TVL1368	Mpumalanga	Barberton	*Pinus* sp.	25.50 S	30.47 E	5.1	23	12	65
H. martini	TVL1370	Mpumalanga	Barberton	Indigenous forest	25.50 S	30.47 E	5.1	20	15	65
H. indicus	TVL1374	Mpumalanga	Barberton	Natural vegetation	25.50 S	30.47 E	5	28	17	55
H. variabilis	TVL1404	Mpumalanga	Nelspruit	Natural vegetation	25.32 S	30.56 E	5.5	0	13	87
H. martini	TVL1405	Mpumalanga	Nelspruit	Natural vegetation	25.32 S	30.56 E	5.5	0	13	87
H. brevis *H. paracanalis*	TVL1420	Mpumalanga	Ngodwana	Indigenous forest	25.34 S	30.45 E	4.4	6	30	64
H. exallus	TVL1428	Mpumalanga	Ngodwana	Natural vegetation	25.34 S	30.46 E	3.6	3	5	92
H. vulgaris	TVL1483	Northern Province	Kruger National Park	*Ficus sycomorus* L. subsp. *sycomorus*	22.41 S	31.06 E	7.3	1	10	89

* Nearest town, National Park

annuli long, located from one to two annuli anterior to excretory pore (n = 3). Hemizonion not seen. Lateral field areolated opposite oesophageal region but not areolated on rest of body; end of lateral field on tail variable. Spermatheca round, offset, filled with elongated sperm. Posterior branch of reproductive tract reduced. Epiptygmata folded into vagina. Phasmid located from five annuli posterior to opposite anus. Caudalid not seen. Tail more curved dorsally, with rounded end; six to eleven tail annuli.

Male: Lip region anteriorly flattened with five lip annuli. Labial framework extending posteriorly over three annuli from basal plate. Cephalids not seen. Stylet knobs posteriorly rounded and anteriorly indented. Overlap of oesophageal lobes 12 ± 2.5 (10-16) µm long, one specimen with dorsal oesophageal overlap. Excretory pore located from middle of isthmus to opposite anterior part of oesophageal lobe. Hemizonid and hemizonion not seen. Lateral field areolated opposite oesophageal region but not areolated on rest of body. Phasmid located less than one body width posterior to cloaca. Bursa extending to tip of tail. Tail with a finger-like tip.

Type host and locality

Collected in the rhizosphere of a pine tree (*Pinus patula* Schiede ex Schldl. & Cham.) in the Elandshoogte Plantation of Sappi Forests (Pty) Ltd, Mpumalanga Pro-vince, South Africa, on 13 March 1991 by J. Tait. Clay loam soil (35% clay, 25% silt, 40% sand), soil pH 4.6.

Type specimens

Holotype female (slide 29739), eleven female paratypes, and three male paratypes (slides 29737-29740, 29743-27944) deposited in the National Collection of Nematodes, ARC-Plant Protection Research Institute, Pretoria, South Africa. Two female paratypes and two male paratypes deposited in Muséum National d'Histoire Naturelle, Paris, France.

Table 2. *Morphometric data of* Helicotylenchus delanus *sp. n. and* H. indicus *from South Africa (All measurements in µm).*

Locality*	*H. delanus* sp. n.			*H. indicus*				
	Holotype	Paratypes		OVS323	TVL1288		TVL1346	TVL1374
	Female	Females	Males	Females	Females	Male	Females	Females
n		20	8	4	9	1	14	9
L	549	547 ± 45.8 (463-624)	571 ± 44.9 (497-629)	458 ± 13.6 (436-473)	517 ± 23.5 (482-546)	546	572 ± 37.8 (501-628)	580 ± 18.5 (555-613)
a	29.9	26.8 ± 3.4 (22.5-33.0)	30.1 ± 3.6 (24.8-36.2)	22.3 ± 1.0 (20.7-23.5)	25 ± 2.1 (21.5-27.9)	28.1	25.7 ± 2.4 (21.6-28.4)	26.1 ± 1.5 (23.8-28.5)
b	4.7	5.1 ± 0.6 (4.6-5.6)	5.1 ± 0.3 (4.8-5.4)	4.1	4.2	4.7	4.9 ± 0.7 (4.2-5.5)	5.0 ± 0.2 (4.1-5.4)
b′	4.2	4.3 ± 0.4 (3.5-5.0)	4.4 ± 0.4 (3.8-4.8)	4.2 ± 11.4 (3.7-4.6)	4.1 ± 0.4 (3.6-4.5)	4.1	4.3 ± 0.5 (3.2-5.0)	4.6 ± 0.4 (4.1-5.4)
c	45.8	44.1 ± 6.4 (35.8-56.5)	32.5 ± 1.6 (30.3-34.9)	30.7 ± 0.8 (29.9-32.1)	26.6 ± 1.5 (24.5-28.0)	36.5	24.9 ± 0.3 (21.2-36.2)	23.4 ± 1.5 (21.4-25.8)
c′	1.0	0.9 ± 0.1 (0.7-1.2)	1.5 ± 0.2 (1.4-1.8)	1.2 ± 0.1 (1.2-1.3)	1.6 ± 0.1 (1.4-1.7)	1.9	1.9 ± 0.3 (1.4-2.4)	1.9 ± 0.1 (1.8-2.1)
DGO	5	6 ± 0.9 (5-8)	6 ± 0.6 (5-7)	10 ± 1.4 (9-12)	8 ± 0.3 (7-8)	-	8 ± 0.4 (7-8)	10 ± 0.6 (9-11)
o	17	25 ± 4.1 (17-31)	26 ± 0.6 (23-33)	37 ± 6.1 (30.4-42.7)	30 ± 2.2 (27-32)	-	30 ± 2.1 (26-33)	36 ± 1.5 (32-39)
V	76	75 ± 1.4 (73-76)	-	66 ± 1.1 (65-68)	65 ± 2.4 (62-70)	-	66 ± 1.5 (63-68)	65 ± 2.3 (61-69)
OV1	23	27 ± 6.1 (23-32)	-	33	25 ± 2.2 (24-27)	-	21 ± 1.4 (20-22)	-
OV2	7	6 ± 1.8 (4-8)	-	-	-	-	-	-
Post. gen. br.	38	32 ± 7.2 (25-44)	-	-	-	-	-	-
Stylet	26	26 ± 0.9 (25-28)	25 ± 1.4 (22-26)	27 ± 0.6 (27-28)	26 ± 0.9 (24-27)	23	26 ± 1.0 (24-28)	28 ± 0.8 (26-29)
m	48	50 ± 2.6 (46-53)	54 ± 3.5 (50-57)	54 ± 0.7 (53-54)	52 ± 1.7 (49-54)	53	49 ± 1.6 (47-52)	52 ± 1.2 (50-53)
Stylet knob height	2	2 ± 0.3 (2-3)	2 ± 0.3	3	2 ± 0.4 (2-3)	2	2 ± 0.4 (2-3)	2 ± 0.3 (2-3)
Stylet knob width	5	5 ± 0.4 (4-6)	5 ± 0.6 (4-5)	5 ± 0.4 (4-5)	5 ± 0.6 (4-6)	3	5 ± 0.6 (4-6)	5 ± 0.4 (5-6)
Oesophagus	131	128 ± 2.9 (114-145)	133 ± 11.4 (118-148)	110 ± 8.1 (102-118)	126 ± 8.2 (117-137)	133	132 ± 6.2 (121-142)	133 ± 7.1 (122-143)
Excretory pore	97	93 ± 5.2 (82-103)	90 ± 3.7 (85-94)	103	89 ± 2.5 (85-93)	87	99 ± 4.0 (94-104)	105 ± 3.2 (100-109)
Body width at midbody	18	21 ± 2.9 (15-26)	19 ± 2.8 (15-24)	21 ± 1.1 (19-22)	21 ± 2.1 (17-25)	19	22 ± 2.4 (19-27)	23 ± 1.4 (21-25)
Body width at excr. pore	18	16 ± 2.0 (14-21)	17 ± 3.1 (14-23)	20 ± 1.1 (19-21)	18 ± 2.5 (16-23)	15	19 ± 2.8 (16-26)	20 ± 1.6 (19-24)
Median bulb length	10	12 ± 1.2 (10-14)	11 ± 1.1 (9-12)	12 ± 1.5 (10-14)	12 ± 0.9 (10-13)	12	12 ± 1.2 (10-14)	13 ± 0.2
Median bulb width	8	9 ± 1.6 (8-14)	8 ± 1.0 (7-10)	9 ± 1.2 (7-10)	9 ± 0.5 (8-10)	9	8 ± 0.5 (7-9)	10 ± 0.7 (9-11)
Lip region width	8	7 ± 0.5 (6-8)	6 ± 0.8 (5-8)	8	6 ± 0.9 (4-7)	8	6 ± 0.6 (5-7)	7 ± 0.9 (6-8)

Table 2 continued next page

Table 2. *(End).*

Locality*	*H. delanus* sp. n.			*H. indicus*				
	Holotype	Paratypes		OVS323	TVL1288		TVL1346	TVL1374
	Female	Females	Males	Females	Females	Male	Females	Females
Lip region height	4	4 ± 0.2 (3-5)	3 ± 0.3 (3-4)	4 ± 0.6 (3-5)	4 ± 0.4 (3-5)	5	4 ± 0.5 (4-5)	4 ± 0.5 (4-5)
Lateral field	3	4 ± 0.8 (3-6)	5 ± 1.1 (5-8)	5 ± 0.7 (4-6)	5 ± 0.7 (4-6)	5	4 ± 0.3 (4-5)	5 ± 0.7 (4-6)
Annulus	2	1 ± 0.2 (1-2)	1 ± 0.3 (1-2)	-	-	-	-	-
Tail	12	13 ± 2.1 (9-17)	18 ± 2.5 (15-19)	15 ± 0.6 (14-16)	19 ± 1.2 (18-22)	21	24 ± 3.1 (17-28)	25 ± 2.0 (23-28)
Tail diameter	12	14 ± 2.6 (10-20)	11 ± 0.9 (10-12)	12 ± 0.4	12 ± 1.0 (11-14)	11	12 ± 1.7 (10-16)	13 ± 1.1 (12-14)
Spicule	-	-	21 ± 1.4 (18-23)	-	-	21	-	-
Gubernaculum	-	-	7 ± 1.0 (6-8)	-	-	6	-	-
Phasmid**	-	0-5 post.	-	7-11 post.	3-7 post.	-	5-11 post.	4-8 post.
Tail annuli	-	6-11	-	11-15	11-15	-	14-21	15-17

* See Table 1.
** Position of phasmid: number of annuli anterior or posterior to anus.

DIAGNOSIS AND RELATIONSHIPS

H. delanus sp. n. is characterized by the posterior position of the vulva, reduced posterior genital branch, position of phasmid, and tail shape in females and by body length, position of excretory pore, and lengths of stylet, spicule, and gubernaculum in males.

H. delanus sp. n. is similar to *H. intermedius* (Luc, 1960) Siddiqi & Husain, 1964, *H. neoformis* (Siddiqi & Husain, 1964) Fortuner, 1984, and *H. valdeclarus* (Orton Williams, 1983) Ebsary, 1991 in having a reduced posterior genital branch and therefore a posterior position of vulva. The new species differs from *H. intermedius* in: position of vulva (V = 73-78 *vs* 78-83.2), length of posterior genital branch (21-33 *vs* 41-53 µm; OV2 = 4-8 *vs* 10.4-12.1), and number of lip annuli (five to six *vs* four) in females and stylet length (22-26 *vs* 20-21 µm), body length (497-629 *vs* 348-387 µm), b-value (4.8-5.4 *vs* 3.7-4.6), position of excretory pore from anterior end (85-94 *vs* 67-69 µm), spicule length (18-23 *vs* 14.5-15 µm), and gubernaculum length (6-8 *vs* 4.5-5 µm) in males. *H. delanus* sp. n. is differentiated from *H. neoformis* by position of dorsal gland opening (5-8 *vs* 9.5 µm), posterior genital branch length (25-44 *vs* 60 µm*), stylet length (25-28 *vs* 22-23 µm), position of phasmid (five annuli posterior to opposite anus *vs* five to eight annuli anterior to anus), number of lip annuli (five to six *vs* four), and presence *vs* absence of males. *H. delanus* sp. n. can be distinguished from *H. valdeclarus* by body length (463-426 *vs* 380-460 µm), c-value (35.8-56.5 *vs* 19.0-27.1), c´-value (0.7-1.2 *vs* 1.4-2.3), position of vulva (V = 73-78 *vs* 67.1-71.8), length of posterior genital branch (25-44 *vs* 47-51 µm**), stylet length (25-28 *vs* 20-22 µm), tail shape, and presence *vs* absence of males.

* Calculated from Fig. 2A from Siddiqi and Husain (1964).

Helicotylenchus brevis **(Whitehead, 1958) Fortuner, 1984**
= *Rotylenchoides brevis* **Whitehead, 1958**

(Fig. 3)

Rotylenchoides brevis is the type species of the genus *Rotylenchoides* Whitehead, 1958 which was synonymized with *Helicotylenchus* by Fortuner (1984). The species has been reported from *Musa paradisiaca* L. in Tanzania (Whitehead, 1958) and indigenous forest and mango trees in South Africa (Van den Berg, 1976, 1993, 1996).

MEASUREMENTS

See Table 3A & B.

** Calculated from paratypes.

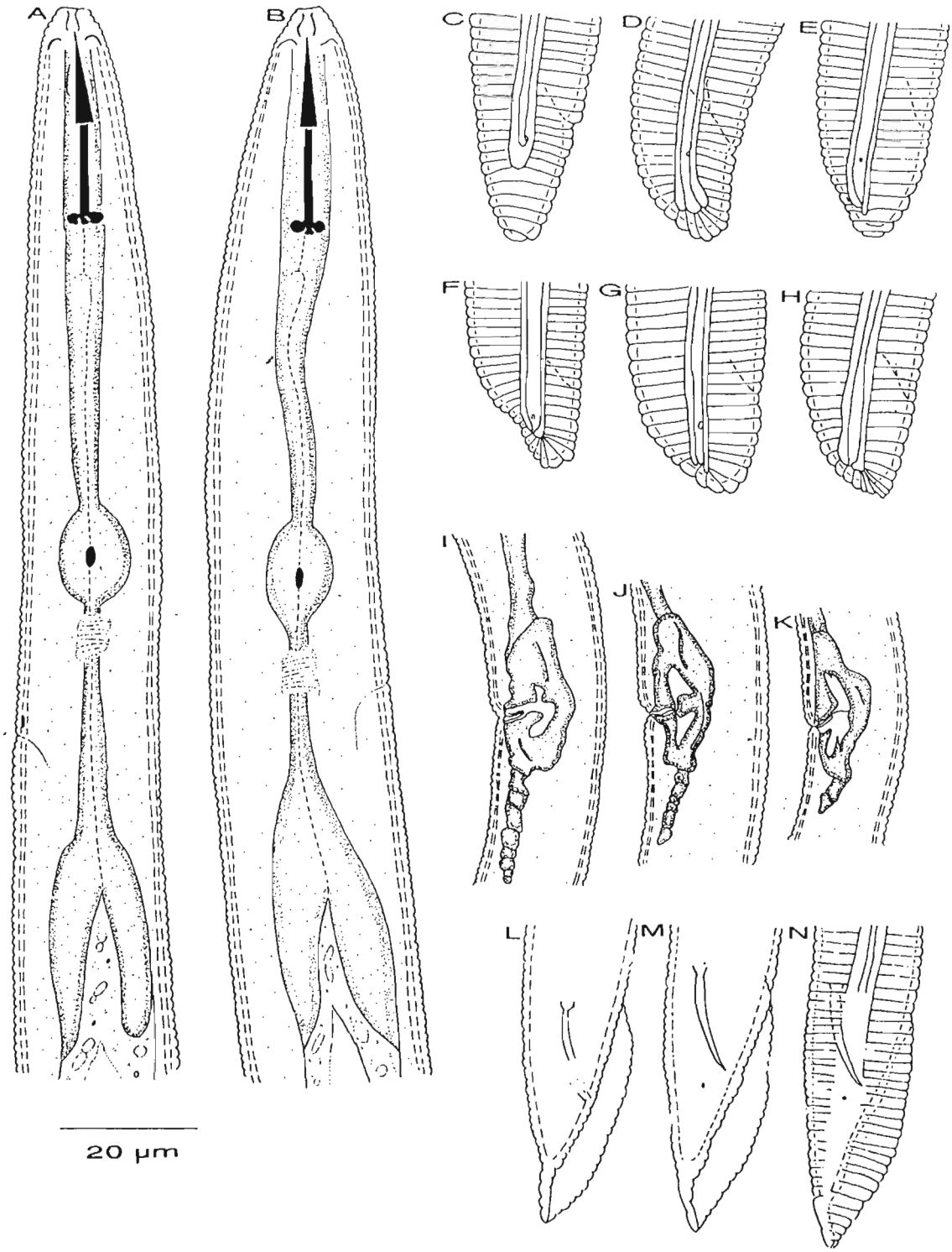

Fig. 1. Helicotylenchus delanus *sp. n. Female: A: Oesophageal region; C-H: Variations in tail shape; I-K: Posterior uterine branch. Male: B: Oesophageal region; L-M: Tail, internal view; N: Tail, external view.*

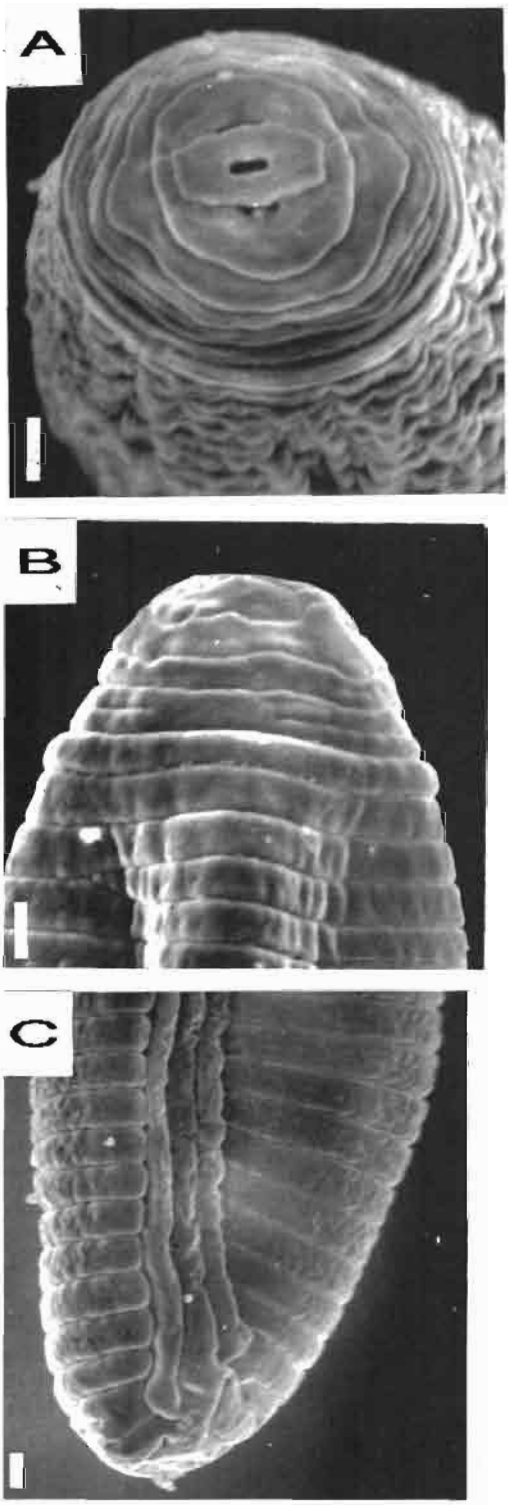

Fig. 2. Helicotylenchus delanus *sp. n. Female: A: Face view, lip region; B: Lateral view, lip region; C: Posterior part of body. (Scale bar = 1 µm).*

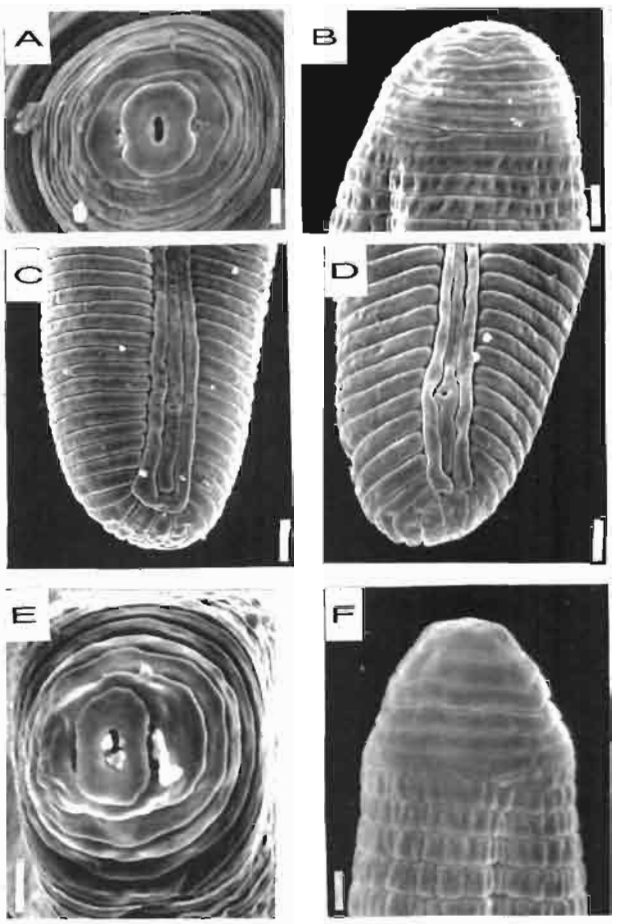

Fig. 3. Helicotylenchus brevis. *Female: A: En face view, lip region; B: Lateral view, lip region; C-D: Posterior part of body* — H. indicus. *Female: E: Face view, lip region; F: Lateral view, lip region. (Scale bar: A-B, E-F = 1 µm; C-D = 2 µm).*

DESCRIPTION

Female: Body posture straight (14%) or C-shaped (86%). Lip region rounded, not offset, with four to six annuli. Labial framework extending posteriorly over three to four annuli from basal plate. Cephalids not seen. Anterior face of stylet knobs rounded (3%), flattened (42%), or indented (45%). Oesophagus with 12 ± 5.8 (6-21) µm long ventral overlap. Position of excretory pore varying from just posterior to median bulb to opposite middle part of oesophageal lobes. Hemizonid seen in only one specimen, two annuli long, one annulus anterior to excretory pore. Hemizonion not seen. Lateral field with four lines, areolated opposite oesophageal region. One specimen from the Tsitsikamma National Park with incompletely areolated lateral fields on the tail and two specimens from Berlin Plantation, Nelspruit, Mpumalanga Province

Table 3A. *Selected morphometric characters of* Helicotylenchus brevis *from South Africa (All measurements in µm).*

Locality*	KP941	KP1544		KP1545	KP1549		KP1553	
	Females	Females	Male	Females	Females	Males	Female	Males
n	4	5	1	9	2	2	1	2
L	491 ± 36.3 (443-528)	462 ± 57.2 (394-528)	621	469 ± 30.1 (415-503)	454	544-552	527	580-615
a	23.0 ± 3.4 (18.1-25.5)	22.4 ± 1.6 (19.5-23.8)	25.4	21.3 ± 2.6 (17.2-25.0)	19.7-21.8	26.0-28.6	26.2	27.6-31.0
b	-	4.2 ± 0.4 (3.8-4.6)	4.6	4.0 ± 0.5 (3.5-4.1)	-	-	-	5.0
b′	4.8 ± 1.3 (3.8-6.7)	3.7 ± 0.3 (3.4-4.1)	4.5	3.8 ± 0.3 (3.3-4.2)	-	5.0	4.1	4.4-4.5
c	53.9 ± 15.0 (38.3-74.2)	54.8 ± 14.1 (38.8-80.1)	37.6	55.9 ± 8.6 (42.3-66.2)	48.6-63.2	32.7-34.4	61.0	29.3-30.6
c′	0.7 ± 0.1 (0.6-0.8)	0.7 ± 0.1 (0.5-0.8)	1.4	0.6 ± 0.1 (0.5-0.8)	0.6-0.8	1.2-1.4	0.7	1.5-1.6
o	20	25 ± 1.6 (24-27)	-	26 ± 1.7 (23-28)	26	34	40	-
DGO	6	7 ± 0.7 (7-8)	-	8 ± 0.6 (8-9)	7	9	12	-
V	88 ± 1.2 (86-89)	86 ± 1.7 (84-88)	-	89 ± 1.5 (87-90)	87-88	-	89	-
OV1	32	24	-	30 ± 22.7 (20-39)	-	-	-	-
OV2	-	4 ± 1.6 (3-6)	-	4 ± 0.6 (3-4)	2-3	-	-	-
Post. gen. br.	-	17 ± 5.6 (13-25)	-	16 ± 2.4 (14-21)	9-13	-	-	-
Stylet	30 ± 1.5 (28-31)	28 ± 1.7 (25-30)	27	32 ± 1.0 (31-34)	28	24-25	29	26-27
m	52 ± 0.6 (51-52)	50 ± 1.6 (49-53)	54	50 ± 1.2 (48-51)	49	52	50	53
Stylet knob height	3 ± 0.4 (2-3)	3 ± 0.3 (3-4)	2	3 ± 0.4 (3-4)	3	2	4	2-3
Stylet knob width	6 ± 0.8 (5-6)	6 ± 0.7 (5-7)	4	7 ± 1.1 (5-8)	6-7	4	6	5
Oesophagus length	116 ± 6.0 (110-122)	121 ± 5.6 (115-130)	139	123 ± 7.7 (112-137)	-	129	128	97-141
Excretory pore	88 ± 5.7 (84-92)	100 ± 10.3 (86-109)	-	85 ± 8.4 (74-98)	100-101	90	93	97-98
Body width at midbody	22 ± 2.0 (20-25)	21 ± 3.7 (17-27)	24	22 ± 2.3 (19-26)	21-23	19-21	20	19-22
Body width at excr. pore	20 ± 2.0 (19-22)	20 ± 3.1 (16-23)	-	20 ± 3.6 (16-28)	15-17	18	17	16
Median bulb length	12 ± 0.3 (11-12)	13 ± 0.8 (12-14)	11	15 ± 3.8 (11-21)	11-12	9	14	12
Median bulb width	9 ± 0.5 (8-9)	10 ± 0.7 (9-10)	8	10 ± 0.8 (9-11)	8	7	9	8
Lip region width	-	9 ± 0.5 (9-10)	7	9 ± 0.6 (9-10)	9	6	9	7
Lip region height	8	4 ± 0.5 (3-4)	4	4 ± 0.4 (4-5)	4	4	4	4
Lateral field	4 ± 0.2	4	5	5 ± 0.4 (5-6)	4-5	4	-	5

End of Table 3A next page

Table 3A. *(continued).*

Locality*	KP941	KP1544		KP1545	KP1549		KP1553	
	Females	Females	Male	Females	Females	Males	Female	Males
Tail	10 ± 2.0 (7-12)	9 ± 1.9 (7-12)	17	9 ± 1.3 (6-10)	7-9	16-17	9	19-20
Tail diameter	14 ± 0.5 (13-14)	13 ± 1.5 (12-15)	12	13 ± 1.9 (9-16)	12	12-13	13	13-14
Spicule	-	-	24	-	-	24	-	22-28
Gubernaculum	-	-	8	-	-	9	-	-
Phasmid**	3 post. to 1 ant.	3 post. to 1 ant.	-	2 post. to 2ant.	1-2 post.	-	1 ant	-
Tail annuli	4-9	6-7	-	6-7	6-7	-	6	-

* See Table 1.

** Position of phasmid: number of annuli anterior or posterior to anus.

with crenated lateral fields posterior to the vulva. Posterior genital branch reduced, 0.7 ± 0.2 (0.3-0.9) times the corresponding body width. In some specimens, spermatheca filled with roundish sperm. Caudalid not seen. Tail broadly rounded.

Male: Body posture straight (33%) to C-shaped (67%). Lip region rounded, with five to six annuli. Anterior face of stylet knobs rounded (18%) or indented (82%). Excretory pore located from opposite middle of isthmus to middle of oesophageal lobes. Hemizonid and hemizonion not seen. Phasmid located opposite cloaca.

REMARKS

The present specimens were identified as *H. brevis* because of position of vulva, presence of a postvulval sac, and tail shape. The South African specimens correspond to the original description by Whitehead (1958) and the subsequent description by Van den Berg (1976). As the species paratypes were not available, the present specimens were compared with previously identified South African specimens (Van den Berg, 1976). The present males differ from the original description in having a longer body (362-621 *vs* 370-440 µm).

Helicotylenchus exallus Sher, 1966
(Fig. 4)

This species is widespread and has been reported from wheat, maize, *Bromus* sp., and pasture soil in the USA (Sher, 1966), *Solanum* spp. in Zaire (Ali *et al.*, 1974), *Cynodon dactylon* (L.) Pers. in Pakistan (Maqbool *et al.*, 1985), various crops in Thailand (Ratanaprapa & Boonduang, 1975), in Poland (Brzeski, 1985), and *Solanum australis* in New Zealand (Wouts & Yeates, 1994). In South Africa the species has been reported from indigenous forests (Van den Berg & Heyns, 1975; Marais & Buckley, 1993; Van den Berg, 1993, 1996).

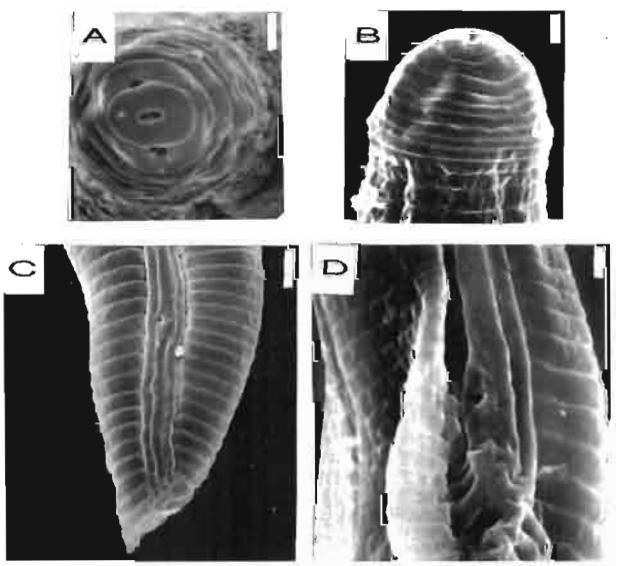

Fig. 4. Helicotylenchus exallus. *Female: A: En face view, lip region; B: Lateral view, lip region; C: Posterior part of body. Male. D: Lateral field in region of bursa. (Scale bar: A, B, D = 1 µm; C = 2 µm).*

MEASUREMENTS

See Table 4.

DESCRIPTION

Female: Habitus C-shaped (19%), 6-shaped (16%), or spiral (65%). Lip region rounded, with five to seven annuli. Labial framework well developed, extending posteriorly over two to four annuli from basal plate. Cephalids not seen. Anterior face of stylet knobs flattened (36%) to indented (64%). Oesophagus with 19 ± 5.4 (9-28) µm long ventral overlap. Excretory pore located from opposite middle of isthmus to opposite middle of oesophageal lobes. Hemi-

Table 3B. *Selected morphometric characters of* Helicotylenchus brevis *from South Africa, other localities (All measurements in µm).*

	KP1563		KP1565	N474		N475		N480		TVL1420	
	Females	Male	Females	Females	Males	Females	Male	Females	Male	Females	Males
n	3	1	2	3	10	3	1	2	1	10	2
L	500 ± 44.9 (455-562)	519	476-528	474 ± 51.2 (430-530)	424 ± 22.9 (394-477)	441 ± 38.7 (417-486)	362	376-440	420	503 ± 49.1 (425-594)	393-430
a	23.4 ± 1.0 (22.1-24.4)	30.1	21.6-23.6	26.6 ± 1.8 (25.3-27.9)	29.4 ± 1.7 (25.9-32.1)	19.3 ± 2.4 (17.4-22.0)	25.8	22.5-23.8	27.8	21.4 ± 2.0 (18.0-24.7)	27.4-30.7
b	-	-	4.2	-	4.4	-	-	-	4.5	-	-
b'	4.2 ± 1.3 (4.0-4.5)	-	3.5-3.8	4.0	4.3 ± 0.5 (3.7-4.8)	4.2 ± 0.4 (3.9-4.5)	4.0	3.8	3.6	3.7 ± 0.2 (3.5-4.1)	3.8
c	54.3 ± 1.3 (53.0-56.1)	30.7	55.1-56.5	54.8 ± 5.5 (48.8-59.7)	30.4 ± 2.9 (26.3-35.6)	45.8 ± 4.6 (41.0-50.1)	28.7	43.4-43.6	31.5	67.7 ± 20.3 (46.5-107.7)	30.5-33.3
c'	0.6 ± 0.1 (0.6-0.7)	2.0	0.6	0.7 ± 0.1 (0.7-0.8)	1.5 ± 0.1 (1.3-1.8)	0.7	1.6	0.8	1.4	0.6 ± 0.2 (0.3-0.9)	1.3-1.4
o	23 ± 0.1 (23.0-23.1)	-	27	-	-	22	-	-	-	25 ± 3.4 (19-30)	31-38
DGO	7 ± 0.2 (7-8)	-	9	-	-	7	-	-	-	8 ± 1.2 (6-10)	7-9
V	90 ± 1.3 (89-91)	-	89-90	88 ± 1.2 (87-89)	-	87 ± 1.2 (86-88)	-	83-87	-	88 ± 1.8 (85-91)	-
OV1	32 ± 7.5 (24-39)	-	37	30	-	34 ± 4.2 (31-39)	-	-	-	24 ± 0.6 (23-24)	-
OV2	2	-	4	-	-	3 ± 0.6 (2-3)	-	-	-	4 ± 0.6 (3-4)	-
Post. gen. br.	9	-	17	-	-	12 ± 3.0 (8-14)	-	-	-	17 ± 3.5 (13-23)	-
Stylet	32 ± 0.6 (31-33)	23	32	28 ± 0.5	20 ± 1.0 (19-22)	29 ± 0.6 (29-30)	22	28-29	22	31 ± 1.1 (30-34)	23-25
m	51 ± 0.5 (51-52)	51	49	-	48 ± 2.1 (46-51)	50 ± 1.8 (48-51)	-	49	-	50 ± 1.7 (48-53)	49-52
Stylet knob height	3 ± 0.3	1	3	3 ± 0.1 (2-3)	2 ± 0.5 (1-3)	3 ± 0.4 (2-3)	2	2-3	-	3 ± 0.6 (2-4)	2
Stylet knob width	7 ± 1.4 (5-8)	4	5-7	6 ± 0.5 (5-6)	4 ± 0.7 (3-5)	5 ± 0.6 (5-6)	4	5-6	-	6 ± 0.5 (5-7)	4
Oesophagus	121 ± 3.5 (118-126)	-	135-138	115	100 ± 9.8 (86-115)	108 ± 1.0 (107-108)	91	117	118	136 ± 14.2 (117-156)	120
Excretory pore	89 ± 4.9 (84-94)	-	-	88	70 ± 2.1 (68-72)	81 ± 10.9 (73-89)	-	86-89	74	104 ± 13.1 (84-119)	-
Body width at midbody	22 ± 1.1 (21-23)	17	20-24	17 ± 2.0 (15-18)	14 ± 1.0 (12-16)	23 ± 1.1 (22-24)	14	15-20	15	24 ± 2.3 (17-28)	14
Body width at excr. pore	22 ± 0.3 (22-22)	-	-	18	13 ± 1.7 (11-15)	21 ± 0.1	-	17-18	14	21 ± 4.1 (17-28)	-
Median bulb length	12 ± 0.5 (12-13)	10	13	10 ± 0.8 (9-10)	9 ± 0.7 (7-10)	10 ± 1.1 (9-11)	-	11	12	11 ± 0.5 (10-12)	9
Median bulb width	10 ± 0.7 (9-10)	7	10-11	8	7 ± 0.7 (6-8)	9 ± 0.5 (8-9)	-	8	6	13 ± 1.8 (8-13)	7-8
Lip region width	10 ± 0.4 (9-10)	7	9	8	5 ± 0.3 (5-6)	9 ± 0.3 (8-9)	6	9	7	9 ± 0.6 (8-10)	6-7
Lip region height	4	4	4	4	3 ± 0.4 (3-4)	5 ± 0.2	4	4	3	4 ± 0.6 (3-5)	3
Lateral field	-	3	5-7	4	3 ± 0.5 (3-4)	5	3	4	-	5 ± 0.8 (4-6)	-

End of Table 3B next page

Table 3B. *(End).*

	KP1563		KP1565	N474		N475		N480		TVL1420	
	Females	Male	Females	Females	Males	Females	Male	Females	Male	Females	Males
Tail	9 ± 0.8 (9-10)	17	9	9 ± 1.8 (8-11)	14 ± 1.2 (12-16)	10 ± 1.1 (8-11)	13	9-10	13	8 ± 0.8 (4-12)	13
Tail diameter	14 ± 0.6 (14-15)	9	13-16	12 ± 1.8 (12-14)	9 ± 0.5 (8-10)	14 ± 1.5 (12-15)	8	14	9	13 ± 1.3 (12-15)	9-10
Spicule	-	17	-	-	16 ± 0.7 (15-18)	-	16	-	19	-	16
Gubernaculum	-	7	-	-	-	-	-	-	-	-	-
Phasmid*	1 ant.	-	1 post.	1-2 ant.	-	1 ant. to 1 post.	-	1 ant.	-	3 ant. to 1 post.	-
Tail annuli	5-7	-	5-7	6-7	-	7-9	-	6-8	-	4-9	-

* Position of phasmid: number of annuli anterior or posterior to anus.

zonid two annuli long, from two annuli anterior to opposite excretory pore. Hemizonion not seen. Spermatheca rounded, offset, and filled with sperm. Lateral field with four lines; the two inner lines fuse together in a u-, μ- or m-shaped pattern. Postanal intestinal diverticulum absent. Tail shape variable, more curved dorsally, and with or without small projection.

Male: Lip region rounded. Oesophagus with 16 ± 5.4 (9-22) μm long ventral overlap, two specimens from Wilderness National Park with dorsal oesophageal overlap. Excretory pore located from opposite anterior part of isthmus to opposite middle part of oesophageal lobes. Lateral field not areolated in the region of the bursa. Phasmids located from half a body width anterior to opposite cloaca. Tail with finger-like tip.

REMARKS

The South African specimens were identified as *H. exallus* because of the presence of males, hemispherical lip region, tail shape, and position of vulva and phasmids. The present specimens agree with the original and subsequent descriptions. The current specimens were also compared with paratypes of *H. regularis* Phillips, 1971 from sclerophyll forest in Australia and with *H. exallus* specimens from South Africa (Van den Berg & Heyns, 1975) and New Zealand (Wouts & Yeates, 1994).

***Helicotylenchus indicus* Siddiqi, 1963**
(Figs. 3, 5)

This species has been reported from India and Pakistan (Siddiqi, 1963; Sher, 1966; Fotedar & Kaul, 1985; Lal & Khan, 1993), Thailand (Boonduang & Pliansinchai, 1980; Mizukubo *et al.*, 1992), Fiji (Van den Berg & Kirby, 1979), and from grasses, *Eucalyptus*, and pine plantations in South Africa (Marais, 1993; Marais & Buckley, 1993). A male was found for the first time in one of the Mpumalanga populations. Variation in female tail shape is illustrated.

MEASUREMENTS

See Table 2.

DESCRIPTION

Male: Lip region truncate. Labial framework extending posteriorly over two annuli from basal plate. Stylet knobs posteriorly rounded and with flattened anterior margins. Hemizonid and hemizonion not seen. Phasmids located less than one body width posterior to cloaca. Bursa extending to tip of tail. Tail with a pointed finger-like, ventrad curved projection.

REMARKS

The present specimens were identified as *H. indicus* because of small body size, post-anal position of phasmids, and lip shape. The species paratypes were not available. The current specimens differ from the original description in c-ratio (21.2-36.2 *vs* 33-47) and stylet length (24-29 *vs* 21-23 μm). They also differ from specimens previously reported from South Africa (Marais, 1993) in stylet length (24-29 *vs* 24.3-26.9 μm) and position of phasmids (two to eleven *vs* two to seven annuli posterior to anus). The current specimens have an exceptionally large median bulb valve 5 ± 0.3 (5-6) μm, similar to specimens from Loteni Nature Reserve and Badplaas (Marais, 1993).

Helicotylenchus martini Sher, 1966 = *H. krugeri* Van den Berg & Heyns, 1975 n. syn.
(Fig. 6)

This species has been reported only from Africa, associated with tea in Zimbabwe (Sher, 1966), *Solanum* sp. and tobacco in Zaïre (Ali *et al.*, 1974), and

Table 4. *Selected morphometric characters of* Helicotylenchus exallus *from South Africa (All measurements in µm).*

Locality*	KP982		KP985		KP1171		KP1184	KP1350		KP1413		KP1520	
	Females	Male	Female	Male	Females	Male	Females	Females	Males	Females	Males	Females	Males
n	5	1	1	1	9	3	4	4	3	10	4	2	2
L	637 ± 63.6 (527-692)	582	647	592	633 ± 43.7 (566-698)	550 ± 13.2 (535-558)	587 ± 58.7 (531-660)	636 ± 30.8 (605-673)	605 ± 47.3 (568-658)	577 ± 52.6 (491-633)	573 ± 23.2 (565-621)	632-663	550-554
a	24.9 ± 2.3 (21.4-27.9)	33.1	26.9	28.4	26.6 ± 2.6 (24.0-32.3)	25 ± 0.5 (24.6-25.7)	25.1 ± 2.3 (21.9-26.9)	22.4 ± 2.7 (19.2-25.8)	26.9 ± 1.0 (25.7-27.5)	23.1 ± 2.5 (20.5-28.3)	28.2 ± 3.2 (24.9-32.6)	23.4-26.0	26.4-27.5
b	4.3	-	-	-	5.2 ± 0.3 (5.0-5.4)	5.1	4.8	-	5.0	-	-	5.0	4.5
b′	4.4 ± 0.4 (3.9-5.1)	4.2	4.4	4.7	4.4 ± 0.3 (3.9-4.7)	4.3 ± 0.1 (4.2-4.5)	4.0 ± 0.1 (3.9-4.1)	4.5 ± 0.4 (4.2-4.8)	4.7 ± 0.1 (4.7-4.8)	4.4 ± 0.4 (4.0-5.0)	4.8	4.3-4.4	4.0-4.1
c	50.9 ± 10.8 (35.6-61.1)	34.4	50.6	30.5	55.6 ± 9.0 (49.1-72.2)	35.8 ± 2.6 (32.5-38.9)	37.8 ± 2.9 (34.6-41.6)	41.4 ± 5.4 (34.8-47.8)	35 ± 4.5 (31.7-4.01)	42.6 ± 6. (35.9-56.5)	30.1 ± 2.6 (27.2-34.2)	63.2-41.9	22.5-25.7
c′	0.8 ± 0.1 (0.7-1.0)	1.3	0.7	1.5	0.8 ± 0.1 (0.6-0.9)	1.4	1.0 ± 0.1 (0.9-1.2)	1.0 ± 0.1 (0.9-1.2)	1.4 ± 0.3 (1.1-1.8)	0.9 ± 0.1 (0.8-1.1)	1.6 ± 0.2 (1.4-1.9)	1.0-1.1	1.6-1.8
o	38 ± 2.4 (36-40)	37	-	-	44 ± 5.9 (35-51)	40 ± 3.5 (36-45)	50 ± 1.0 (49-51)	34 ± 1.3 (32-35)	37	38 ± 5.2 (33-41)	41	33-34	41
DGO	11 ± 1.8 (10-12)	9	-	-	11 ± 1.3 (9-13)	9 ± 1.0 (9-11)	12 ± 0.8 (12-13)	9 ± 0.5 (9-10)	9	10 ± 0.9 (9-12)	10	9-10	10
V	66 ± 1.8 (64-69)	-	65	-	66 ± 1.6 (63-68)	-	64 ± 1.3 (62-65)	63 ± 1.3 (62-64)	-	65 ± 0.9 (64-67)	-	64-65	-
OV1	17	-	-	-	25	-	25 ± 1.0 (24-27)	-	-	28	-	26	-
OV2	16 ± 0.4 (16-17)	-	-	-	-	-	20 ± 1.0 (19-21)	26	-	-	-	24	-
Stylet	29 ± 2.3 (26-31)	24	30	25	26 ± 1.0 (24-27)	23 ± 0.8 (22-24)	25 ± 1.3 (23-26)	28 ± 1.3 (26-29)	25 ± 0.6 (24-25)	26 ± 1.9 (23-28)	23 ± 1.4 (21-24)	28-30	24
m	46 ± 2.5 (44-47)	54	50	-	46 ± 1.5 (44-48)	50 ± 3.6 (47-55)	47 ± 4.1 (42-52)	49 ± 2.5 (46-51)	50 ± 3.6 (48-53)	49 ± 1.9 (45-51)	50	49	48-52
Stylet knob height	3 ± 0.6 (2-3)	2	3	2	2 ± 0.4 (2-3)	2 ± 0.3	3 ± 0.5 (2-3)	2 ± 0.3 (2-3)	2 ± 0.5 (1-3)	3 ± 0.4 (2-4)	2 ± 0.2 (1.8-2.2)	3	2

continued next page

Table 4. *(continued).*

Locality*	KP982		KP985		KP1171		KP1184	KP1350		KP1413		KP1520	
	Females	Male	Female	Male	Females	Male	Females	Females	Males	Females	Males	Females	Males
Stylet knob width	5 ± 0.3	4	6	5	5 ± 0.5 (4-5)	5 ± 0.5 (4-5)	5 ± 0.3 (4-5)	5 ± 1.3 (3-6)	4 ± 0.4	6 ± 0.7) (4-7	4.3 ± 0.3 (4-5)	5	4
Oesophagus	148 ± 19.4 (120-170)	138	148	127	146 ± 12.2 (129-160)	131 ± 9.2 (120-141)	144 ± 4.5 (139-148)	140 ± 5.0 (136-144)	132 ± 8.6 (126-139)	131 ± 14.4 (118-156)	129	144-153	133-139
Excretory pore	100 ± 13.2 (81-111)	104	109	93	111 ± 10.4 (98-128)	99 ± 4.6 (94-104)	95 ± 5.3 (90-100)	107 ± 5.7 (101-112)	99 ± 9.4 (93-110)	109 ± 11.1 (97-136)	107 ± 4.5 (103-111)	109-115	91-95
Body width at midbody	26 ± 3.5 (21-31)	18	24	21	24 ± 2.3 (20-27)	20 ± 2.2 (17-23)	24 ± 4.2 (20-28)	29 ± 4.7 (24-35)	23 ± 1.3 (21-24)	25 ± 3.0 (22-31)	21 ± 1.6 (19-23)	26-27	20-21
Body width at excr. pore	20 ± 3.4 (17-23)	16	19	18	17 ± 1.3 (15-19)	15 ± 1.5 (14-19)	21 ± 2.8 (18-23)	18 ± 2.3 (16-21)	16 ± 0.5	20 ± 1.2 (18-21)	17	21	17
Median bulb length	12 ± 1.2) (10-13	10	12	12	12 ± 1.3 (10-14)	10 ± 0.2	12 ± 1.2 (11-14)	12 ± 0.2 (11-12)	11 ± 0.7 (10-11)	12 ± 0.7 (11-13)	10	12	10
Median bulb width	9 ± 1.2 (8-11)	5	9	7	9 ± 0.7 (6-8)	6 ± 0.2	10 ± 1.4 (8-11)	10 ± 1.6 (8-11)	8 ± 0.7 (7-9)	9 ± 1.3 (8-12)	7	9	8
Lip region width	8 ± 0.7 (7-9)	5	8	8	7 ± 0.7 (6-8)	6 ± 0.1 (5-6)	6 ± 0.8 (6-7)	8 ± 0.8 (8-9)	7 ± 0.7 (7-8)	7 ± 0.5 (7-8)	7 ± 0.4 (7-8)	8	7
Lip region height	4 ± 0.4 (4-5)	3	4	3	4 ± 0.4 (3-4)	3	4 ± 0.8 (3-4)	4 ± 0.4 (4-5)	4 ± 0.4	4 ± 0.9 (3-4)	4 ± .3	4	4
Tail	13 ± 3.1 (11-18)	17	12	19	11 ± 1.6 (9-14)	15 ± 0.9 (14-16)	16 ± 1.4 (15-18)	15 ± 1.0 (14-16)	17 ± 1.1 (16-19)	14 ± 1.4 (11-16)	20 ± 1.9 (17-22)	15-18	22-24
Tail diameter	16 ± 2.0 (14-19)	13	17	13	15 ± 1.7 (12-17)	11 ± 0.9 (10-12)	15 ± 1.4 (13-16)	15 ± 1.4 (15-18)	12 ± 1. (12-15)	15 ± 1.1 (13-16)	12 ± 1.0 (11-13)	15-16	12-15
Spicule	-	24	-	24	-	22 ± 0.7 (21-22)	-	-	24 ± 2.3 (22-25)	-	22 ± 1.6 (19-24)	-	22-23
Gubernaculum	-	8	-	-	-	-	-	-	9 ± 2.0 (8-10)	-	8	-	8
Phasmid**	3-10 ant.	-	3 ant.	-	1-8 ant.	-	7-8 ant.	4-5 ant.	-	8 ant. to 3 post.	-	4 ant.	-
Tail annuli	7-11	-	10	-	6-11	-	7-9	8-10	-	6-12	-	8-9	-

* See Table 1.

continued next page

** Position of phasmid: number of annuli anterior or posterior to anus.

Table 4. *(continued).*

	KP1533		KP1537	KP1545	KP1549	KP1567	TVL702		TVL1277		TVL1428	
	Females	Males	Females	Females	Females	Female	Females	Male	Females	Males	Females	Males
n	5	4	3	3	2	1	13	1	11	10	5	4
L	581 ± 39.8 (540-651)	525 ± 49.0 (475-605)	611 ± 35.3 (571-639)	596 ± 32.8 (573-619)	563-650	662	647 ± 39.8 (574-711)	525	668 ± 60.7 (566-761)	594 ± 42.0 (494-652)	528 ± 36.9 (482-574)	478 ± 36.9 (438-530)
a	22.3 ± 0.5 (21.6-22.8)	26.0 ± 2.4 (24.4-30.2)	22.1 ± 2.7 (19.0-24.0)	18.7 ± 0.6 (18.3-19.1)	19.7-24.8	36.1	25.5 ± 2.7 (22.6-30.2)	34.9	24.6 ± 3.1 (20.6-32.4)	28.3 ± 3.0 (22.7-33.5)	24.9 ± 1.9 (22.7-26.8)	27.9 ± 4.6 (22.7-33.6)
b	5.6	4.4	4.5	-	-	5.4	5.7 ± 0.5 (4.9-6.4)	-	5.0 ± 0.4 (4.5-5.7)	4.2	-	-
b′	4.7 ± 0.1 (4.6-4.8)	4.3 ± 0.2 (4.2-4.6)	4.2 ± 0.2 (4.0-4.3)	-	4.1-4.4	4.6	4.9 ± 0.6 (3.8-6.2)	-	4.5 ± 0.5 (3.7-5.2)	4.4 ± 0.4 (3.8-4.8)	3.8	4.0 ± 0.2 (3.8-4.1)
c	38.3 ± 3.9 (33.3-43.3)	29.7 ± 4.6 (23.4-35.7)	47.6 ± 6.9 (39.7-52.3)	43.3 ± 6.3 (38.9-47.8)	34.0-56.5	41.9	39.5 ± 5.6 (28.9-50.6)	28.6	35.6 ± 5.6 (28.2-46.4)	28.5 ± 3.7 (21.7-35.3)	36.2 ± 6.1 (31.6-46.5)	27.6 ± 1.8 (25.3-29.5)
c′	1.0 ± 0.1 (0.8-1.1)	1.4 ± 0.2 (1.2-1.7)	0.8 ± 0.2 (0.6-1.0)	0.7	0.8-1.0	0.8	1.2 ± 0.1 (1.0-1.3)	1.8	1.2 ± 0.1 (0.9-1.4)	1.7 ± 0.2 (1.3-2.2)	1.1 ± 0.1 (0.9-1.2)	1.7 ± 0.1 (1.7-1.8)
o	33 ± 4.9 (25-38)	47	38 ± 3.1 (35-41)	-	37-41	39	-	-	33 ± 2.1 (30-35)	38	48	45 ± 4.0 (42-48)
DGO	9 ± 0.8 (8-10)	11	11 ± 0.5 (10-12)	-	12	11	-	-	10 ± 0.7 (9-11)	9	13	10 ± 0.5 (9-10)
V	65 ± 1.6 (63-67)	-	64 ± 0.6 (64-65)	64 ± 4.0 (61-67)	65-67	62	62 ± 1.7 (60-66)	-	64 ± 1.3 (62-67)	-	65 ± 1.9 (63-68)	-
OV1	-	-	20 ± 1.8 (19-22)	25	20	-	27 ± 3.5 (21-30)	-	22 ± 2.4 (19-27)	-	-	-
OV2	-	-	-	25	-	-	-	-	20 ± 1.8 (18-23)	-	-	-
Stylet	27 ± 1.7 (25-30)	24 ± 0.6 (23-25)	29 ± 0.5 (29-30)	32 ± 1.0 (31-32)	28-31	29	25 ± 1.3 (22-27)	21	30 ± 1.2 (27-31)	24 ± 1.2 (21-25)	26 ± 1.8 (24-28)	22 ± 0.7 (21-23)
m	49 ± 2.2 (47-52)	53	49 ± 1.7 (48-51)	50 ± 1.6 (49-51)	47-51	49	47 ± 1.4 (44-48)	48	50 ± 0.9 (48-52)	51 ± 1.8 (48-53)	50	52 ± 1.1 (51-53)
Stylet knob height	2 ± 0.1 (2-3)	2 ± 0.2 (2-3)	3 ± 0.4	3 ± 0.5 (2-3)	2-3	3	2 ± 0.4 (2-3)	2	2 ± 0.3 (2-3)	2 ± 0.2	2	2 ± 0.2
Stylet knob width	5 ± 0.5 (4-6)	4 ± 0.4 (4-5)	5 ± 0.2	6	5-6	7	5 ± 0.6 (3-5)	3	6 ± 0.4 (5-6)	4 ± 0.4 (3-5)	5 ± 0.4 (5-6)	5 ± 0.3 (4-5)
Oesophagus length	124 ± 8.2 (116-137)	115 ± 6.8 (110-125)	147 ± 13.9 (132-157)	-	137-148	144	133 ± 14.0 (104-153)	-	149 ± 8.8 (137-162)	137 ± 6.3 (129-148)	137	121 ± 9.8 (114-128)

End of Table 4 next page

Table 4. *(End).*

	KP1533		KP1537	KP1545	KP1549	KP1567	TVL702		TVL1277		TVL1428	
	Females	Males	Females	Females	Females	Female	Females	Male	Females	Males	Females	Males
Excretory pore	88 ± 11.2 (73-103)	81 ± 3.9 (76-85)	102 ± 6.1 (97-109)	91 ± 10.2 (83-98)	109	113	101 ± 7.2 (89-112)	85	110 ± 8.6 (95-123)	99 ± 7.3 (85-108)	95 ± 5.8 (89-100)	87 ± 3.6 (83-90)
Body width at midbody	26 ± 2.0 (24-30)	20 ± 2.8 (17-25)	28 ± 4.3 (24-33)	32 ± 0.8 (31-32)	23-33	-	27 ± 5.3 (22-42)	-	28 ± 3.7 (20-34)	21 ± 2.1 (17-24)	21 ± 3.2 (18-25)	17 ± 2.5 (15-20)
Body width at excr. pore	20 ± 1.1 (19-22)	16 ± 0.9 (15-17)	18 ± 2.0 (16-20)	23 ± 1.3 (22-23)	19	18	19 ± 1.5 (17-22)	-	21 ± 2.3 (17-25)	17 ± 1.1 (15-19)	15 ± 0.3 (15-16)	14 ± 0.2
Median bulb length	12 ± 0.8 (11-13)	12 ± 1.0 (10-12)	12 ± 0.5 (12-13)	12 ± 1.0 (12-13)	11-13	13	12 ± 1.4 (10-16)	-	13 ± 0.7 (12-15)	12 ± 0.6 (11-13)	11 ± 0.6 (11-12)	11 ± 1.1 (10-12)
Median bulb width	8 ± 0.7 (7-9)	8 ± 0.3 (7-8)	9 ± 0.5 (8-9)	10 ± 1.5 (9-11)	8-9	9	10 ± 1.0 (8-12)	-	9 ± 0.9 (8-11)	8 ± 0.9 (6-9)	8 ± 0.4 (8-9)	8 ± 0.5 (7-8)
Lip region width	7 ± 0.5 (7-8)	7 ± 0.5 (7-8)	7 ± 0.4 (7-8)	8 ± 0.5 (8-9)	8-9	8	6 ± 0.4 (5-6)	-	7 ± 0.5 (7-8)	6 ± 0.3 (6-7)	7 ± 0.6 (6-8)	7 ± 0.5 (7-8)
Lip region height	4 ± 0.5 (3-4)	4 ± 0.3	4	5 ± 0.5 (4-5)	5	4	3 ± 0.5 (2-4)	-	4 ± 0.3 (3-5)	4 ± 0.6 (3-5)	4 ± 0.3	3 ± 0.1 (3-4)
Tail	15 ± 2.3 (13-19)	20 ± 2.2 (18-22)	13 ± 1.5 (12-14)	14 ± 1.3 (13-15)	12-17	16	17 ± 2.4 (13-21)	18	19 ± 2.8 (16-24)	21 ± 2.3 (17-24)	15 ± 2.8 (10-18)	17 ± 1.7 (15-19)
Tail diameter			18 ± 2.5 (15-20)	19 ± 0.6 (19-20)	15-22	19	14 ± 1.7 (12-18)	13	23 ± 5.2 (14-28)	11 ± 1.6 (10-13)	15 ± 2.1 (12-17)	11 ± 0.8 (10-12)
Spicule	-	23 ± 0.3 (22-23)	-		-	-	-	22	-	23 ± 1.1 (21-25)	-	19 ± 2.3 (17-22)
Gubernaculum	-	6	-		-	-	-	-	-	9 ± 1.0 (7-10)	-	-
Phasmid	2-4 ant.	-	3-5 ant.	3-4 ant.	4 ant.	5 ant.	4 ant. to 3 post.	-	3 ant. to 2 post.	-	5 ant. to 2 post.	-
Tail annuli	8-11	-	7-11	7	7	8	12-17	-	8-16	-	10-13	-

various hosts in South Africa (Van den Berg & Heyns, 1975; Van den Berg, 1978; Marais, 1993; Marais & Buckley, 1993).

MEASUREMENTS

See Table 5.

DESCRIPTION

Female: Body posture open C-shape (6%) to spiral (94%). Lip region high, truncate, not offset, without annuli. Labial disc conspicuous in lateral view. Outer margins of labial framework extending posteriorly over two to four annuli from the basal plate. Stylet knobs

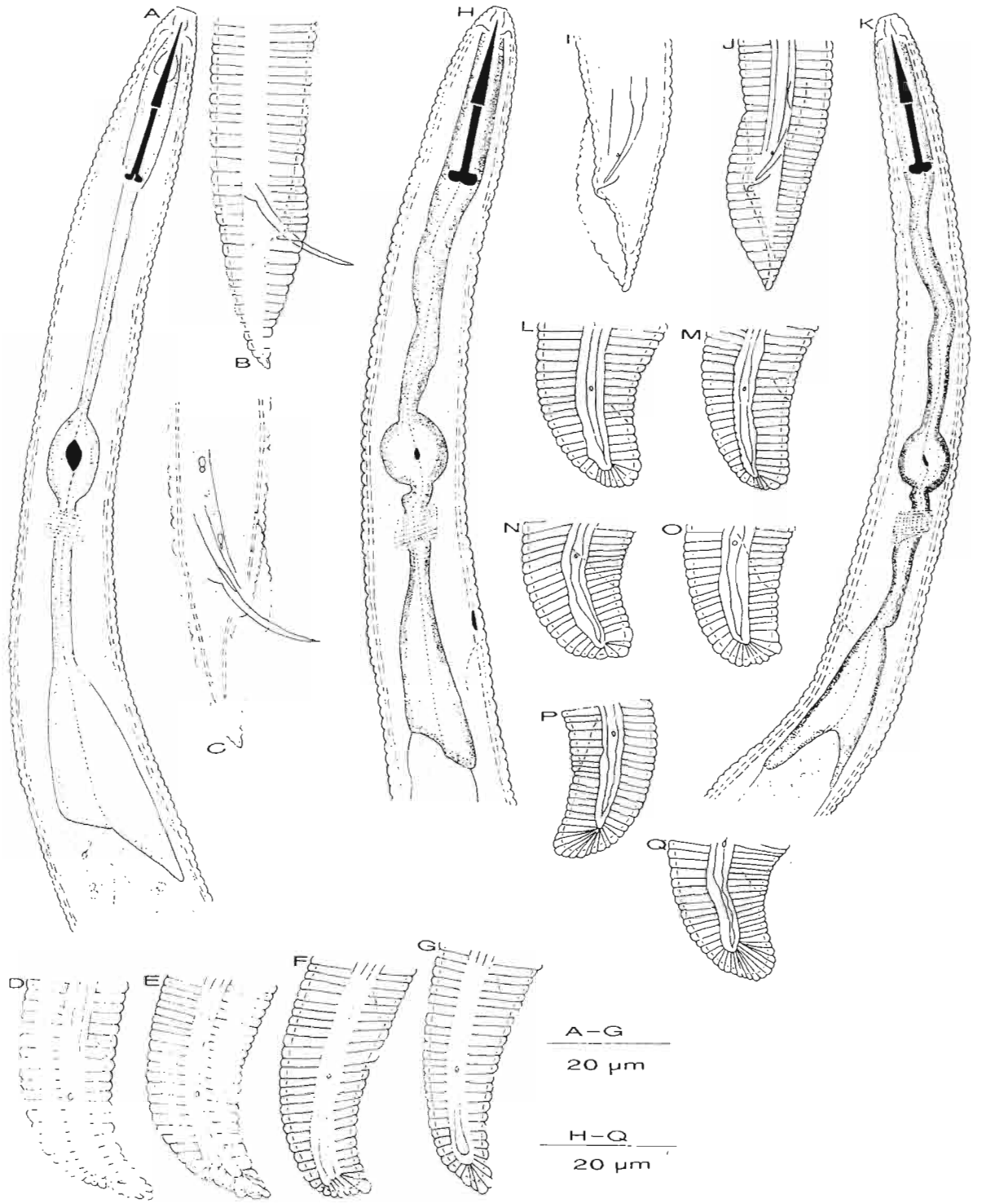

Fig. 5. Helicotylenchus indicus. *Male: A: Oesophageal region; B: Tail, external view; C: Tail, internal view; D-G: Variations in tail shape* – Helicotylenchus variabilis. *Female: H: Oesophageal region; L-Q: Variations in tail shape. Male. I: Tail, internal view; J: Tail, external view; K: Oesophageal region.*

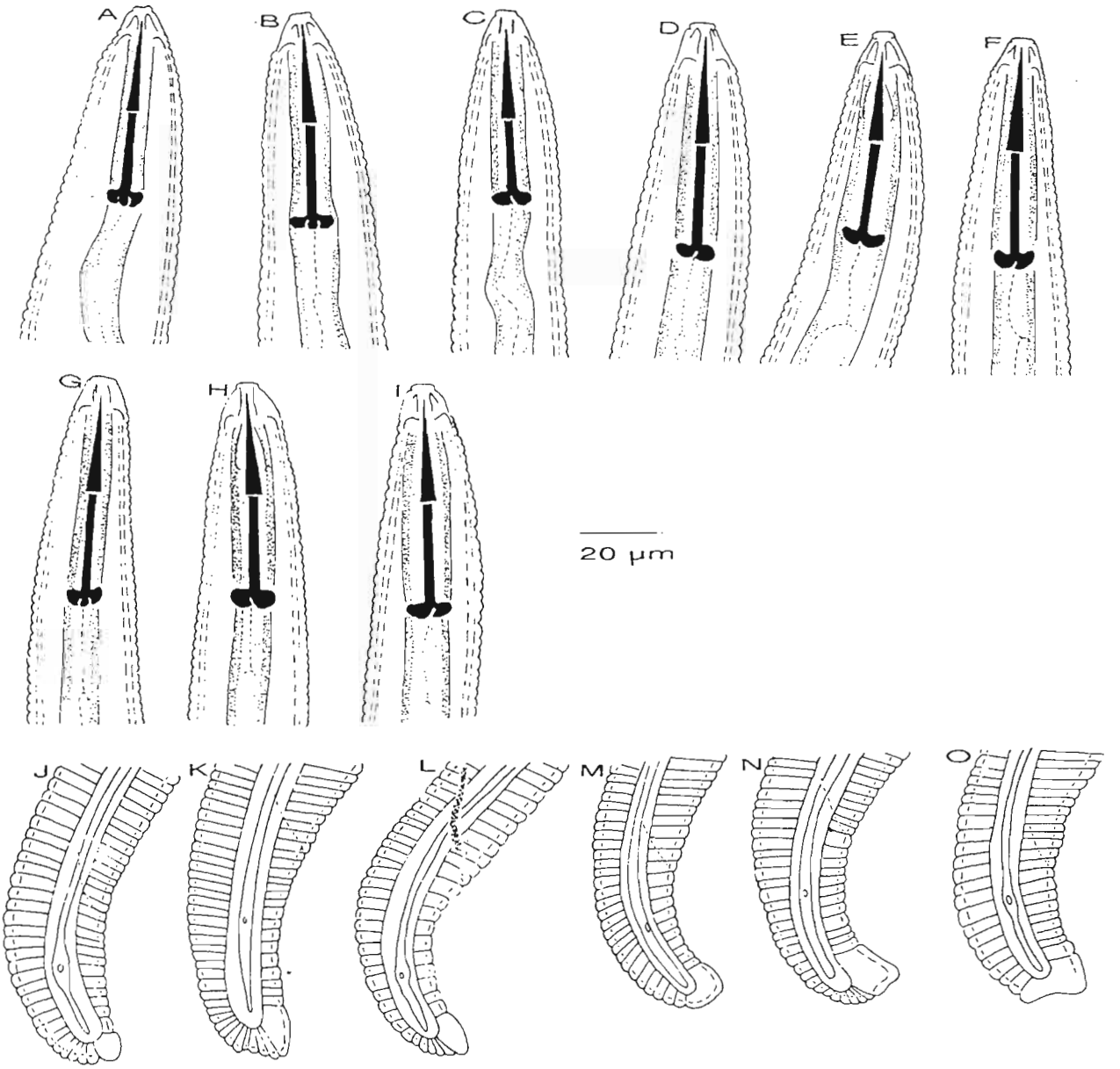

Fig. 6. Helicotylenchus martini. *Female: A-I: Variation in lip region; J-O: Variations on tail shape.*

posteriorly rounded, anteriorly indented (31%), flattened (65%), or rounded (4%). Median bulb ovate. Overlap of oesophageal lobe 18 ± 11.2 (7-48) µm long; overlap dorsal in some specimens. Excretory pore located from opposite posterior part of isthmus to opposite middle of oesophageal lobe. Hemizonid one and a half to two annuli long, located from opposite to three annuli anterior to excretory pore. Hemizonion one annulus long, located from seven to ten annuli posterior to hemizonid. Lateral field with four lines, areolated opposite oesophageal region, in one population incompletely areolated on rest of body, the two inner lines fuse together in a µ- or u-shaped pattern. Spermatheca distinct, in some specimens filled with sperm. Epiptygmata folded into vagina. Intestine not overlapping rectum. Caudalid not seen. Lateral canals seen in some specimens. Tail rounded without ventral projection. Tail tip annulation variable from absent to tail tip partially annulated.

Table 5. *Selected morphometric characters of* Helicotylenchus martini *from South Africa (All measurements in µm).*

Locality*	KP739	KP1132	KP1189	KP1270	KP1343		KP1505	N624
	Females	Females	Females	Male	Females	Male	Female	Females
n	3	2	3	1	6	1	1	6
L	657 ± 50.9 (624-710)	749-771	657 ± 50.9 (623-715)	542	616 ± 30.7 (583-669)	631	608	636 ± 83.9 (563-787)
a	28.6 ± 0.8 (27.6-29.6)	27.1-27.8	26.4 ± 2.4 (24.7-29.2)	27.0	26.4 ± 4.7 (21.2-35.1)	28.4	23.8	28.5 ± 2.5 (25.0-30.2)
b	-	6.4	5.8	-	4.8	-	-	-
b'	5.3 ± 0.3 (5.0-5.6)	5.5-5.6	4.9 ± 0.4 (4.5-5.2)	-	4.9 ± 0.2 (4.6-5.3)	4.8	4.3	4.7 ± 0.5 (4.0-5.1)
c	22.8 ± 2.5 (20.1-26.2)	21.9-25.1	26.5 ± 3.8 (22.7-30.3)	28.5	22.6 ± 1.3 (21.2-25.0)	22.8	27.3	24.8 ± 2.1 (21.8-27.9)
c'	2.0 ± 0.3 (1.7-2.3)	1.7-2.0	1.8 ± 0.3 (1.5-2.1)	2.5	2.2 ± 0.2 (1.9-2.4)	2.3	1.7	1.8 ± 0.2 (1.5-2.1)
o	47	42-44	32 ± 2.3 (31-35)	-	40 ± 8.1 (31-52)	-	-	42
DGO	10	12	9 ± 0.6 (8-9)	-	9 ± 1.4 (7-11)	-	-	11
V	50 ± 3.9 (45-55)	56-57	59 ± 0.5 (58-59)	-	57 ± 1.8 (54-60)	-	58	57 ± 1.8 (54-59)
OV1	-	-	-	-	30	-	20	-
OV2	23	-	19	-	-	-	21	-
Stylet	22 ± 0.5 (21-22)	27-29	27 ± 1.3 (26-29)	19	24 ± 0.8 (23-25)	22	28	27 ± 1.6 (25-29)
m	49 ± 1.0 (48-50)	49-50	47 ± 0.3	-	51 ± 1.8 (49-53)	-	48	44 ± 3.6 (40-47)
Stylet knob height	2 ± 0.3	2-3	2	-	2 ± 0.2	-	3	3 ± 0.4
Stylet knob width	4 ± 0.5 (3-4)	5	5 ± 0.4 (4-5)	-	4 ± 0.4	-	6	6 ± 0.5 (5-6)
Oesophagus	136 ± 27.7 (111-166)	133-140	134 ± 3.9 (130-138)	-	129 ± 7.8 (122-144)	131	141	144 ± 9.0 (133-154)
Excretory pore	102 ± 2.3 (99-105)	113	114 ± 6.5 (107-120)	90	97 ± 7.6 (91-112)	101	105	105 ± 10.4 (98-117)
Body width at midbody	24 ± 1.6 (21.8-25.7)	27-28	25 ± 0.4	20	25 ± 2.2 (23-29)	21	26	23 ± 5.0 (19-31)
Body width at excr. pore	19 ± 0.4 (19-20)	21	18 ± 1.6 (17-20)	15	19 ± 0.9 (17-19)	18	17	18 ± 1.3 (16-19)
Median bulb length	12 ± 1.0 (11-13)	11-13	12 ± 0.9 (11-12)	-	11 ± 0.3 (11-12)	11	13	12 ± 1.2 (11-13)
Median bulb width	10 ± 0.7 (9-10)	7-11	8 ± 0.7 (7-9)	-	9 ± 0.6 (8-9)	6	8	10 ± 0.7 (9-11)
Lip region width	8 ± 0.9 (7-9)	6-8	7 ± 0.2	-	7 ± 0.4 (7-8)	7	7	7 ± 1.1 (5-8)
Lip region height	5 ± 0.2	5-6	4 ± 0.4	-	4 ± 0.4 (3-4)	5	4	4 ± 0.3 (4-5)
Tail	30 ± 1.9 (27-31)	30-35	24 ± 3.3 (21-27)	29	27 ± 2.4 (23-31)	28	22	26 ± 1.2 (26-18)
Tail diameter	16 ± 1.7 (14-17)	17	13 ± 0.7 (12-14)	12	13 ± 0.9 (12-24)	12	-	2314 ± 1.1 (13-16)
Spicule	-	-	-	21	-	22	-	-
Gubernaculum	-	-	-	-	-	-	-	-
Phasmid**	7-9	6-8	9-10	-	5-9	-	8	6-9
Tail annuli	16-19	16-18	14-18	-	11-15	-		11-15

* See Table 1.

continued next page

** Position of phasmid: number of annuli posterior to anus.

Table 5. *(continued).*

Locality*	TVL1255	TVL1284	TVL1314	TVL1349	TVL1353	TVL1364		TVL1368	TVL1370	TVL1405	
	Females	Females	Females	Females	Females	Females	Male	Females	Females	Females	Males
n	2	2	2	5	8	2	1	2	2	24	9
L	628-663	559-664	712-739	528 ± 40.7 (475-570)	668 ± 29.3 (518-604)	475-499	480	622-697	622-695	522 ± 37.3 (451-596)	540 ± 23.2 (502-567)
a	26.8-28.0	18.7-27.3	30.2-33.5	25.1 ± 5.2 (20.0-33.0)	27.3 a 2.4 (22.7-29.6)	22.8-24.0	25.1	19.8-24.5	21.2-23.1	25.6 ± 3.6 (19.8-37.4)	35.5 ± 3.4 (28.8-42.3)
b	-	-	-	5.2	5.8 ± 0.3 (5.3-6.0)	-	-	-	-	5.4 ± 0.4 (4.7-5.7)	5.2 ± 0.4 (4.7-5.8)
b′	4.2	4.2-5.0	5.1-5.5	4.9 ± 0.7 (4.2-5.7)	4.9 ± 0.2 (4.6-5.2)	4.3	-	-	4.4-4.5	4.6 ± 0.3 (4.1-5.1)	4.7 ± 0.2 (4.5-5.1)
c	25.7-27.5	24.3-25.3	22.5-24.1	23.2 ± 2.7 (19.3-26.8)	22.3 ± 3.6 (17-29)	20.0	24.7	21.1-24.6	23.7-23.4	24.8 ± 2.2 (21.0-29.1)	28.6 ± 2.4 (25.7-34.2)
c′	1.8	1.8-1.9	2.5-3.0	2.1 ± 0.3 (1.8-2.5)	2.3 ± 0.4 (1.6-2.9)	2.1	2.1	1.6-2.0	2.0	1.9 ± 0.2 (1.3-2.3)	1.7 ± 0.2 (1.4-2.1)
o	40	-	37-45	37 ± 4.4 (34-42)	30 ± 3.7 (25-37)	29-36	-	40-48	41	33 ± 4.1 (27-44)	54 ± 2.1 (52-57)
DGO	11	-	10-13	8 ± 1.0 (8-10)	7 ± 0.9 (6-9)	6-8	-	11-13	11	8 ± 0.9 (6-11)	10 ± 0.6 (9-11)
V	58	56-59	55-58	55 ± 1.6 (53-57)	55 ± 2.1 (53-58)	55	-	54-57	56	57 ± 2.2 (55-60)	-
OV1	-	-	28	-	-	-	-	-	-	26 ± 3.1 (23-30)	-
OV2	-	-	-	-	20	-	-	-	-	-	-
Stylet	26	27-28	27-28	23 ± 0.8 (22-24)	24 ± 0.8 (23-25)	22	18	26-28	27	24 ± 1.0 (21-26)	19 ± 1.2 (17-20)
m	48-52	46-47	46-47	47 ± 2.8 (45-49)	48 ± 1.1 (46-49)	50	-	43-46	49	48 ± 2.2 (43-52)	52
Stylet knob height	2-3	2-3	2-3	2 ± 0.4	2 ± 0.3 (2-3)	1-2	1	2-3	2	2 ± 0.2 (2-3)	2 ± 0.3 (1-2)
Stylet knob width	5	5	6	4 ± 0.8 (4-6)	5 ± 0.5 (4-6)	4	2	5	6	4 ± 0.6 (4-6)	3 ± 0.2
Oesophagus length	151-157	132-133	134-140	109 ± 6.5 (99-114)	114 ± 6.7 (105-124)	112	-	-	137-152	113 ± 5.1 (102-124)	105 ± 20.2 (73-127)
Excretory pore	103-11	103	101-113	88 ± 7.7 (77-97)	91 ± 4.8 (82-95)	77-83	85	110	107-129	88 ± 4.1 (81-93)	94 ± 1.4 (93-96)
Body width at midbody	22-25	24-30	22-24	22 ± 3.8 (17-26)	20 ± 2.5 (17-25)	21	19	25-35	29-30	21 ± 2.6 (18-27)	16 ± 2.6 (13-22)
Body width at excr. pore	22	17-18	16-20	17 ± 3.1 (14-22)	15 ± 1.0 (14-17)	14-17	13	21	19-24	15 ± 1.5 (13-19)	12 ± 1.3 (11-14)
Median bulb length	13-14	14-15	11-13	11	11 ± 1.8 (9-14)	9-10	-	12	11	10 ± 1.0 (9-12)	11 ± 0.5 (10-11)
Median bulb width	9-10	7-8	9-11	9	8 ± 1.2 (7-10)	6-8	-	10	7-8	8 ± 1.2 (6-10)	5 ± 0.7 (4-6)
Lip region width	6	7	6-7	6 ± 0.9 (5-7)	7 ± 0.5 (6-8)	6	6	6-8	7	8 ± 1.2 (6-10)	6 ± 0.4 (6-7)
Lip region height	4	4	4	4 ± 0.2	4 ± 0.7 (4-6)	4	4	4-5	4	4 ± 0.3 (3-4)	5 ± 0.5 (4-6)

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Table 5. *(End).*

Locality*	TVL 1255	TVL 1284	TVL 1314	TVL 1349	TVL 1353	TVL1364		TVL1368	TVL1370	TVL1405	
	Females	Females	Females	Females	Females	Females	Male	Females	Females	Females	Males
Tail	23-26	22-27	30-33	23 ± 3.8 (20-30)	26 ± 3.8 (23-34)	25	19	25-33	26-30	21 ± 2.2 (18-26)	19 ± 1.3 (17-21)
Tail diameter	-	12-14	11-12	11 ± 1.4 (9-13)	12 ± 1.5 (9-14)	12	10	15-16	12-15	12 ± 1.5 (9-16)	12 ± 1.3 (11-17)
Spicule	-	-	-	-	-	-	21	-	-	-	21 ± 1.3 (20-23)
Gubernaculum	-	-	-	-	-	-	-	-	-	-	7
Phasmid	4-6	8	10-11	7-9	5-9	6	-	7-8	9-10	6-9	-
Tail annuli	14-16	17	16-18	13-16	14-20	13-15	-	15-18	16-17	9-16	-

Male: Labial framework extending posteriorly over two annuli from basal plate. Stylet knobs posteriorly rounded and anteriorly flattened. Excretory pore located from opposite anterior part to opposite middle part of the oesophageal lobe. Hemizonid two to three annuli long and located from opposite to two annuli anterior to excretory pore. Hemizonion not seen. Phasmids located more than one body width posterior to cloaca. Bursa extending to tip of tail. Tail with a pointed finger-like, ventrad curved projection.

REMARKS

The current specimens were identified as *H. martini* because of truncate lip region, absence of lip annuli, long tail, and conspicuous phasmids near centre of tail. These specimens agree with the original and subsequent descriptions of specimens from South Africa (Van den Berg & Heyns, 1975; Van den Berg, 1976; Marais, 1993).

H. krugeri Van den Berg & Heyns, 1975 was differentiated from *H. martini* in the original description by the following characters: head with a more prominent labial disc, spear knobs mostly flattened anteriorly, sides of lip region more bulging, opposite outer margins of labial framework. In *H. martini* the non-annulated section of the tail stretches around the tip of the tail whereas it is located on the ventro-posterior side of the tail in *H. krugeri*. Males are absent in *H. krugeri*.

After examination of all previously identified *H. martini* and *H. krugeri* populations from South Africa (Van den Berg & Heyns, 1975; Van den Berg, 1976; Marais, 1993; Marais & Buckley, 1993; Kleynhans et al., 1996; Marais & Swart, 1996; Marais & Van den Berg, 1996) and of the type material of *H. krugeri*, it was concluded that the characteristics used to distinguish between these two species are highly variable, making it extremely difficult to differentiate these two species. SEM micrographs of both species showed the labial disc to be equally prominent. The lip margins are similar in shape. Stylet knob

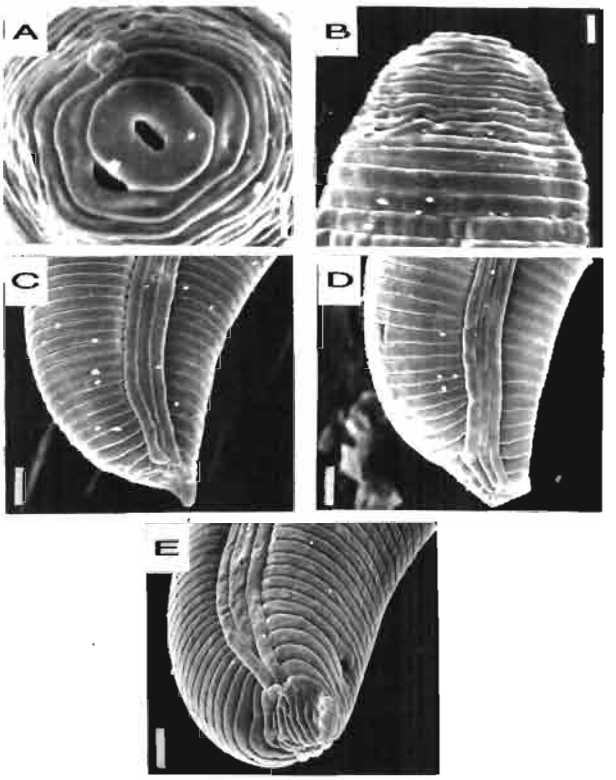

Fig. 7. Helicotylenchus paracanalis. *Female: A: En face view, lip region; B: Lateral view, lip region; C-E: Posterior region of body. (Scale bar: A, B = 1 µm; C-E = 3 µm).*

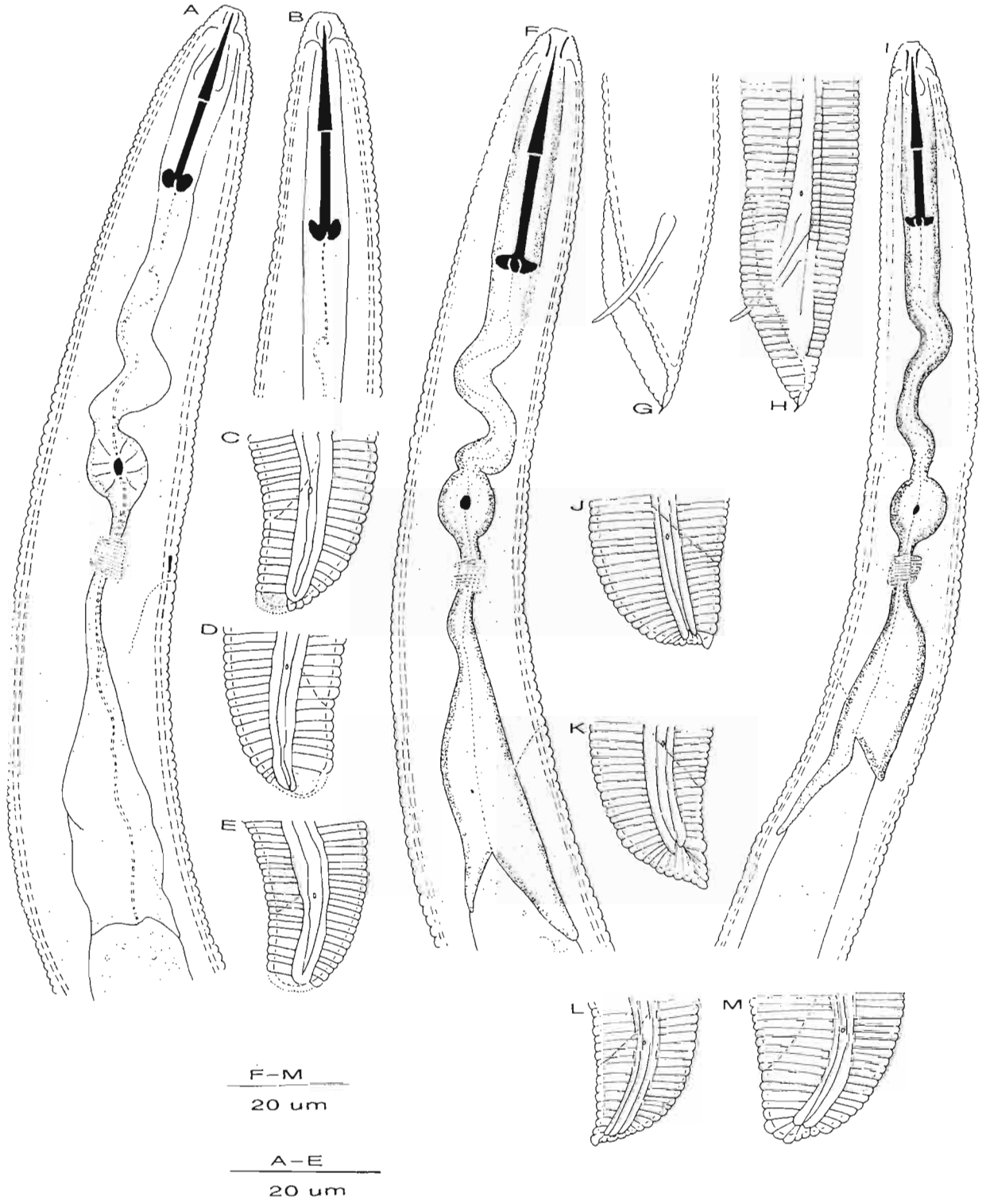

Fig. 8. Helicotylenchus vulgaris. *Female: A: Oesophageal region; B: Lip region; C-E: Variation in tail shape* – Helicotylenchus paracanalis. *Female: F: Oesophageal region; J-M: Variation in tail shape. Male: G: Tail, internal view; H: Tail, external view.*

Table 6. *Selected morphometric characters of* Helicotylenchus paracanalis, H. variabilis, *and* H. vulgaris *from South Africa (All measurements in µm).*

	H. paracanalis		*H. variabilis*		*H. vulgaris*			
Locality*	TVL1420		TVL1404		KP1243	KP1293	KP1289	TVL1483
	Females	Males	Females	Males	Females	Females	Females	Females
n	23	26	14	2	9	5	6	3
L	826 ± 70.8 (668-998)	739 ± 43.6 (668-840)	571 ± 34.3 (497-619)	527-530	743 ± 41.9 (697-813)	783 ± 64.7 (707-861)	681 ± 58.3 (609-751)	783 ± 18.4 (771-804)
a	24.8 ± 2.4 (21.1-29.9)	29.7 ± 2.9 (25.0-35.3)	24.2 ± 2.8 (20.4-29.6)	30.4-33.6	24.8 ± 2.3 (20.4-28.4)	27.7 ± 3.0 (25.1-31.4)	26.3 ± 3.7 (22.4-31.4)	25.8 ± 3.5 (21.9-28.7)
b	5.3 ± 0.9 (4.6-7.3)	5.8 ± 0.6 (5.3-6.7)	5.3 **	-	5.7 ± 2.3 (5.6-5.9	-	4.9 ± 0.5 (4.5-5.2)	5.1 ± 0.1 (5.0-5.2)
b′	4.6 ± 0.4 (3.8-5.5)	5.1 ± 0.4 (4.5-5.9)	4.6 ± 0.5 (3.8-5.6)	4.3	5.1 ± 0.5 (4.3-5.9)	4.9 ± 0.2 (4.5-5.1)	4.6 ± 0.5 (4.2-5.3)	4.7 ± 0.1 (4.6-4.7)
c	54.8 ± 10.1 (40.0-88.2)	37.0 ± 4.9 (27.6-52.5)	43.2 ± 6.6 (35.5-56.6)	30.9-28.2	63.0 ± 15.0 (54.2-82.2)	66.3 ± 5.8 (60.1-72.5)	64.1 ± 13.7 (47.6-82.5)	75.0 ± 13.1 (63.9-89.4)
c′	0.8 ± 0.1 (0.5-1.0)	1.5 ± 0.2 (1.0-1.8)	0.9 ± 0.1 (0.6-1.1)	1.8	0.7 ± 0.1 (0.6-0.9)	0.8 ± 0.1 (0.7-0.9)	0.7 ± 0.1 (0.6-0.9)	0.6 ± 0.1 (0.5-0.7
o	28 ± 2.5 (25-33)	30 ± 3.2 (25-38)	48 ± 4.2 (42-54)	49	45 ± 3.4 (39-48)	43 ± 2..7 (39-45)	44 ± 2.5 (39-46)	48 ± 3.0 (45-50)
DGO	10 ± 0.9 (9-13)	9 ± 0.9 (8-12)	13 ± 1.3 (10-15)	11	14 ± 1.0 (12-15)	13 ± 0.9 (12-14)	13 ± 0.6 (12-13)	14 ± 0.9 (13-15)
V	63 ± 1.8 (60-67)	-	64 ± 1.9 (60-66)	-	65 ± 1.1 (63-66)	64 ± 2.1 (62-67)	66 ± 1.1 (64-67)	63 ± 0.6 (63-64)
OV1	18 ± 4.1 (15-27)	- -			29 ± 10.4 (21-36)	-	24	39
OV2	16 ± 1.6 (15-18)	-			19	-	19 ± 2.5 (17-21)	-
Stylet	37 ± 0.9 (35-38)	30 ± 1.0 (29-32)	27 ± 1.1 (25-29)	22	30 ± 1.4 (28-31)	30 ± 1.1 (30-32)	29 ± 0.8 (28-30)	30 ± 0.5 (29-30)
m	48 ± 1.7 (44-51)	51 ± 1.7 (48-55)	48 ± 2.1 (44-51)	50	46 ± 1.7 (43-48)	47 ± 0.8 (46-48)	47 ± 1.3 (45-49)	50
Stylet knob height	3 ± 0.5 (2-4)	2 ± 0.3 (2-3)	3 ± 0.4 (2-4)	1	3 ± 0.4 (2-3)	2 ± 0.3 (2-3)	3 ± 0.3 (2-3)	3
Stylet knob width	7 ± 0.7 (6-8)	5 ± 0.5 (4-6)	5 ± 0.4 (4-5)	4	5 ± 0.7 (4-7)	5 ± 0.5 (4-5)	5 ± 0.3 (5-6)	5
Oesophagus	179 ± 10.5 (166-199)	146 ± 10.2 (127-167)	124 ± 9.6 (105-139)	124	145 ± 14.0 (127-169)	157 ± 4.9 (149-167)	158 ± 7.7 (149-167)	169 ± 6.3 (165-174)
Excretory pore	128 ± 6.1 (119-142)	106 ± 8.8 (90-121)	91 ± 10.4 (74-109)	96	103 ± 7.6 (93-111)	112 ± 6.9 (102-119)	108 ± 12.3 (96-129)	117 ± 5.2 (111-120)
Body width at midbody	34 ± 4.1 (22-40)	25 ± 2.4 (21-29)	23 ± 3.1 (17-29)	16-17	31 ± 13.3 (27-40)	28 ± 1.7 (27-31)	26 ± 5.0 (20-34)	31 ± 4.1 (27-35)
Body width at excr. pore	23 ± 2.3 (19-29)	20 ± 1.6 (17-27)	18 ± 1.5 (15-20)	13	24 ± 4.1 (19-33)	21 ± 1.2 (19-22)	23 ± 4.3 (17-29)	22 ± 1.1 (22-24)
Median bulb length	13 ± 1.2 (11-15)	12 ± 1.0 (11-14)	11 ± 0.8 (9-13)	10	13 ± 0.6 (12-14)	13 ± 0.5 (12-13)	12 ± 0.9 (11-13)	12 ± 0.5 (12-13)
Median bulb width	10 ± 1.2 (8-12)	7 ± 0.6 (7-8)	8 ± 0.9 (7-10)	8	9 ± 1.0 (8-11)	8 ± 0.8 (7-9)	9 ± 0.9 (7-10)	9 ± 1.5 (8-11)
Lip region width	9 ± 0.6 (8-10)	8 ± 0.5 (7-9)	7 ± 0.5 (6-7)	6	7 ± 0.3 (7-8)	8 ± 0.3 (7-8)	8 ± 0.5 (7-8)	8 ± 0.7 (7-9)
Lip region height	5 ± 0.7 (4-6)	5 ± 0.4 (4-6)	4 ± 0.3 (3-4)	4	4 ± 0.3 (3-4)	4 ± 0.2	4 ± 0.4	5 ± 0.4 (4-5)

* See Table 1.

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Table 6. *(End).*

	H. paracanalis		*H. variabilis*		*H. vulgaris*			
Locality*	TVL1420		TVL1404		KP1243	KP1293	KP1289	TVL1483
	Females	Males	Females	Males	Females	Females	Females	Females
Tail	20 ± 2.7 (14-24)	20 ± 2.7 (14-24)	14 ± 2.3 (10-16)	17-19	12 ± 1.8 (10-15)	12 ± 1.6 (10-14)	11 ± 3.1 (9-16)	11 ± 2.0 (9-12)
Tail diameter	20 ± 1.9 (16-24)	14 ± 1.2 (11-16)	14 ± 1.2 (12-16)	14	17 ± 1.1 (15-19)	16 ± 2.9 (13-20)	15 ± 0.9 (14-16)	18 ± 1.6 (16-19)
Spicule length	-	24 ± 1.6 (22-29)	-	20-24				
Gubernaculum	-	9 ± 0.5 (8-10)	-	8				
Phasmid**	1-6 ant.	-	2-8 ant.	-	3-6 ant.	2-4 ant.	1-4 ant.	3 ant. to 1 post.
Tail annuli	5-11	-	7-10	-	5-9	5-13	6-8	5-8

* See Table 1.

** Position of phasmid: number of annuli anterior to anus.

shape in both species varies from anteriorly indented or flattened to rounded. Not all the populations with a *martini*-type tail have males present. During a survey in the Nelspruit area, Mpumalanga Province, a population (TVL1405) was found with all the characteristics attributed to *H. krugeri* in the original description, but with males present. All the morphometric characters of *H. martini* and *H. krugeri* agree and the species are also sympatric. *H. krugeri* is therefore here proposed as a junior synonym of *H. martini.*

Helicotylenchus paracanalis Sauer & Winoto, 1975

(Figs 7, 8)

This species was described from a rainforest in Malaysia and was reported from other tropical forests, in Fiji (Van den Berg & Kirby, 1979), India (Mohandas, 1976), and the Ivory Coast (Fortuner *et al.*, 1981). This is the first report of this species in South Africa.

MEASUREMENTS

See Table 6.

DISCUSSION

Female: Habitus C-shaped (15%) to spiral (85%). Lip region hemispherical, sometimes slightly flattened, not offset, with six to eight annuli. Outer margin of labial framework posteriorly extending over three to four annuli from basal plate. Anterior face of stylet knobs indented (3%) to flattened (97%). Excretory pore located from opposite middle of isthmus to opposite anterior part of oesophageal lobe. Hemizonid and hemizonion not seen. Spermatheca large, oblong, and filled with roundish sperm. Lateral canals clearly visible in intestinal area of 75% of the specimens. Epiptygmata apparently folded into vagina. Lateral field with four lines, inner lines ending on tail in a m-shaped pattern. Tail bluntly rounded or with a small ventral projection.

Male: Outer margin of labial framework posteriorly extending over two to four annuli from basal plate. Stylet knobs indented (55%) or anteriorly flattened (45%). Median bulb oblong. Oesophagus 146 ± 10.2 (127-167) µm long. Lateral field areolated opposite oesophageal part of body and in region of bursa. Phasmid located one body width anterior to cloaca. Bursa extending to tip of tail. Tail with a mucro on the finger-like ventrad curved projection.

REMARKS

The current specimens were identified as *H. paracanalis* owing to the presence of lateral canals and males, position of the vulva, and overall body and stylet lengths. The South African specimens conforms to the original description of *H. paracanalis* and the subsequent descriptions by Van den Berg and Kirby (1979) and Fortuner *et al.* (1981). The specimens were also compared with and found to be similar to paratypes from Malaysia.

Helicotylenchus variabilis Phillips, 1971

(Fig. 5)

This species was described from Australia and is reported here for the first time in South Africa.

MEASUREMENTS

See Table 6.

DESCRIPTION

Female: Body posture open C (29%) to spiral (71%). Lip region high, anteriorly flattened, not offset, with five to six annuli. Outer margin of labial framework extending posteriorly over three to four annuli from basal plate. Stylet knobs anteriorly flattened to sloping backwards. Median bulb oblong. Excretory pore located from opposite middle of isthmus to opposite middle of oesophageal lobe. Hemizonid two annuli long, one annulus anterior to excretory pore. Hemizonion not seen. Spermatheca round and filled with roundish sperm. Epiptygmata folded into vagina. Lateral field with four lines, areolated opposite oesophageal part of body and incompletely areolated on posterior part of body. Inner lines ending in a u-, v- or y-shaped pattern on tail.

Male: Outer margin of labial framework extending posteriorly over three annuli from basal plate. Phasmid one body width anterior to cloaca. Bursa reaching tip of tail.

REMARKS

The specimens generally conform to the original description, but differ in having five to six lip annuli *vs* no distinct annuli. The specimens were also compared with paratypes of *H. variabilis* from grassland in Queensland, Australia; lip annuli were seen.

***Helicotylenchus vulgaris* Yuen, 1964**
(Figs 8, 9)

H. vulgaris was described from grass in England and was subsequently reported from *Pinus mugo* and olive-tree in Italy (Mancini & Moretti, 1976; Abrantes *et al.*, 1987) and from an orchard in New Zealand (Wouts & Knight, 1993). The species also occurs in the Netherlands (Bongers, 1987) and Poland (Brzeski, 1985). This is the second report of this species after the first report by Van den Berg and Heyns (1975).

MEASUREMENTS

See Table 6.

DESCRIPTION

Female: Habitus C-shaped (28%) to spiral (72%). Lip region truncate (88%) or rounded (12%), not offset from body, with five to seven annuli. Labial framework well developed, extending posteriorly over two to three annuli from basal plate. Cephalids not seen. Anterior face of stylet knobs indented (52%), flattened (40%), or rounded (8%). Median bulb rounded. Excretory pore located from opposite middle of isthmus to opposite posterior part of oesophageal lobes. Oesophageal gland lobe overlap over intestine 14 ± 4.3 (9-19) µm long. Hemizonid seen in only two specimens, two annuli long, located from opposite excretory pore to one annulus anterior to excretory pore. Hemizonion not seen. Lateral field with four lines, areolated opposite oesophageal region only, lateral field end on tail variable, inner lines joined together in a u-, v- or m-shaped pattern. Epiptygmata apparently folded into vagina in all the specimens. Phasmid located one to five annuli anterior to anus. Caudalid not seen. Tail rounded, more curved dorsally, with five to thirteen annuli. Annuli on tail fine and subdivided, not arranged in an orderly fashion and irregular around tip.

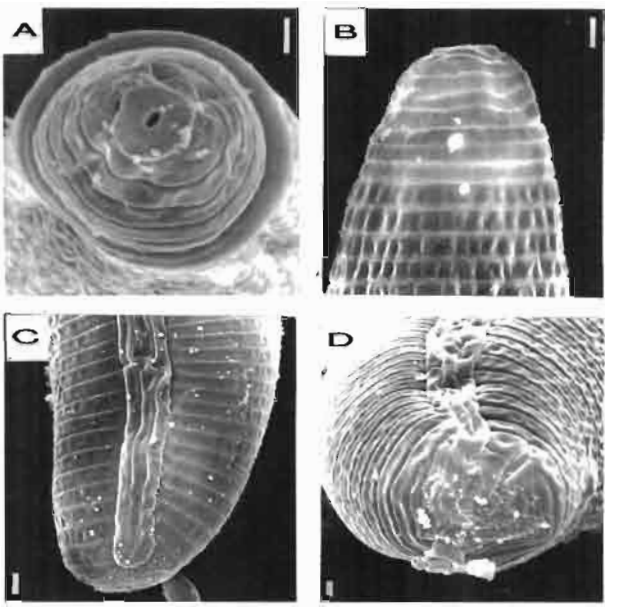

Fig. 9. Helicotylenchus vulgaris. *Female: A: En face view, lip region; B: Lateral view, lip region; C-D: Posterior region of body. (Scale bar = 1 µm).*

Male: Not found.

REMARKS

These specimens were identified as *H. vulgaris* because of the presence of fine, subdivided annuli on the tail tip. The specimens were compared with female paratypes of *H. vulgaris* from grass, Rothamsted Experimental Station, UK, from which they differ slightly in the following characters: b value (4.2-5.9 *vs* 6.8-9.1), o value (39-50 *vs* 28-34) and therefore dorsal gland opening further from stylet knobs (12-15 *vs* 9-12 µm), position of vulva (V = 62-68 *vs* 56-62), stylet length (28-32 *vs* 30-34 µm), and position of phasmids (one to five *vs* six to eighteen annuli anterior to anus). According to Sher (1966), populations from France also have stylets shorter and phasmids more posteriorly located than the type specimens.

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