

**STUDIES OF PLANT AND SOIL NEMATODES. 15.  
ELEVEN NEW SPECIES OF RADOPHOLUS THORNE  
AND A NEW SPECIES OF RADOPHOLOIDES DE  
GUIRAN (NEMATODA: TYLENCHOIDEA) FROM  
AUSTRALIA**

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**SUMMARY**

*Radopholus rectus* n. sp., *R. crenatus* n. sp., *R. intermedius* n. sp., *R. brevicaudatus* n. sp., *R. serratus* n. sp., *R. ferax* n. sp., *R. megadorus* n. sp., *R. inanis* n. sp., *R. clarus* n. sp., *R. vacuus* n. sp., *R. capitatus* n. sp., and *Radopholoides laevis* n. sp., are described.

Keys to the males and females of *Radopholus* species are presented.

**Introduction**

Sher (1968) revised the genus *Radopholus* and suggested that it was indigenous to Australia. In addition to describing five new species from native habitats in Australia, he indicated that his collection contained at least nine other species which were not described because of insufficient and/or poorly preserved specimens.

Sher referred to the sperms of *Radopholus* species as rod-like (most species) or round (*R. rotundisemenus* Sher) and in his key to the species used the character "sperms present in spermatheca". In some species described in this paper, the sperms showed considerable variation and could not be readily placed in either of these categories. It was not uncommon to find that sperms were not present in all females of a species from one population.

Egunjobi (1968) described *R. cavenessi* from New Zealand. Several characters introduced by Sher, e.g. the length of the hyaline area in the tail and sperm shape, were not noted nor can they be determined from the illustrations. The value of  $b$  ( $= 3.2$ ) appears to be incorrect. For these reasons, *R. cavenessi* is not included in the keys in this paper.

**Materials and Methods**

Specimens were killed and fixed in F. A. 4 : 1 and processed to glycerine by Seinhorst's glycerol-ethanol method.

In the dimensions given in this paper, the proportion EO is the length of the body anterior to the excretory pore expressed as a percentage of the length of the oesophagus to the posterior end of the lobe and st is an abbreviation for stylet length. Measurements of spicules were made across their arc.

25. *Radopholus rectus* n.sp.

(Figure 1)

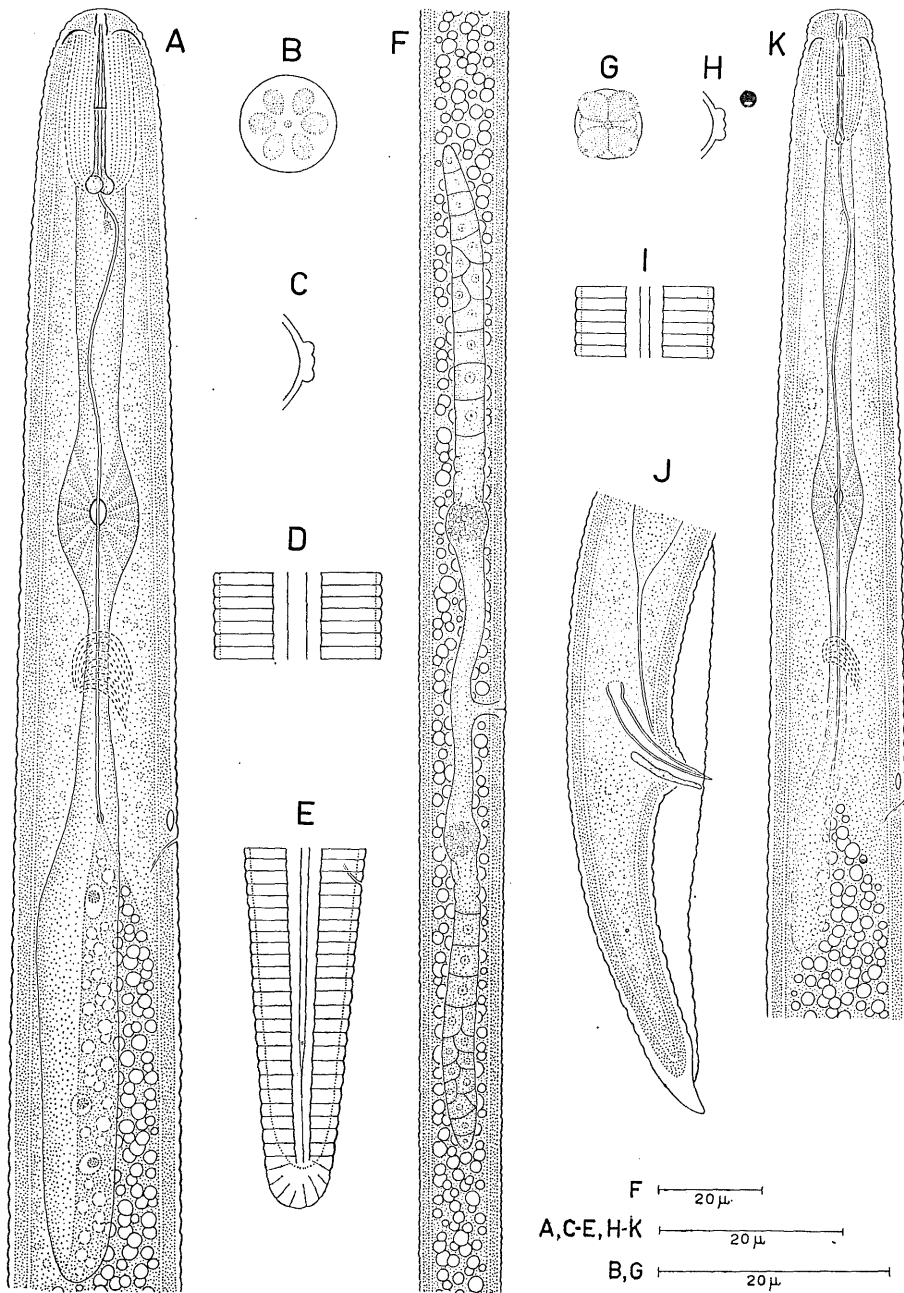


Fig. 1.—*Radopholus rectus* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, *en face* view; H, male, transverse section of lateral field; I, male, lateral field; J, male tail; K, male, anterior end.

*Females* (14).—L = 510 (450–640)  $\mu$ ; a = 30 (25–36); b = 6.0 (5.5–6.8); b' = 3.5 (3.1–3.9); c = 14 (13–16); c' = 2.6 (2.3–2.9); H = 4 (3–5)  $\mu$ ; V = <sup>27</sup>(17–30) 61 (59–63) <sup>20</sup>(17–22); stylet = 17 (16–18)  $\mu$ ; EO = 59 (51–65); tail = 36 (34–39)  $\mu$  = 2.0 (1.9–2.2) st.

*Female (holotype)*.—L = 580  $\mu$ ; a = 35; b = 6.2; b' = 3.4; c = 15; c' = 2.8; H = 3  $\mu$ ; V = <sup>20</sup>63 <sup>20</sup>; stylet = 18  $\mu$ ; EO = 51; tail = 38  $\mu$  = 2.1 st.

Lip region hemispherical, slightly set off, three or four annules. Lateral fields with four incisures reduced to three near phasmids. Stylet knobs 4–5  $\mu$  wide, rounded. Spermathecae small, subspherical; sperms round. Tail tapering slightly to broadly rounded terminus with fine, regular annulation; hyaline area shorter than width at base.

*Males* (5).—L = 500 (450–570)  $\mu$ ; a = 36 (34–39); b = 6.4 (6.0–6.9); b' = 5.1 (4.9–5.2); c = 14 (12–17); c' = 3.0 (2.7–3.3); H = 5 (4–6)  $\mu$ ; stylet = 13 (12–14)  $\mu$ ; spicules = 15 (13–17)  $\mu$ ; gubernaculum = 9  $\mu$ .

*Male (allotype)*.—L = 531  $\mu$ ; a = 37; b = 6.5; b' = 5.1; c = 15; c' = 2.9; H = 4  $\mu$ ; stylet = 13  $\mu$ ; spicules = 16  $\mu$ ; gubernaculum = 9  $\mu$ .

Lip region wider than long, set off by distinct depression, five annules, lobes evident in lateral view. Lateral fields with four incisures, inner pair sometimes appearing as one. Stylet with small basal swelling. Dorsal oesophageal gland orifice 7  $\mu$  behind stylet. Caudal alae enveloping tail. Tail contracting sharply near anterior end of hyaline area. Spicules acutely pointed. Proximal end of gubernaculum straight.

*Juvenile*.—Similar to female except for shorter hyaline area in tail terminus (1.2  $\mu$ ) (see Figure 11).

*Types*.—Holotype (female) slide Reg. No. G. 5377 and allotype (male) slide Reg. No. G. 5378 in the Queensland Museum. Paratypes (44 ♀♀, 8 ♂♂, 1 juvenile) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by the author from a culture maintained on blady grass in a glasshouse since August 1963.

*Type host*.—*Imperata cylindrica* (L.) Beauv. var. *major* (Nees) C. E. Hubbard (blady grass).

*Type locality*.—New South Wales: lookout above Maclean.

*Differential diagnosis*.—*R. rectus* n.sp. most closely resembles *R. neosimilis* Sauer and *R. ferax* n.sp. but can be distinguished from these species by the shape of the sperms.

*Other records*.—In Queensland, *R. rectus* has been found in soil from eucalypt forests at Beerwah, Carnarvon National Park, Goomborian, Imbil, Kandanga, Yandina and in a citrus orchard at Mundubbera.

## 26. *Radopholus crenatus* n.sp.

(Figure 2)

*Females* (7).—L = 560 (452–654)  $\mu$ ; a = 25 (23–31); b = 6.8 (6.3–7.3); b' = 4.3 (3.8–5.0); c = 14 (12–18); c' = 2.8 (2.6–3.0); H = 9 (8–10)  $\mu$ ; V = <sup>24</sup>(20–29) 61 (57–64) <sup>18</sup>(16–22); stylet = 19 (18–21)  $\mu$ ; EO = 61 (57–64); tail = 41 (34–46)  $\mu$  = 2.1 (1.7–2.4) st.

*Female (holotype)*.—L = 572  $\mu$ ; a = 31; b = 7.3; b' = 4.5; c = 17; c' = 2.6; H = 9  $\mu$ ; V = <sup>23</sup>64 <sup>16</sup>; stylet = 20  $\mu$ ; EO = 63; tail = 34  $\mu$  = 1.7 st.

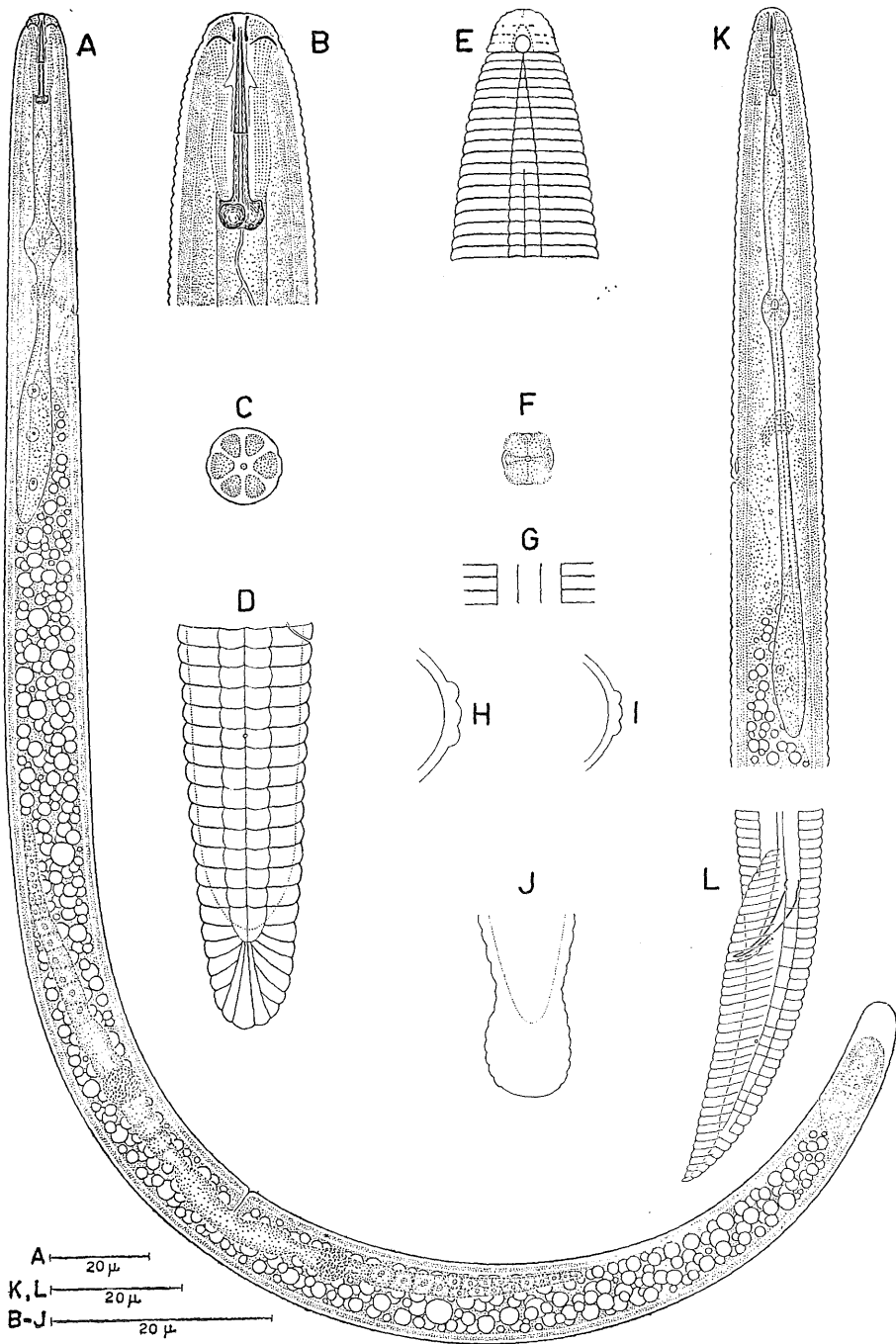


Fig. 2.—*Radopholus crenatus* n.sp. A, female; B, female head; C, female, *en face* view; D, female tail; E, male head; F, male, *en face* view; G, female, lateral field; H, female, transverse section of lateral field; I, male, transverse section of lateral field; J, female tail, aberrant paratype; K, male, anterior end; L, male tail.

Lip region narrow, hemispherical, set off, without distinct annules. Lateral fields with four incisures converging to three anterior to anus; bands areolated over greater portion of body. Stylet knobs concave to flattened anteriorly. Spermathecae small, spherical; sperms thick, rod-shaped. Tail tapering slightly to broadly rounded terminus; terminal striae coarse, regular; hyaline area longer than width at base.

*Males* (8).—L = 461 (401–520)  $\mu$ ; a = 32 (23–38); b = 6.4 (5.9–6.7); b' = 4.4 (4.1–4.7); c = 13 (11–14); c' = 3.9 (2.9–4.2); H = 10 (8–12)  $\mu$ ; stylet = 13 (12–18)  $\mu$ ; spicules = 17 (14–18)  $\mu$ ; gubernaculum = 8 (7–9)  $\mu$ .

*Male (allotype)*.—L = 474  $\mu$ ; a = 29; b = 5.9; b' = 4.1; c = 12; c' = 3.9; H = 8  $\mu$ ; stylet = 14  $\mu$ ; spicules = 15  $\mu$ ; gubernaculum = 8  $\mu$ .

Lip region high, hemispherical, widest at base, set off by constriction, without distinct annules. Amphids opening through irregularly shaped longitudinal clefts. Lateral fields with four incisures reduced to three near end of oesophagus; areolation confined to stylet and tail regions.

*Juvenile*.—Similar to female except for shorter hyaline area in tail terminus (4–8  $\mu$ ) (see Figure 11).

*Types*.—Holotype (female) slide Reg. No. G. 5379 and allotype (male) slide Reg. No. G. 5380 in the Queensland Museum. Paratypes (13♀, 12♂, 5 juveniles) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by the author in July 1967.

*Type habitat*.—Sandy soil in eucalypt forest dominated by *Eucalyptus intermedia* R. T. Baker (bloodwood).

*Type locality*.—South Queensland: within 50 yards of the Camp Cable Monument.

*Differential diagnosis*.—*R. crenatus* n.sp. most closely resembles *R. inaequalis* Sauer but can be distinguished by the fewer incisures in the lateral fields and the dorsal stylet knob is not abnormally enlarged. The distinctive lateral clefts on the male head have not been observed in other *Radopholus* species.

Females usually lie straight when mounted. There is considerable variation in sperm shape, ranging from ovate to long thick rods, ovaries are occasionally reflexed and female tails may be slightly clavate (Figure 2J).

*Other records*.—*R. crenatus* has been found in eucalypt forest at Amity Point (Stradbroke Is.), Beerburum, Beerwah, Burrum Heads, Cowan-Cowan (Moreton Island), Elimbah, Hampton, Landsborough, Tannymorel, Woombye, and Harwood (New South Wales).

## 27. *Radopholus intermedius* n.sp.

(Figure 3, A-E)

*Females* (9).—L = 432  $\mu$  (371–498)  $\mu$ ; a = 32 (28–41); b = 5.6 (5.1–6.1); b' = 3.9 (3.3–4.7); c = 12 (11–14); c' = 3.8 (2.9–4.5); H = 3 (2–4)  $\mu$ ; V = <sup>23</sup> (21–26) 64 (60–66) <sup>16</sup> (15–17); stylet = 12 (11–13)  $\mu$ ; EO = 56 (53–57); tail = 36 (32–39)  $\mu$  = 2.9 (2.5–3.0) st.

*Female (holotype)*.—L = 439  $\mu$ ; a = 41; b = 5.5; b' = 3.3; c = 14; c' = 3.7; H = 2  $\mu$ ; V = <sup>24</sup> 66 <sup>15</sup>; stylet = 12  $\mu$ ; EO = 53; tail = 34  $\mu$  = 2.8 st.

Body slender, strongly curved when relaxed. Lip region not set off, tapering slightly to flattened anterior margin, three annules; internal sclerotization light, dorsal and ventral rays broader than sublaterals towards periphery. Lateral field

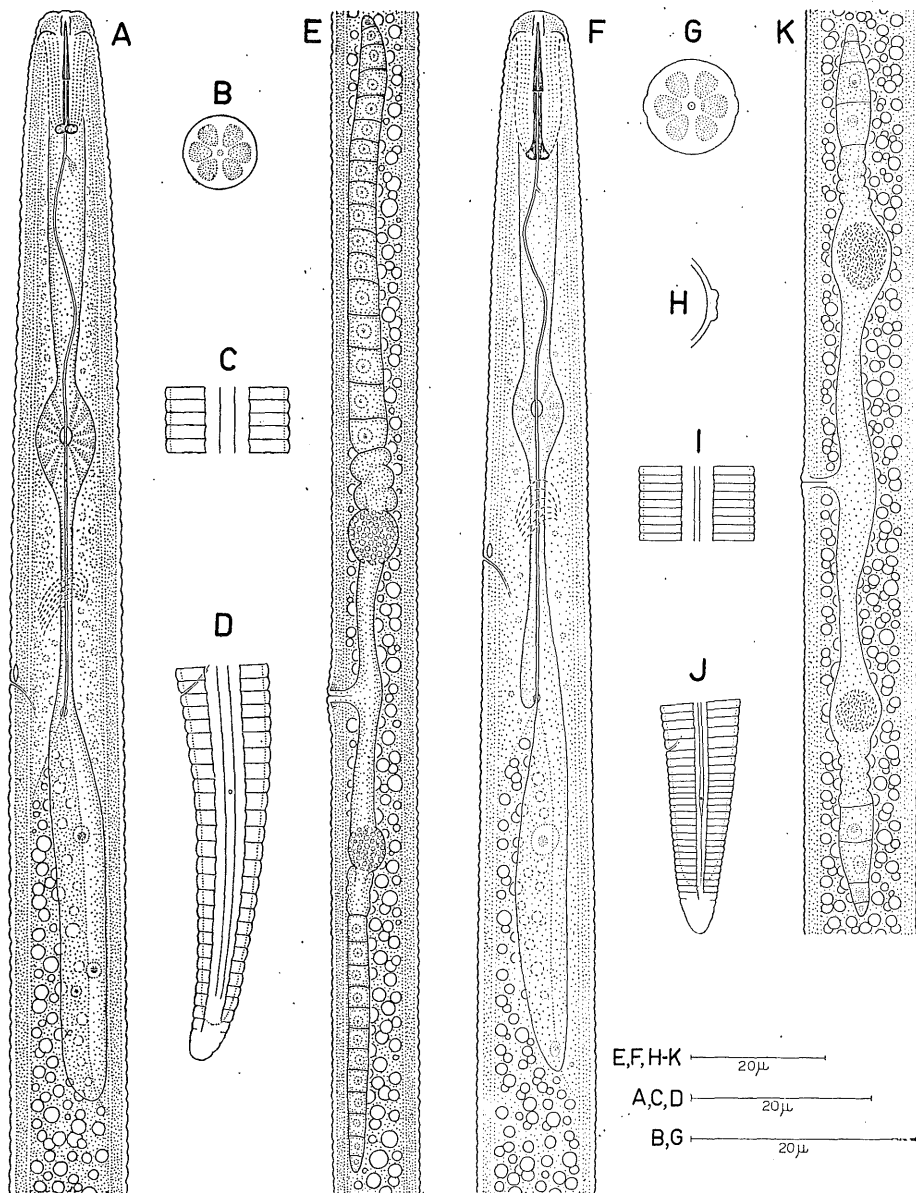


Fig. 3.—A-E, *Radopholus intermedius* n.sp., female: A, anterior end; B, *en face* view; C, lateral field; D, tail; E, mid-body. F-K, *Radopholus brevicaudatus* n.sp. female: F, anterior end; G, *en face* view; H, transverse section of lateral field; I, lateral field; J, tail; K, mid-body.

with four incisures between excretory pore and phasmid. Stylet knobs squat, broadly rounded. Anterior ovary and spermatheca considerably larger than posterior ovary and spermatheca. Spermathecae oval; sperms small, round to ovate. Tail long, 21-24 annules, tapering slightly to broadly-rounded, unstriated terminus. Hyaline area of terminus short, hemispherical.

*Male*.—Unknown.

*Juvenile*.—Unknown.

*Types*.—Holotype slide Reg. No. G. 5381 in the Queensland Museum. Paratypes (16 ♀♀) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by Janet S. McCulloch in August 1967.

*Type habitat*.—Soil in virgin forest around the roots of *Casuarina torulosa* Soland. (forest oak) and *Themeda australis* (R. Br.) Stapf (kangaroo grass).

*Type locality*.—Queensland: beside the Toowoomba–Hampton road, two miles from Hampton.

*Differential diagnosis*.—*R. intermedius* n.sp. is distinguished from other species of the genus by the slender body which is strongly curved when relaxed, reduced posterior gonad, short stylet, relatively long tail with short hyaline area and unstriated terminus. It resembles *Radopholoides laevis* n.sp. in overall appearance but differs in having a posterior ovary with spermatheca and more anteriorly placed vulva.

*Other records*.—A few specimens of *R. intermedius* were found in soil from eucalypt forest at Glasshouse Mountains.

## 28. *Radopholus brevicaudatus* n.sp.

(Figure 3, F-K)

*Females* (7).—L = 431 (395–455)  $\mu$ ; a = 24 (19–26); b = 4.8 (4.5–5.2); b' = 3.1 (3.0–3.4); c = 15 (12–17); c' = 2.5 (2.2–3.1); H = 7 (6–8)  $\mu$ ; V = <sup>16</sup> (14–19) 62 (61–64) <sup>16</sup> (14–18); stylet = 21 (20–21)  $\mu$ ; EO = 59 (55–63); tail = 28 (25–31)  $\mu$  = 1.4 (1.2–1.5) st.

*Female (holotype)*.—L = 455  $\mu$ ; a = 26; b = 4.8; b' = 3.1; c = 16; c' = 2.3; H = 6  $\mu$ ; V = <sup>17</sup> 61 <sup>15</sup>; stylet = 21  $\mu$ ; EO = 55; tail = 27  $\mu$  = 1.3 st.

Lip region hemispherical, slightly set off, 3 annules, Lateral lips set off. Lateral fields with four incisures, inner pair close together, converging to three near phasmids. Stylet knobs flattened anteriorly. Dorsal oesophageal gland opening 4  $\mu$  behind stylet. Ovaries short; spermathecae spherical; sperms rod-shaped. Tail conoid, terminus smooth.

*Males*.—Unknown.

*Juvenile*.—Similar to female except for smaller hyaline area in tail terminus (3–4  $\mu$ ) (see Figure 11).

*Types*.—Holotype (female) slide Reg. No. G. 5382 in the Queensland Museum. Paratypes (23 ♀♀, 9 juveniles) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by P. W. Reynolds in January 1969.

*Type habitat*.—Clay loam near the roots of *Cenchrus ciliaris* L. (buffel grass).

*Type locality*.—Queensland: Winton Railway Station.

*Differential diagnosis*.—*Radopholus brevicaudatus* n.sp. most closely resembles *R. magniglans* Sher but can be distinguished from this species by the shorter body and number of annules on the lip region. The tail is shorter in relation to the stylet length (1.2–1.5) st than in other species of the genus.

29. *Radopholus serratus* n.sp.

(Figure 4)

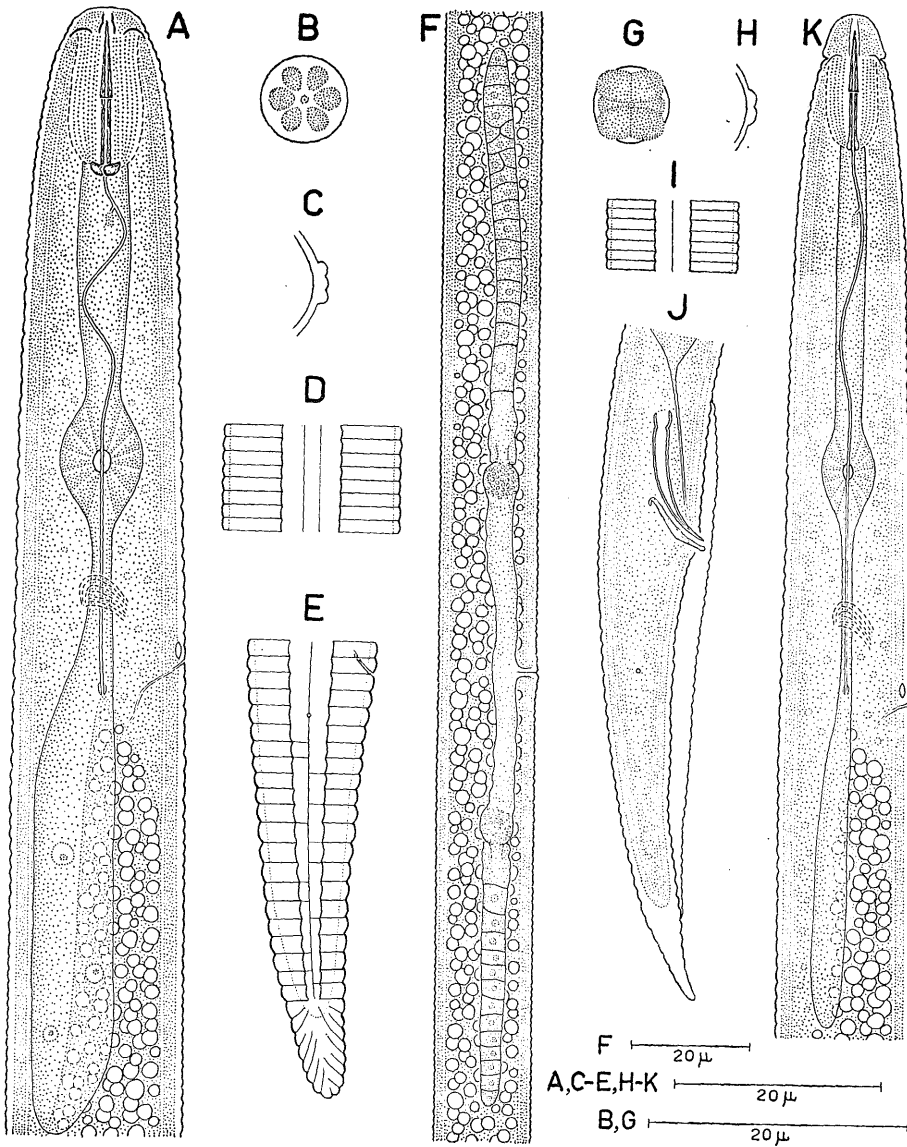


Fig. 4.—*Radopholus serratus* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, *en face* view; H, male, transverse section of lateral field; I, male, lateral field; J, male tail; K, male, anterior end.



*Females* (9).—L = 442 (369–501)  $\mu$ ; a = 30 (27–34); b = 6.4 (6.0–7.2); b' = 4.2 (3.7–4.7); c = 12 (11–13); c' = 3.5 (3.0–3.9); H = 8 (6–9)  $\mu$ ; V = <sup>21</sup>(19–25) 59 (55–63) <sup>15</sup>(13–16); stylet = 14 (13–16)  $\mu$ ; EO = 62 (57–66); tail = 38 (35–41)  $\mu$  = 2.5 (2.2–2.7) st.

*Female (holotype)*.—L = 455  $\mu$ ; a = 32; b = 6.2; b' = 4.0; c = 11; c' = 3.5; H = 8  $\mu$ ; V = <sup>23</sup>59 <sup>14</sup>; stylet = 14  $\mu$ ; EO = 65; tail = 41  $\mu$  = 2.7st.

Body slender, curved when relaxed. Lip region broadly rounded, not set off, three indistinct annules. Lateral fields with four incisures reduced to three near anus; bands areolated incompletely on tail. Stylet knobs concave on anterior margin. Spermathecae small; sperms ellipsoidal. Tail conoid, tapering to narrow terminus with very coarse annulation.

*Males* (9).—L = 453 (380–515)  $\mu$ ; a = 37 (33–40); b = 6.7 (5.6–7.2); b' = 4.9 (4.5–5.6); c = 11 (10–13); c' = 4.2 (3.3–4.6); H = 10 (7–11)  $\mu$ ; stylet = 10 (9–11)  $\mu$ ; spicules = 14 (13–16)  $\mu$ ; gubernaculum = 8 (7–9)  $\mu$ .

*Male (allotype)*.—L = 415  $\mu$ ; a = 39; b = 6.0; b' = 4.6; c = 12; c' = 4.6; H = 9  $\mu$ ; stylet = 9  $\mu$ ; spicules = 14  $\mu$ ; gubernaculum = 8  $\mu$ .

Body curved when relaxed. Lip region conoid, longer than wide, width greatest at base, annulation indistinct. Lateral fields with three incisures (four in some paratypes). Stylet with small basal swelling. Tail tapering to narrow terminus. Caudal alae extending to terminus.

*Juvenile*.—Similar to female except for shorter hyaline area in tail terminus. (3–5  $\mu$ ) (see Figure 11).

*Types*.—Holotype (female) slide Reg. No. G. 5383 and allotype (male) slide Reg. No. G. 5384 in the Queensland Museum. Paratypes (29 ♀♀, 23 ♂♂, 9 juveniles) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by K. Fisher-Webster in February 1968.

*Type habitat*.—Sandy soil in virgin forest dominated by *Casuarina equisetifolia* L. (dune sheoak).

*Type locality*.—Queensland: beside the Howard-Burrum Heads Road, four miles from Burrum Heads.

*Differential diagnosis*.—*R. serratus* n.sp. most closely resembles *R. vertexplanus* Sher, from which it is distinguished by the shape of the sperms and stylet knobs.

In some paratypes the sperms are thick, rod-like (much shorter and thicker than in *R. similis*), whereas in others they vary from round to short, ellipsoidal.

In some paratypes the caudal alae envelop little more than half the tail.

*Other records*.—*R. serratus* n.sp. was found also in soil around *Xanthorrhoea* sp. (a grass-tree) on Moreton Island.

### 30. *Radopholus ferax* n.sp.

(Figure 5)

*Females* (13).—L = 680 (620–740)  $\mu$ ; a = 26 (21–30); b = 7.6 (6.6–9.4); b' = 4.4 (3.8–5.0); c = 15 (13–16); c' = 2.5 (2–3); H = 4 (2–5)  $\mu$ ; V = <sup>32</sup>(23–39) 59 (54–61) <sup>29</sup>(20–38); stylet = 18 (17–20)  $\mu$ ; EO = 61 (58–67); tail = 46 (43–50)  $\mu$  = 2.5 (2.3–2.7) st.

*Female (holotype)*.—L = 710  $\mu$ ; a = 28; b = 7.1; b' = 4.2; c = 16; c' = 2.5; H = 5  $\mu$ ; V = <sup>31</sup>54 <sup>28</sup>; stylet = 19  $\mu$ ; EO = 61; tail = 49  $\mu$  = 2.5 st.

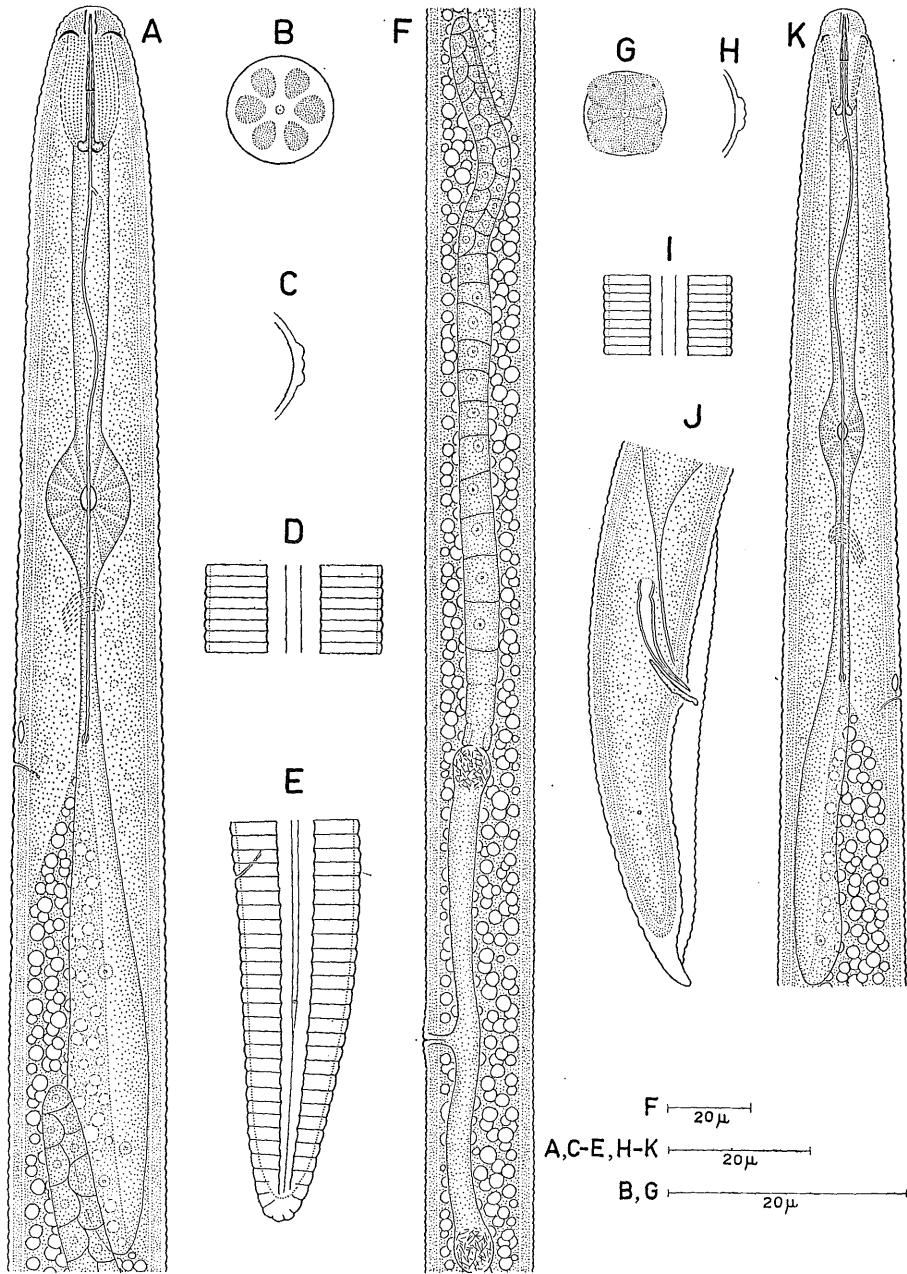


Fig. 5.—*Radopholus ferax* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, *en face* view; H, male, transverse section of lateral field; I, male, lateral field; J, male tail; K, male, anterior end.

Body robust, straight when relaxed. Lip region hemispherical, slightly set off, four annules. Lateral fields with four incisures reduced to three near excretory pore and phasmids; bands on tail incompletely areolated. Stylet knobs concave to flattened anteriorly. Ovaries long; spermathecae small oblong, sperms rod-like. Tail tapering slightly to broadly rounded terminus with very coarse striae.

*Males* (10).—L = 600 (540–690)  $\mu$ ; a = 32 (30–37); b = 6.6 (5.4–7.7); b' = 4.4 (4.0–4.8); c = 15 (12–17); c' = 3.0 (2.8–3.2); H = 8 (6–9)  $\mu$ ; stylet = 14 (13–15)  $\mu$ ; spicules = 17 (16–20)  $\mu$ ; gubernaculum = 9 (7–10)  $\mu$ .

*Male (allotype)*.—L = 570  $\mu$ ; a = 30; b = 6.6; b' = 4.4; c = 15; c' = 3.0; H = 8  $\mu$ ; stylet = 13  $\mu$ ; spicules = 17  $\mu$ ; gubernaculum = 10  $\mu$ .

Lip region high, hemispherical, slightly set off, five or six annules. Lateral fields with four incisures reduced to three near excretory pore. Stylet knobs well developed. Oesophageal lobe distinct, nucleus near posterior end; metacarpus oval; sclerotized valve present. Caudal alae extend to terminus. Gubernaculum swollen at ends, titillae present.

*Juvenile*.—Similar to female except the tail lacks a distinct hyaline area (Figure 11).

*Types*.—Holotype (female) and allotype (male) slide Reg. No. G. 5385 in the Queensland Museum. Paratypes (59 ♀♀, 45 ♂♂, 1 juvenile) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by F. D. Hockings in April 1968.

*Type habitat*.—Lesions on the roots of *Gerbera jamesoni* Bolus (gerbera).

*Type locality*.—Queensland: property of B. Yorke, 24 Mulgowie Street, Sunnybank, Brisbane.

*Differential diagnosis*.—*R. ferax* n.sp. most closely resembles *R. neosimilis* Sauer, from which it is distinguished by the shape of the stylet knobs and more pronounced terminal annulation. The ovaries are well developed, often extending to the oesophagus and anus, where the ends may be reflexed.

In males of *R. ferax*, the stylet knobs and oesophageal lobe are larger than in most other *Radopholus* species.

*Other records*.—*R. ferax* is associated with a root rot of gerberas throughout the Brisbane area.

### 31. *Radopholus megadorus* n.sp.

(Figure 6)

*Females* (4).—L = 588 (515–642)  $\mu$ ; a = 26 (24–29); b = 6.6 (5.9–7.1); b' = 4.0 (3.9–4.2); c = 14 (13–15); c' = 3.1 (2.9–3.3); H = 10 (9–12)  $\mu$ ; V = <sup>18</sup>(12–20) 66 (62–67) <sup>16</sup>(11–17); stylet = 21 (20–22)  $\mu$ ; EO = 62 (59–66); tail = 48 (47–50)  $\mu$  = 2.2 st.

*Female (holotype)*.—L = 588  $\mu$ ; a = 29; b = 6.5; b' = 4.2; c = 14; c' = 3.3; H = 9  $\mu$ ; V = <sup>15</sup>67 <sup>11</sup>; stylet = 22  $\mu$ ; EO = 66; tail = 50  $\mu$  = 2.2 st.

Lip region small, without distinct annules, internal sclerotization well developed. Lateral fields with 4 incisures, inner pair very close and often appearing as one. Stylet robust, knobbed base very large, spherical. Ovary with some oocytes in double row; spermathecae spherical, sperms rod-shaped. Tail conoid, tapering to broadly rounded terminus with regular annulation, hyaline area longer than width at base.

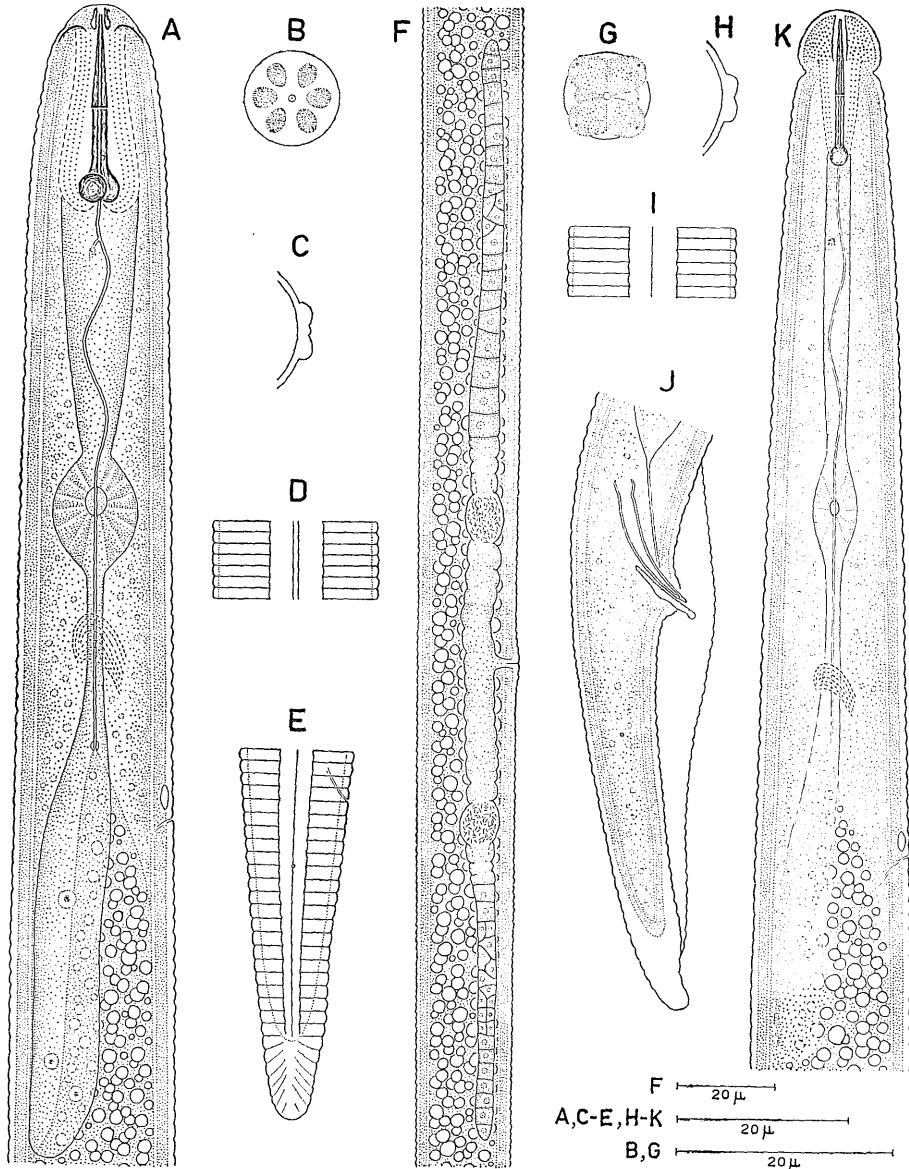


Fig. 6.—*Radopholus megadorus* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, *en face* view; H, male, transverse section of lateral field; I, male, lateral field; J, male tail; K, male, anterior end.

*Males* (3).—L = 568 (500–623)  $\mu$ ; a = 32 (30–35); b = 6.9 (6.8–7.0); b' = 4.5 (4.3–4.7); c = 12; c' = 4.1 (4.0–4.1); H = 8 (6–10)  $\mu$ ; stylet = 16  $\mu$ ; spicules = 16 (15–18)  $\mu$ ; gubernaculum = 9 (9–10)  $\mu$ .

*Male (allotype).*—L = 582  $\mu$ ; a = 30; b = 6.8; b' = 4.7; c = 12; c' = 4.1; H = 9  $\mu$ ; stylet = 16  $\mu$ ; spicules = 18  $\mu$ ; gubernaculum = 9  $\mu$ .

Lip region subspherical, strongly lobed, set off by conspicuous constriction, annules 7–8, distinct. Lateral field with three incisures (two longitudinal ridges). Stylet knobs small, rounded. Caudal alae extending to broadly-rounded tail terminus, margins crenate. Gubernaculum with swollen distal portion.

*Juvenile* (Moreton Island).—Similar to female except for shorter hyaline area in tail terminus (2–3  $\mu$ ) (see Figure 11).

*Types.*—Holotype (female) slide Reg. No. G. 5386 and allotype (male) slide Reg. No. G. 5387 in the Queensland Museum. Paratypes (3 ♀♀, 2 ♂♂) in the Queensland Department of Primary Industries Nematology Collection.

*Type habitat.*—Sandy soil in native scrub dominated by *Casuarina equisetifolia* L. var. *incana* A. Cunn. ex Benth. (dune sheoak).

*Type locality.*—Stradbroke Island: Camel Rock.

*Differential diagnosis.*—*Radopholus megadorus* n.sp. is distinguished by the very large stylet knobs and small unstriated lip region with heavy internal sclerotization.

The male lip region is larger and more spherical than in other *Radopholus* species.

*Other records.*—*R. megadorus* has been found in sand around the roots of *Ficus opposita* Miq. (a sandpaper fig) at The Bluff (central Queensland) and at Battery Hill, Moreton Island, around the roots of *Dianella caerulea* Sims (blue flax lily, blueberry lily).

### 32. *Radopholus inanis* n.sp.

(Figure 7)

*Females* (5).—L = 568 (477–596)  $\mu$ ; a = 32 (28–34); b = 5.8 (5.5–6.1); b' = 4.2 (3.4–4.5); c = 13 (12–14); c' = 3.2 (2.8–3.6); H = 2.1 (1.5–3.0)  $\mu$ ; stylet = 14 (14–15)  $\mu$ ; V = <sup>27</sup>(22–30) 58 (57–61) <sup>24</sup>(20–27); EO = 57 (53–62); tail = 38 (35–40)  $\mu$  = 2.7 (2.5–2.9) st.

*Female (holotype).*—L = 477  $\mu$ ; a = 32; b = 5.8; b' = 3.4; c = 13; c' = 3.0; H = 1.5  $\mu$ ; V = <sup>26</sup>61 <sup>24</sup>; stylet = 14  $\mu$ ; EO = 54; tail = 37  $\mu$  = 2.6 st.

Lip region flattened anteriorly, rounded edges, slightly set off, three annules. Lateral fields with four incisures. Stylet knobs rounded. Dorsal oesophageal gland orifice 2  $\mu$  behind stylet. Oesophageal lobes distinct. Spermathecae spherical, about half as wide as body, sperms round. Tail conoid, tapering to smooth, rounded terminus; cuticle at terminus barely thickened.

*Males* (5).—L = 563 (471–662)  $\mu$ ; a = 30 (27–31); b = 6.1 (6.0–6.3); b' = 4.2 (3.9–4.7); c = 13 (12–14); c' = 3.5 (3.2–3.7); H = 3.3 (2.4–4.0)  $\mu$ ; stylet = 12 (11–13)  $\mu$ ; spicules = 16 (14–17)  $\mu$ ; gubernaculum = 9 (8–10)  $\mu$ .

*Male (allotype).*—L = 582  $\mu$ ; a = 28; b = 6.0; b' = 4.4; c = 14; c' = 3.5; H = 4  $\mu$ ; stylet = 11  $\mu$ ; spicules = 17  $\mu$ ; gubernaculum = 10  $\mu$ .

Lip region subspherical, set off from body by conspicuous constriction, about 6 annules. Lateral fields with four incisures. Stylet without distinct basal swelling. Oesophageal lobe well developed, with one distinct nucleus. Tail conoid, tapering to bluntly rounded terminus. Caudal alae subterminal (variable envelopment of tail in paratypes).

*Juvenile.*—Similar to female except the tail lacks a distinct hyaline area (Figure 11).

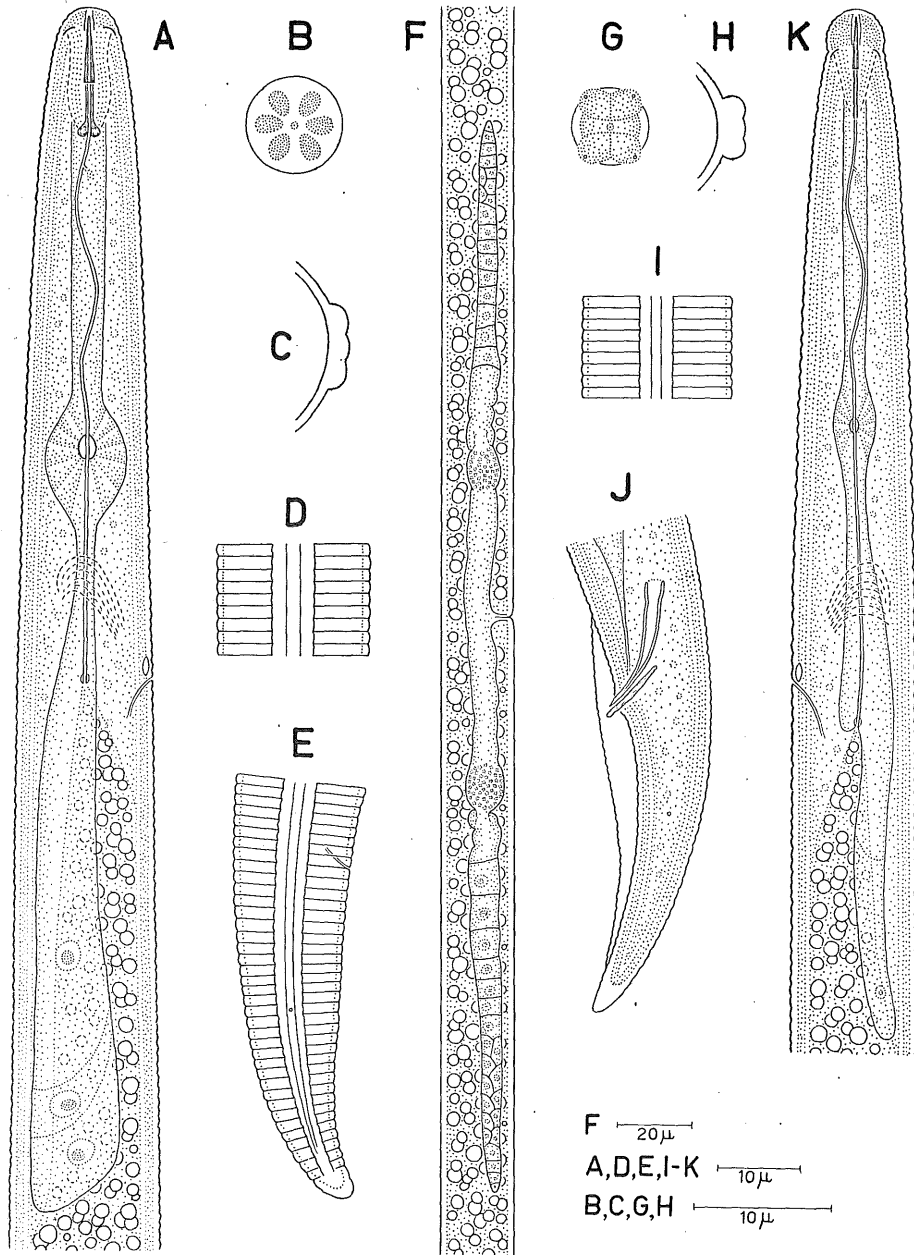


Fig. 7.—*Radopholus inanis* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, *en face* view; H, male, transverse section of lateral field; I, male, lateral field; J, male tail; K, male, anterior end.

*Types*.—Holotype (female) slide Reg. No. G. 5388 and allotype (male) slide Reg. No. G. 5389 in the Queensland Museum. Paratypes (6 ♀♀, 8 ♂♂, 1 juvenile) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by T. E. O'Sullivan in April 1970.

*Type habitat*.—Heavy black soil in open downs country.

*Type locality*.—Queensland: Retro siding, via Emerald. *R. capitatus* n.sp. and *R. clarus* n.sp. were also found in this area.

*Differential diagnosis*.—*Radopholus inanis* n.sp. resembles *R. vacuus* n.sp., *R. intermedius* n.sp. and *R. nigeriensis* Sher in having a smooth tail terminus with little thickening. It is distinguished from *R. vacuus* n.sp. by the shorter oesophageal overlap, from *R. intermedius* n.sp. by the greater development of the posterior gonad and from *R. nigeriensis* Sher by the position of the phasmids. The swelling at the base of the male stylet is smaller than in other *Radopholus* species described in this paper.

### 33. *Radopholus clarus* n.sp.

(Figure 8)

*Females* (5).—L = 602 (553–683)  $\mu$ ; a = 26 (23–28); b = 6.9 (5.9–7.3); b' = 4.4 (3.9–4.8); c = 14 (12–16); c' = 3.3 (2.7–3.9); H = 9 (8–10)  $\mu$ ; V = <sup>27</sup> 58 (23–31) <sup>21</sup> (17–24); stylet = 20 (19–21)  $\mu$ ; EO = 68 (65–71); tail = 45 (36–54)  $\mu$  = 2.2 (1.9–2.6) st.

*Female (holotype)*.—L = 585  $\mu$ ; a = 27; b = 7.0; b' = 4.5; c = 16; c' = 2.7; H = 8  $\mu$ ; V = <sup>25</sup> 61 <sup>22</sup>; stylet = 19  $\mu$ ; EO = 71; tail = 36  $\mu$  = 1.9 st.

Lip region hemispherical, not set off, four fine annules. Lateral fields with four incisures. Stylet knobs rounded. Spermathecae spherical; sperms rod-shaped. Tail with 25 annules on ventral side, conoid to cylindrical; terminus broadly rounded, striated, hyaline area as long as width at base.

*Males* (2).—L = 515–600  $\mu$ ; a = 39–45; b = 6.4; b' = 4.2–4.4; c = 15–16; c' = 3.1–3.6; H = 5–7  $\mu$ ; stylet = 14  $\mu$ ; spicules = 16–17  $\mu$ ; gubernaculum = 9–10  $\mu$ .

*Male (allotype)*.—L = 600  $\mu$ ; a = 45; b = 6.4; b' = 4.2; c = 15; c' = 3.6; H = 5  $\mu$ ; stylet = 14  $\mu$ ; spicules = 16  $\mu$ ; gubernaculum = 10  $\mu$ .

Body J-shaped when relaxed. Lip region high, widest at base, tapering slightly to broadly-rounded anterior margin, set off by distinct constriction. Lateral fields with four incisures. Caudal alae enveloping tail which tapers slightly to broadly rounded, unstriated terminus. Gubernaculum knobbed distally.

*Juvenile*.—Similar to female except for shorter hyaline area in tail terminus (2–3  $\mu$ ) (see Figure 11).

*Types*.—Holotype (female) slide Reg. No. G. 5390 and allotype (male) slide Reg. No. G. 5391 in the Queensland Museum. Paratypes (4 ♀♀, 1 ♂, 8 juveniles) in the Queensland Department of Primary Industries Nematology Collection.

The types were collected by K. Middleton in August 1967.

*Type habitat*.—Virgin soil.

*Type locality*.—Queensland: Winton Railway Station.

*Differential diagnosis*.—*Radopholus clarus* n.sp. most closely resembles *R. vangundyi* Sher but can be distinguished from this species by the shorter oesophageal overlap, four annules on the lip region and broader tail.

*Other records*.—*Radopholus clarus* n.sp. was found also in soil from open grassland at Retro siding.

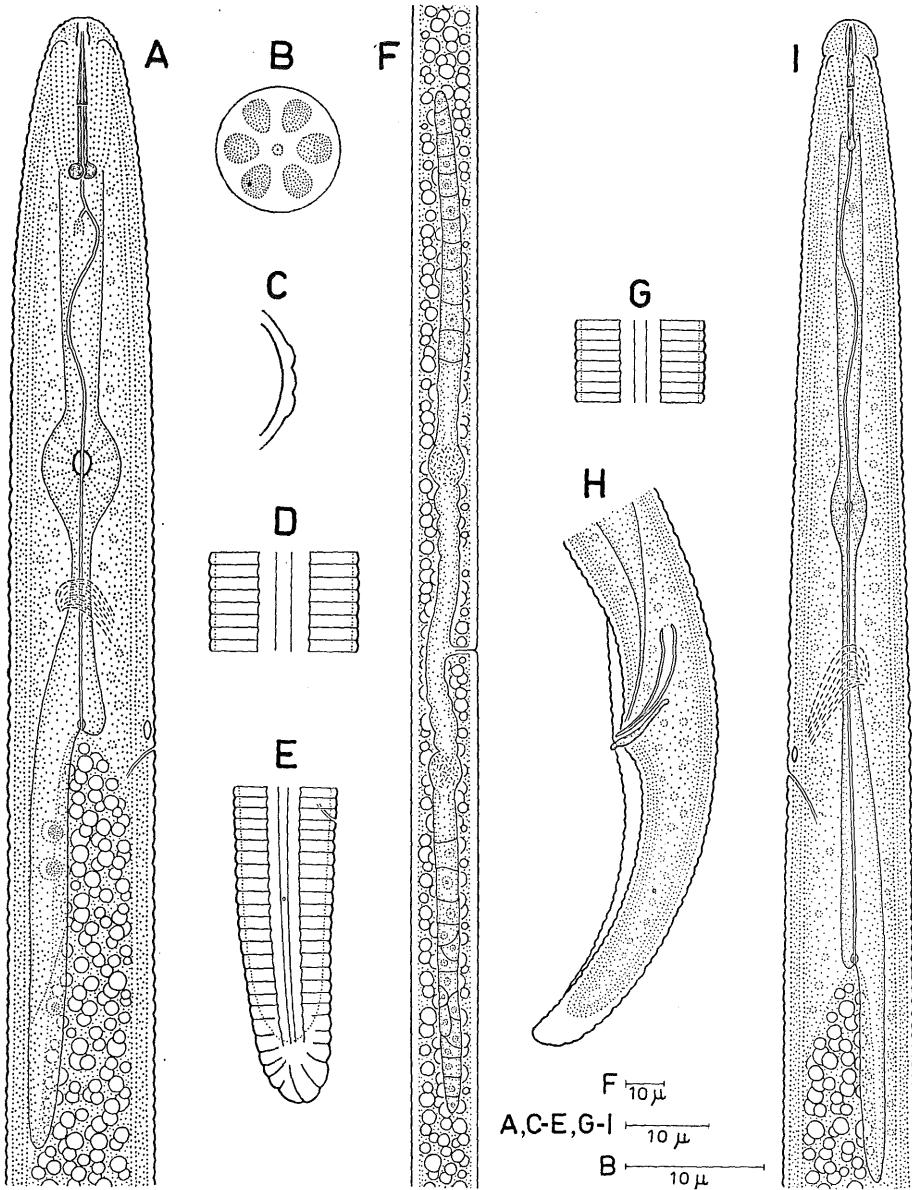


Fig. 8.—*Radopholus clarus* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, lateral field; H, male tail; I, male, anterior end.



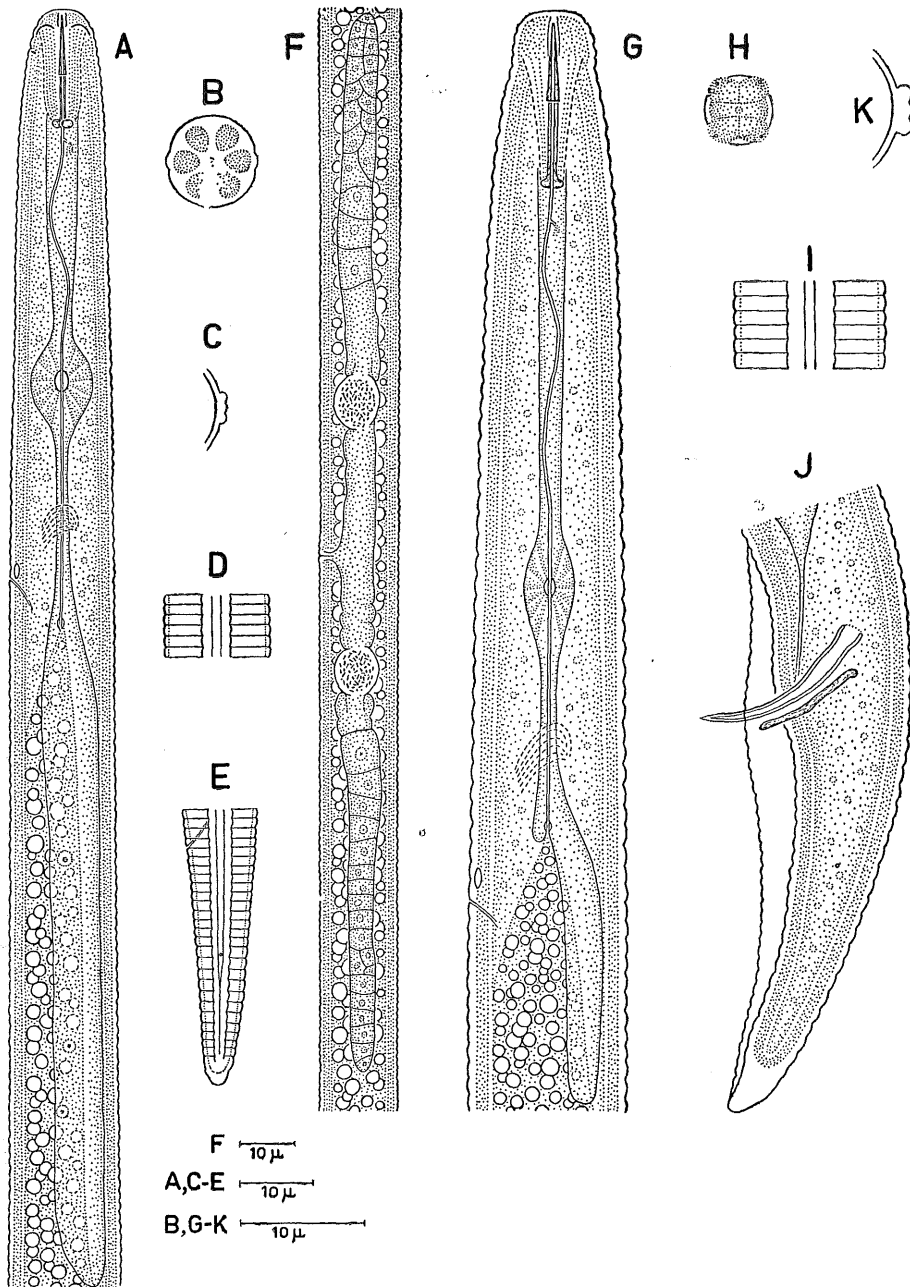


Fig. 9.—*Radopholus vacuus* n.sp. A, female, anterior end; B, female, *en face* view; C, female, transverse section of lateral field; D, female, lateral field; E, female tail; F, female, mid-body; G, male, anterior end; H, male, *en face* view; I, male, lateral field; J, male tail; K, male, transverse section of lateral field.

**34. *Radopholus vacuus* n.sp.**

(Figure 9)

*Females* (8).—L = 433 (408–461)  $\mu$ ; a = 30 (25–35); b = 5.5 (4.8–6.0); b' = 2.6 (2.5–2.7); c = 13 (12–13); c' = 3.1 (2.7–3.4); H = 2.4 (2–3)  $\mu$ ; V = <sup>21</sup>(19–24) 61 (59–61) <sup>22</sup>(20–27); stylet = 15 (14–15)  $\mu$ ; EO = 45 (42–48); tail = 32 (28–34)  $\mu$  = 2.2 (2.0–2.4) st.

*Female (holotype)*.—L = 415  $\mu$ ; a = 26; b = 5.0; b' = 2.5; c = 13; c' = 2.7; H = 2  $\mu$ ; V = <sup>24</sup>59 <sup>25</sup>; stylet = 14  $\mu$ ; EO = 44; tail = 33  $\mu$  = 2.3 st.

Lip region slightly set off, two annules. Lateral fields with four incisures converging to three near phasmids. Stylet knobs broad, rounded. Oesophageal lobe long, broad. Spermathecae small, spherical; sperms short, ellipsoidal. Tail conoid, tapering to smooth, bluntly rounded terminus; hyaline area short.

*Males* (2).—L = 436–461  $\mu$ ; a = 34–39; b = 7.0; b' = 4.8–5.0; c = 13–14; c' = 3.2–3.7; H = 4–5  $\mu$ ; stylet = 12–13  $\mu$ ; spicules = 13–17  $\mu$ ; gubernaculum = 9  $\mu$ .

*Male (allotype)*.—L = 461  $\mu$ ; a = 34; b = 7.0; b' = 5.0; c = 13; c' = 3.7; H = 4  $\mu$ ; stylet = 13  $\mu$ ; spicules = 17  $\mu$ ; gubernaculum = 9  $\mu$ .

Lip region wider than long, set off by slight depression, five or six annules. Lateral fields with four incisures. Stylet base small, rounded. Caudal alae extend to terminus.

*Juvenile*.—Similar to female except for the absence of a distinct hyaline area at the tail terminus (Figure 11).

*Types*.—Holotype (female) slide Reg. No. G. 5392 and allotype (male) slide Reg. No. G. 5393 in the Queensland Museum. Paratypes (8 ♀♀, 2 ♂♂, 1 juvenile) in the Queensland Department of Primary Industries Nematology Collection.

*Type habitat*.—Sandy soil in virgin forest.

*Type locality*.—Stradbroke Island: hill overlooking the Pacific Ocean between Camel Rock and Cylinder Headland.

*Differential diagnosis*.—*Radopholus vacuus* n.sp. resembles *R. williamsi* Siddiqi, *R. brevicaudatus* n.sp. and *R. magniglans* Sher in having a relatively long oesophagus. It is distinguished from these species by the small hyaline area in the tail terminus.

**35. *Radopholus capitatus* n.sp.**

(Figure 10, G-L)

*Females* (14).—L = 531 (474–580)  $\mu$ ; a = 30 (26–33); b = 5.4 (4.7–6.1); b' = 3.4 (3.2–3.9); c = 17 (13–19); c' = 2.7 (2.3–3.0); H = 11 (9–12)  $\mu$ ; V = <sup>13</sup>(11–14) 64 (63–69) <sup>12</sup>(11–14); stylet = 19 (18–21)  $\mu$ ; EO = 54 (52–58); tail = 33 (29–35)  $\mu$  = 1.7 (1.5–1.8) st.

*Female (holotype)*.—L = 523  $\mu$ ; a = 28; b = 5.3; b' = 3.5; c = 16; c' = 2.4; H = 9  $\mu$ ; V = <sup>14</sup>63 <sup>14</sup>; stylet = 19  $\mu$ ; EO = 57; tail = 33  $\mu$  = 1.6 st.

Body curved when relaxed. Lip region sub-conical, slightly set off, two indistinct annules; internal sclerotization moderate, circumoral ridge prominent. Lateral fields with four incisures. Stylet knobs flattened to convex on anterior margins. Oesophagus with ovate metacarpus and long slender lobe. Vulval lips prominent. Ovaries short; spermathecae large, spherical; sperms short, rod-like. Tail short, conoid, tapering unevenly to narrow terminus with irregular annulation; hyaline area of tail longer than width at base.

*Male*.—Unknown.

*Juvenile*.—Similar to female except for the shorter hyaline area in the tail terminus (3–5  $\mu$ ) (See Figure 11).

*Types*.—Holotype slide Reg. No. G. 5394 in the Queensland Museum. Paratypes (13 ♀♀, 8 juveniles) in the Queensland Department of Primary Industries Nematology Collection.

The type material was collected by T. E. O'Sullivan in April 1968.

*Type habitat*.—Heavy black soil under tussock of *Dichanthium sericeum* (R. Br.) A. Camus (Queensland blue grass) in open downs country.

*Type locality*.—Central Queensland: 20 yards to the western side of the railway line in Mr. John White's property "Springvale", one mile south of Capella on the Emerald–Capella Road.

*Differential diagnosis*.—*Radopholus capitatus* n.sp. most closely resembles *R. magniglians* Sher but can be distinguished from this species by the shape of the lip region and the anterior and posterior spermathecae are approximately equal in size.

### 36. *Radopholoides laevis*

(Figure 10, A–F)

*Females* (6).—L = 443 (407–488)  $\mu$ ; a = 33 (32–36); b = 4.9 (4.4–5.2); b' = 3.1 (2.9–3.7); c = 13 (12–14); c' = 3.8 (3.3–4.1); H = 2.6 (2.4–2.8)  $\mu$ ; V = <sup>26</sup>(24–29) 71 (68–72); stylet = 12 (12–13)  $\mu$ ; EO = 58 (57–60); tail = 34 (31–36)  $\mu$  = 2.7 (2.5–3.0) st.

*Female (holotype)*.—L = 488  $\mu$ ; a = 36; b = 5.2; b' = 3.7; c = 13; c' = 4.1; H = 2.5  $\mu$ ; V = <sup>25</sup>68; stylet = 12  $\mu$ ; EO = 57; tail = 34  $\mu$  = 2.6 st.

Body slender, curved ventrally when relaxed. Lip region tapering slightly to flattened anterior margin, three distinct annules. Lateral fields with four evenly spaced incisures. Stylet knobs broad, rounded. Ovary with some oocytes in double row; spermathecae spherical, without sperms. Post-vulval uterine sac narrow, straplike, 1.5–2.5 times as long as body width at vulva. Tail conoid, tapering slightly to rounded terminus without annulation; hyaline area of terminus short.

*Male*.—Unknown.

*Juvenile*.—Unknown.

*Types*.—Holotype slide Reg. No. G. 5395 in the Queensland Museum. Paratypes (74 ♀♀) in the Queensland Department of Primary Industries Nematology Collection.

The type material was collected by Elizabeth Williams in August 1968.

*Type habitat*.—Queensland: soil around the roots of *Livistona* sp. (a fan palm) near the C.W.A. hut, Carnarvon National Park.

*Differential diagnosis*.—*R. laevis* n.sp. is distinguished from *R. litoralis* de Guiran, 1967, by the shape of the lip region, shorter stylet and terminus without annulation.

*Other records*.—*R. laevis* n.sp. has been found also in soil around the roots of *Casuarina torulosa* Soland. (forest oak) and *Themeda australis* (R. Br.) Stapf (kangaroo grass) beside the Toowoomba–Hampton Road, two miles from Hampton. The latter is the type locality of *Radopholus intermedius* n.sp., a species with which it appears to have a close phylogenetic relationship.

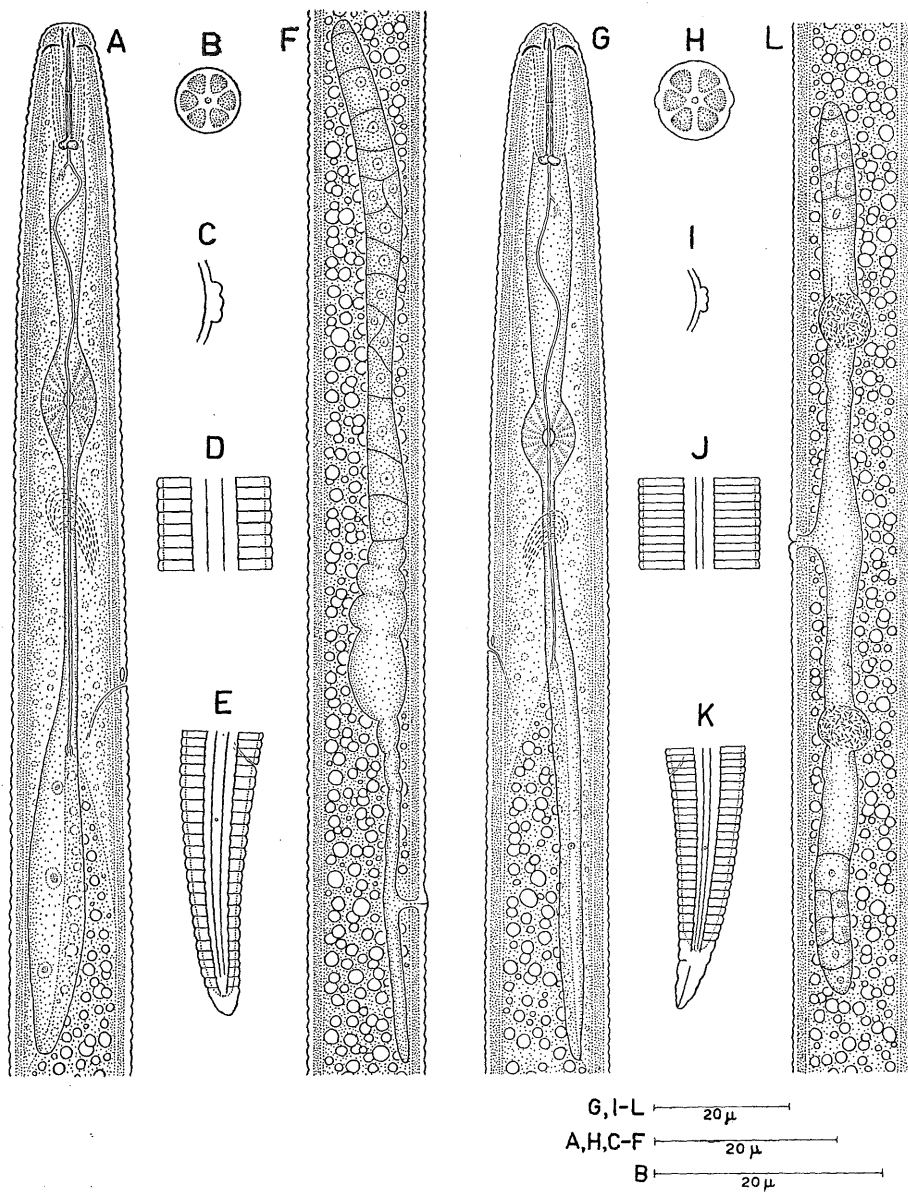


Fig. 10.—A-F, *Radopholoides laevis* n.sp. female: A, anterior end; B, *en face* view; C, transverse section of lateral field; D, lateral field; E, tail; F, mid-body. G-L, *Radopholus capitatus* n.sp. female: G, anterior end; H, *en face* view; I, transverse section of lateral field; J, lateral field; K, tail; L, mid-body.

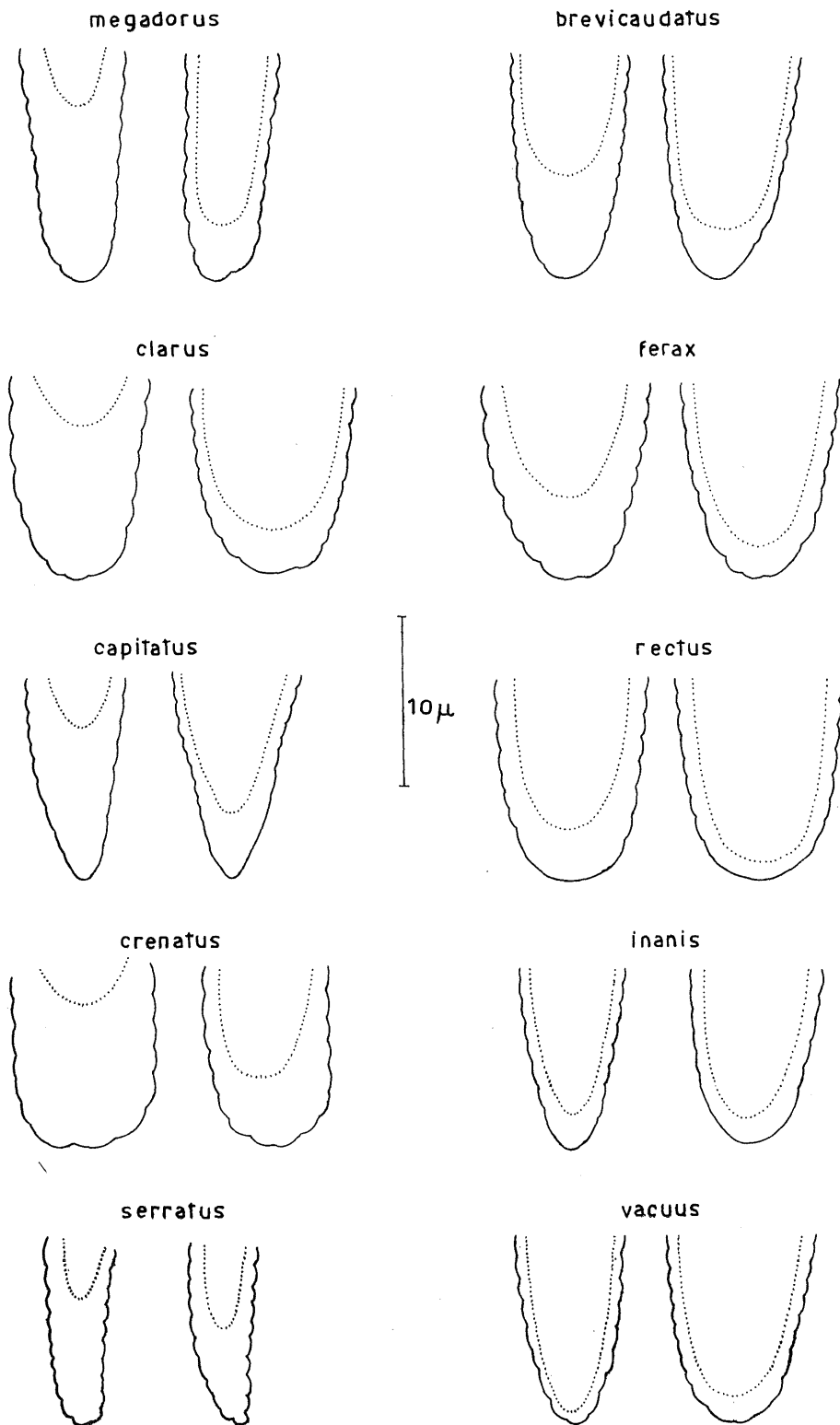


Fig. 11.—Tail termini of females and juveniles of *Radopholus* species described. In each pair the female is on the left.

Key to the Females of *Radopholus* Species

- |  |         |                                 |
|--|---------|---------------------------------|
| 1. Tail > 52 $\mu$   | .. .. . | 2                               |
| Tail < 52 $\mu$  | .. .. . | 3                               |
| 2. H = 2-4 $\mu$ ; tail about 54 $\mu$ long                                    | .. .. . | <i>nigeriensis</i> Sher         |
| H = 9-17 $\mu$ ; tail 65-70 $\mu$ long   | .. .. . | <i>similis</i> (Cobb)           |
| 3. Lateral fields with 3 incisures   | .. .. . | <i>trilineatus</i> Sher         |
| Lateral fields with 4 or more incisures  | .. .. . | 4                               |
| 4. Stylet knobs with pointed anterior projections usually of unequal size;     | .. .. . | <i>inaequalis</i> Sauer         |
| lateral fields with 5-7 incisures  | .. .. . |                                 |
| Stylet knobs symmetrical; lateral fields with 4-5 incisures                    | .. .. . | 5                               |
| 5. $b' < 3.1$  | .. .. . | 6                               |
| $b' > 3.1$   | .. .. . | 9                               |
| 6. H < 5 $\mu$   | .. .. . | <i>vacuus</i> n.sp. (34)        |
| H > 5 $\mu$  | .. .. . | 7                               |
| 7. Stylet 15-16 $\mu$  | .. .. . | <i>williamsi</i> Siddiqi        |
| Stylet 19-23 $\mu$   | .. .. . | 8                               |
| 8. Lip region with two distinct annules; posterior spermatheca reduced in size | .. .. . | <i>magniglans</i> Sher          |
| Lip region with indistinct annules, spermathecae subequal                      | .. .. . | <i>brevicaudatus</i> n.sp. (28) |
| 9. H < 5 $\mu$   | .. .. . | 10                              |
| H > 5 $\mu$  | .. .. . | 14                              |
| 10. Stylet < 13 $\mu$ ; posterior ovary and spermatheca much reduced           | .. .. . | <i>intermedius</i> n.sp. (27)   |
| Stylet > 13 $\mu$ ; posterior ovary and spermatheca slightly reduced           | .. .. . | 11                              |
| 11. Tail conoid, tapering to narrow, unstriated terminus; H = 1-3 $\mu$        | .. .. . | <i>inanis</i> n.sp. (32)        |
| Tail subcylindrical, terminus broadly rounded, striated; H = 2-5 $\mu$         | .. .. . | 12                              |
| 12. Sperms round   | .. .. . | <i>rectus</i> n.sp. (25)        |
| Sperms rod-like  | .. .. . | 13                              |
| 13. Striae around terminus coarse; stylet knobs with anterior points           | .. .. . | <i>ferax</i> n.sp. (30)         |
| Striae around terminus fine; stylet knobs rounded                              | .. .. . | <i>neosimilis</i> Sauer         |
| 14. Tail < 35 $\mu$  | .. .. . | 15                              |
| Tail > 35 $\mu$  | .. .. . | 16                              |
| 15. H = 5-10 $\mu$ ; stylet = 16 $\mu$ ; L < 470 $\mu$                         | .. .. . | <i>williamsi</i> Siddiqi        |
| H = 9-12 $\mu$ ; stylet = 19 $\mu$ ; L > 470 $\mu$                             | .. .. . | <i>capitatus</i> n.sp. (35)     |
| 16. EO = 65-71   | .. .. . | <i>clarus</i> n.sp. (33)        |
| EO = < 63  | .. .. . | 17                              |

17. Stylet knobs abnormally large, spherical; lip region small, set off, without transverse striations .. .. . *megadorus* n.sp. (31)  
 Stylet knobs not abnormally large .. .. . 18
18. L < 480  $\mu$ ; stylet = 13–16  $\mu$ ; tail tapering to narrow, coarsely striated terminus .. .. . *serratus* n.sp. (29)  
 L > 480  $\mu$ ; stylet = 16–20  $\mu$ ; tail subcylindrical, tapering to broad terminus 19
19. Tail > 2.3 st .. .. . *vertexplanus* Sher  
 Tail < 2.3 st .. .. . 20
20. Lateral fields with 5 or 6 incisures; sperms round .. .. . *rotundisemenus* Sher  
 Lateral fields with 4 incisures; sperms rod-shaped or absent .. .. . 21
21. Spermathecae without sperms .. .. . *nativus* Sher  
 Spermathecae with sperms .. .. . 22
22. Tail subcylindrical, sometimes clavate; lip region small, set off, with indistinct annulation .. .. . *crenatus* n.sp. (26)  
 Tail tapering to rounded, almost pointed terminus; lip region not set off, three annules .. .. . *vangundyi* Sher

#### Key to the Males of *Radopholus* Species

1. Tail > 60  $\mu$  .. .. . *similis* (Cobb)  
 Tail = 30–45  $\mu$  .. .. . 2
2. H < 5  $\mu$  .. .. . 3  
 H > 5  $\mu$  .. .. . 4
3. Lip region subspherical, set off by distinct constriction;  
 L = 470–660  $\mu$  .. .. . *inanis* n.sp.  
 Lip region squat, cylindrical, set off by slight depression; L < 450  $\mu$  *vacuus* n.sp.
4. Lip region narrow, oblate; amphids opening through irregular longitudinal clefts .. .. . *crenatus* n.sp.  
 Amphid apertures not irregular longitudinal clefts .. .. . 5
5. Sperms subspherical or short ellipsoidal .. .. . 6  
 Sperms rod-like .. .. . 7
6. Lip region broad, flattened, slightly set off .. .. . *rectus* n.sp.  
 Lip region high, rounded, widest at base, well set off .. .. . *serratus* n.sp.
7. L = 370–430  $\mu$  .. .. . *williamsi* Siddiqi  
 L > 430  $\mu$  .. .. . 8
8. Lip region set off by slight depression; stylet knobs well developed .. .. . *ferax* n.sp.  
 Lip region distinctly set off; stylet knobs absent or poorly developed .. .. . 9

9. Lip region very large, subspherical, set off by conspicuous constriction .. .. .	.. .. .	by conspicuous	<i>megadorus</i> n.sp.	
Lip region oblate or hemispherical, not abnormally large .. .. .	.. .. .			10
10. Lateral field with 5 or 6 incisures .. .. .	.. .. .		<i>inaequalis</i> Sauer	
Lateral field with 3 or 4 incisures .. .. .	.. .. .			11
11. Lip region high, flattened anteriorly .. .. .	.. .. .		<i>neosimilis</i> Sauer	
Lip region not flattened anteriorly .. .. .	.. .. .			12
12. Tail terminus broad .. .. .	.. .. .		<i>clarus</i> n.sp.	
Tail terminus narrow .. .. .	.. .. .		<i>vangundyi</i> Sher	

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