

Revision of the Genus *Paratylenchus* Micoletzky, 1922 and Descriptions of New Species. Part I of 3 parts.¹

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Abstract: A revision of part of the genus *Paratylenchus* is reported covering those species with stylets averaging $< 22 \mu\text{m}$. Thirteen new species are described and further observations are given on the morphology and relationships of nine other species. *Paratylenchus gabrici* is transferred to the genus *Hemicriconemoides*. This article is the first of three parts; the second will treat *Paratylenchus* spp. with stylets averaging $24\text{--}40 \mu\text{m}$ (and include a key to the species described in parts I and 2), the third will include species with stylets $> 40 \mu\text{m}$, respectively. **Key Word:** taxonomy.

The pin nematodes of the genus *Paratylenchus* Micoletzky, 1922 (11) now include 56 nominal species. This genus was reviewed first by Tarjan (16) who described two new species and proposed a key to the species. Tarjan proposed the withdrawal of *Tylenchus macrophallus* de Man, 1880 (9) from *Paratylenchus*, and the designation of it as *incertae sedis*.

Raski (12) proposed the genus *Gracilacus* to include those species of *Paratylenchus* with stylets longer than $48 \mu\text{m}$. Brzeski (3) and Siddiqi and Goodey (13) did not agree with this concept and synonymized *Gracilacus* with *Paratylenchus*. Geraert (4) accepted this

synonymy based in part on a collection of four females and one male from Colombia associated with the roots of oil-palm. Measurements and a detailed description were given as evidence of their intermediate position "between *Paratylenchus*, as defined by Raski (1962), and *Gracilacus* Raski (1962)". The specimens were not described as a new species because Geraert judged the numbers to be insufficient.

Geraert (4) reviewed the genus and recognized 34 species as valid, synonymized five species and placed *Paratylenchus macrophallus* de Man, 1880 (Goodey, 1934) in *species inquirendae*. Geraert concluded that there are few characters that can be used to distinguish species and emphasized stylet length in relation to total length, vulva position and (to a lesser degree) tail form, head form, and lateral field. He did not use males in the systematics, and divided the genus into ten groups based on stylet length and vulva position. Fifteen new species have been described since Geraert's review, including one by Wouts (19) who proposed another key to the species.

Solovyeva (14) published a comprehensive

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review of the genus including a new key to the species. Besides the basic characters used by other authors, the key by Solovyeva included differences in width of cuticular rings, length of female gonad (in relation to length of esophagus), distance from dorsal gland orifice to stylet knobs, position of excretory pore in relation to esophagus, and number of annules on the head.

In contrast with Geraert's conclusions, the present study indicates that total length is a reliable character for distinguishing species. I have placed more emphasis on stylet length (not necessarily in relation to total length), on tail shape, head shape, and number of lines in the lateral field. The presence or absence of males, length of males, degree of development or absence of male stylet, and variations in their tail shape have proven to be very useful characters.

This study, based on specimens collected in many areas of the world mounted on more than 1,800 slides, has been divided into three parts to organize the material into more manageable increments. The first part presented here deals with all the nominal species bearing stylets averaging $< 22 \mu\text{m}$ in length except *P. nawadus* which will be reviewed in Part II. The second part, now in preparation, will cover species with stylets averaging $24\text{--}49 \mu\text{m}$ in length and will include a key to all species covered in Parts I and II. Part III will cover species with stylets longer than $40 \mu\text{m}$.

Paratylenchus humilis n. sp.

(Fig. 1-4)

Paratypes (6 females): L = .18 mm (.17 - .19); a = 18 (16-20); b = 3.4 (3.2 - 3.5); c = 17 (15-18); V = $^{40}_{(25-51)}$ 83 (81-84); stylet = 18 μm (16-19); prorrhaddon = 12 μm (11-13); excretory pore = 47 μm (43-50).

Paratypes (14 males): L = .20 mm (.18 - .21); a = 24 (21-28); c = 26 (20-30); T = 34 (29-37); excretory pore = 48 μm (41-54); spicules = 13 μm (12-14); gubernaculum = 2.4 μm (2-3).

Holotype (female): L = .17 mm; a = 19; b = 3.2; c = 17; V = $^{31}_{83}$; stylet = 18 μm ; prorrhaddon = 12 μm ; excretory pore = 45 μm . Body curved ventrally in an open 'C' shape when in fixative. Head not set off, tapering with sloping sides to truncate anterior end; tiny lips protrude slightly to give rounded corners to truncate surface. Stylet

slender with backward-directed knobs. Dorsal gland orifice about 3 μm posterior to stylet knobs. Excretory pore at same level as hemizonid at anterior end of posterior bulb. Esophago-intestinal valve rounded. Ovary outstretched, spermatheca large, rounded, filled with spermatozoa. Vagina with posterior rounded protuberance resembling a small post-uterine branch. Vulvar flap prominent, rounded. Tail conoid, narrows gradually, then more abruptly near terminus to give a slight digitate appearance with a rounded, almost acute, tip. Body annules average about 1 μm wide. Lateral field with three lines, the inner one very faint, outer two more prominent.

Allotype (male): L = .20 mm; a = 28; c = 20; T = 37; excretory pore = 50 μm ; spicules = 14 μm ; gubernaculum = 3 μm . Body slightly ventrally curved. Head not set off, narrows with sloping sides to rounded margins and truncate anterior surface, sclerotization very light. Stylet absent, esophagus degenerate. Excretory pore at same level as hemizonid. Testis outstretched, spicules only slightly curved; anal sheath protrudes distinctly with slight projection at posterior edge. Tail narrows abruptly posterior to cloaca, curves almost 90 degrees ventrad, then narrows again abruptly near tip (as in the female) to a very fine, rounded, almost acute, terminus. Body annules average about 1 μm wide. Lateral field with three lines, as in female.

Holotype: Female, collected in 1973 by R. D. Sharma, slide number 1343, University of California Nematode Survey Collection, Davis, California.

Allotype: Male, same data and slide number as holotype, University of California Nematode Survey Collection, Davis, California.

Paratypes: 5 females, 13 males, same data as holotype, deposited as follows: 8 males University of California Nematode Survey Collection, Davis, California; 1 female, 1 male at each of the following: University of California Nematode Survey Collection, Riverside, California; United States Department of Agriculture Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: *Theobroma cacao*.

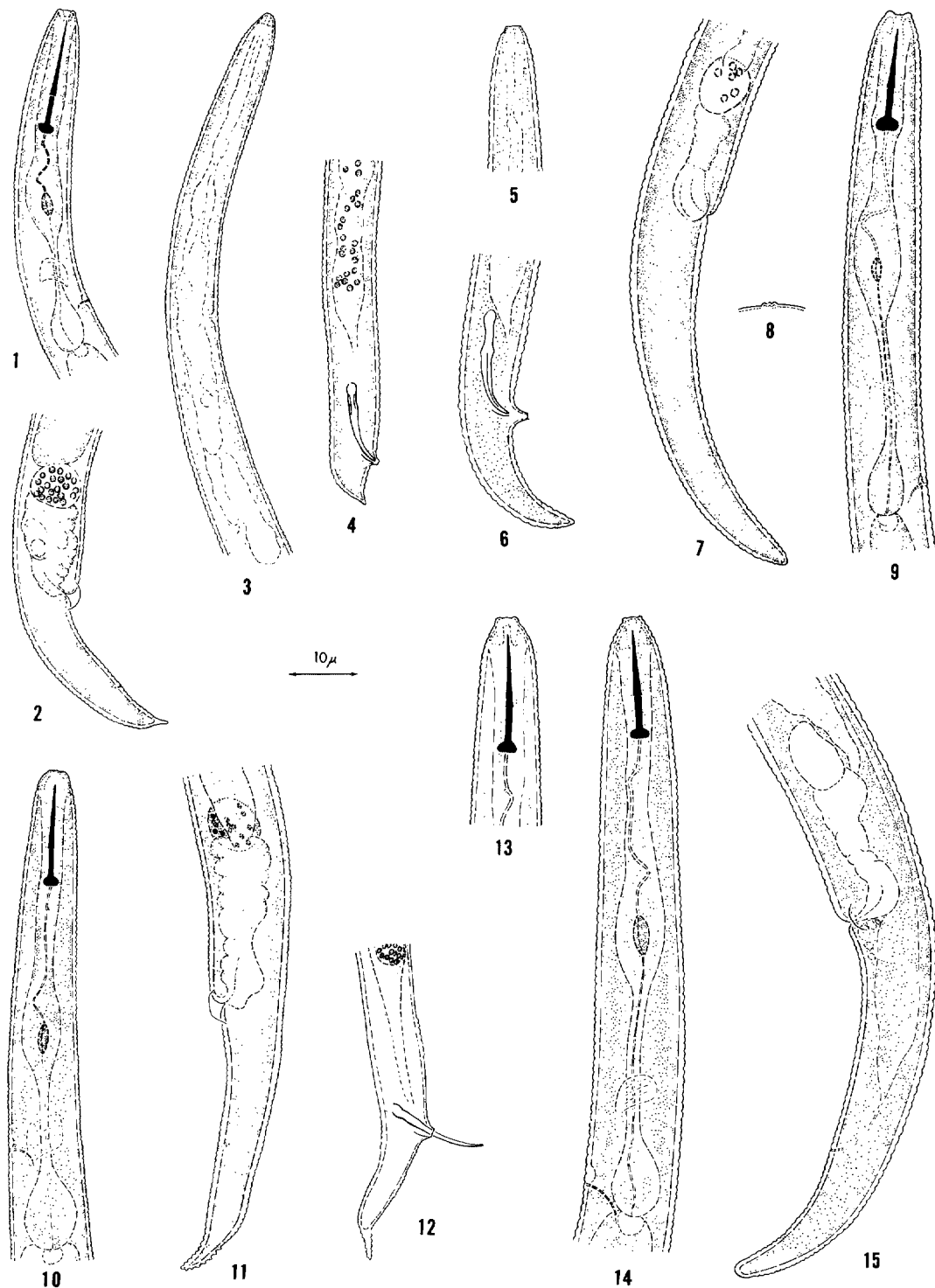


FIG. 1-15. 1-4, *Paratylenchus humilis* n. sp.; 5-9, *Paratylenchus colbrani* n. sp.; 10-12, *Paratylenchus serricaudatus* n. sp.; 13, *Paratylenchus tateae*; 14-15, *Paratylenchus similis*.

Type locality: Pousa Alegre, Porto Seguro, Brazil.

Diagnosis: This species is most closely related to *P. aquaticus* (10) from which it differs in its smaller size [.34 mm (.27-.37) vs. .18 mm (.17-.19)].

Additional collection: 11 females: L = .20 mm (.17-.21); a = 20 (17-23); b = 3.4 (3.1-3.6); c = 17 (15-20); V = ³⁷ (27-44) 83 (82-84); stylet = 18 μ m (15-20); prorhabdion = 13 μ m (10-14); excretory pore = 48 μ m (44-53). These specimens were collected from soil about *T. cacao* near Fax. Pirangi-Prado, Brazil also by R. D. Sharma in 1973. The females conform very closely with the type specimens and slightly extend the range of some characters. Males were not found in this collection.

Paratylenchus tateae Wu & Townshend, 1973

(Fig. 13)

Specimens of *P. tateae* (38 females and 19 juveniles) were found in nine collections from soil samples taken by J. R. Willard working on the International Biological Program Project Matador in Saskatchewan, Canada. These had been sent to S. A. Sher, University of California, Riverside, who forwarded them to University of California, Davis, for identification. Part of the samples had been taken from irrigated grassland, others from natural, nonirrigated grassland.

These specimens are easily identified as *P. tateae* by their small stylet, total length, forward position of the vulva, and distinctly protruding lip region. The following data taken from the above specimens slightly extends the range of the characters of the species.

19 Females: L = .38 mm (.33-.43); a = 27 (19-36); b = 4.1 (3.8-4.4); c = 11 (10-13); V = 80 (78-82); stylet = 17 μ m (17-19); excretory pore = 75 μ m (67-81). In some specimens the spermatheca is quite prominent, elongate and oval in shape, and filled with large refractive spermatozoa. In other specimens, no spermatozoa were seen.

The samples also contained 2 females and 3 males of *Gracilacus aculeatus* and 11 females of a *Paratylenchus* sp. with a stylet about 30 μ m long. A single male was also found which is judged to belong to the latter species because the head region is similar to it and distinct from that of *P. tateae*.

The juveniles of *P. tateae* appear to be

fourth-stage, some of which have a very reduced stylet, 10-12 μ m long. In other specimens, the stylet could not be distinguished. At least two juvenile specimens are judged to be males because the gonad is developing near the tail and the esophagus is more vestigial than in the other juveniles. Both male and female juveniles have head regions with a protruding lip area similar in outline to the adult females. It is concluded that the males would probably have a similar head structure and represent further evidence in support of the conclusion that the single male above belongs to the species with the larger stylet. The presence of male juveniles and females with spermathecae full of spermatozoa indicates males exist in these populations. Additional collections at different times in the year should eventually reveal the presence of males.

Paratylenchus similis Khan,
Prasad and Mathur, 1967

(Fig. 14-15)

A single slide with 2 females and 2 juveniles was available for study on loan from the National Nematode Collection at IARI, New Delhi.

Paratypes (2 females): L = .37-.39 mm; a = 28-30; b = 4.2-4.5; c = 15; V = 84; stylet = 16 μ m; prorhabdion = 10-11 μ m; excretory pore = 79-80 μ m. Both specimens have rounded heads that narrow abruptly at the anterior end with small, round, definitely projecting lips. The head is truncate at anterior surface. These lips are narrower and project forward more than indicated by the illustrations in the original description. The stylet measured 16 μ m in both specimens—longer than the 11-12 μ m as described. The dorsal gland orifice is 3-4 μ m from stylet knobs. Presence of a post-uterine branch is doubtful in these specimens; none could be seen with certainty. Body and tail shape are similar to the original illustrations and the tail has a bluntly rounded terminus. The lateral field is very obscure but four incisures were present on one specimen. Other measurements extend the range of those given in the original description.

Paratypes (two juveniles): L = .30-.35 mm; a = 24-28; b = 4.0-4.6; stylet = 13 μ m (not discernible in the larger juvenile); prorhabdion = 9 μ m; excretory pore = 70-72 μ m. The condition of the juveniles after fixing

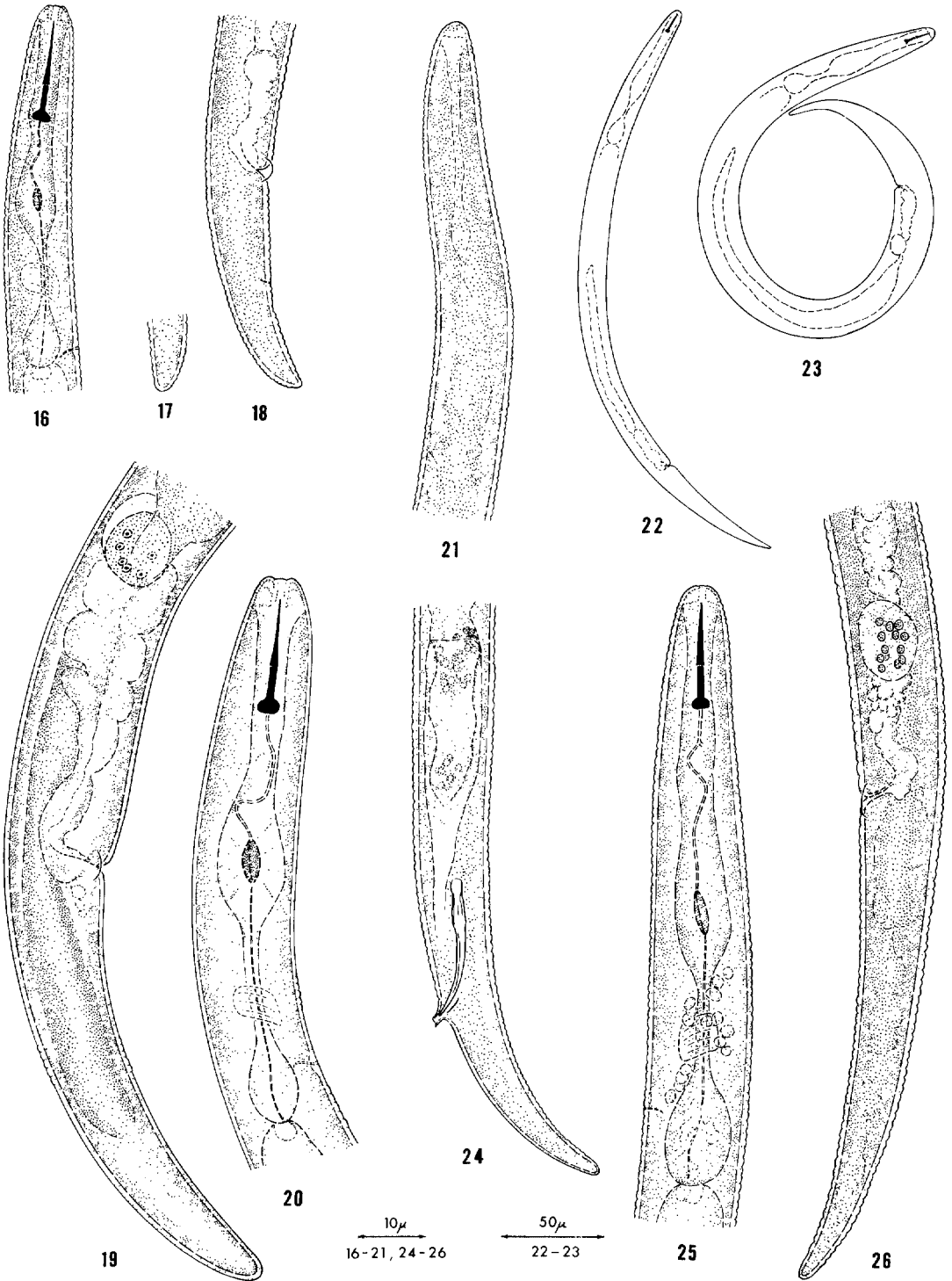


FIG. 16-26. 16-18. *Paratylenchus breviculus* n. sp.; 19-20. *Paratylenchus leiodermis* n. sp.; 21-26. *Paratylenchus goldeni* n. sp.

and preserving is not as good as the adult females and the head structure of the juveniles is not clear. They have slightly protruding lips similar to the adults, but not protruding as far. The tail narrows gradually to a bluntly rounded terminus.

Additional collection: 3 females (Israel): L = .36 mm (.35 - .37); a = 24 (23-25); b = 4.0 (3.9 - 4.0); c = 14 (14-16); V = ³⁶ (32-43) 83 (82-83); stylet = 16 μ m (16-17); prorhabdion = 10 μ m (9-10); excretory pore = 82 μ m (78-88). The above amendments to the description of *P. similis* make the identity of these specimens quite clearly the same as the Indian collection. These specimens have been beautifully fixed and preserved, and show some characters more clearly. The annules are more prominent on the head region; the lateral field has four equally spaced incisures. The ovary of one specimen has a small flexure about 11 μ m long at the anterior end, vagina with a rounded protuberance consisting of two or three lobes on dorso-posteriad side, but apparently not a true post-uterine branch. Spermatheca a small ovate protuberance at right latero-ventral side but without spermatozoa.

Four juveniles - third stage? (Israel): L = .32 mm (.31 - .33); a = 24 (22-30); b = 3.9 (3.6 - 4.2); stylet = 15 μ m (14-16); prorhabdion = 8 μ m (7-10); excretory pore = 77 μ m (68-74); gonad = 37 μ m (31-46). Lip region similar to female with distinctly protruding lips near oral aperture; tail with more bluntly-rounded terminus than adult females.

These specimens from Israel were collected in 1971 by M. Mordechai from soil about apple near Tzuba.

Diagnosis: The protruding lip region of *P. similis* indicates a relationship with *P. tateae*, from which it differs by its smaller size [.33 mm (.28 - .39) for *similis* vs. .32 - .40 mm in the original description and .38 mm (.33 - .43) in the Matador collection referred to earlier]; by the more posterior vulva [84 (83-84) vs. 81-84 in type description of *tateae* 80 (78-83) in the Matador collection]; and more blunt rounded tail of *similis* (tail of *tateae* is more variable, slender, conoid, some even with an acute terminus).

Paratylenchus leiodermis n. sp.

(Fig. 19-20)

Paratypes (19 females): L = .38 mm (.34 - .42); a = 22 (19-25); b = 4.7 (4.2 - 5.8); c = 18

(15-20); V = ⁵⁷ (48-67) 82 (80-84); stylet = 17 μ m (16-19), prorhabdion = 10 μ m (9-12); excretory pore = 78 μ m (70-84).

Holotype (female): L = .40 mm; a = 22; b = 5.0; c = 17; V = ⁵⁰ 82; stylet = 18 μ m; prorhabdion = 11 μ m; excretory pore = 82 μ m. Head bluntly rounded, almost hemispherical, with a slight depression at the oral aperture. Stylet moderately developed, knobs backwardly directed (in some paratypes, knobs appear to be squared off). Dorsal gland orifice 5 μ m behind stylet knobs. Excretory pore slightly posterior to end of esophagus (in paratypes the position varies up to midregion of posterior bulb). Hemizonid at same level as excretory pore. Esophago-intestinal valve indistinct (more distinct in some paratypes). Ovary outstretched; spermatheca rounded and filled with small spermatozoa, latero-ventrad at right side, on anterior end of uterus. Vulvar flap small, inconspicuous. Tail tapering uniformly to a bluntly rounded, almost hemispherical, terminus. Body annules average about 1.0 - 1.3 μ m wide, but are inconspicuous resulting in a smooth appearance to cuticle. Lateral field not seen in totemounts or cross section.

Male: Unknown.

Holotype: Female, collected 7 December 1951 by G. Thorne, slide number 1328, UCNS Collection, Davis, California.

Paratypes: 18 females, same data as holotype, deposited as follows: 8 females UCNS Collection, Davis, California; 2 females each at the following: UCNS Collection, Riverside, California; USDA Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: Sugarcane.

Type locality: Paleson, Indonesia.

Diagnosis: This species is most closely related to *P. microdorus* but differs from it and all other species by its bluntly rounded head and tail and the indistinct annules which give a smooth appearance to the cuticle.

Paratylenchus serricaudatus n. sp.

(Fig. 10-12)

Paratypes (30 females): L = .24 mm (.21 - .26); a = 21 (16-27); b = 3.4 (3.1 - 3.9); c = 14

(11-18); $V = {}^{37(27-50)} 84$ (82-86); stylet = 16 μm (15-18); prorhabdion = 10 μm (9-10); excretory pore = 58 μm (48-64).

Paratypes (13 males): $L = .24$ mm (.24-.26); $a = 32$ (30-35); $b = 4.6$; $c = 13$ (12-14); spicules = 16 μm (14-17); gubernaculum = 3 μm (2-4); $T = 32$ (20-37); excretory pore = 58 μm (54-63).

Holotype (female): $L = .23$ mm; $a = 19$; $b = 3.2$; $c = 18$; $V = {}^{48} 85$; stylet = 16 μm ; prorhabdion = 10 μm ; excretory pore = 58 μm . Body narrows in anterior region, more so on the head which is not set off. Tiny rounded lips at margins of truncate anterior terminus. Body annules appear to continue onto head, but are too fine to resolve with certainty. Sclerotization of head light. Knobs of stylet directed backward. Isthmus slender about 13 μm long with moderate sized posterior bulb. Hemizonid slightly anterior to excretory pore which is just anterior to posterior bulb. Ovary outstretched with prominent round spermatheca on right-ventral side. Vulvar flap prominent. Body annules about 1 μm wide. Lateral field with four lines; the inner two are very indistinct, even in cross section. Tail ventrally arcuate, conoid until body contents end, then tail narrows abruptly and annules appear as fine dark rings giving a serrate appearance in outline; serrations continue to terminus which is finely rounded (paratypes similar or with acute tip).

Allotype (male): $L = .24$ mm; $a = 31$; $b = 4.6$; $c = 13$; spicules = 15 μm ; gubernaculum = 3 μm ; $T = 30$; excretory pore = 54 μm . Body narrows at anterior end to rounded head truncate at terminus; sclerotization very light. Hemizonid anterior to excretory pore which is slightly posterior to end of degenerate esophagus. Lateral field not observed. Body annules very fine, difficult to resolve on most of body. Tail narrows abruptly after cloacal opening and bends sharply ventrad to the last six or seven annules which have a serrate appearance similar to females. Terminus acute or very finely rounded.

Holotype (female): Collected 20 April 1960 by R. H. Sciaroni, slide number 1329, UCNS Collection, Davis, California.

Allotype: Male, same data as holotype, slide number 1330, UCNS Collection, Davis, California.

Paratypes: 30 females, 13 males, 3 juveniles, same data as holotype deposited as follows: 18 females, 7 males, 3 juveniles, UCNS Collection, Davis, California; 7 females, 1

male UCNS Collection, Riverside, California; 1 female, 1 male each at the following: USDA Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: *Camellia japonica*.

Type locality: Half Moon Bay, San Mateo County, California.

Diagnosis: This species is most closely related to *P. minutus* and *P. breviculus* and differs from both in the serrate end of tail in both males and females.

Paratylenchus goldeni n. sp.

(Fig. 21-26)

Paratypes (24 females): $L = .38$ mm (.35-.43); $a = 27$ (19-33); $b = 4.2$ (3.9-5.0); $c = ?$; $V = {}^{34(30-42)} 80$ (78-81); stylet = 17 μm (14-19); prorhabdion = 11 μm (10-11); excretory pore = 77 μm (67-83).

Paratypes (7 males): $L = .33$ mm (.30-.38); $a = 29$ (27-29); $b = 5.4$; $c = 9$ (8-10); spicules = 22 μm (21-23); gubernaculum = 4 μm (3-5); $T = 32$ (29-36); excretory pore = 63 μm (54-66).

Holotype (female): $L = .40$ mm; $a = 30$; $b = 4.3$; $V = {}^{35} 80$; stylet = 17 μm ; prorhabdion = 11 μm ; excretory pore = 83 μm . Body slightly curved ventrad on fixation (paratypes mostly the same, except for five females which curved almost to a closed 'C' shape when in fixative). Body narrows gradually at anterior end to a bluntly rounded almost hemispherical outline. Stylet knobs indistinct but appear to be backwardly directed. Dorsal gland orifice 5 μm from knobs of stylet. Median bulb very elongate and swells gradually from anterior end, not set off. Posterior bulb strongly rounded; esophago-intestinal valve present. Excretory pore at about midlevel of posterior bulb. Hemizonid occupies about three body annules immediately anterior to excretory pore. Ovary outstretched, spermatheca an ovate protrusion of anterior end of uterus, on left latero-ventral side, devoid of spermatozoa (in some paratypes spermatheca filled with large round spermatozoa). Vulvar flap distinct, low rounded. Vagina has a prominent rounded swelling on dorso-posterior side, but no definite post-uterine branch. Tail long, slender with rounded terminus. Lateral field with four lines equally

spaced about 1 μm apart, the inner two less strongly set off than the outer two. Body annules coarse averaging 1.3 - 1.6 μm .

Allotype (male): L = .33 mm; a = 27; b = 5.4; c = 9; spicules = 21 μm ; gubernaculum = 4 μm ; T = 30; excretory pore = 55 μm . Body tapers to a narrow head bluntly rounded in outline; body annules in cephalic region indistinct. Spear lacking; esophagus degenerate, but distinct. Excretory pore at midlevel of posterior bulb; testis outstretched, with large round refractive spermatozoa; posterior part of testis surrounded by well-developed testicular gland; anal sheath protrudes prominently with projecting posterior hook-like process. Tail narrows behind cloacal opening then slender in outline, curving slightly dorsad. Annules extending almost to terminus which is finely rounded. Average width of annules 1.2 - 1.5 μm . Lateral field indistinct.

Holotype: Female, collected 20 June 1960, collector unknown, on slide number 1340, UCNS Collection, Davis, California.

Allotype: Male, same data as holotype, on slide number 1341, UCNS, Davis, California.

Paratypes: 23 females, 6 males, 2 juveniles same data as holotype deposited as follows: 17 females, 2 males, 2 juveniles, UCNS Collection, Davis, California; 1 female, 1 male each at: USDA Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England; 2 females UCNS Collection, Riverside, California.

Type host: Boxwood, *Buxus* sp.

Type locality: Salemburg, North Carolina.

Diagnosis: This species is most closely related to *P. microdorus* and *P. pesticus*. It differs in the rounded head as contrasted with the sloping sides and truncate appearance of both the other species. The tail of *P. goldeni* is straighter and more slender than the conoid shaped tail of *microdorus* and more finely rounded than the tail of *pesticus*.

Additional collection: 9 females (Tifton, Georgia): L = .45 mm (.39 - .50); a = 21 (15-23); b = 4.5 (3.8 - 4.8); c = 11; V = 79 (76-81); stylet = 18 μm (17-19); prorhabdion = 11 μm (10-14); excretory pore = 87 μm (77-98).

1 Male: L = .32 mm; a = ?; b = 4.6; c = 13; T = 35; spicules = 23 μm ; gubernaculum = 4 μm ; excretory pore = 70 μm .

These are fully developed, swollen females and the single male had just molted but had not shed its last cuticle. Except for the larger size, these closely resemble the Salemburg specimens.

The species is named in honor of A. M. Golden who has published many studies on *Paratylenchus*, and who sent the Tifton collection and other material for this review.

Paratylenchus pesticus

Thorne and Malek, 1968

A single slide identified as *Paratylenchus* I from the Nematode Collection at Brookings, South Dakota, was made available by Prof. G. Thorne for study. This slide was designated in the original description as containing the holotype and other specimens. There were four females on the slide which were too close to the ring for study and were remounted, two females on each of two slides. These have been returned to Brookings for redesignation of a holotype and deposition there. Measurements of these specimens are as follows:

4 Females: L = .44 mm (.41 - .48); a = 25 (23-29); b = 4.8 (4.4 - 5.0); V = 80 (79-81); stylet = 19 μm (18-20); prorhabdion = 11 μm (11-12); excretory pore = 83 μm (74-87). Head region with sloping sides and flattened anterior surface, almost truncate. Rounded lips at margins of truncate surface. Tail long and slender, tapering slightly to a bluntly conoid, rounded or almost truncate terminus. Vulvar flap small, rounded as illustrated, but one or two specimens had more broadly rounded flap.

Paratylenchus besoekianus

Bally & Reydon, 1931

Perhaps the best decision to take for *P. besoekianus* would be to place it in *species inquirendae* because original type material does not exist, topotypes have not yet been found and the original description is inadequate considering our present knowledge of the genus. However, it was finally decided to leave its status unchanged since the authors suggested a weak stylet was present in the male and a postuterine branch present in the female. Accepting these characters *besoekianus* keys to *P. veruculatus* from which it appears to differ by its longer stylet. The data in the de Manian formula given by the authors of *besoekianus* report

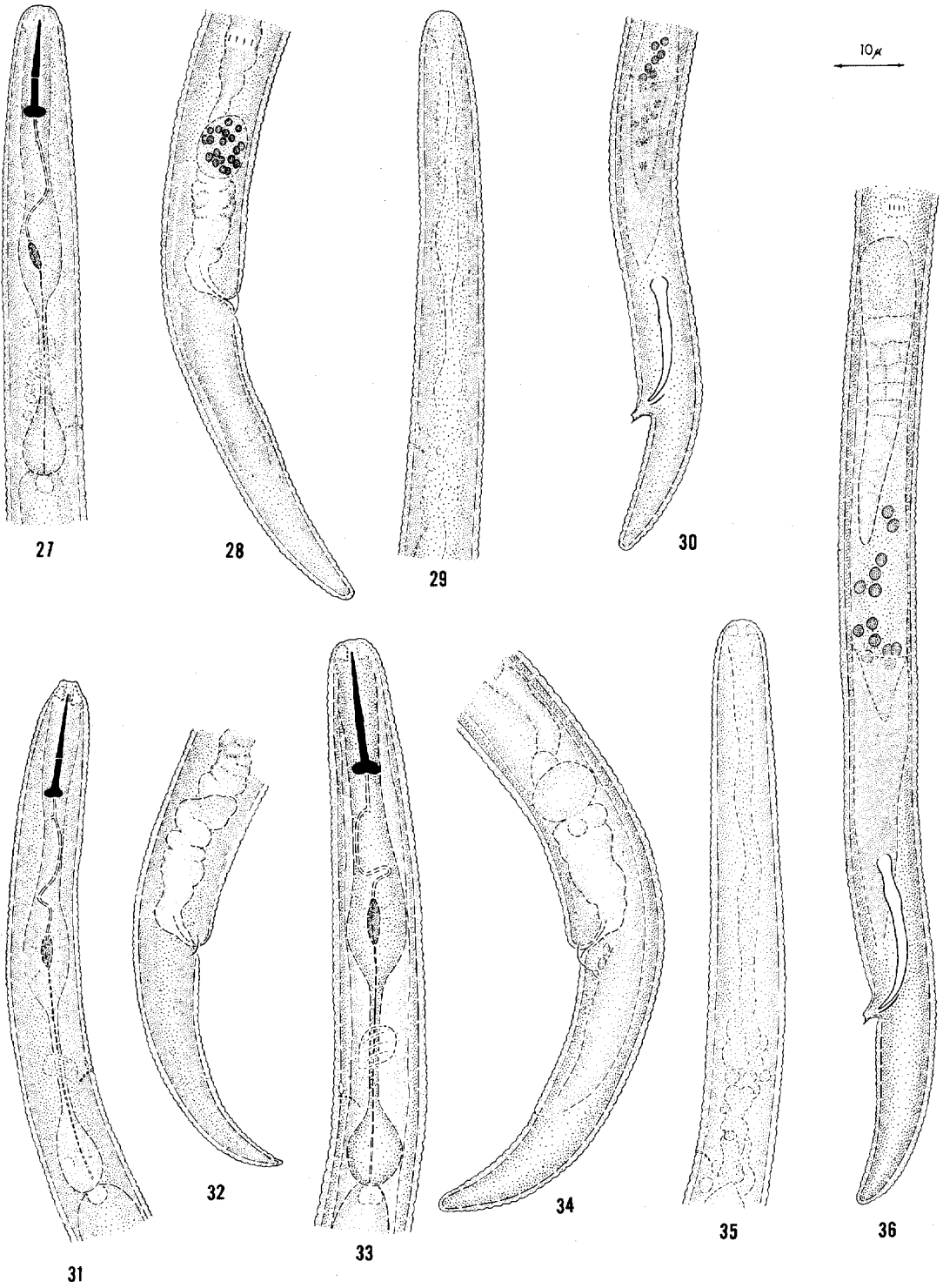


FIG. 27-36. 27-30. *Paratylenchus variabilis* n. sp.; 31-32. *Paratylenchus italiensis* n. sp.; 33-36. *Paratylenchus alleni* n. sp.

7.5% from anterior end of the body to the posterior end of the stylet. With a total length of .254 mm that would give a measurement of 18.8 μm . Subtracting the distance from the anterior end of the body to beginning of the stylet (probably averages about 2 μm) would make the stylet about 17 μm in length.

Paratylenchus veruculatus Wu, 1962

Three slides of paratypes were available for study. Two slides were from the Canadian National Collection of Nematodes and contained four females and two males respectively. One slide (T-942p) with five females was loaned from the USDA Nematode Collection.

These paratype females have the rounded head with somewhat truncate anterior end as described, sometimes with a slight depression in the oral region. Body annules are coarse and the tail variable, acute to finely rounded and some curved sharply ventrad near the terminus. The position of the vulva in these type specimens was 82 (81-84) with a stylet-length of 14 μm (12-14).

Another collection of five females and two males was available from a collection taken on the St. Andrews Golf Course in Scotland. The specimens have measurements within the range above; males have weak stylets and females prominent spermathecae. The vulva is 82 (80-85).

A single female sent by De Grisse from Belgium has the following measurements: L = .27 mm; a = 20; b = 3.6; V = 81; stylet = 14 μm ; excretory pore = 60 μm . The head is more bluntly rounded, annules finer, and the spermatheca empty and not as prominent as in the types. The tail is conoid, strongly curved ventrally with rounded terminus. More specimens are needed to be certain of this identification especially to determine the average position of vulva, stylet length, and variation in tail shape.

Paratylenchus breviculus n. sp.

(Fig. 16-18)

Paratypes (8 females): L = .21 mm (.19 - .23); a = 20 (19-23); b = 3.8 (3.4 - 4.2); c = 15 (13-18); V = 85 (84-86); stylet = 16 μm (15-17); prorhabdion = 10 μm (9-10); excretory pore = 50 μm (47-53).

Holotype (female): L = .20 mm; a = 20; b =

3.4; c = 15; V = 85; stylet = 16 μm ; prorhabdion = 9 μm ; excretory pore = 48 μm . Body narrows in anterior region more so on the head, which is not set off. Tiny rounded lips at margins of truncate lip region. Body annules appear to continue onto head but are too fine to resolve with certainty. Sclerotization of head light. Stylet knobs squared off or slightly anteriorly directed. Dorsal gland orifice about 3 μm posterior to knobs. Isthmus slender 13 μm (11-14) long with small posterior bulb. Hemizonid immediately anterior to excretory pore at anterior end of posterior bulb. Distinct, rounded esophago-intestinal valve. Ovary outstretched with small round spermatheca filled with small round spermatozoa. Vulvar flap prominent. Body annules average 1.0 - 1.3 μm wide. Lateral field with four lines each about equally distinct. Tail slightly arcuate ventrad, narrows evenly to bluntly rounded terminus. Annules evident almost to tip which is set off with slight indents at end of annulations.

Male: Unknown.

Holotype: Female, collected 12 July 1968 by S. A. Sher, slide number 1339, UCNS Collection, Davis, California.

Paratypes: 7 females same data as holotype deposited as follows: 2 females UCNS Collection, Davis, California; and 1 female each at USDA Nematode Collection, Beltsville, Maryland; Nematology Department, Rothamsted Experimental Station, Harpenden, England; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; UCNS Collection Riverside, California.

Type host: Soil about the roots of rambutan, *Nephelium lappaceum*.

Type locality: Mae Jo Agricultural Experiment Station, Chiangmai, Thailand.

Diagnosis: This species is most closely related to *P. minutus* from which it is distinguished by its shorter tail (V = 85 vs. 82-83) and blunt, round shape of tail.

Paratylenchus alleni n. sp.

(Fig. 33-36)

Paratypes (37 females): L = .37 mm (.30 - .45); a = 23 (20-27); b = 4.3 (3.6 - 4.5); c = 17 (13-21); V = ^{47 (30-64)} 85 (82-86); stylet = 18 μm (16-20); prorhabdion = 11 μm (9-12);

excretory pore = 77 μ m (66-91).

Holotype (female): L = .36 mm; a = 24; b = 4.1; c = 17; V = ⁴²85; stylet = 18 μ m; prorhabdion = 11 μ m; excretory pore = 74 μ m. Body curves ventrally, more so at posterior end, to an open 'C' position when in fixative; narrows only slightly at anterior end with rounded, hemispherical outline. Small, rounded lips give a slightly truncate surface around oral aperture. Four distinct annules on head. Stylet stout, knobs backwardly directed. Dorsal gland orifice 6 μ m (5-7 in paratypes) from knobs. Hemizonid at same level as (slightly anterior in paratypes) excretory pore at anterior end of posterior bulb [more posterior (as far as esophago-intestinal valve) in paratypes]. Esophago-intestinal valve prominent, rounded. Deirids present. Ovary outstretched (occasional paratype has small flexure at anterior end of ovary). Spermatheca prominent, rounded, at left latero-ventral side, devoid of spermatozoa. Vulvar flap prominent, rounded. Tail conoid, narrows gradually to bluntly rounded terminus. Body annules coarse, averaging 1.1 - 1.3 μ m wide (0.9 - 1.7 μ m in other paratypes) extending almost to end of tail, terminus smooth. Lateral field with four lines about 1 μ m apart, outer two slightly more distinct than the inner two.

Allotype (male): L = .40 mm; a = 34; c = 13; T = 29; excretory pore = 79 μ m; spicules = 26 μ m; gubernaculum = 4 μ m. Body almost straight, only slightly curved ventrad in anterior half. Head end similar to female, bluntly rounded. Body annules clearly evident up to base of head, but lacking or very fine on head. Sclerotization light. Hemizonid one annule anterior to excretory pore. Testis about 45 μ m long with a single flexure near anterior end. Testicular gland large and prominent. Anal sheath prominent. Tail narrows markedly immediately posterior to cloacal opening and is then nearly cylindrical having a tubular appearance. Body annules coarse, averaging 0.9 - 1.1 μ m wide and ending just short of smooth blunt rounded terminus. Lateral field with four lines, the inner two indistinct.

Holotype: Female, collected by A. H. Bell 28 March 1970, slide number 1331, UCNS Collection, Davis, California.

Allotype: Male, same data as holotype, slide number 1332, UCNS Collection, Davis, California.

Paratypes: 119 females, 3 juveniles same

data as holotype, deposited as follows: 104 females, 3 juveniles, UCNS Collection, Davis, California; 3 females each at the following: UCNS Collection, Riverside, California; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England; USDA Nematode Collection, Beltsville, Maryland; and Plantenziektenkundige Dienst, Wageningen, The Netherlands.

Type host: Shadscale, *Atriplex confertifolia*.

Type locality: Richfield, Utah.

Diagnosis: This species is most closely related to *P. variabilis* from which it differs in its greater length [.36 mm (.30 - .45) vs. .29 mm (.25 - .34)]; longer stylet [18 μ m (16-20) vs. 14 μ m (13-16)]; and more broadly rounded head.

Additional collections: 24 females (Cactus; Richfield, Utah): L = .39 mm (.35 - .44); a = 25 (22-30); b = 4.5 (4.0 - 4.9); c = 16 (13-19); V = 85 (83-86); stylet = 19 μ m (17-20); prorhabdion = 11 μ m (10-12); excretory pore = 82 μ m (74-92).

12 Females (Willow; St. George, Utah): L = .37 mm (.31 - .41); a = 26 (23-28); b = 4.4 (3.7 - 4.7); c = 15 (12-17); V = 84 (83-86); stylet = 19 μ m (16-22); prorhabdion = 11 μ m (9-14); excretory pore = 80 μ m (68-91).

Paratylenchus vexans
Thorne & Malek, 1968

Two slides from the Nematode Collection at Brookings, South Dakota, were available for study. One slide labelled *Paratylenchus* 6a from Glendive, Montana, had three females with a legend indicating one as holotype. The other slide labelled *Paratylenchus* 6c from Parker, South Dakota had five females. The allotype male was not available for this study. Measurements of the above two collections were as follows:

	3 females (Montana)	5 females (South Dakota)
L. (mm)	= .30 (.29 - .32)	.37 (.36 - .38)
a	= 22 (21-24)	25 (24-26)
b	= 3.9 (3.7 - 4.1)	4.0 (3.8 - 4.1)
V	= 85 (84-86)	86 (85-87)
stylet (μ m)	= 15 (15-16)	17 (17-18)
excretory pore (μ m)	= 71 (66-75)	75 (75-76)

In both collections the head was rounded or with slightly conoid sloping sides with a truncate anterior end. Also the tail was distinctly arcuate ventrally with rounded

terminus more blunt in the South Dakota specimens than in the Montana females.

Paratylenchus colbrani n. sp.

(Fig. 5-9)

Paratypes (16 females): L = .30 mm (.28 - .33); a = 24 (19-26); b = 4.1 (3.7 - 5.4); c = 13 (11-16); V = ³⁷(²³⁻⁶⁷) 81 (79-82); stylet = 16 μ m (15-18); prorhabdion = 9 μ m (8-10); excretory pore = 69 μ m (63-79).

Paratypes (4 males): L = .29 mm (.25 - .32); a = 30 (29-34); b = 5.0; c = 14 (12-15); T = 29 (26-32); excretory pore = 66 μ m (62-67); spicules = 18 μ m (16-20); gubernaculum = 3 μ m (3-4).

Holotype (female): L = .30 mm; a = 24; b = 4.0; c = 15; V = 81; stylet = 15 μ m; prorhabdion = 9 μ m; excretory pore = 71 μ m. Head with very fine annules; narrowing with conoid sides to truncate anterior end. Dorsal and ventral lips distinctly rounded; lateral lips appear smaller giving a slight depression in outline at oral aperture. Stylet with stout prominent knobs. Dorsal gland aperture 4 μ m (in paratypes 4-5 μ m) from knobs. Hemizonid indistinct, excretory pore seems to be at same level (in paratypes, the pore is immediately posterior to hemizonid). Ovary outstretched, spermatheca round, on right ventro-lateral side, filled with large refractive spermatozoa. Small, distinct vulvar flap. Tail curves gently ventrad, tapers gradually to a bluntly round terminus (some paratypes have slight ventral indent near tip). Average width of body annules ranges 1.0 - 1.4 μ m, extending to the terminus. Lateral field with four equally distinct lines occupying about 18% of body width.

Allotype (male): L = .25 mm; a = 29; c = 13; T = 26; excretory pore = 62 μ m; spicules = 19 μ m; gubernaculum = 3 μ m. Head with sloping, rounded sides, slightly truncate; rounded lips discernible at edges of truncate end. Testis full of large refractive spermatozoa; tail conoid, with rounded terminus, curves almost 90 degrees ventrad posterior to cloacal opening. Anal sheath prominent. Body annules about 1.2 μ m wide. Lateral field with four fine lines.

Holotype: Female, collected in January, 1972 by R. Colbran, slide number 1333, UCNS Collection, Davis, California.

Allotype: Male, same data as holotype, slide number 1334, UCNS Collection, Davis, California.

Paratypes: 30 females, 4 males, 1 juvenile, same data as holotype deposited as follows: 15 females, 3 males, 1 juvenile, UCNS Collection, Davis, California; 5 females, 1 male, Plant Pathology Laboratory, Department of Primary Industries, Queensland, Australia; 2 females each at the following: USDA Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England; UCNS Collection, Riverside, California.

Type habitat: Virgin soil.

Type locality: Beerwah, Queensland, Australia.

Diagnosis: This species is most closely related to *P. minutus* from which it is distinguished by its greater size, more robust stylet, and more distinctly rounded lips on the female.

Paratylenchus variabilis n. sp.

(Fig. 27-30)

Paratypes (27 females): L = .29 mm (.25 - .34); a = 22 (19-25); b = 4.1 (3.6 - 4.7); c = 14 (12-18); V = ³⁸(²⁶⁻⁵⁵) 83 (82-85); stylet = 14 μ m (13-16); prorhabdion = 9 μ m (8-10); excretory pore = 63 μ m (59-71).

Paratypes (3 males): L = .31 mm (.29 - .33); a = 31 (28-32); c = 13 (12-14); T = 30 (29-31); excretory pore = 67 μ m (65-68); spicules = 19 μ m (18-20); gubernaculum = 4 μ m (3-4).

Holotype (female): L = .28 mm; a = 21; b = 4.7; c = 14; V = ⁴¹83; stylet = 15 μ m; prorhabdion = 9 μ m; excretory pore = 68 μ m. Body open 'C' shape when in fixative. Head rounded almost hemispherical, with tiny rounded lips giving a slightly flattened anterior surface. Annules small and obscure on head. Hemizonid anterior to excretory pore, at level midway to posterior bulb. Deirids present. Ovary outstretched, spermatheca ovate, located left ventral side, filled with spermatozoa. Vulvar flap prominent, rounded. Tail narrows gradually to a bluntly rounded terminus. Body annules coarse, averaging 1.3 - 1.4 μ m wide, and extending almost to terminus. Lateral field with four equally prominent lines extending almost to terminus.

Allotype (male): L = .31 mm; a = 30; c = 12; T = 30; excretory pore = 68 μ m; spicules = 18

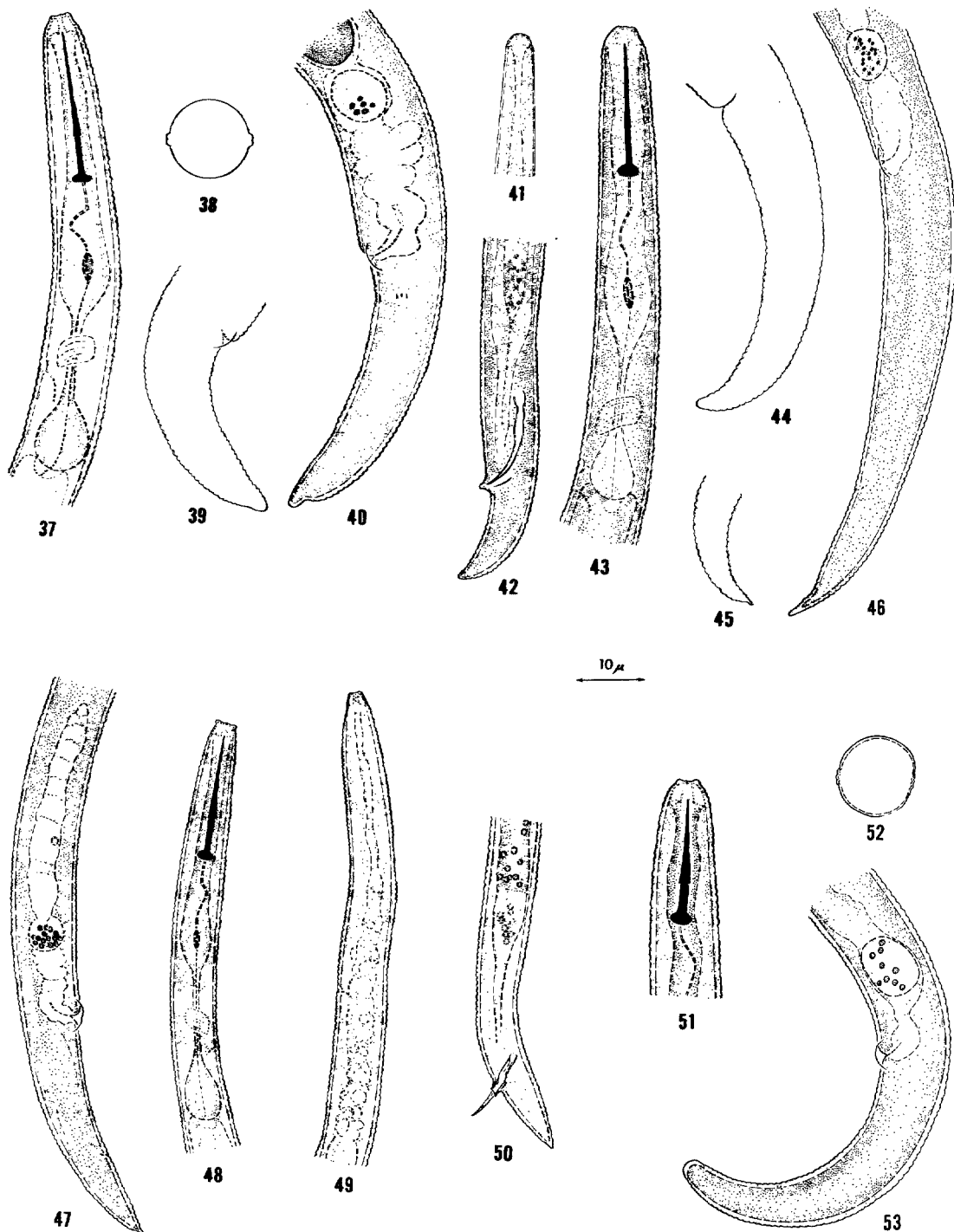


FIG. 37-53. 37-40. *Paratylenchus leptos* n. sp.; 41-46. *Paratylenchus longicaudatus* n. sp.; 47-50. *Paratylenchus perlatus* n. sp.; 51-53. *Paratylenchus obtusicaudatus* n. sp.

μ m; gubernaculum = 3 μ m. Body almost straight to about midway in length then curves slightly dorsad, tail curves ventrad posterior to cloaca. Head rounded with moderate

sclerotization. Hemizonid immediately anterior to excretory pore. Testis outstretched. Anal sheath prominent, slight projection of posterior edge. Tail narrows

slightly posterior to cloaca, then tapers to a bluntly rounded terminus. Body annules coarse, averaging 1.3 - 1.5 μm wide, and extending almost to terminus. Lateral field with four lines, inner two very faint (more prominent on other paratypes).

Holotype: Female, collected 25 March 1971 by S. A. Sher, on slide number 1346, UCNS Collection Davis, California.

Allotype: Male, same data and on same slide as holotype, UCNS Collection, Davis, California.

Paratypes: 26 females, 2 males, 2 juveniles, same data as holotype deposited as follows: 21 females, 1 male, 1 juvenile, UCNS Collection, Davis, California; 1 female, 1 male at the National Nematode Collection, IARI, New Delhi, India; 1 female, 1 male, 1 juvenile, Nematology Department, Rothamsted Experimental Station, Harpenden, England; 1 female each at UCNS Collection, Riverside, California; Plantenziektenkundige Dienst, Wageningen, The Netherlands; and USDA Nematode Collection, Beltsville, Maryland.

Type host: *Rhus trilobata*.

Type locality: Joshua Tree National Monument; San Bernardino County, California.

Diagnosis: This species keys to and is closely related to *P. colbrani* from which it differs by the more posterior vulva of *variabilis* [83 (82-85) vs. 81 (79-82)]. Also the head of *colbrani* has more prominent, rounded lips and stouter spear knobs. *P. variabilis* is also closely related to *vexans*, from which it differs by the bluntly rounded tail of the male (pointed in *vexans*) and the rounded almost hemispherical head of the female.

Additonal collections: 9 females (Scrub oak; Salina, Utah): L = .31 mm (.25 - .34); a = 22 (18-26); b = 3.9 (3.2 - 4.2); c = 16 (14-19); V = 84 (82-86); stylet = 14 μm (14-15); prorhabdion = 9 μm (8-10); excretory pore = 73 μm (68-79).

14 Females (Sagebrush; Salina, Utah): L = .31 mm (.27 - .34); a = 22 (20-26); b = 3.8 (3.3 - 4.3); c = 15 (13-17); V = 84 (83-87); stylet = 15 μm (14-16); prorhabdion = 9 μm (8-10); excretory pore = 70 μm (65-75).

1 Female (*Hymenoclea salsola*; Borrego State Park, San Diego County, California): L = .28 mm; b = 4.0; c = 13; V = 83; stylet = 16 μm ; prorhabdion = 10 μm ; excretory pore = 64 μm .

8 Females (Apple; Tzuba, Israel): L = .31

mm (.29 - .35); a = 22 (20-25); b = 4.0 (3.5 - 4.4); c = 14 (13-14); V = 85 (84-86); stylet = 14 μm (13-14); prorhabdion = 8 μm (8-9); excretory pore = 67 μm (62-71).

Paratylenchus italiensis n. sp.

(Fig. 31-32)

Paratypes (31 females): L = .28 mm (.23 - .34); a = 22 (15-25); b = 3.7 (3.2 - 4.0); c = 14 (11-18); V = ^{39 (33-55)} 84 (80-85); stylet = 15 μm (12-17); prorhabdion = 9 μm (8-11); excretory pore = 64 μm (58-75).

Holotype (female): L = .27 mm; a = 20; b = 3.5; c = 11; V = ³⁸84; stylet = 15 μm ; prorhabdion = 9 μm ; excretory pore = 61 μm . Body curved ventrally in fixation to form an open 'C' shape when in fixative. Head with sloping sides and truncate anterior surface. Small rounded lips protrude near oral aperture (paratypes divided almost equally, half with head similar to holotype, the others with the same sloping sides and truncate anterior surface but lips do not protrude). Body annules continue onto head, but are very fine. Stylet knobs squared-off and may be projecting forward slightly. Dorsal gland orifice 5 μm from knobs. Excretory pore at a level slightly anterior to posterior bulb; hemizonid and deirids at same level as excretory pore. Esophago-intestinal valve prominent, lobed. Ovary outstretched; spermatheca an indistinct protrusion at anterior left side of uterus, devoid of spermatozoa. Vagina protrudes posteriorly but does not form a true post-uterine branch (six or seven rounded inclusions occur just posterior to this protrusion between the cuticle and the intestine giving the appearance of a degenerate post-uterine branch but these appear to be individual and not connected to or part of the gonad-similar globules occur in other parts of the body). Vulvar flap prominent, rounded. Body tapers gradually posterior to vulva, slightly curved ventrad, conoid in outline. Tail tip finely rounded, almost acute (paratypes have variations to bluntly rounded terminus). Body annules fine, average width up to 1 μm ; lateral field with four lines, equally spaced, about 1 μm apart, inner two less prominent than outer two.

Male: Unknown.

Holotype: Female, collected 3 January 1964 by S. A. Sher, slide number 1342, UCNS Collection, Davis, California.

Paratypes: 30 females, 12 juveniles, same

data as holotype, deposited as follows: 25 females, 12 juveniles, UCNS Collection, Davis, California; 1 female each at the following: UCNS Collection, Riverside, California; USDA Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; Nematology Department, Rothamsted Experimental Station, Harpenden, England; National Nematode Collection, IARI, New Delhi, India.

Type host: Grass and weed soil.

Type locality: Taormina, Sicily, Italy.

Diagnosis: This species is most closely related to *P. veruculatus* from which it differs in the shape of the head and lip region (rounded in *veruculatus*); presence of males with stylet in *veruculatus*; presence of prominent spermatheca in *veruculatus* filled with large refractive spermatozoa; coarser annulation in *veruculatus*.

P. italiensis also keys to *P. minutus* from which it differs by its smaller stylet [$15\ \mu\text{m}$ (12-17) vs. $17\ \mu\text{m}$ (16-19) for *minutus*] position of vulva [84 (80-85) vs. 82 (81-84) for *minutus*] and absence of males.

The sample from which these specimens were collected also contained a single male. There were also four other females of another species of *Paratylenchus* (three in the type collection above and the fourth from another collection nearby) with stylets about 23-25 μm . Three of the four females had a prominent spermatheca filled with spermatozoa. On this basis, the male was judged to belong with this second species.

The second collection (also made by S. A. Sher the same day as the type collection) held a single female and 18 juveniles of *P. italiensis*. The female was similar in all respects to the type specimens except in the 'b' measurement which was 4.7.

Additional collection: 17 females (Vallendar, Rhine): L = .28 mm (.25-.32); a = 22 (21-23); b = 3.6 (3.4 - 3.9); V = 82 (82-83); stylet = 15 (14-16) μm .

Paratylenchus minutus Linford in Linford, Oliveira & Ishii, 1949

Tarjan (1960) concluded *P. minutus* is a synonym of *P. elachistus* which is refuted below; Geraert (1965) judged synonymy with *P. besoekianus* more probable. Type material of *besoekianus* was not preserved and until new type material is collected decision on this

synonymy cannot be resolved. It is recommended *P. besoekianus* be considered a distinct species based on presence of a post-uterine branch in females and a reduced stylet in males.

Two collections of *P. minutus* from pineapple fields in Hawaii are in the UCNS Collection at University of California, Davis. One collection made in 1949 by M. B. Linford from the type locality has 65 females, 19 males, 11 juveniles. These are part of a collection reported as made July 27, 1949, some specimens of which were also sent by Linford to G. Thorne. Three slides made by Thorne with 17 females, 3 males, 15 juveniles have been on loan for this study and judged to be topotypes from which a neotype and topotype specimens are designated below. Specimens in the second collection made in March 1951 (collector unknown) from several pineapple fields in Hawaii fit the above very closely and are judged to be the same species.

Topotypes (17 females): L = .26 mm (.20 - .29); a = 20 (18-23); b = 4.0 (3.4 - 4.3); c = 16; V = 82 (81-84); stylet = 17 μm (16-19); prorhabdion = 11 μm (10-12); excretory pore = 56 μm (47-61).

Topotypes (3 males): L = .25 mm (.22 - .28); a = 25 (23-27); c = 17 (15-19); spicules = 17 μm (15-18); gubernaculum = 3 μm (2-4); excretory pore = 54 μm (49-59); T = 30 (24-33).

Neotype (female): L = .27 mm; a = 18; b = 4.2; c = 16; V = ⁴⁷83; stylet = 17 μm ; prorhabdion = 11 μm ; excretory pore = 58 μm . Body tapers toward anterior end with rounded head, not set off. Tiny lips protrude slightly near oral aperture giving a truncate anterior tip. Lateral field with four lines, inner two slightly less distinct than the outer two. Vulval flap present. Tail evenly conoid, ventrally arcuate with a round tip (other topotypes more blunt at terminus, some slightly misshapen to subdigitate).

Neotype: Female, collected 27 July 1949 by M. B. Linford, deposited in USDA Nematode Collection, Beltsville, Maryland.

Topotypes: 15 females, 3 males, 15 juveniles, same data as neotype deposited as follows: 6 females, 1 male, 4 juveniles, USDA Nematode Collection, Beltsville, Maryland; 7 females, 1 male, 7 juveniles, UCNS Collection, Davis, California; 1 female, Plantenziektenkundige Dienst, Wageningen, The Netherlands; 1 female, National Nematode Collection, IARI, New Delhi,

Additional collections:	Pineapple		Coffee	Jungle Soil - Ceylon	
	Oahu, Hawaii	Hawaii	Bahia, Brazil	Hewaheta	Kotagala
L. (mm) =	.25 (.22 - .28)	.27 (.25 - .28)	.24 (.20 - .27)	.24 (.21 - .27)	.23 (.21 - .25)
a =	20 (18-24)	20 (18-21)	20 (18-23)	21 (18-29)	20 (17-27)
b =	3.9 (3.3 - 4.4)	4.0 (3.9 - 4.0)	3.9 (3.4 - 4.1)	3.4 (3.1 - 3.8)	3.4 (3.1 - 3.6)
V =	82 (80-84)	82 (80-84)	82 (81-82)	81 (80-84)	82 (79-84)
stylet (μ m) =	17 (15-19)	18 (16-20)	17 (15-21)	16 (14-20)	16 (15-17)
excretory pore (μ m) =	55 (49-64)	62	54 (47-59)	59 (55-66)	56 (52-63)

India; 1 female, 1 male, Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: *Ananas comosus* (L.) Merr.

Type locality: Oahu, Hawaii.

Paratylenchus leptos n. sp.

(Fig. 37-40)

Paratypes (8 females): L = .22 mm (.20 - .26); a = 17 (15-22); b = 3.2 (3.0-3.5); c = ?; V = ⁴⁹ (29-58) 82 (77-84); stylet = 22 μ m (20-23); prorhabdion = 15 μ m (14-16); excretory pore = 55 μ m (51-57).

Holotype (female): L = .21 mm; a = 22; b = 3.2; V = ²⁹ 81; stylet = 23 μ m; prorhabdion = 15 μ m; excretory pore = 51 μ m. Body assumes an open 'C' shape when in fixative. Head rounded with truncate anterior end. Dorsoventral lips distinctly rounded and set-off. Stylet moderately robust. Excretory pore at level of nerve ring, immediately posterior to hemizonid which occupies about two body annules. Ovary outstretched; spermatheca large, round, with large refractive spermatozoa and located to left, lateral side at anterior end of uterus (on two paratypes on right side). Vulvar flap small, distinct. Tail narrows very gradually to near terminus then abruptly on dorsal side giving a digitate appearance (on two paratypes the indentation is slight and the digitate outline is less distinct). Body annules fine, averaging less than 1 μ m wide. Lateral field with three lines, the mid-line indistinct and often indiscernible in lateral view.

Male: Unknown.

Holotype: Female, collected in June 1961 by F. Plaumann, slide number 1336, UCNS Collection, Davis, California.

Paratypes: 7 females, same data as holotype deposited as follows: 2 females at UCNS Collection, Davis, California; 1 female each at the following: UCNS Collection, Riverside, California; USDA Nematode Collection,

Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: Soil about *Piper* sp.

Type locality: Nova Teutonia, Brazil.

Diagnosis: This species is most closely related to *P. vandenbrandei* (6) but differs in its digitate tail, shorter stylet [22 μ m (20-23) vs. (28-33)] and shorter total length [.22 mm (.20 - .26) vs. (.25 - .29)].

Paratylenchus microdorus Andr ssy, 1959
syn. female of *T. macrophallus* de Man, 1880
P. brevihastus Wu, 1962

A single female on slide Y-231 designated as holotype was available for study on loan from Andr ssy. Also seven females and three males, paratypes of *P. brevihastus*, were loaned from the Canadian National Collection of Nematodes.

Ten collections totalling 65 females from seven other countries also were identified as *P. microdorus*. These were taken from: cotoneaster, East Malling, Kent, England; grass, Arcen, The Netherlands; grass, San Remo, Italy; grass, Laffrey, France; grass, Cape Antibes, France; strawberry, Olsetyn, Poland; marronnier d'Inde (horse chestnut), Morges, Switzerland; *Cherimoya*, Quillota, Chile.

The holotype was not described specifically in the original description and this specimen differed in the position of the vulva (79 - range given in description was 81-82) and had a total length of .32 mm, the lower limit of the range given. The specimens of *P. brevihastus* had measurements very close to those given for *microdorus* but some were longer ranging up to .44 mm. The specimens from the other countries had total lengths averaging slightly less (range of averages = .32 - .35 mm) with a

total range from .28 - .39 mm. The range of averages for vulva position is 81-82 with total range of vulva 79-85. The head has a slightly conoid slope to the sides with squared-off, almost truncate anterior surface. Males are known only from the types of *P. brevihastus*.

This species is closely related to *P. veruculatus*, *P. pesticus* and *P. goldeni*. *P. veruculatus* is smaller (range of average L = .27 - .28 mm; total range of L = .24 - .32 mm); stylet is smaller (13-15 μ m, total range = 12-16); and has a more sharply conoid tail. *P. pesticus* differs in having a more bluntly rounded, almost truncate terminus. *P. goldeni* is discussed under that species.

Paratylenchus longicaudatus n. sp.

(Fig. 41-46)

Paratypes (27 females): L = .28 mm (.22 - .34); a = 21 (14-26); b = 4.1 (2.9 - 4.7); V = 78 (76-80); stylet = 20 μ m (18-22); prorhabdion = 12 μ m (10-14); excretory pore = 67 μ m (57-77).

Paratypes (12 males): L = .24 mm (.22 - .26); a = 28 (25-32); c = 16 (14-17); spicules = 16 μ m (15-18); gubernaculum = 3 μ m (2-4); excretory pore = 57 μ m (53-63); T = 30 (26-36).

Holotype (female): L = .28 mm; a = 25; b = 4.5; V = 79; stylet = 18 μ m; prorhabdion = 12 μ m; excretory pore = 69 μ m. Body narrows gradually at anterior end to head which is conoid and truncate. Stylet slender, moderately developed with posteriorly directed knobs. Dorsal gland orifice about 5 μ m from knobs. Excretory pore posteriad to posterior bulb of esophagus (in paratypes at level about midway to posterior bulb). Ovary outstretched, spermatheca small round on left latero-dorsal side at anterior end of uterus. Vulvar flaps small but distinct. Tail slightly arcuate ventrally, tapers gradually to a very finely rounded terminus. Annules almost to tip of tail. Lateral field with four lines about 1 μ m apart and occupying about 15% of body width, inner two lines less distinct than the outer two.

Allotype (male): L = .26 mm; a = 30; c = 16; spicules = 15 μ m; gubernaculum = 4 μ m; excretory pore = 63 μ m; T = 29. Body narrows gradually to a small, bluntly rounded head. Hemizonid occupies about two body annules immediately anterior to excretory pore. Testis

outstretched with prominent testicular gland enveloping posterior portion. Spicules only gently curved. Body narrows rather abruptly behind cloacal opening, tail curves slightly ventrad, tapers gradually to a finely rounded tip. Body annules almost to terminus. Lateral field appears to have four lines but they are obscure and difficult to determine. Body annules fine, averaging less than 1 μ m wide.

Holotype: Female, collected September 10, 1957 by S. A. Sher, slide number 1337, UCNS Collection, Davis, California.

Allotype: Male, same data as holotype, slide number 1338 (specimen number 1 on slide with 2 males), UCNS Collection, Davis, California.

Paratypes: 38 females, 11 males, 2 juveniles, same data as holotype, deposited as follows: 32 females, 1 male, 1 juvenile, UCNS Collection, Davis, California; 1 female, 2 males, UCNS Collection, Riverside, California; 1 female, 2 males, USDA Nematode Collection, Beltsville, Maryland; 1 female, 2 males, 1 juvenile, Plantenziektenkundige Dienst, Wageningen, The Netherlands; 2 females, 2 males, National Nematode Collection, IARI, New Delhi, India; 1 female, 2 males, Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: *Equisetum* sp.

Type locality: Santa's Kitchen, Santa Barbara County, California.

Diagnosis: This species is most closely related to *P. elachistus* from which it differs by its more anteriorly located vulva (average V = 78 vs. 82-83) and more slender conoid tail.

Paratylenchus obtusicaudatus n. sp.

(Fig. 51-53)

Paratypes (16 females): L = .26 mm (.24 - .28); a = 23 (20-25); b = 4.0 (3.6 - 4.3); c = 17 (15-19); V = 82 (81-83); stylet = 21 μ m (19-23); prorhabdion = 14 μ m (13-17); excretory pore = 62 μ m (57-69).

Holotype (female): L = .27 mm; a = 22; b = 4.2; c = 17; V = ²⁰82; stylet = 22 μ m; prorhabdion = 15 μ m; excretory pore = 62 μ m. Body assumes open 'C' shape when in fixative. Head bluntly rounded truncate at anterior end. Fine annules on head. Dorsolateral and ventro-lateral lips prominent, rounded, with slight depression in outline at oral aperture. Stylet moderately robust.

Measurements of collections:

	USDA (3)	Ramie Belle Glade, Florida	Lemon Oxnard, California	Orange Australia	Potato Mexico	<i>Morus alba</i> India
Paralectotypes						
L (mm) =	.27 (.26-.28)	.28 (.26-.32)	.28 (.23-.31)	.28 (.26-.30)	.30 (.27-.36)	.29 (.23-.31)
a =	19 (14-22)	22 (17-26)	18 (15-24)	18
b =	3.9 (3.7-4.0)	4.0 (3.5-4.5)	...	4.0 (3.8-4.1)	3.8 (3.3-4.3)	4.4 (4.4-4.5)
V =	83 (83-84)	83 (80-87)	82 (81-84)	82 (82-83)	82 (80-83)	83 (82-85)
stylet (μ m) =	21 (21-22)	22 (20-23)	22 (20-24)	21 (19-22)	21 (20-24)	20 (20-21)
excretory pore (μ m) =	64 (63-65)	67 (57-79)	66 (53-80)	65

Dorsal gland aperture about 4 μ m posterior to knobs. Excretory pore at end of posterior bulb, hemizonid small, occupies about one annule immediately anterior to excretory pore. Ovary outstretched, no spermatheca visible (in some paratypes spermatheca is small, round, on left ventro-lateral side, filled with large refractive spermatozoa) vulvar flap small, distinct. Tail narrows gradually to a blunt, squared-off terminus. Annules average about 1 μ m wide, extending almost to tip of tail. Lateral field with four lines, each about equally distinct, about 0.7 μ m apart, occupies about 22% of body width.

Male: Unknown.

Holotype: Female, collected 12 October 1968, collector unknown, slide number 1335, UCNS Collection, Davis, California.

Paratypes: 15 females, same data as holotype, deposited as follows: 10 females at UCNS Collection, Davis, California; 1 female each at UCNS Collection, Riverside, California; USDA Nematode Collection, Beltsville, Maryland; Plantenziektenkundige Dienst, Wageningen, The Netherlands; National Nematode Collection, IARI, New Delhi, India; Nematology Department, Rothamsted Experimental Station, Harpenden, England.

Type host: Soil about roots of *Sorghum* sp.

Type locality: South Turkana, Kenya.

Diagnosis: This species is most closely related to *P. nainianus* from which it differs by its smaller stylet [21 μ m (19-23) vs. 24 μ m (21-27) in types of *nainianus* and ranges from 24-31 in other collections] and by its more blunt almost truncate tail contrasting with the rounded terminus of *nainianus*. *P. obtusicaudatus* is also related to *elachistus* from which it differs by its truncate tail shape and prominently rounded dorso-lateral and ventro-lateral lips which are not present in *elachistus*.

Paratylenchus elachistus Steiner, 1949

Three paralectotypes established by Tarjan and Golden (17) were available for study on loan from the USDA Nematode Collection. Another collection made by the author from the type host in the near vicinity of the type locality also was used in this study. These confirm *P. elachistus* as a species distinct from *P. minutus*. In addition, other collections from California, Mexico, India and Australia support this conclusion.

The most striking difference from *minutus* is the longer, more robust stylet in *elachistus* which averages 20-22 μ m in length with an overall range of 19-24 μ m. *P. elachistus* also averages slightly larger in total length (range of averages for L = .27 - .30 mm) with an overall range of .23 - .36 mm. The tail of *elachistus* also appears to be more slender conoid with a terminus usually more finely rounded to an almost acute tip.

Paratylenchus perlatus n. sp.

(Fig. 47-50)

Paratypes (28 females): L = .19 mm (.17-.24); a = 21 (14-28); b = 3.2 (2.8-3.6); c = 15 (12-18); V = ²⁹(21-39) 82 (79-86); stylet = 20 μ m (19-22); prorhabdion = 14 μ m (11-15); excretory pore = 48 μ m (41-58).

Paratypes (14 males): L = .19 mm (.17-.21); a = 25 (21-30); c = 15 (13-17); T = 30 (22-36); excretory pore = 46 μ m (39-48); spicules = 12 μ m (11-13); gubernaculum = 2 μ m (2-3).

Holotype (female): L = .20 mm; a = 17; b = 3.5; c = 13; V = ³¹80; stylet = 21 μ m; prorhabdion = 14 μ m; excretory pore = 45 μ m. Body with gentle ventral curve in anterior part then bends markedly to a roughly open 'C' shape (other paratypes almost straight or curve more abruptly posterior to vulva) when in fixative. Head narrows with sloping sides then constricts slightly to set off small, distinctly rounded, lips. Anterior surface

truncate (constriction less noticeable in some paratypes, stronger in others). Head sclerotization light. Stylet slender with small backwardly directed knobs. Dorsal gland orifice obscure. Excretory pore at same level as (in some paratypes, posterior to) hemizonid, at level of anterior end of posterior bulb. Esophago-intestinal valve distinct, rounded. Ovary outstretched, spermatheca small, rounded, full of spermatozoa. Vagina with rounded protuberance posteriorly resembling a small post-uterine branch. Vulvar flap distinct, rounded. Tail conoid, tapers fairly evenly to a very fine rounded, almost sharp terminus. Annules fine, averaging about $0.8\ \mu\text{m}$ wide. Lateral field with two distinct lines plus two inner lines that are extremely fine (in some paratypes these inner lines are visible, and in others not at all).

Allotype (male): $L = .18\ \text{mm}$; $a = 24$; $c = 17$; $T = 26$; excretory pore = $45\ \mu\text{m}$; spicules = $12\ \mu\text{m}$; gubernaculum = $2\ \mu\text{m}$. Body more or less straight, then bends ventrad and recurves sharply dorsad at posterior end. Body narrows to a very small head with sloping sides and truncate anterior surface, sclerotization very weak. Stylet lacking. Esophagus degenerate. Excretory pore at same level as hemizonid. Gonad outstretched, spicules with slight curve. Anal sheath present with only slight protrusion at posterior edge. Tail evenly conoid with a finely rounded terminus. Lateral field as in female with two distinct lines, but two more inner lines could not be resolved with certainty.

Holotype: Female, collected in 1973 by R. D. Sharma, slide number 1344, UCNS Collection, Davis, California.

Allotype: Male, same data as holotype, specimen #5 on slide number 1345, UCNS Collection, Davis, California.

Paratypes: 62 females, 21 males, 11 juveniles, same data as holotype, deposited as follows: 47 females, 12 males, 8 juveniles at UCNS Collection, Davis, California; 3 females, 1 male, 1 juvenile, USDA Nematode Collection, Beltsville, Maryland; 2 females, 3 males, 1 juvenile, National Nematode Collection, IARI, New Delhi, India; 2 females, 2 males, 1 juvenile, UCNS Collection, Riverside, California; 4 females, 2 males, Nematology Department, Rothamsted Experimental Station, Harpenden, England; 4 females, 1 male, Plantenziektenkundige Dienst, Wageningen, The Netherlands.

Type host: *Theobroma cacao*.

Type locality: Pedra Grande, Itamaraju, Brazil.

Diagnosis: This species is most closely related to *P. elachistus* from which it differs by its smaller size [$L = .19\ \text{mm}$ (.17 - .24) vs. .27 mm (.23 - .26)].

This species was found in another collection also made by R. D. Sharma in 1973 from sandy soil about *Theobroma cacao* at Faz. Cachoera do Ouro-Itamaraju, Brazil. A total of 79 females, 14 males, and 26 juveniles was collected which fit the type measurements and characteristics very closely. In both samples, *P. perlatus* was the only species of *Paratylenchus* present.

Paratylenchus gabrici Yeates, 1972

A single slide (NH47) containing 6 females paratypes has been deposited in the UCNS Collection, Davis, an examination of which confirms this species as a member of the genus *Hemicriconemoides*. It is hereby transferred to that genus as follows:

Hemicriconemoides gabrici (Yeates, 1972)
n. comb. syn. *Paratylenchus gabrici*
Yeates, 1972.

LITERATURE CITED

1. ÁNDRASSY, I. 1959. Neue und wenig bekannte Nematoden aus Jugoslawien. Ann. Hist.-Natur. Mus. Nat. Hung. 51:259-275.
2. BALLY, W., and G. A. REYDON. 1931. De tegenwoordige stand van het vraagstuk van de wortelaaltjes in de koffiecultuur. Arch. Koffiecult. Nederl.-Indië. 5:23-216.
3. BRZESKI, M. W. 1963. *Paratylenchus macrodorus* n. sp. (Nematoda, Paratylenchidae), a new plant parasitic nematode from Poland. Bull. Acad. Pol. Sci. Cl. (II Ser., Biol.) 11:277-280.
4. GERAERT, E. 1965. The genus *Paratylenchus*. Nematologica 11:301-334.
5. GOODEY, T. 1934. Observations on *Paratylenchus macrophallus* (de Man, 1880). J. Helminthol. 12:79-88.
6. DE GRISSE, A. 1962. *Paratylenchus vandenbrandei* n. sp. (Nematoda: Criconematidae) nouvelle espèce de *Paratylenchus* associée aux racines d'agave au Kenya. Nematologica 8:229-232.
7. KHAN, E., S. K. PRASAD, and V. K. MATHEUR. 1967. Two new species of the genus *Paratylenchus* Micoletzky, 1922 (Nematoda: Criconematidae) from India. Nematologica 13:79-84.
8. LINFORD, M. B., J. M. OLIVEIRA, and M. ISHII. 1949. *Paratylenchus minutus*, n. sp. a nematode parasitic on roots. Pac. Sci. 3:111-119.
9. DE MAN, J. G. 1880. Die einheimischen, frei in der reinen Erde und im süßen Wasser lebende

- Nematoden. Vorläufiger Bericht und descriptivsystematischer Theil. Tijdschr. Diergeneesk. 5:1-104.
10. MERNY, G. 1966. Nematodes d'afrigue tropicale: un nouveau Paratylenchus (Criconematidae), deux nouveaux Longidorus et observations sur Longidorus laeviscapitatus Williams, 1959 (Dorylaimidae). *Nematologica* 12:385-395.
 11. MICOLETZKY, H. 1922. Die freilebenden Erd-Nematoden mit besondere Berücksichtigung der Steiermark und der Bukowina, zugleich mit einer Revision sämtlicher nicht mariner, freilebender Nematoden in Form von Genus-Beschreibungen und Bestimmungsschlüsseln. Arch. Naturg. (Berl.) 87:321-650.
 12. RASKI, D. J. 1962. Paratylenchidae n. fam. with descriptions of five new species of Gracilacus n. g. and an emendation of Cacopaurus Thorne, 1943, Paratylenchus Micoletzky, 1922 and Criconematidae Thorne, 1943. *Proc. Helminthol. Soc. Wash.* 29:189-207.
 13. SIDDIQI, M. R., and J. B. GOODEY. 1964. The status of the genera and subfamilies of the Criconematidae (Nematoda): with a comment on the position of Fergusobia. *Nematologica* 9:363-377.
 14. SOLOVYEV, G. I. 1972. Parasitic nematodes of woody and nonwoody plants. Nauka Leningrad USSR:1-102.
 15. STEINER, G. 1949. Plant nematodes the grower should know. *Proc. Soil Sci. Soc. Fla.* (1942) 4-B:72-117.
 16. TARJAN, A. C. 1960. A Review of the genus Paratylenchus Micoletzky, 1922 (Paratylenchinae: Nematoda) with a description of two new species. *Ann. N.Y. Acad. Sci.* 84:329-390.
 17. TARJAN, A. C., and A. M. GOLDEN. 1963. Designation of a lectotype for Paratylenchus elachistus Steiner, 1949 (Nematoda: Paratylenchidae). *Nematologica* 9:472.
 18. THORNE, G., and R. B. MALEK. 1968. Nematodes of the northern great plains. Part I. Tylenchida (Nemata: Secernentea). *S. Dak. Agric. Exp. Stn. Tech. Bull.* 31:1-111.
 19. WOUTS, W. M. 1966. Paratylenchus halophilus (Nematoda: Criconematidae), a new species from New Zealand. *N.Z.J.Sci.* 9:281-286.
 20. WU, L. Y. 1962. Paratylenchus veruculatus n. sp. (Criconematidae: Nematoda) from Scotland. *Can. J. Zool.* 40:773-775.
 21. WU, L. Y. 1962. Paratylenchus brevihastus n. sp. (Criconematidae: Nematoda). *Can. J. Zool.* 40:392-393.
 22. WU, L. Y., and J. L. TOWNSHEND. 1973. Paratylenchus tateae n. sp. (Paratylenchinae, Nematoda). *Can. J. Zool.* 51:109-111.
 23. YEATES, G. W. 1972. Taxonomy of some soil nematodes from the New Hebrides. *N. Z. J. Sci.* 15:673-697.