

**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**

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The Paratylenchinae is comprised of two genera, *Cacopaurus* Thorne, 1943 and *Paratylenchus* Micoletzky, 1922. In recent years a number of species of *Paratylenchus* have been described with an elongated stylet 48 microns or longer. A comparison of type specimens and new collections of many nominal species with specimens representing new species has been made possible from material from the University of California Nematode Survey Collection at Davis.

After reviewing the characters used to distinguish these genera and species it was apparent that the short blunt tail and ornate cuticular markings of *C. pestis* are unique among all the Paratylenchinae. Since this is the type species of the genus and the new species described below are closely related to *C. epacris*, the logical change is to place *C. epacris* in a new genus with the new species and certain species now assigned to *Paratylenchus*.

The relationships of the two subfamilies of the Criconematidae were considered. The relation between these two groups is found in the swollen and amalgamated pro- and metacarpus, the degenerate males, the stylet with a disproportionately long prorrhadion, and the single prodelpic ovary. However, it is also clear that several basic differences exist between these two groups. In Paratylenchinae the isthmus is slender and quite distinct, the annulation fine, stylet slender and caudal alae very reduced or lacking. On the other hand in Criconematinae the isthmus is short and broad, very reduced or almost lacking, the female stylet very robust, and annulation is very strong, often retrorse, sometimes with scales or spines. In three genera of Criconematinae the adult female bears a fifth cuticle. Finally the caudal alae of males are most strongly developed. These differences are judged distinct enough to warrant a separate family status for the Paratylenchinae and it is hereby proposed.

PARATYLENCHIDAE n. fam.

DIAGNOSIS: Tylenchoidea. Procorpus and metacarpus swollen and amalgamated into a large valvated bulb; isthmus slender and distinct. Stylet of females well developed, prorrhadion much longer than meso-metarrhaddions; male degenerate, stylet reduced or lacking. Cuticle finely annulated. Vulva near posterior end. Ovary single. Postuterine branch usually lacking, rarely present, very reduced. Caudal alae lacking or at most slight evaginations of the cuticle.

TYPE GENUS: *Paratylenchus* Micoletzky, 1922

OTHER GENERA: *Cacopaurus* Thorne, 1943

Gracilacus n. g.

KEY TO THE GENERA OF PARATYLENCHIDAE

1. Female obese with cuticular ornamentations, with short very blunt tail, excretory pore in region of valve of metacarpus or further anterior *Cacopaurus*

- Female slender to obese, without cuticular ornamentations, tail short and conical to elongate—slender, excretory pore variable from bulbar region to metacarpus 2
2. Female with short stylet (36 microns or less), young larvae with small, delicate stylet, non-feeding preadult with stylet degenerate or lacking, excretory pore always near nerve ring or posterior

Paratylenchus

Female with elongate stylet (48-119 microns), young larvae with strong well-developed stylet, preadult with strong stylet (*G. peraticus* excepted), excretory pore generally near metacarpus or further anterior but near nerve ring in some species *Gracilacus*

KEY TO THE SPECIES OF *Gracilacus*

1. Lateral field 2 or 3 lines 2
Lateral field 4 lines 5
2. Lateral field 2 lines, stylet 110-119 microns *elegans* n. sp.
Lateral field 3 lines, stylet 54-88 microns 3
3. Female stylet 87-88 microns, vulvar flap small *idalimus* n. sp.
Female stylet <69 microns, vulvar flap lacking 4
4. Female stylet 54-62 microns, tail broad *aculentus* (Brown)
Female stylet 61-69 microns, tail slender *aciculus* (Brown)
5. Spermatheca absent, males unknown 6
Spermatheca present 7
6. Stylet ave. = 89 microns (83-92 microns);
swollen to obese females common *intermedius* n. sp.
Stylet ave. = 77 microns (70-85 microns);
only slender females known *mirus* n. sp.
7. Female stylet 85-119 microns 8
Female stylet 48-71 microns 10
8. Lips set off *peraticus* n. sp.
Lips rounded 9
9. Tail elongate, conoid; males unknown *anceps* (Cobb)
Tail short, blunt; males common *epacris* (Allen & Jensen)
10. Female ave.L. = .48 mm., male with stylet *goodeyi* (Oostenbrink)
Female ave.L. = .39 mm., male unknown or without stylet 11
11. Tail claw-like; female ave.L. = .34 mm. *audriellus* (Brown)
Tail not claw-like, conical with rounded tip 12
12. Female stylet ave. = 53 microns (54-60 microns);
male without stylet *sarissus* (Tarjan)
Female stylet ave. = 67 microns (63-71 microns); male unknown 13
13. Female ave.L. = .28 mm. (.24-.31 mm.); excretory pore near
base of stylet *steimeri* (Golden)
Female ave.L. = .39 mm. (.34-.42 mm.); excretory pore near
nerve ring *marylandicus* (Jenkins)

GENUS *Gracilacus* n. g.

DIAGNOSIS: Paratylenchidae. Small species less than 0.50 mm. Most larvae with elongate stylet. Female slender to obese with a stylet 48-119 microns in length. Body posterior to vulva elongate. Cuticle finely annulated, without ornamentation. Excretory pore generally in region of metacarpus near the valve or further anterior but may be near nerve ring. Male slender,

active, stylet absent or much reduced. Caudal alae represented by thickened, cuticular evaginations. Ovary single. Testis one.

TYPE SPECIES: *Gracilacus epacris* (Allen & Jensen, 1950) n. comb.

Syn.: *Cacopaurus epacris* Allen & Jensen, 1950

OTHER SPECIES INCLUDE:

Gracilacus aciculus (Brown, 1959) n. comb.

syn. *Paratylenchus aciculus* Brown, 1959

Gracilacus aculentus (Brown, 1959) n. comb.

syn. *Paratylenchus aculentus* Brown, 1959

Gracilacus anceps (Cobb, 1923) n. comb.

syn. *Paratylenchus anceps* Cobb, 1923

Gracilacus audriellus (Brown, 1959) n. comb.

syn. *Paratylenchus audriellus* Brown, 1959

Gracilacus goodeyi (Oostenbrink, 1953) n. comb.

syn. *Paratylenchus goodeyi* Oostenbrink, 1953

Gracilacus marylandicus (Jenkins, 1960) n. comb.

syn. *Paratylenchus marylandicus* Jenkins, 1960

Gracilacus sarissus (Tarjan, 1960) n. comb.

syn. *Paratylenchus sarissus* Tarjan, 1960

Gracilacus steineri (Golden, 1961) n. comb.

syn. *Paratylenchus steineri* Golden, 1961

Gracilacus is derived from the Latin *gracilis*, slender, and *acus*, pin.

The genus *Gracilacus* differs from *Cacopaurus* in the absence of cuticular ornamentation and in the elongate, slender body shape posterior to the vulva. It differs from *Paratylenchus* in the well-developed stylet of the younger larval stages and the elongate stylet of the female (48-119 microns in *Gracilacus*, <36 microns in *Paratylenchus*). In *Gracilacus* the excretory pore is generally near the metacarpus or further anterior (exceptions being *G. marylandicus*, *G. audriellus*, *G. sarissus*, *G. goodeyi* in which the pore is located near the nerve ring).

Gracilacus epacris (Allen & Jensen, 1950)

LARVA (SECOND-STAGE?): (7) 0.25 mm. (.23-.28 mm.); a = 22.2 (20.0-24.1); b = 3.2 (2.6-4.1); c = ?; stylet = 43 microns (39-47 microns).

Slender larva with rounded head. Stylet guide prominent. Esophagus well developed. Excretory pore at level of posterior end of valve in median bulb. Tail curves slightly tapering to a rounded tip.

LARVA (THIRD-STAGE?): (7) 0.29 mm. (.25-.32 mm.); a = 18.0 (15.2-20.2); b = 2.8 (2.4-3.7); c = ?; stylet = 63 microns (60-70 microns).

Similar to larva (second stage) with much stronger, longer stylet. Esophagus well developed. Excretory pore at level of anterior end of valve in median bulb. Tail slightly more conoid and narrower at rounded tip.

LARVA (FOURTH-STAGE FEMALE?): (2) 0.28 mm. (.27-.29 mm.); a = 15.0 (13.5-16.5); b = 2.9; c = ?; stylet-lacking.

Robust larva inside cuticle of previous stage with molted prorhabdion 53 and 55 microns respectively. Body tapers anteriorly and posteriorly to conoid tail. Head region similar to adult female. Esophagus well developed, elongate. Stylet rudimentary, located midway in procorpus. Prorhabdion short; basal knobs indistinct.

LARVA (FOURTH-STAGE MALE?): (1) 0.29 mm.; a = 17.6; b = 3.9; c = ?; stylet-lacking.

Head smoothly rounded. Esophagus very short and degenerate. Testis and developing spicules observed. Tail conical with rounded tip.

FEMALE: (5) 0.31 mm. (.25-.35 mm.); a = 14.5 (12.4-15.6); b = 2.3 (1.8-2.6); c = 14.1; V = 84% (82-86%); stylet = 111 microns (99-119 microns).

In the original description of *Gracilacus epacris* the excretory pore was shown anterior to the metacarpus in the young female and near the posterior bulb in the senile, obese female. This latter may be the result of shortening of the esophagus when the stylet is extruded during feeding.

The degree of thickening of the cuticle in *G. epacris* is quite variable even in the type material. Other collections show similar variations and some populations had virtually no special thickening of the cuticle. It is not known whether this variation reflects an influence of different host plants, time of year or age of specimens but in all other respects the populations are similar.

LECTOTYPE: Female. 0.28 mm.; a = 8.8; b = 2.4; c = ?; V = 82%; stylet = 105 microns.

The lectotype was selected from original material collected from roots of California black walnut, *Juglans hindsii* Jepson, near Visalia, Tulare County, California in April, 1949 and used by Allen and Jensen in the description of this species. Catalogue number 207 University of California, Nematode Survey Collection, Davis.

OTHER HOSTS: Oak, *Quercus* sp., 2 mi. north of Woodland, Yolo County; California laurel, *Umbellularia californica* Nutt., bank of Russian River, 5 miles east of Jenner, Sonoma County, and Berkeley, Alameda County.

Gracilacus anceps (Cobb, 1923) (Plate II C, D, Plate VI, C)

LARVA (SECOND-STAGE?): (8) 0.21 mm. (.21-.23 mm.); a = 22.2 (19.0-26.1); b = 2.6 (2.4-3.1); c = ?; stylet = 42 microns (39-43 microns).

Slender larvae with rounded head. Stylet stout, esophagus well developed and strong median bulb with valve. Tail tapering to bluntly rounded tip.

LARVA² (THIRD-STAGE?): (5) 0.27 mm. (.26-.28 mm.); a = 21.4 (19.1-22.5); b = 3.0 (2.5-3.5); c = ?; stylet = 52 microns (50-54 microns).

Body stout, rounded head. Esophagus and stylet strongly developed. Tail more bluntly conical with rounded terminus.

FEMALE: (7) 0.31 mm. (.28-.34 mm.); a = 21.6 (19.1-23.3); b = 2.2 (2.1-2.3); c = 13.8; V = 82% (78-86%); stylet = 97 microns (91-103 microns).

NEOTYPE. Female. 0.34 mm.; a = 23.2; b = 2.2; c = 15.0; V = 81%; stylet = 102 microns.

Slender female, annulation fine becoming obscure on rounded head region. Sclerotization delicate, stylet guide prominent. Excretory pore anterior to knobs of stylet, about 92 microns from anterior end. Stylet knobs very strongly developed. Lateral field marked by 4 lines, the outer two slightly more prominent than the inner two. Vulvar lips protrude slightly. Vulvar flaps moderately developed. Vagina sclerotized, prominent. Uterus contains what appear to be minute spermatozoa possibly produced by specialized cells at anterior end of uterus. Tail slender conoid, taper to fine, almost pointed terminus.

DIAGNOSIS (EMENDED): *Gracilacus anceps* most closely resembles *G. intermedius* and *G. mirus* but differs in the presence of minute spermatozoa produced apparently by a modified cell at the anterior end of the uterus. The

longer stylet of *anceps* (91-103 microns) further differentiates it from *mirus* (70-85 microns). This is also reflected in a difference in esophageal length. It is differentiated also by its shorter length (ave. .31 mm.) from *G. intermedius* (ave. .38 mm.). The esophageal length further distinguishes these two species.

NEOTYPE: Female collected January 6, 1959 by the author from soil about the roots of California laurel, *Umbellularia californica* Nutt., in White Park, Riverside, California. Catalogue number 208 University of California, Nematode Survey Collection, Davis.

OTHER HOSTS: *Platanus racemosa*, Santa Barbara, California.

California laurel is not known to grow in non-cultivated areas in the environs of Riverside. The only known trees that could be found were growing in White Park in the center of town. The larval specimens collected about the roots of these trees fit very closely the description by Cobb. The identification of two larval stages also clarifies the apparent inconsistencies discussed by Tarjan (1960).

Samples were obtained on three different occasions and a special effort made to recover senile forms from the roots and soil but the only specimens found were slender females not developed to the stage of oviposition.

Gracilacus marylandicus (Jenkins, 1960)

A slide containing two female paratypes was sent to the University of California, Davis by Jenkins for deposit in the Nematode Survey Collection.

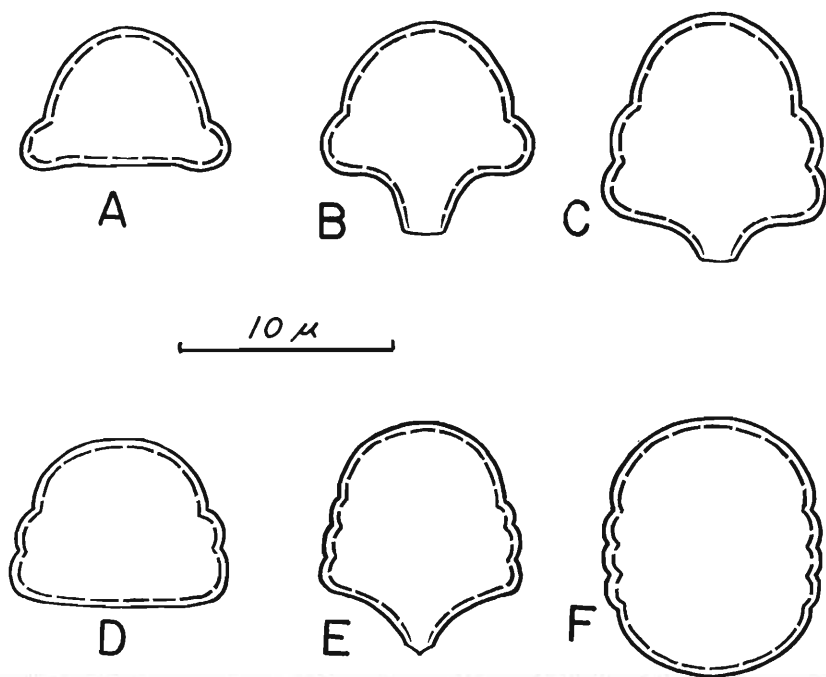


Plate I. Cross sections in the region of the caudal alae. *Cacopaurus pestis*, A-B; *Gracilacus epacris*, C; *Paratylenchus hamatus*, D-F.

On the same slide were two females and one male of a species which keys to *G. aciculus*. The males described as *marylandicus* were evidently specimens of *aciculus* which it fits very closely in size, tail shape and lines in lateral field. Pending the collection of additional material the males of *marylandicus* must be considered unknown.

Gracilacus aciculus (Brown, 1959)

The identification of specimens in the type collection of *G. marylandicus* extends the range of *G. aciculus* to Maryland about the roots of *Pinus virginiana*.

Additional specimens have also been collected by the author 9 May 1955 about the roots of grass and *Mesembryanthemum* sp. at Dillon Beach, California.

Gracilacus sarissus (Tarjan, 1960)

LARVA (SECOND-STAGE?): (2) 0.20 mm. (.19-.20 mm.); a = 19.8 (19.5-20.1); b = 2.4; c = ?; stylet = 36 microns.

LARVA (FOURTH-STAGE): (6) 0.29 mm. (.25-.33 mm.); a = 22.3 (19.6-25.2); b = 3.3 (2.9-3.8); c = ?; stylet = 45 microns (43-46 microns).

FEMALE: (19) 0.37 mm. (.32-.42 mm.); a = 23.9 (16.0-30.0); b = 3.7 (2.9-4.4); c = 13.8 (11.9-15.0); V = 82% (80-84%); stylet = 53 microns (48-61 microns).

MALE: (3) 0.34 mm. (.33-.38 mm.); a = 33.7 (26.0-38.3); b = ?; c = 13.6 (12.2-15.0); T = 22% (15-28%); spicules = 20 microns (19-20 microns); gubernaculum = 4 microns (2-4 microns).

The males of *Gracilacus sarissus* were described as lacking an anal sheath. These specimens have a prominent sheath extending from the cloacal opening. The posterior edge extends as a rodlike projection.

These records extend slightly the specific limits of *G. sarissus* and identify two larval stages.

This species is quite common in California and has been collected in soil about the roots of the following: oak, Mt. Diablo, Alameda County; black sage, Badger Canyon; California laurel, near Fairfield, Solano County; Willets, Mendocino County; and University of California campus, Berkeley; manzanita, near Monticello, Solano County.

Gracilacus mirus n. sp. (Plate III A, B and Plate VI D)

LARVA (SECOND-STAGE?): (2) 0.25 mm. (.24-.27 mm.); a = 18.6; b = 2.8 (2.7-2.9); c = ?; stylet = 48 microns (45-51 microns).

Slender larva with rounded head. Annulation fine, well pronounced. Excretory pore opposite nerve ring. Stylet long, slender, prohabdion especially strong.

LARVA (THIRD-STAGE?): (2) 0.31 mm. (.29-.33 mm.); a = 21.3 (19.9-23.8); b = 3.3 (3.3-3.4); c = ?; stylet = 41 microns (39-44 microns).

Slender larva with rounded head. Esophagus weakly developed, slender and degenerate. Stylet slender, knobs weak, backwardly directed. Tail conoid, almost pointed.

FEMALE: (8) 0.33 mm. (.28-.38 mm.); a = 21.4 (17.1-25.4); b = 2.8 (2.5-2.9); c = 19.8 (15.1-20.5); V = 83% (80-86%); stylet 77 microns (70-85 microns).

HOLOTYPE: Female. 0.35 mm.; a = 20.4; b = 2.6; c = 16.8; V = 83%; stylet = 80 microns.

Female slender with rounded lip region. Body annulation fine, visible on lip region. Sclerotization delicate, stylet guide prominent. Hemizonid two annules wide, anterior to excretory pore at level of stylet knobs. Lateral field with four very fine lines. Vulvar lips do not protrude. Vulvar flaps moderate in size. Anus obscure. Tail slender, conoid almost pointed at tip.

DIAGNOSIS: This species is most closely related to *G. anceps* and *G. intermedius* and is differentiated from the former as discussed under that species.

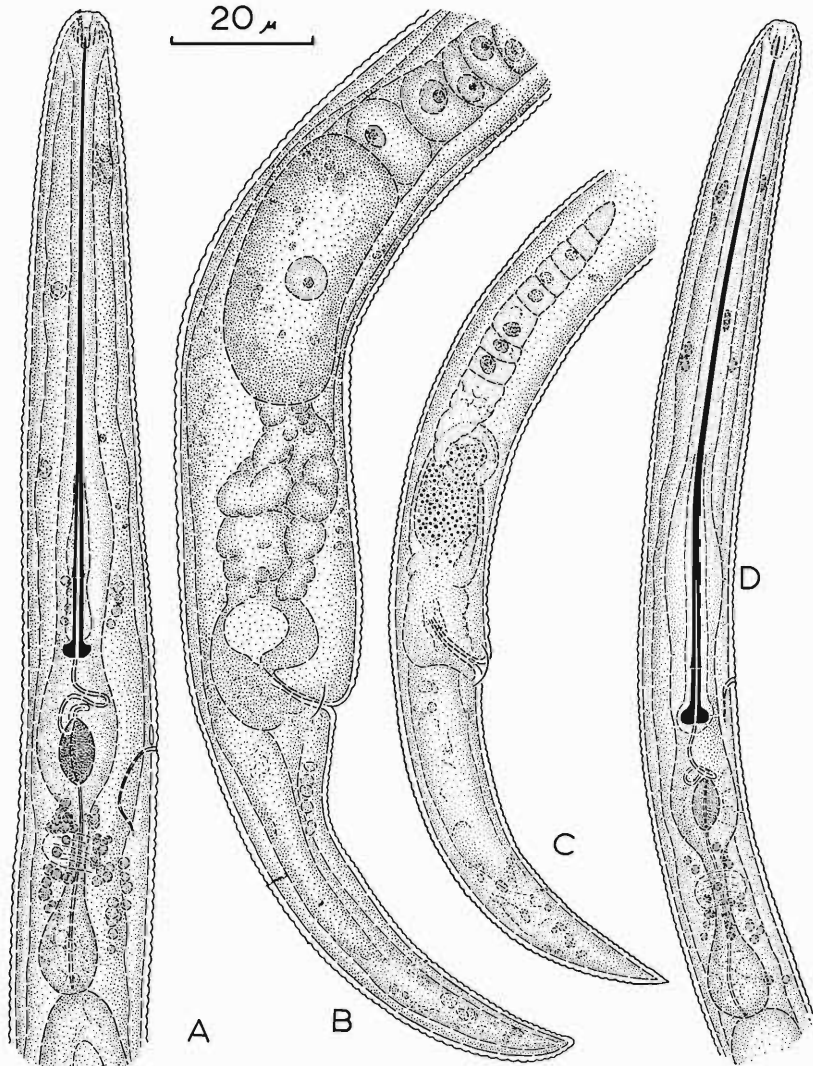


Plate II. *Gracilacus intermedius*, head region—A, tail region—B. *Gracilacus anceps*, tail region—C, head region—D.

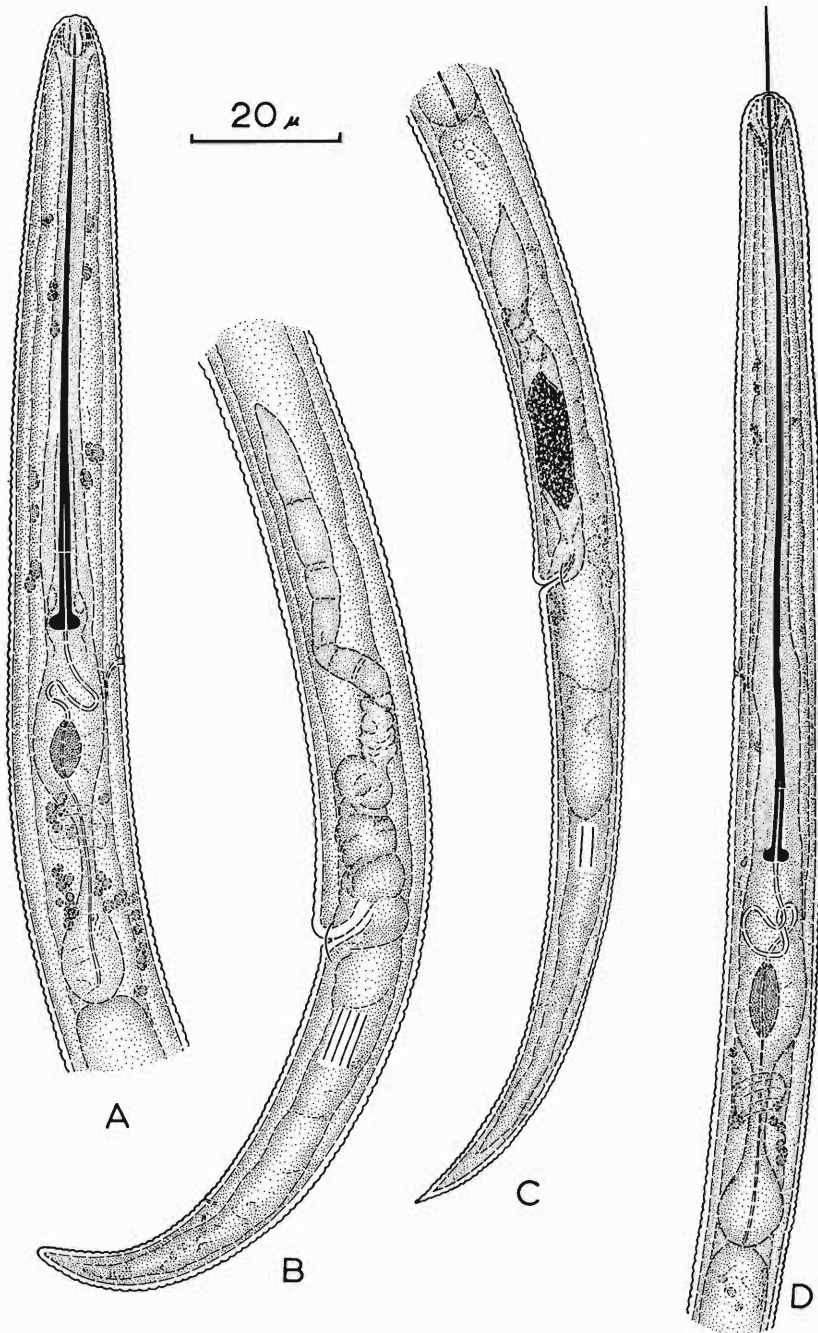


Plate III. *Gracilacus mirus*, head region—A, tail region—B. *Gracilacus elegans*, tail region—C, head region—D.

It differs from *G. intermedius* in the shorter stylet (70-85 microns): (83-92 microns) of *mirus* vs. that of *G. intermedius* (83-92 microns). The larger size of *intermedius* (.32-.44 mm. vs. .28-.38 mm. for *mirus*) is another distinguishing character.

HOLOTYPE: Female collected February 27, 1961, by the author, Catalogue number 209 University of California, Nematode Survey Collection, Davis.

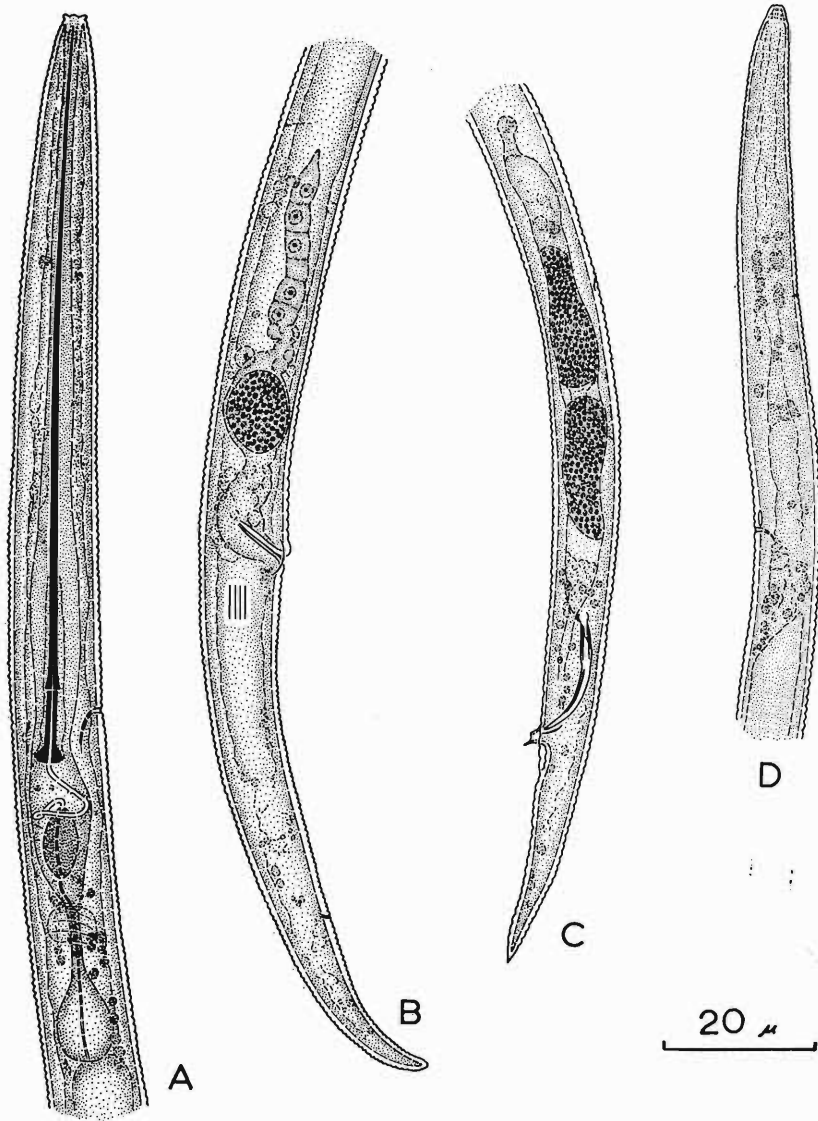


Plate IV. *Gracilacus idalimus*, female head region—A, female tail region—B, male tail region—C, male head region—D.

PARATYPES: Five females, same data as holotype, deposited in University of California, Nematode Survey Collection, Davis; two females, same data as holotype, deposited one each in United States Department of Agriculture Nematode Collection, Beltsville, Maryland and Nematode Collection, Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABIT: Soil about roots of cultivated grapevines, *Vitis vinifera* L., grown on St. George rootstocks.

TYPE LOCALITY: Wente Bros. commercial vineyard near Livermore, California.

OTHER LOCALITY: Two females and one larva of *G. mirus* were also collected in soil from a vineyard in Redwood Valley, Mendocino County, California.

Gracilacus intermedius n. sp. (Plate II A-B, Plate VI A-B, E-G)

LARVA (FOURTH-STAGE?): (5) 0.42 mm. (.40-.45 mm.); a = 26.8 (22.9-32.2); b = 4.2 (4.0-4.4); c = ?; stylet = 51 microns (49-52 microns).

FEMALE: (7) .38 mm. (.32-.44 mm.); a = 24.8 (16.7-30.8); b = 3.0 (2.8-3.2); c = ?; V = 82% (79-86%); stylet = 89 microns (83-92 microns).

HOLOTYPE: Female. .40 mm.; a = 26.3; b = 2.8; c = ?; V = 79%; stylet = 92 microns.

Slender female with fine but definite annulation extending onto rounded head region. Sclerotization weak, stylet guide prominent. Dierids and phasmids not observed. Excretory pore at level of stylet knobs. Hemizonid two annules wide anterior to excretory pore, separated from pore by about two annules. Stylet strong, slightly curved, knobs set off, not backwardly directed. Spermatheca lacking. Lips of vulva protrude slightly. Vulvar flaps moderately developed. Anus not visible. Tail conoid, tapering slightly, strongly annulated to rounded tip.

DIAGNOSIS: As mentioned earlier *Gracilacus intermedius* is most closely related to *G. mirus* and *G. anceps* and are distinguished from them in the diagnosis of each.

HOLOTYPE: Female collected March 23, 1952 by the author. Catalogue number 210 University of California, Nematode Survey Collection, Davis.

PARATYPES: 51 females, same data as holotype, deposited in University of California, Nematode Survey Collection, Davis; four females, same data as holotype, two each deposited in United States Department of Agriculture Nematode Collection, Beltsville, Maryland and Nematode Collection, Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABITAT: Soil about the roots of Monterey cypress, *Cupressus macrocarpa* Hartweg.

TYPE LOCALITY: Two miles northeast of Bolinas, Marin County, California.

OTHER HABITATS: Soil about roots of California laurel near Napa, California; *Arctostaphylos manzanita*, highway 37, 10 miles south of Monticello, Napa County and *Arctostaphylos* sp., Moraga Ridge, Contra Costa County.

Gracilacus elegans n. sp. (Plate III C, D, Plate VI, L)

FEMALE: (9) 0.31 mm. (.27-.34 mm.); a = 24.0 (21.1-28.0); b = 2.0 (1.9-2.1); c = 9.8 (8.6-13.2); V = 72% (70-74%); stylet = 114 microns (110-119 microns).

HOLOTYPE: Female. 0.34 mm.; a = 28.2; b = 2.1; c = 12.1; V = 73%; stylet = 107 microns.

Female slender with fine body annulation faintly visible on bluntly rounded head region. Sclerotization delicate, stylet guide prominent. Hemizonid about

two body annules wide anterior to excretory pore which is situated one body width anterior to knobs of stylet. Ovary rudimentary, spermatheca prominent. Lips of vulva protrude very slightly. Cuticular vulvar flaps very small. Anus obscure. Tail elongate, tapering, ending in an acute, almost pointed, terminus.

DIAGNOSIS: *Gracilacus elegans* differs from all other species of this genus by having two lines in the lateral field area and a long slender body posterior

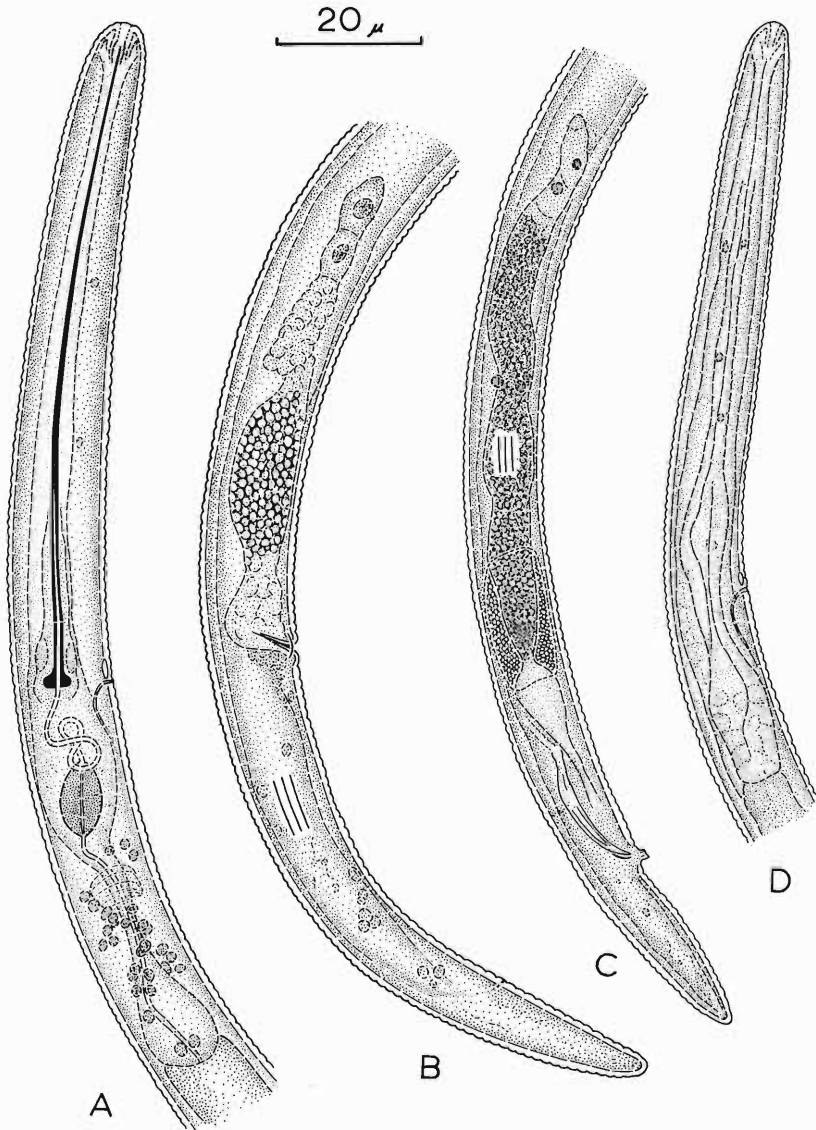


Plate V. *Gracilacus peraticus*, female head region—A, female tail region—B, male tail region—C, male head region—D.

to the vulva ($V = 72\%$). The long slender stylet (ave. = 114 microns) and esophagus (ave. $a = 2.0$) further distinguish it from other species.

HOLOTYPE: Female collected November 20, 1955 by the author. Catalogue number 211 University of California, Nematode Survey Collection, Davis.

PARATYPES: Eight females, same data as holotype, deposited in University of California, Nematode Survey Collection, Davis; two females, same data as holotype, one each deposited in United States Department of Agriculture Nematode Collection, Beltsville, Maryland and Nematode Collection, Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABITAT: Soil about roots of magnolia.

TYPE LOCALITY: Along marshy shore of lake on west side of highway near south end of Winter Haven, Florida.

Gracilacus peraticus n. sp. (Plate IV, A-D, Plate VI, H-1)

LARVA (SECOND-STAGE?): (11) 0.22 mm. (.20-.24 mm.); $a = 22.6$ (20.2-24.0); $b = 2.6$ (2.4-2.8); $c = ?$; stylet = 47 microns (44-51 microns).

Head rounded, lips protrude, slightly set off. Esophagus elongate, median bulb and valve moderately developed. Excretory pore opposite nerve ring. Tail elongate conical, terminus digitate or hook-like occasionally simply rounded.

LARVA (THIRD-STAGE?): 0.25 mm.; $a = 22.0$; $b = 2.7$; $c = ?$; stylet = 56 microns.

Lips definitely set off. Esophagus well developed. Tail elongate conical with rounded terminus.

LARVA (FOURTH-STAGE FEMALE?): (2) 0.28 mm. (.27-.28 mm.); $a = 25.4$ (22.4-28.3); $b = 3.3$ (3.2-3.3); $c = 10.6$; stylet = lacking.

Lips definitely set off but not so conspicuous as those of adult female. Esophagus elongate, moderately developed; median bulb with a valve; isthmus elongate. Sclerotization of lumen observable in anterior part of esophagus but no definable stylet present. Excretory pore near posterior bulb. Genital primordium forming the vagina at 72-82%. Tail digitate to hooked.

LARVA (FOURTH-STAGE MALE?): (2) 0.28 mm. (.25-.30 mm.); $a = 28.4$ (27.1-29.7); $b = ?$; $c = 10.3$ (9.7-10.9); stylet=lacking.

Slender larva. Lips rounded, not set off. Esophagus very slender, degenerate, median bulb and valve lacking. Developing spicules at 90-91%. Tail tapering, digitate to hooked.

FEMALE: (6) 0.31 mm. (.28-.34 mm.); $a = 24.5$ (14.1-30.1); $b = 2.4$ (2.3-2.6); $c = 13.8$ (12.4-16.4); $V = 78\%$ (77-79%); stylet = 92 microns (86-95 microns).

MALE: (2) 0.32 mm. (.30-.33 mm.); $a = 33.4$ (30.0-36.8); $b = 3.6$ (3.6-3.7); $c = 10.4$ (9.7-11.0); $T = 22\%$ (25-28%); stylet = lacking; spicules = 17 microns (17-18 microns); gubernaculum = 3 microns (3-4 microns).

HOLOTYPE: Female. 0.29 mm.; $a = 23.2$; $b = 2.3$; $c = 12.6$; $V = 78\%$; stylet = 78%; stylet = 90 microns.

Female slender. Lips protrude, distinctively set off. Sclerotization delicate. Lateral field with four, very delicate lines. Dierids and phasmids not observed. Excretory pore slightly anterior to knobs of stylet. Spermatheca well set off at anterior end of uterus. Lips of vulva protrude slightly, vulvar flap small and distinct. Anus obscure, rectum and prerectum not discernible. Tail elongate conoid with rounded tip.

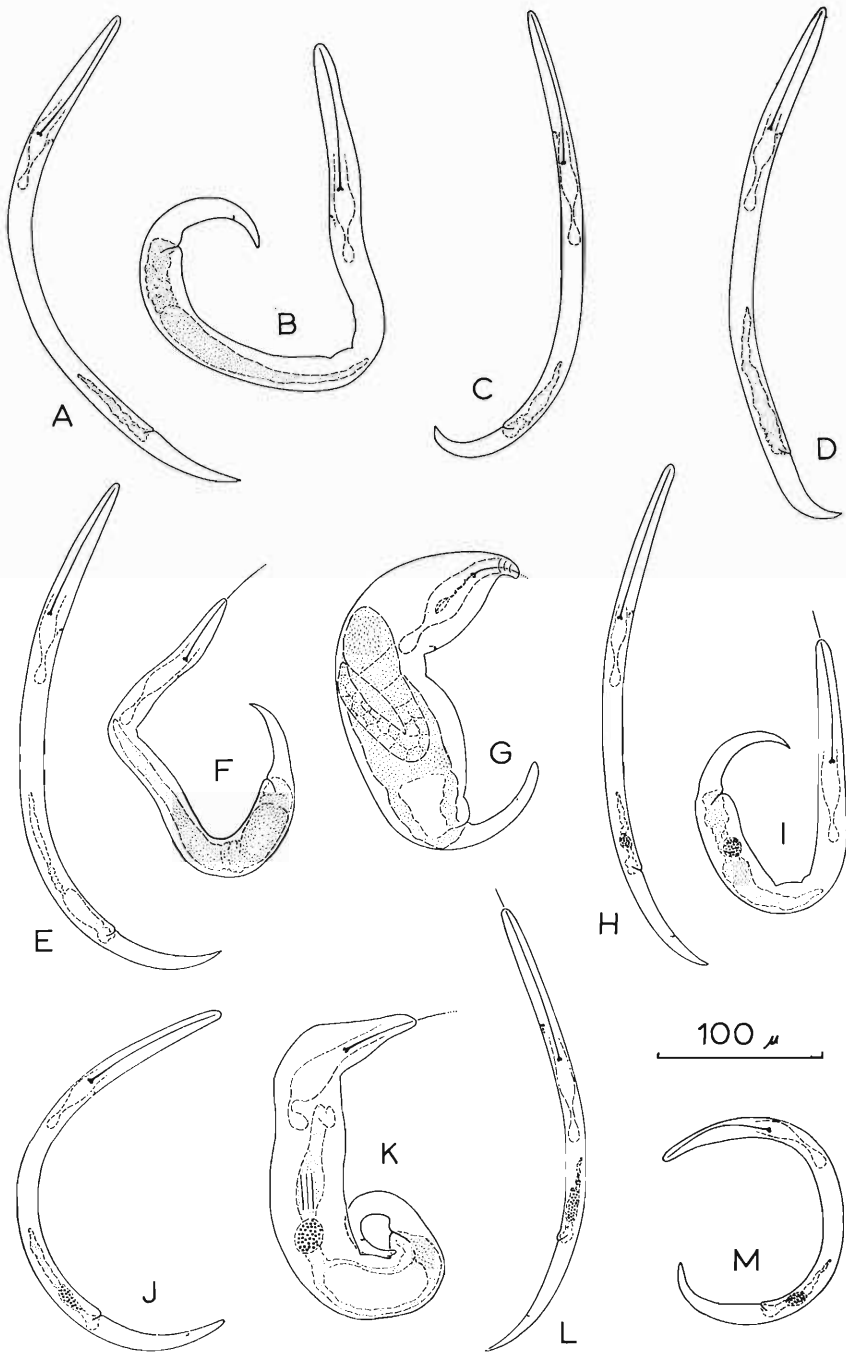


Plate VI. *Gracilacus* spp. A-B, E-G, *intermedius*; C, *anceps*; D, *mirus*; H-I, *peraticus*; J-K, *idalimus*; L, *elegans*; M, *steineri*.

ALLOTYPE: 0.30 mm.; a = 30.0; b = ?; c = 9.7; T = 28%; stylet = lacking; spicules = 18 microns; gubernaculum = 3 microns.

Small, very slender male with rounded head region, lips not set off. Sclerotization very delicate. Annulation fine, not discernible on head region. Esophagus degenerate, stylet lacking. Excretory pore 70 microns from anterior end. Spicules slender, curved. Gubernaculum simple rod-like. Caudal alae very short, distinct. Tail slender, conoid with rounded terminus.

DIAGNOSIS: *Gracilacus peraticus* is uniquely distinctive from other species in this genus by the protruding lips which are set off in both the larvae and adult female. It is most closely related to *G. epacris* but differs in the longer, more slender body shape posterior to the vulva in *peraticus*.

HOLOTYPE: Female collected June 25, 1959 by B. Weischer, Biologische Bundestalt für Land- und Forstwirtschaft, Münster, Germany. Catalogue number 212 University of California, Nematode Survey Collection, Davis.

ALLOTYPE: Male, same data as holotype. Catalogue number 213 University of California, Nematode Survey Collection, Davis.

PARATYPES: Four females, same data as holotype, deposited in University of California, Nematode Survey Collection, Davis; one female, one male, same data as holotype, deposited in Nematode Collection, Münster, Germany.

TYPE HABITAT: Soil about 30-year old grapevines.

TYPE LOCALITY: A slope of the valley of the Mosel at Rehlinger Trausch (near Nittler/Mosel), Germany.

Gracilacus idalimus n. sp. (Plate V, A-D, Plate VI, J-K)

LARVA (SECOND-STAGE?): (1) 0.21 mm.; a = 17.2; b = 2.8; c = ?; stylet = 30 microns.

Slender larva with bluntly rounded head. Annulation moderately strong, extending onto lip region. Sclerotization delicate, stylet guide prominent. Stylet and esophagus well developed. Excretory pore near posterior bulb. Tail tapers slightly with annulation almost to tip. Terminus bluntly rounded. Genital primordium very small, four-celled.

LARVA (FOURTH-STAGE?): (4) 0.26 mm. (.25-.28 mm.); a = 18.7 (16.3-22.1); b = 3.0 (2.7-3.2); c = 11.8; stylet = 40 microns (38-43 microns).

Slender larva with bluntly rounded head. Esophagus strongly developed. Stylet strong with knobs well set off. Excretory pore posterior to nerve ring. Tail slender, tapering to rounded terminus.

Specimens of both a female and a male observed inside cast cuticle with molted prohabdions of 34 and 37 microns respectively. This corresponds to the larval stylet measurements given above which indicates it would be the fourth-stage preadult.

Two specimens of larvae inside cast cuticles with a molted prohabdion of 24 microns were observed also. This corresponds closely with the first larva and suggests these specimens are the third stage. In both cases the esophagus was extremely reduced and degenerate with no stylet visible. However it is possible this condition represents the extreme change during molt and the fully developed larval stage is not present and could be quite different in structure.

FEMALES: (22) 0.32 mm. (.31-.46 mm.); a = 17.7 (4.6-28.0); b = 2.5 (2.4-2.6); c = 14.3 (14.1-14.5); V = 73% (71-76%); stylet = 83 microns (75-88 microns).

MALE: (6) 0.35 mm. (.29-.39 mm.); a = 24.0 (19.6-26.7); b = ?; c = 12.5 (10.3-13.5); T = 37% (35-41%); stylet = lacking; spicules = 18-20 microns; gubernaculum = 3-4 microns.

HOLOTYPE: Female. .35 mm.; a = 22.8; b = 2.4; c = ?; V = 74%; stylet = 85 microns.

Body tapering slightly anteriorly to a bluntly rounded head. Annules moderately strong extending faintly onto head region. Sclerotization weak, stylet guide prominent. Lateral field with three prominent lines. Hemizonid obscure, anterior to excretory pore which is opposite valve of median bulb. Lips of vulva not protruding. Cuticular flaps of vulva very reduced, indistinct. Spermatheca prominent. Anus obscure. Tail elongate conoid with bluntly rounded terminus.

ALLOTYPE: L. = 32 mm.; a = 26.7; b = ?; c = 12.0; T = 34%; stylet = lacking; spicules = 20 microns; gubernaculum = 4 microns.

Body slightly tapering anteriorly, ending in bluntly rounded head. Sclerotization delicate. Body annulation fine to moderately strong. Hemizonid prominent anteriorly adjacent to excretory pore, 79 microns from anterior end. Testis appears to be composed of two parts, the posterior portion completely surrounded by large granular gland. Spicules cephalated, slightly curved. Gubernaculum simple, rod shaped. Spicule sheath protrudes without hook-like process on posterior edge. Conoid tail narrows slightly posterior to spicules, forms conoid rounded terminus. Strong annulation almost to terminus.

DIAGNOSIS: *Gracilacus idalimus* is most closely related to *G. aculeatus* and *G. aciculus*, differing from both in the longer stylet of *G. idalimus* (ave. 83, 58, and 67 microns respectively. It also varies in the obese females found in *G. idalimus* with an elongate, rounded tail and a prominent lateral field.

HOLOTYPE: Female collected November 12, 1958 by S. D. Van Gundy. Catalogue number 214 University of California Nematode Survey Collection, Davis.

ALLOTYPE: Same data as holotype. Catalogue number 215 University of California, Nematode Survey Collection, Davis.

PARATYPES: 24 females, 19 males, same data as holotype deposited in University of California, Nematode Survey Collection, Davis; two females, two males, same data as holotype, one each deposited in United States Department of Agriculture Nematode Collection, Beltsville, Maryland and Nematode Collection, Citrus Experiment Station, Lake Alfred, Florida.

TYPE HABITAT: Soil about the roots of *Ericameria palmeri* (Gray) Hall.

TYPE LOCALITY: University of California, Riverside, California.

CRICONEMATIDAE Thorne, 1943

DIAGNOSIS (EMENDED): Tylenchoidea. Procorpus and metacorpus swollen and amalgamated into a very large valvated bulb; isthmus short and broad, very reduced or almost lacking. Stylet of females very strongly developed, prohabdion much longer than meso-metarhabdions; male degenerate, stylet lacking. Cuticle heavily annulated, often retrorse, sometimes with scales or spines. Three genera bear a fifth cuticle on adult female (*Criconema*, *Hemicyclophora*, *Hemicriconemoides*). Vulva near posterior end. Ovary single. Postuterine branch lacking. Caudal alae present, well developed.

GENERA: *Criconema* Hofmänner & Menzel, 1914

Criconemoides Taylor, 1936

Hemicycliophora de Man, 1921

Hemicriconemoides Chitwood & Birchfield, 1957

GENUS *Paratylenchus* Micoletzky, 1922

DIAGNOSIS (EMENDED): Paratylenchidae. Small species, .5 mm. or less. Female slender, stylet short <36 microns. Body posterior to vulva elongate. Cuticle finely annulated, without ornamentation. Excretory pore at level of nerve ring or further posterior. Male slender, active, stylet absent or reduced. Caudal alae absent or at most a ventral flattening in anal region. Ovary single. Testis one.

GENUS *Cacopaurus* Thorne, 1943

DIAGNOSIS (EMENDED): Paratylenchidae. Small species, .3 mm. or less. Larvae with strong, elongate stylet. Female short and stout to obese with stylet about 100 microns in length. Cuticle ornamented with minute, refractive elements. Excretory pore in the region of the metacarpus near the valve or further anterior. Body posterior to vulva very short and bluntly rounded. Male slender, active, stylet absent. Caudal alae represented by thickened, cuticular evaginations. Ovary single. Testis one.

TYPE SPECIES: *Cacopaurus pestis* Thorne, 1943

LARVA (SECOND-STAGE?): (7) 0.27 mm. (.24-.30 mm.); a = 25.7 (23.2-30.0); b = 3.2 (3.0-3.5); c = ?; stylet = 42 microns (39-45 microns).

Head rounded, lightly sclerotized. Stylet knobs small, delicate, backwardly directed. Esophagus slender, moderately developed. Excretory pore near or posterior to nerve ring. Tail elongate conoid with bluntly rounded tip.

LARVA (FOURTH-STAGE?): (6) 0.23 mm. (.21-.25 mm.); a = 12.8 (8.0-16.5); b = 2.3 (2.1-2.5); c = ?; stylet = 60 microns (55-66 microns).

Head rounded. Esophagus stout, strongly developed. Excretory pore opposite valve in median bulb.

LECTOTYPE: Female. 0.21 mm.; a = 6.9; b = 2.2; c = ?; V = 93% stylet = 92 microns.

The lectotype was selected from original material collected from walnut, *Jualans regia* Linn., variety Mayette, near Santa Clara, California, May 12, 1942, and used by Thorne in the description of this species. Slide T-21t, United States Department of Agriculture Nematode Collection, Beltsville, Maryland.

DISCUSSION: The illustrations in the original description distinguish two larval stages which were figured separately by Thorne but in the written description both stages were included in the range of size, shape and stylet length.

The molted prorhabdion of the fourth-stage larval stylet was observed on two specimens of newly molted adult females. These measured 50 and 58 microns respectively. The specimens (larva) most closely fitting this figure bear a stylet of 55-66 microns with a prorhabdion 48-56 microns in length.

The stylet of the adult female was described as 40-110 microns. The lower range is undoubtedly from specimens in which the stylet was broken during collection. Four specimens with the stylet intact showed an average stylet size of 97 microns (92-102 microns).

The lateral field was described as "three lines extending from near the middle of the neck to the terminus, each line composed of two rows of minute

elements". These are broader than lines and more like bands, and in disposition actually present the appearance of four lines setting off these three bands.

DISCUSSION

The work reported here has included detailed studies of certain characters which merit special emphasis. First is the **STYLET** development in larval forms. The original description of *C. pestis* emphasized the well developed stylet of the larvae. It further suggested to the authors of *C. pestis* that *G. anceps* might be a *Cacopaurus* because of the large, robust stylet found in the larvae of that species. The larvae of *G. epacris* also were described with stylets similar to *C. pestis*.

The larvae of *Paratylenchus* were not known to be so well endowed and were characterized by Thorne (1943) as frequently found living free in the soil and did not possess a well-developed spear. Thorne and Allen (1950) further reported the recovery of immature forms of *P. hamatus* lying dormant in the soil. Rhoades and Linford (1959) specifically identified this stage as the nonfeeding, preadult larvae in their studies on *P. projectus* and *P. dianthus*.

It is true that the predominant larval stage of *Paratylenchus* found in most soil samples is the preadult fourth-stage in which the stylet is very degenerate or lacking. However, in collections of at least two species, *P. hamatus* and *P. elachistus*, younger larval stages have been found which possess a stylet approximately 13-16 microns long. The preadult larvae of these two species have a degenerate stylet which is apparently non-functional. The larvae of *Cacopaurus* and *Gracilacus* show that the preadult stage is variable with regard to the development of the esophagus and stylet. In *C. epacris* and *G. peraticus* the preadult is a dormant, nonfeeding stage without a stylet. Adult females and males of *C. pestis*, *G. sarissus* and *G. idalimus*, however, have been observed inside molted cuticles containing the prohabdion of the previous stage. These stylet remnants have been very prominent indicating a strong stylet in the preadult. More information is needed on the life cycles in these genera to be able to compare and judge these differences in larval structures. Until more precise studies under controlled conditions are made with single specimens, such information is only attainable by interpretation of field samples. Unfortunately specimens usually occur in low numbers in natural habitats and the evidence is incomplete. Mixtures of species and/or genera also are common. Larval males and females are not always easy to distinguish. Specimens in the process of molting may present further difficulties when one tries to decide whether the specimens are lacking a stylet or have a degenerate structure. The male stylet is completely lacking in eight species of *Gracilacus* but is present as a reduced organ in males of *goodeyi*.

The use of the **OBESE FEMALE** body shape as a taxonomic character will depend on more complete collections in the future. The degree to which some of these species enlarge seems to vary considerably. Also the specimens may be rare in some soil samples and abundant in others. Because of the sluggish to immobile condition of such specimens special attention must be given to their recovery from soil by use of coarse screens and the examination of heavy sedimented materials. Collection in this manner led to the discovery of the extreme size in *G. intermedius* (Plate VI, G) even though swollen specimens of the same species (Plate VI, B and F) were relatively common.

The occurrence of obese females in *C. pestis*, *G. epacris*, etc., appears to be associated with the elongated stylet in the female. It is possible that the obesity of these species derives from their evolution as a sessile type parasite which no longer migrates in search of food once feeding is started. In any event, more information is needed to understand the nature and taxonomic importance of the swollen female stage of these various species.

The first reference to the EXCRETORY PORE as an indication of relationship of species of *Paratylenchus* was by Tarjan (1960). In discussing *Hemicyclophora strenzkei* he pointed out the position of the excretory pore near the metacarpus suggested that species was related to *Cacopaurus*. It has been found that the position of the excretory pore is variable among the species described. In *Paratylenchus* the pore is located near the nerve ring, midway in the isthmus, or as far back as the posterior bulb.

In *C. pestis* and most species of *Gracilacus* the pore is located near the metacarpus or further forward but in four species, *G. marylandicus*, *G. audriellus*, *G. sarissus* and *G. goodeyi*, it is near the nerve ring. The basic position of the excretory pore is best observed in the slender females before feeding begins. When the stylet is extruded the esophagus appears to have shortened and the pore located further posterior relative to the esophagus.

The description of SPERMATHECA in the females of three species (*G. steineri*, *G. gracilis*, and *G. anceps*) for which males are unknown suggests this structure may be more correctly identified as a spermagonium. Unfortunately there has been only a limited number of specimens of these species collected so far. It is quite possible males are present in natural field populations.

However the specimens available for study are young slender females recently molted. The ovary is rudimentary yet the spermatozoa are found in considerable numbers. In *G. gracilis* the uterus is constricted near the vagina then swells anteriorly full of spermatozoa. The anterior end is a blind sac and the ovary continues anteriorly from the lateral side of the uterus. The same is true for *G. anceps* but differs in that the spermatozoa appear to be much smaller. In both species there is apparently a specialized cell at the anterior end of the uterine wall which produces the spermatozoa.

The extension of the cuticle into VULVAR 'FLAPS' at the lateral margins of the vulva is typical of most females of *Paratylenchus* and has been described for *C. epacris*. However it is lacking in *C. pestis* and *G. steineri* and is very reduced in other species. This character is variable and may be of limited use in specific diagnosis but is not considered a generic differentiation.

The CAUDAL ALAE of *C. pestis* were described by Thorne (1943) as 'small, obscure, appearing to be only a slight evagination of the cuticle.' He also compared this structure with that of a male of *Paratylenchus hamatus* which he described as similar but more obscure. Plate I, A-F illustrates these structures in cross section and shows the simple development of the caudal alae of these species. *G. epacris* appears to be intermediate between *C. pestis* and *P. hamatus*.

SUMMARY

A new family Paratylenchidae is proposed to include the following genera: *Paratylenchus* Micoletzky, 1922, *Cacopaurus* Thorne, 1943, *Gracilacus* n. g.

The new genus *Gracilacus* is proposed to include five new species, *G. elegans*, *G. mirus*, *G. intermedius*, *G. peraticus* and *G. idalimus*.

A redescription of *Paratylenchus anceps* is presented and a neotype designated. The following species are transferred to *Gracilacus*: *Paratylenchus*

anceps, *P. goodeyi*, *P. aciculus*, *P. aculentus*, *P. audriellus*, *P. sarissus*, *P. marylandicus*, *P. steineri*; *Cacopaurus epacris*.

Emended diagnoses are presented for the family Criconematidae and for the genera *Paratylenchus* and *Cacopaurus*.

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Paracephalobus* (Nematoda: Cephalobidae) A New Genus of Soil-Inhabiting Nematodes

S. A. AKHTAR

Among the nematodes collected in a soil sample taken in November 1960, from around the roots of sugarcane, *Saccharum officinarum* L., cultivated in plots within the laboratories area, were two female nematodes belonging to the subfamily *Cephalobinae* Filipjev, 1934. The subfamily now contains 3 genera, viz., *Cephalobus* Bastian, 1865, *Eucephalobus* Steiner, 1936, and *Heterocephalobus* Brzeski, 1960. Because the females show certain characters

*From West Regional Laboratories, Soil Zoology, Lahore.

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