

Descriptions of Females (Emended), a Male, and Juveniles of *Paralongidorus microlaimus* (Nematoda: Longidoridae)

R. T. ROBBINS¹

Abstract: The male and juveniles of *Paralongidorus microlaimus* Siddiqi, 1964, are described and the female description emended. A key to the nominal species of the genus is given. *Key Words:* Taxonomy, Longidoridae.

In April 1974 *Paralongidorus microlaimus* Siddiqi, 1964, was found in association with roots of declining almond (on almond rootstock) and interplanted Persian walnut (on California black walnut rootstock) growing in Zamora silty clay loam in Glenn County, California. The nematode was not found associated with various grasses and weeds growing among the almonds or in adjacent fields of safflower or prunes. As many as 146 *P. microlaimus* per 400 cm³ of soil were found, including numerous females, all 4 juvenile stages, and 1 male specimen. A later sampling revealed as many as 389 *P. microlaimus*/400 cm³ of soil, but no additional males. This nematode had been collected in 1962 from a Sutter County, California, walnut orchard, but not identified until recently.

The original description of *P. microlaimus* was from one holotype female (8). I have not examined the holotype, but Siddiqi has examined females from the California population and suggested that a redescription of the female would be desirable. Therefore, a redescription of the species was undertaken to include descriptions of the male and juvenile stages.

MATERIALS AND METHODS

The nematodes were killed and fixed by the slow addition of boiling 4% formalin to water containing the nematodes until the original volume was doubled. They were processed to glycerine by modifying Seinhorst's rapid method (6) as follows: step 1, eliminate ethanol; step 2, keep at room temperature at least 24 hours; and step 4, keep at room temperature. Specimens were

also studied using the SEM. Materials and methods for SEM work are as described by Sher and Bell (7). Parenthetic measurements in the descriptions represent population range.

SYSTEMATICS

Paralongidorus microlaimus
Siddiqi, 1964
(Fig. 1, 2)

MEASUREMENTS

Female (Holotype; from Siddiqi, 1964): L = 3.05 mm; a = 76; b = 10.6; c = 98; V = ^{7.6} 49 ^{6.8}; odontostyle = 65 μm; odontophore = 46 μm; total stylet length = 111 μm; tail length = 31 μm; lip width = 10 μm; (following from Siddiqi, 1964, illustrations: c' (tail/anal body diameter) = 1.1; DGR (distance from anterior end to guide ring) = 29 μm.

Females (n = 30): L = 3.26 mm (2.72-3.73); a = 77 (66-89); b = 9.5 (8.2-12.4); c = 112 (85-150); V = ^{6.0} 50 ^{5.5} (⁴⁻⁸ 46-54 ⁴⁻⁷); odontostyle = 76 μm (71-84); odontophore = 53 μm (50-59); total stylet length = 130 μm (125-136); c' = 1.0 (0.8-1.2); tail length = 29 μm (24-32); DGR = 35 μm (33-38); distance from anterior end to hemizonid = 157 μm (146-169); lip width = 11 μm (10-12).

Male (n = 1): L = 3.54 mm; a = 75; b = 9.6; c = 110; T = 51; odontostyle = 73 μm; odontophore = 59 μm; total stylet length = 132 μm; spicules = 55 μm; c' = .94; tail length = 32 μm; DGR = 36 μm; distance from anterior end to hemizonid = 152 μm; lip width = 11.5 μm.

Juveniles: All four stages, see Table 1.

DESCRIPTIONS

Females (emended): Lips amalgamated, inner circle of 6 papillae, outer circle of 10 (light microscope and SEM, Fig. 1, 3). Guide ring slightly greater than 3 lip widths

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¹Plant Nematologist III, Laboratory Services/Nematology, Division of Plant Industry, California Department of Food and Agriculture, 1220 N Street, Sacramento, CA 95814. I express appreciation to A. R. Maggenti and E. M. Noffsinger (University of California, Davis) for their help in preparing this manuscript, and to A. H. Bell and J. L. Imbriani (University of California, Riverside) for technical SEM assistance.

TABLE 1. Biometrical characters of the juvenile stages of *Paralongidorus microlaimus*.

Character	L1	L2	L3	L4
n	12	8	13	13
L (mm)	1.09 (1.01-1.23) ^a	1.35 (1.25-1.50)	1.68 (1.53-1.89)	2.43 (1.85-2.77)
a	53 (48-59)	56 (53-60)	65 (60-71)	74 (65-83)
b	4.5 (3.9-5.0)	5.5 (3.6-6.9)	5.9 (4.8-6.8)	7.3 (6.3-8.7)
c	39 (36-42)	45 (42-50)	56 (50-63)	81 (62-93)
Odontostyle (μm)	51 (49-53)	53 (51-56)	57 (54-59)	67 (63-71)
Odontophore (μm)	34 (30-38)	38 (35-40)	46 (43-50)	50 (47-55)
Total stylet length (μm)	85 (80-87)	91 (86-95)	103 (99-107)	117 (109-122)
Replacement odontostyle (μm)	54 (53-56)	57 (54-61)	65 (60-68)	77 (72-81)
c'	2.0 (1.8-2.2)	1.8 (1.6-1.9)	1.6 (1.4-1.7)	1.2 (1.1-1.4)
Tail length (μm)	28 (26-30)	30 (28-33)	30 (28-33)	30 (28-33)
Body width (μm)	21 (20-23)	24 (22-26)	26 (23-27)	33 (28-38)
DGR (μm)	22 (22-23)	23 (22-24)	26 (25-28)	30 (27-31)
Distance from anterior end to hemizonid (μm)	103 (101-110)	111 (106-120)	123 (108-130)	139 (128-150)

^aMeans, with range in parentheses.

from anterior end (Fig. 1). Distance from stylet base to nerve ring variable with degree of stylet extrusion. Expanded esophagus base 94 μm (83-104) long, 17 μm (16-23) wide. Esophageal glands typical of genus. Cuticle composed of several layers, marked by fine transverse striae (light microscope and SEM, Fig. 2, 3). Anterior and posterior gonads reflexed to same or opposite sides of body.

Male: Similar to female, differing only in primary and secondary sexual characteristics. Tail conspicuously more ventrally curved than female. Series of 6 supplements: 4 ventral, unevenly spaced; 2 ventro-submedian, 12 and 16 μm anterior to anus (Fig. 2).

Juveniles: Similar to females. Tails of first three juvenile stages narrower than females, all approximately same length

(Fig. 2). Juvenile stages distinguished by size, shape, and number of cells of genital primordia when visible (Fig. 1). Biometric ranges sometimes overlap between successive juvenile stages (Table 1). When overlap occurred, length of body and stylet were relied on to identify the stage. Most individuals with overlapping range showed signs of approaching molt.

DIAGNOSIS

Females closely resemble *P. erriae* Heyns (1 & 2) and *P. spiralis* Khan, Saha and Seshadri (4). Females differ from *P. spiralis* by: assuming a "c" or "j" shape instead of a spiral shape when killed; a lesser distance to guide ring (29-38 vs. 40-48 μm); having slightly set off vs. continuous lips; usually narrower lip region (10-12 vs. 11-14 μm).

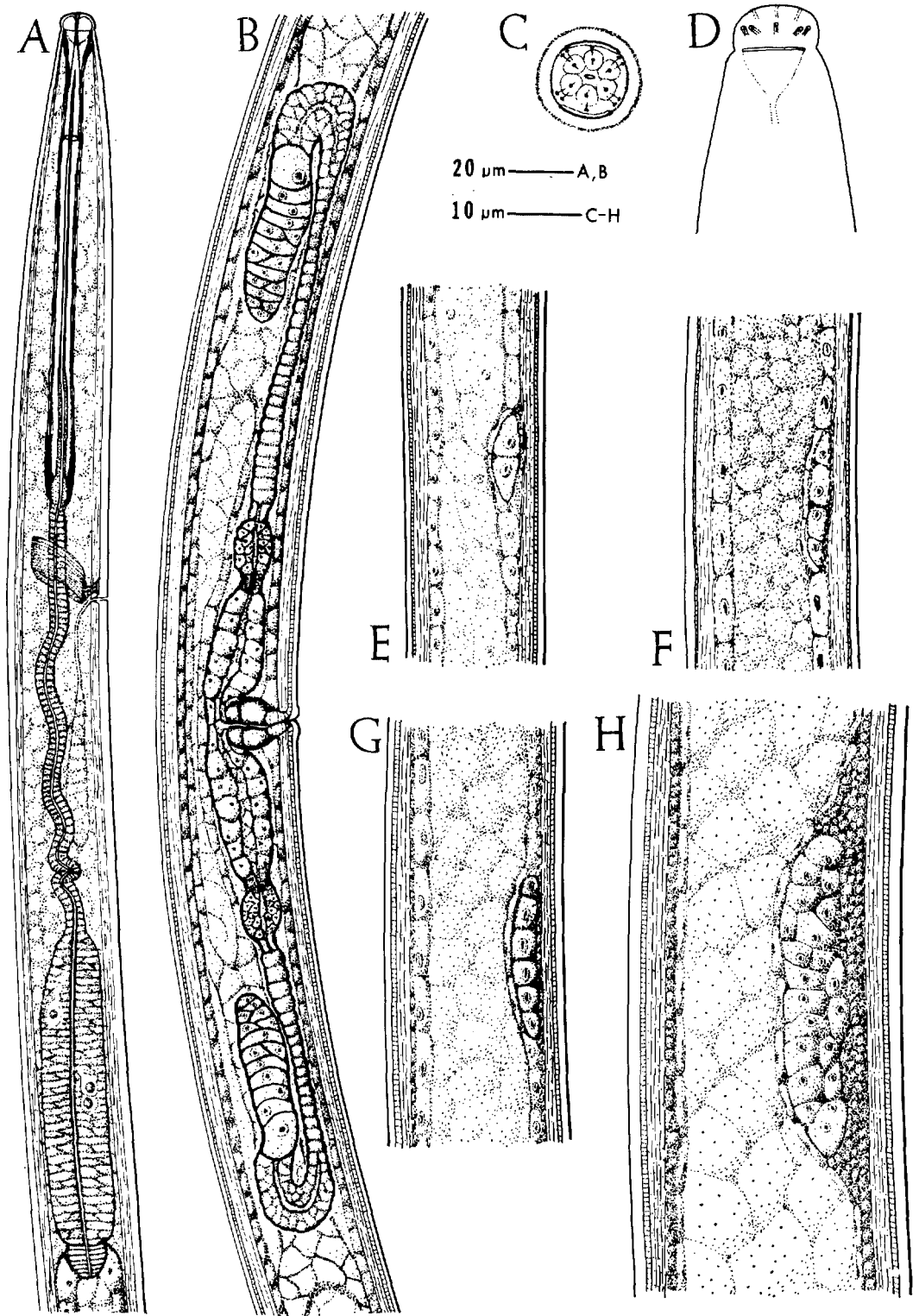


FIG. 1.—(A-H). *Paralongidorus microlaimus*. A-D) Female. A) Anterior region. B) Vulval region. C) Face view. D) Head. E-H) Genital primordia of juveniles. E) First-stage. F) Second-stage. G) Third-stage. H) Fourth-stage.

Females differ from *P. erriae* by: body usually shorter (2.72-3.73 vs. 3.23-5.60 mm); and distance to guide ring greater (3 vs. 2 lip widths).

The male of *P. microlaimus* differs from other known species of *Paralongidorus* by having 4 irregularly placed ventral supplements vs. 7-15 regularly placed ventral supplements. The 2 ventrosubmedian supplements of *P. microlaimus* occur at different distances from the anus and thus are not a true adanal pair. Excepting *P. erriae*, the male of *P. microlaimus* is shorter in total length (3.54 vs. 4.3-10.7 mm) and has a shorter odontostyle (73 vs. 105-211 μm) than all other known males of this genus.

Slides of the male, females, and juveniles of the California population of *P. microlaimus* have been deposited at the University of California Nematode Collection, Davis. Slides of females and juveniles are deposited at the California Department of Food and Agriculture Nematode Collection, Sacramento; and USDA Nematode Collection, Beltsville, Maryland.

DISCUSSION

The odontostyle and odontophore length and DGR are slightly less for the holotype than for the California population of *P. microlaimus*. The differences are believed minor and within the range of species variation found in Longidoridae. No other morphological differences were found.

While using the light microscope, very small structures (appearing setae-like) were observed on specimens of *P. microlaimus*. This prompted an SEM study of the surface structures of this nematode. In subsequent SEM examinations, these structures were not found. SEM examination of the anterior region confirms the number and placement of papillae on the lips and the large amphid openings. Small transverse striae are found on the surface the entire body length.

The nominal species of *Paralongidorus* listed by Lamberti (5) are included in the key. The following species are also included in the key: *P. droseri* Sukul (9); *P. fischeri* Heyns (2); *P. major* Verma (10); *P. oryzae* Verma (10); *P. similis* Khan, Chawla, and Prasad (3); and *P. spasskii* Heyns (2). This key is based on published descriptions of all nominal species of *Paralongidorus* found

by manual search and by searches of commercially available computerized data bases. In the key, if the range of species overlaps a couplet, the species is included in both couplets.

KEY TO THE NOMINAL SPECIES OF *PARALONGIDORUS* (FEMALES)

1. Odontostyle 93 μm or less 2.
 Odontostyle 96 μm or more 13.
2. Total length less than 4 mm 3.
 Total length 4 mm or more 8.
3. DGR less than 40 μm 4.
 DGR 40 μm or greater
 *P. spiralis* Khan, Saha and Seshadri, 1972.
4. Lip width less than 10 μm 5.
 Lip width 10 μm or more 6.
5. Lips continuous, *c'* 1.0 or less
 *P. similis* Khan, Chawla and Prasad, 1971.
 Lips slightly offset, *c'* 1.0 or greater
 *P. oryzae* Verma, 1973.
6. Amphid slit length/width of lips (AS/WL)
 0.67 or more 7.
 AS/WL 0.5 or less
 *P. utriculoides*
 (Corbett, 1964) Siddiqi and Husain, 1965.
7. DGR about 3 lip widths, head rounded,
 cardia distinct, lips slightly offset, mean
 total length 3.3 mm
 *P. microlaimus* Siddiqi, 1964.
 DGR about 2 lip widths, head flattened,
 cardia indistinct, lips definitely offset,
 mean total length 4.1 mm
 *P. erriae* Heyns, 1965.
8. Total length 5.8 mm or greater 9.
 Total length 5.6 mm or less 10.
9. DGR 38 μm or greater, *c'* 1.1 or greater
 *P. lutosus* (Heyns, 1965) Aboul-Eid, 1970.
 DGR 35 μm or less, *c'* 0.9 or less
 *P. spasskii* Heyns, 1972.
10. Odontostyle usually 65 μm or greater; if less,
 lips slightly offset 11.
 Odontostyle 65 μm or less, lips continuous,
 AS/WL 0.4 or less
 *P. utriculoides*
 (Corbett, 1964) Siddiqi and Husain, 1965.
11. DGR 31 μm or less, AS/WL greater than
 0.67 12.
 DGR 33 μm or greater, AS/WL less than 0.5
 *P. fischeri* Heyns, 1972.
12. Lip width 17 μm , tail tip narrowly rounded
 *P. beryllus* Siddiqi and Husain, 1965.
 Lip width 15 μm or less, tail tip broadly
 rounded *P. erriae* Heyns, 1965.
13. Total length 7.6 mm or greater 14.
 Total length less than 7.6 mm 17.
14. V 44% or greater, lip width less than 30 μm ,
 c' 0.7 or greater 15.
 v. less than 41%, lip width 35 μm or greater,
 c' 0.5-0.6
 *P. maximus* (Bütschli, 1874) Siddiqi, 1964.
15. Odontostyle greater than 150 μm 16.
 Odontostyle less than 150 μm
 *P. capensis* Heyns, 1966.

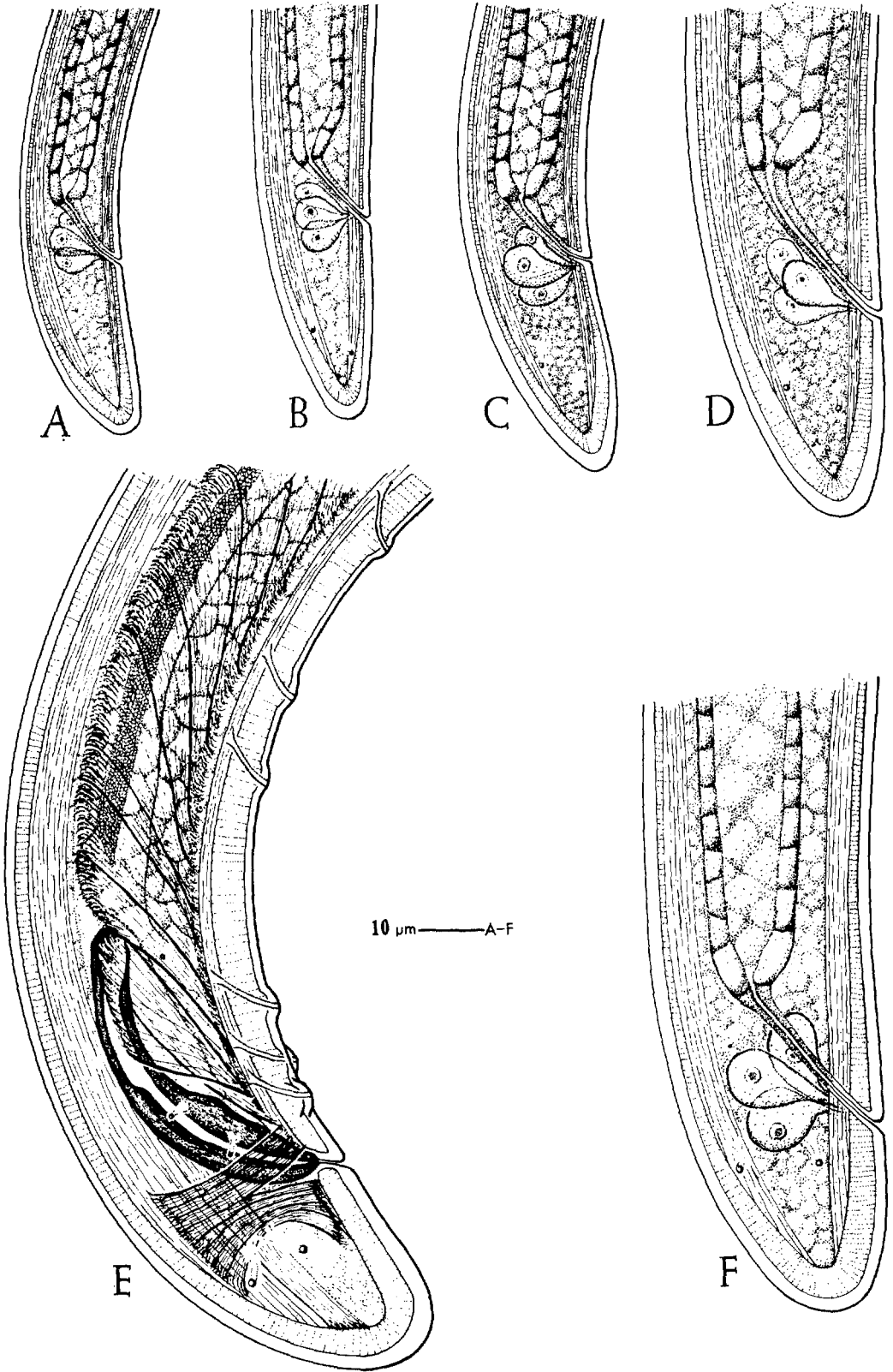




FIG. 3-(A-C). Scanning electron micrographs of *Paralongidorus microlaimus*. A-B) Anterior region. A) Adult female. B) Fourth-stage juvenile. C) Vulval region.

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| 16. DGR 60 μm or greater, odontostyle less than 185 μm <i>P. hooperi</i> Heyns, 1966. | 27. Lip width less than 21 μm 28. |
| DGR 35 μm or less, odontostyle greater than 200 μm <i>P. epimikis</i> Dalmasso, 1969. | Lip width greater than 22 μm 29. |
| 17. Odontostyle 155 μm or less 18. | <i>P. paramaximus</i> Heyns, 1965. |
| Odontostyle 170 μm or greater 19. | 28. DGR less than 35 μm 29. |
| <i>P. renyi</i> (Altherr, 1963) Siddiqi and Husain, 1965. | DGR greater than 35 μm 30. |
| 18. c' greater than 2.2 19. | 29. Odontostyle 120 μm or less, total length 5.2 mm or less, lips continuous 29. |
| c' less than 1.6 20. | <i>P. sacchari</i> Siddiqi, Hooper and Khan, 1963. |
| 19. DGR 34 μm or greater, lips continuous, total length over 4.5 mm 21. | Odontostyle 124 μm or greater, total length 5.6 mm or more, lips slightly offset 30. |
| <i>P. flexus</i> Khan, Seshadri, Weischer and Mathen, 1971. | <i>P. fici</i> Edward, Misra and Singh, 1964. |
| DGR less than 30 μm , lips slightly offset, total length less than 4.2 mm 22. | 30. Lips offset, AS/WL 0.8, c 111-151, width of esophagus base 19 μm or less 29. |
| <i>P. afzali</i> (Khan, 1964) Siddiqi and Husain, 1965. | <i>P. eucalypti</i> Fisher, 1964. |
| 20. Total length greater than 3 mm 21. | Lips slightly offset, AS/WL 0.6-0.7, c 156-212, width of esophagus base 20 μm or more 30. |
| Total length less than 3 mm 22. | <i>P. capensis</i> Heyns, 1966. |
| <i>P. sali</i> Siddiqi, Hooper and Khan, 1963. | 31. DGR usually 35 μm or less, lip width 17 μm or less 32. |
| 21. DGR 49 μm or greater 22. | DGR usually 35 μm or more, lip width 18 μm or more 33. |
| DGR 47 μm or less 24. | 32. Odontostyle 122 μm or less, AS/WL 0.6-0.7, lip width 14-16 μm , c 167 or less 32. |
| 22. AS/WL 0.6 or more, total length less than 5.0 mm 23. | <i>P. major</i> Verma, 1973. |
| AS/WL 0.2, total length greater than 5.0 mm 24. | Odontostyle 124 μm or more, AS/WL 0.5, lip width 17 μm , c 166 or more 33. |
| <i>P. strelitziae</i> (Heyns, 1966) Aboul-Eid, 1970. | <i>P. fici</i> Edward, Misra and Singh, 1964. |
| 23. DGR 52 μm or less 25. | 33. AS/WL 0.6 or greater, a 122 or less 34. |
| <i>P. boshi</i> Khan, Saha and Seshadri, 1972. | AS/WL 0.4, a 122 or greater 34. |
| DGR 62 μm or greater 26. | <i>P. citri</i> (Siddiqi, 1959) Siddiqi, Hooper and Khan, 1963. |
| <i>P. xiphinemoides</i> Heyns, 1965. | 34. c 199 or greater, cardia flattened 34. |
| 24. Lip width 14 μm or greater, total length 4.1 mm or greater 25. | <i>P. georgiensis</i> (Tulaganov, 1937) Siddiqi, 1965. |
| Lip width 12 μm , total length less than 4.1 mm 26. | c 181 or less, cardia elongated 34. |
| <i>P. nudus</i> (Kirjanova, 1951) Lamberti, 1975. | <i>P. droseri</i> Sukul, 1971. |
| 25. V 45% or more 26. | |
| V 44% or less 31. | |
| 26. Odontostyle usually 105 μm or more; if less, lips continuous; AS/WL 0.8 or greater 27. | |
| Odontostyle 105 μm or less, lips offset expanded, AS/WL 0.5 27. | |

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FIG. 2-(A-F). *Paralongidorus microlaimus* posterior regions. A-D) Juveniles. A) First-stage. B) Second-stage. C) Third-stage. D) Fourth-stage. E) Male. F) Female.

34 *Journal of Nematology, Volume 10, No. 1, January 1978*

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