

# Description of *Thecavermiculatus andinus* n.sp. (Meloidoderidae), a Round Cystoid Nematode from the Andes Mountains of Peru

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**Abstract:** *Thecavermiculatus andinus* n.sp. is described and illustrated from *Oxalis tuberosa* originally collected in the vicinity of Lake Titicaca high in the Andes mountains of southern Peru. This new species differs markedly from the other two species in the genus, especially in having a much greater female vulval-anal distance and annules with lined punctation on most of the female body with a lacelike pattern restricted to the posterior portion, particularly at the vulva and anus which do not protrude. Females are essentially spherical with protruding neck, white to yellowish in color, and can easily be mistaken for potato cyst nematodes. Among the dozen or more known weed and crop host plants are potato and eggplant. In order to accommodate this new species, the genus *Thecavermiculatus* is emended. A key to the species of this genus is presented. **Key words:** taxonomy, morphology, *Thecavermiculatus*, new species, cystoid nematode, *Oxalis tuberosa*, potato, hosts.

Journal of Nematology 15(3):357-363. 1983.

On several collection trips in 1976, 1977, and 1978 to the southern highlands of Peru in the Department of Puno near Lake Titicaca, Jatala et al. (5) noted on the roots of several nonsolanaceous plants, females which appeared to be potato cyst nematodes (*Globodera rostochiensis* [Wollenweber, 1923] Behrens, 1975 and *G. pallida* [Stone, 1973] Behrens, 1975). Using specimens collected in the field from *Oxalis tuberosa* Mol. and *Chenopodium quinoa* Willd., they found in a preliminary test that these plants and potato (*Solanum tuberosum* subsp. *andigena* [Juz. & Buk.] Hawkes) were hosts for this nematode. In their report, Jatala et al. (5) pointed out that several earlier workers in Peru had thought that the above plants, and some others, were hosts for potato cyst nematodes and had seen "white cysts" on the roots of *O. tuberosa*, *Tropaeolum tuberosum* (Ruiz and Pav.), and *Medicago* species in the central and northern highlands of Peru. According to Jatala et al. (5), Franco (unpublished) tested these species in a greenhouse with *G. pallida* and was unable to find cysts on their roots.

In the summer of 1979 we critically studied the morphology of this nematode from Lake Titicaca and found that it was not a *Globodera* species despite the facts that females, to the unaided eye and even under low magnification, were similar to po-

tato cyst nematodes and could also be found on potato roots. In 1980 Franco et al. (2) gave additional details about this nematode and clarified and expanded its previously known host range. Golden et al. (3) in 1981 discussed the morphology of this form and indicated it could be placed in the genus *Thecavermiculatus* of the subfamily Ataloderinae with some generic changes. Accordingly, we describe herein this nematode from Lake Titicaca as a new species in the above genus and propose certain emendations to that genus; the emendations include male characteristics since males were unknown when the genus was established.

## MATERIALS AND METHODS

Specimens used in this description were obtained from cultures originating near Lake Titicaca and grown on *Oxalis tuberosa* (and other hosts) in a greenhouse at La Molina, Lima, Peru. Females were removed directly from the plant roots and larvae were hatched from females placed in water in small dishes. Males were recovered from soil by sieving and Baermann funnel extraction. The procedures used in measuring, drawing, and preparing specimens were essentially those used by Golden and Birchfield (4) except that some fixed females were cut and mounted in clear lactophenol solution. Photomicrographs of single females and portions of females were made with an automatic 35 mm camera attached to a compound microscope having an interference contrast system; those of infected roots and groups of females were made

Received for publication 29 September 1982.

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Appreciation for technical assistance is extended to Donna M. S. Ellington, Support Scientist, and Paula Crowley, Laboratory Technician in laboratory of senior author.

with a  $8.3 \times 10.8$ -cm sheet-film camera attached to a dissecting microscope.

## SYSTEMATICS

Genus *Thecavermiculatus* Robbins, 1978

*Diagnosis* (emended)—Ataloderinae. *Female*: Cuticle annulated in neck region or on most of body, but lacelike pattern on posterior portion of body. Body round to oval, with protruding neck. Anus and vulva terminal or nearly so, and may or may not be on a slight prominence. Eggs develop quickly into second-stage juveniles and hatch. The body of older females is filled with second-stage juveniles. No cyst stage.

*Second-stage juvenile*: SEM shows a distinct labial disc. Esophageal glands fill one-half or less of the body width. Phasmids with lenslike structures.

*Male*: 1 mm or more in length. Labial disc present. No longitudinal striations on basal head annule. Tail short, if present. Cloacal opening ventroterminal, or ventrally subterminal.

*Type species*: *Thecavermiculatus gracililancea* Robbins, 1978.

### *Thecavermiculatus andinus* n.sp.

(Figs. 1–23)

*Females* (20): Length 508–756  $\mu\text{m}$  (mean 598  $\mu\text{m}$ , standard deviation [SD] 64  $\mu\text{m}$ ); width 306–548  $\mu\text{m}$  (407  $\mu\text{m}$ , SD 74);  $a = 1.2$ – $1.9$  (1.5, SD 0.2); stylet 22.8–24.2  $\mu\text{m}$  (23.5  $\mu\text{m}$ , SD 0.6); width of stylet knobs 4.1–5.9  $\mu\text{m}$  (4.9  $\mu\text{m}$ , SD 0.7); dorsal esophageal gland orifice (DGO) 4.7–5.9  $\mu\text{m}$  (5.5  $\mu\text{m}$ , SD 0.5) from base of stylet; center of median bulb 53–71  $\mu\text{m}$  (63  $\mu\text{m}$ , SD 7) from anterior end; vulva slit length 6–8  $\mu\text{m}$  (6.5  $\mu\text{m}$ , SD 0.6); distance from vulva slit to anus 44–91  $\mu\text{m}$  (59  $\mu\text{m}$ , SD 12); excretory pore from anterior end 120–164  $\mu\text{m}$  (143  $\mu\text{m}$ , SD 16).

*Holotype* (female): Length 583  $\mu\text{m}$ ; width 369  $\mu\text{m}$ ;  $a = 1.6$ ; stylet 23  $\mu\text{m}$ ; width of stylet knobs 4.4  $\mu\text{m}$ ; DGO 5.2  $\mu\text{m}$  from base of stylet; center of median bulb 59  $\mu\text{m}$  from anterior end; vulva slit length 7.1  $\mu\text{m}$ ; distance from vulva slit to anus 68  $\mu\text{m}$ ; excretory pore from anterior end 119  $\mu\text{m}$ .

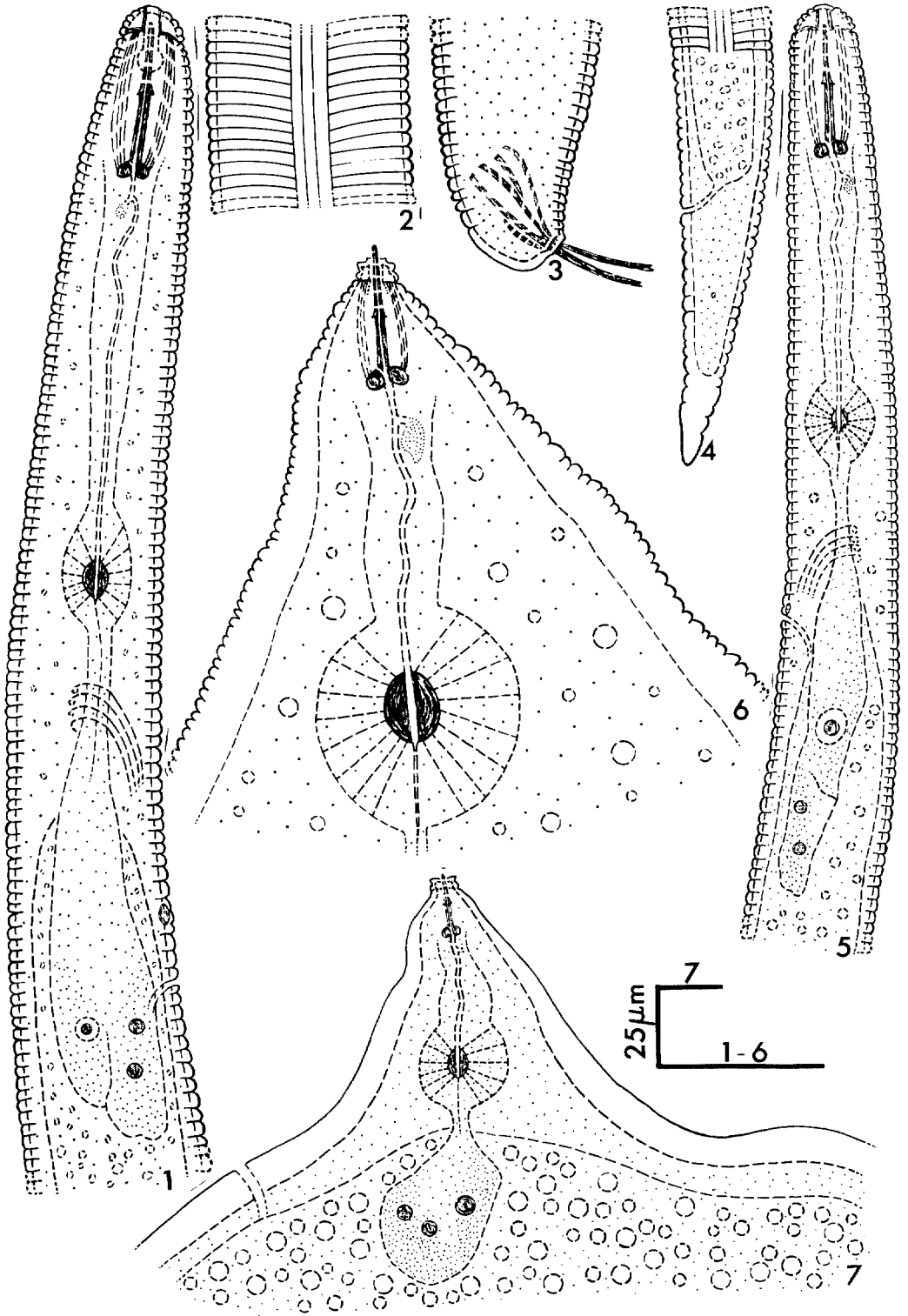
*Description of females*: Body of young females white, becoming yellowish in some

older specimens; round to oval, smooth and rounded posteriorly, with small neck protruding anteriorly. Body of older females fills with eggs which hatch; resulting second-stage larvae are retained in female body. Head offset, with two annules and a labial disc. Stylet strong, with heavy, large knobs sloping posteriorly. Excretory pore prominent, opening at a level opposite esophageal glands. Cuticle thick, 11–15  $\mu\text{m}$  (Fig. 15). Cuticular surface in posterior part of body, and especially in the vulval-anal area, consists of a lacelike pattern (Figs. 8–10) overlaying random punctation (Figs. 11–12). On the neck, annules are present on the cuticle, but on the anterior and mid-region of the body, the cuticle shows annules formed essentially by lined punctations (Figs. 13, 14, 16) which blend and merge with the lacelike pattern posteriorly. Vulva and anus well separated, not on a protuberance.

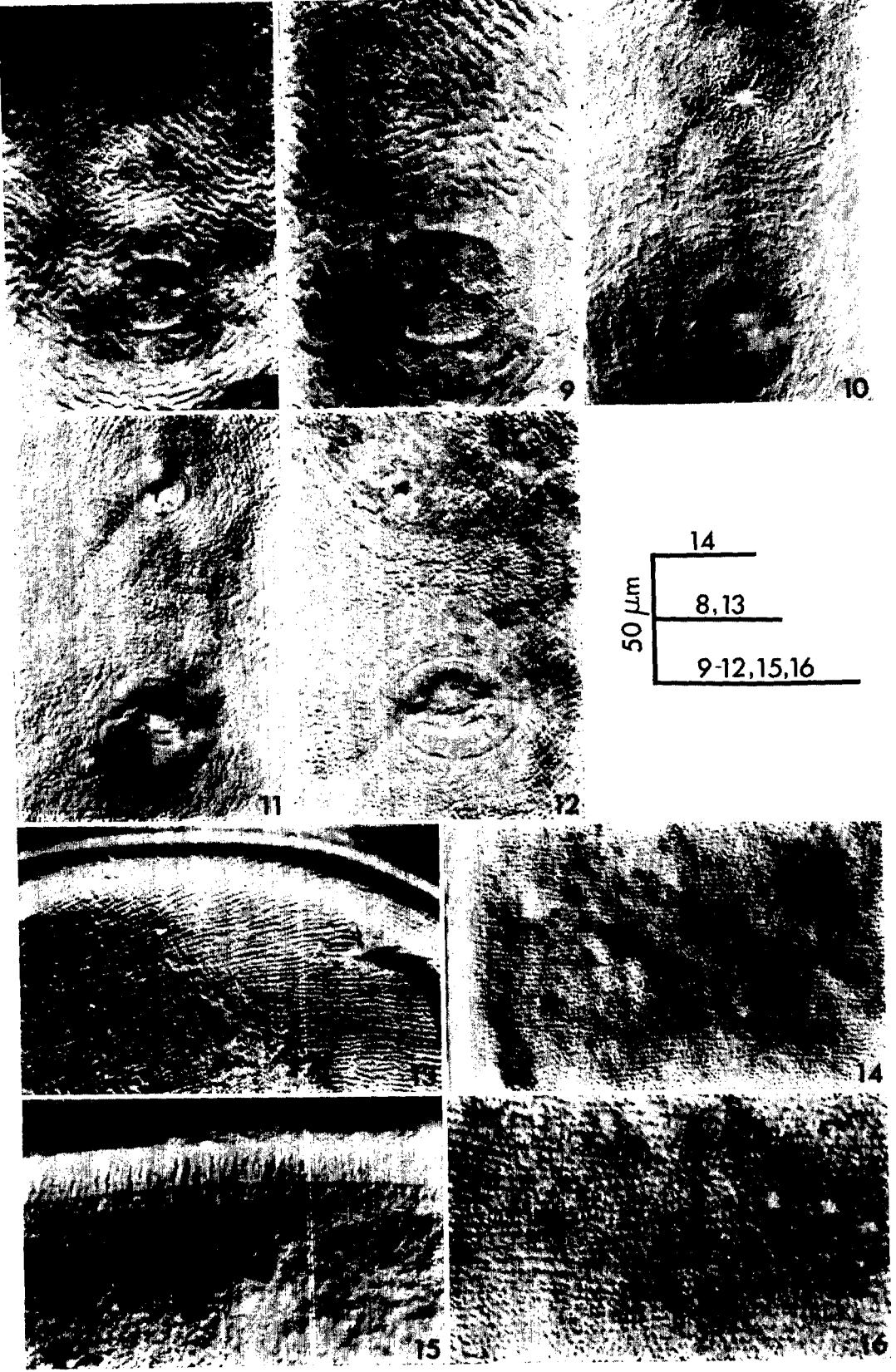
*Males* (32): Length 961–1,168  $\mu\text{m}$  (1,081  $\mu\text{m}$ , SD 50);  $a = 28$ – $39$  (34, SD 2.6);  $b = 5.6$ – $6.4$  (6, SD 0.3);  $c = 118$ – $360$  (223, SD 69); stylet 24.5–26.2  $\mu\text{m}$  (25.4  $\mu\text{m}$ , SD 0.3); DGO 3.4–5.9  $\mu\text{m}$  (4.3  $\mu\text{m}$ , SD 0.7) from base of stylet; center of median bulb 83–94  $\mu\text{m}$  (89  $\mu\text{m}$ , SD 3.8) from anterior end; head width 9.4–11.2  $\mu\text{m}$  (10.6  $\mu\text{m}$ , SD 0.4); head height 4.7–5.9  $\mu\text{m}$  (5.2  $\mu\text{m}$ , SD 0.3); hw/hh ratio 1.9–2.3 (2.0, SD 0.1); spicules 28–33  $\mu\text{m}$  (31.4  $\mu\text{m}$ , SD 1.6); gubernaculum 7–11 (9  $\mu\text{m}$ , SD 1); tail 3–9  $\mu\text{m}$  (5.2  $\mu\text{m}$ , SD 1.5).

*Allotype* (male): Length 1,085  $\mu\text{m}$ ;  $a = 37$ ;  $b = 6$ ;  $c = 310$ ; stylet 25.4  $\mu\text{m}$ ; DGO 4.1  $\mu\text{m}$  from base of stylet; center of median bulb 90  $\mu\text{m}$  from anterior end; head width 10.6  $\mu\text{m}$ ; head height 4.7  $\mu\text{m}$ ; hw/hh ratio 2.3; spicules 30  $\mu\text{m}$ ; gubernaculum 10  $\mu\text{m}$ ; tail 3.5  $\mu\text{m}$ .

*Description of males*: Body slender, vermiform, tapering slightly at both extremities. Head offset, heavy framework, with 4–5 annules and a labial disc. Cuticular annules distinct. Midbody width 25–35  $\mu\text{m}$  (32  $\mu\text{m}$ , SD 2.6). Lateral field with four lines forming three bands of equal width, without areolation and about one-fifth body width. Stylet, knobs, esophageal glands, and anterior portion commonly appear as illustrated (Fig. 1). Excretory pore about 5–15  $\mu\text{m}$  (10  $\mu\text{m}$ ) posterior to distinct hemizonid.



Figs. 1-7. Drawings of *Thecavermiculatus andinus* n.sp. 1) Male, anterior region. 2) Male, lateral field near midbody. 3) Male, posterior portion. 4) Larva, posterior region. 5) Larva, anterior region. 6) Female, head and neck portion. 7) Female, anterior region in outline.



Testis one. Spicules arcuate, with notched tips as illustrated (Fig. 3), were protruding in all of 50 males examined. Gubernaculum present. Phasmids not seen. Tail short, rounded.

*Second-stage larvae* (40): Length 362–437  $\mu\text{m}$  (400  $\mu\text{m}$ , SD 20); a = 17–25 (21, SD 2); b = 2.7–3.3 (3, SD 0.2); c = 10–12 (11, SD 0.6); stylet 19.8–21.1  $\mu\text{m}$  (20.5  $\mu\text{m}$ , SD 0.3); DGO 3.4–5.9  $\mu\text{m}$  (4.2  $\mu\text{m}$ , SD 0.5) from base of stylet; center of median bulb 57–67  $\mu\text{m}$  (62  $\mu\text{m}$ , SD 3) from anterior end; head width 8.2–9  $\mu\text{m}$  (8.7  $\mu\text{m}$ , SD 0.3); head height 3–4.1  $\mu\text{m}$  (3.4  $\mu\text{m}$ , SD 0.4); hw/lh ratio = 2.2–3.3 (2.6, SD 0.3); tail length 31–41  $\mu\text{m}$  (36  $\mu\text{m}$ , SD 3), hyaline tail terminal 10–17  $\mu\text{m}$  (15  $\mu\text{m}$ , SD 1.6); caudal ratio = 2.2–3.3 (2.6, SD 0.3); tail length B 3.6–7.2 (5, SD 0.3); phasmids located 24–26  $\mu\text{m}$  (24.8  $\mu\text{m}$ , SD 0.8) from tail tip.

*Description of larvae*: Body small, vermiform, averaging 19.4  $\mu\text{m}$  in width at midbody, tapering at both extremities but more so posteriorly. Head offset, with strong cephalic framework, bearing four annules and a labial disc. Cuticle distinctly annulated. Lateral field with four lines, forming three bands of equal width, not areolated, about one-fourth of body width. Stylet, knobs, hemizonid, excretory pore, and anterior portion generally appearing as illustrated (Fig. 5). Phasmids small, with lens-like structure, located about one-third tail length posterior to anus. Rectum not inflated. Tail short, conically tapering to a rounded terminus, as illustrated (Fig. 4).

*Eggs* (35): Length 95–112  $\mu\text{m}$  (101  $\mu\text{m}$ , SD 4); width 41–54  $\mu\text{m}$  (48  $\mu\text{m}$ , SD 4); L/W ratio 1.8–2.5 (2.1, SD 0.2). Egg shell hyaline, without visible markings, when observed with optical microscopy.

*Holotype* (female): Collected by J. Franco and P. Jatala from *Oxalis tuberosa* originally from the vicinity of Lake Titicaca and subsequently grown on *O. tuberosa* in a greenhouse at La Molina, Lima, Peru. Slide T-358t, USDA Nematode Collection (USDANC), Beltsville, Maryland, USA.

*Allotype* (male): Slide T-359t. Same

data as holotype. USDANC, Beltsville, Maryland, USA.

*Paratypes* (males, females, larvae, and eggs): USDANC, Beltsville, Maryland, USA; University of California Nematode Survey Collection (UCNSC), Davis, California, USA; Nematology Department, Rothamsted Experimental Station, Harpenden, Hertfordshire, England; Canadian National Collection of Nematodes, Ottawa, Canada; Laboratoire des Vers, Museum National d'Histoire Naturelle, Paris, France; Institute voor Dierkunde, Laboratorium voor Morfologie en Systematiek der Dieren, Ledeganckst, 35, B-9000, Gent, Belgium; Laboratory voor Nematologie, Binnehave 10, Wageningen, Netherlands; and Commonwealth Institute of Parasitology Collection, St. Albans, Hertfordshire, England.

*Type host and locality*: Roots of *Oxalis tuberosa* in a field in the vicinity of Lake Titicaca high in the Andes Mountains in the Department of Puno, Peru.

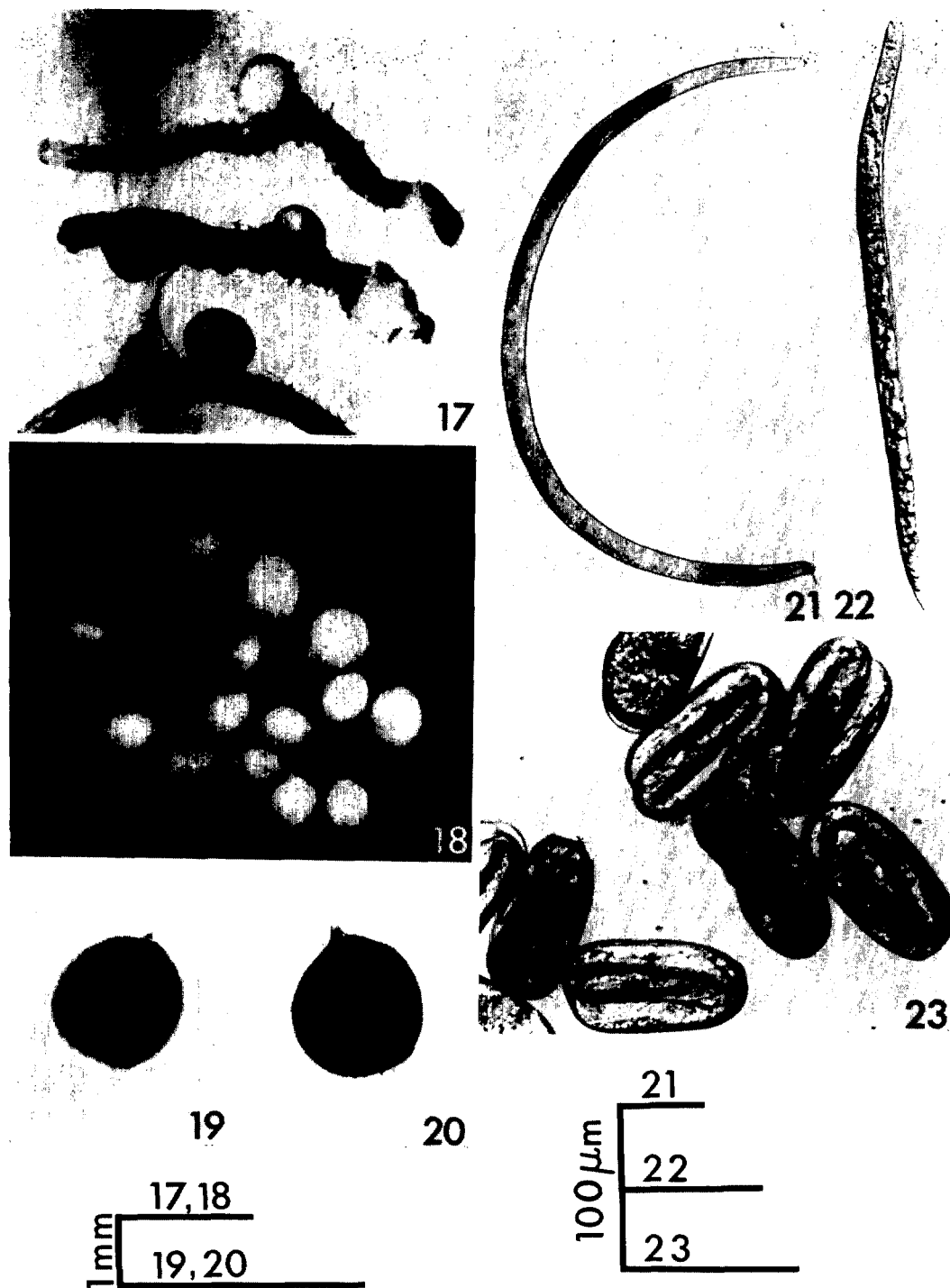
*Diagnosis*: *Thecavermiculatus andinus* n.sp. differs from the other two species in the genus by i) greater female vulva-anus distance—59  $\mu\text{m}$  average vs. only 19  $\mu\text{m}$  for *T. gracililancea* Robbins, 1978 (6) and 18  $\mu\text{m}$  for *T. crassicrustata* Bernard, 1981 (1); ii) presence of lacelike pattern on female cuticle restricted to posterior portion, especially vulval and anal areas, and with annules on rest of body (the other two species have annules only on neck region and lacelike or zig-zag pattern on other portion of body); and iii) short larval tail—36  $\mu\text{m}$  average vs. 55  $\mu\text{m}$  for *T. gracililancea* and 80  $\mu\text{m}$  for *T. crassicrustata*.

During the course of this study, specimens of *T. andinus* n.sp. were examined from the following host plants and were found to conform well with the above description of this species: *Oxalis tuberosa*, *Medicago hispida*, *Chenopodium quinoa*, *Ullucus tuberosus*, *Solanum tuberosum* subsp. *andigena*, *Capsella bursa-pastoris*, *Solanum melongena*, *Malvastrum coromandelianum*, and *Lupinus mutabilis*.

Some of these hosts, and certain addi-



Figs. 8–16. Photomicrographs of portions of females of *Thecavermiculatus andinus* n.sp. 8–10) Lacelike pattern on surface at vulval/anal area. 11,12) Deeper focus of above showing underlying punctations. 13–16) Cuticular surface at or near midbody (note thick cuticle as shown in Fig. 15).



Figs. 17-23. Photomicrographs of various stages of *Thecavermiculatus andinus* n.sp. 17) Females on roots of *Oxalis tuberosa*. 18) A group of female specimens showing overall shape. 19-20) Two single female specimens in more detail. 21) Male, gross shape (note protruded spicules). 22) Larva, gross shape. 23) Eggs.

tional ones, have been reported previously (2,3,5).

Specimens of *Thecavermiculatus* were obtained also from Chile on potato (?) through the courtesy of Pedro Gallo Donoso, Universidad del Norte, Arica, and identified as *T. andinus* n.sp.

Key to the species of *Thecavermiculatus*

1. Females rounded posteriorly, vulva and anus not on a protuberance; males present ..... 2  
Females not rounded posteriorly, vulva and anus on a small but distinct protuberance; males absent .....  
..... *T. gracililancea*
2. Female vulval/anal distance 19  $\mu\text{m}$ ; larval stylet 42.4  $\mu\text{m}$ ; male stylet 30.4 .....  
..... *T. crassicrustata*  
Female vulval/anal distance 59  $\mu\text{m}$ ; larval stylet 20.5  $\mu\text{m}$ ; male stylet 25.4  $\mu\text{m}$  ..... *T. andinus* n.sp

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