

## Descriptions of Two New Species of *Tylenchorhynchus* Cobb, 1913 (Nematoda: Tylenchida), with Details on Morphology and Variation of *T. claytoni*<sup>1</sup>

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**Abstract:** Two new species of plant parasitic nematodes (*Tylenchorhynchus quaidi* n. sp. and *T. tritici* n. sp.) from Pakistan are described and illustrated. *Tylenchorhynchus quaidi* n. sp., from soil around roots of potato (*Solanum tuberosum*) from an experimental field of NNRC, Karachi, Pakistan, is distinguishable from other species by its peculiar sunken dome-shaped head. Although similar to *T. goffarti*, it differs by head shape, areolation of lateral field, ratios a (23-28 vs. 29-37) and c (11-14 vs. 13-20), and a vagina that is half sclerotized and half unsclerotized. *Tylenchorhynchus tritici* n. sp., from soil around roots of wheat (*Triticum aestivum*) from Campbellpur, Pakistan, is similar to *T. ventrosignatus* and *T. nordiensis*. It differs from *T. ventrosignatus* by a continuous lip region, number of head annules (2-3 vs. 4), coarse body annulation, absence of a wave-like structure near the vulva, and by tail shape and number of tail annules (15-23 vs. 28-32). It differs from *T. nordiensis* by stylet length (12.4-14.6 vs. 11-13  $\mu$ m), shape of stylet knobs, number of head annules (2-3 vs. 4), non-areolated lateral field in region of phasmids, and not fusing in posterior third of tail. Morphometrics of *Tylenchorhynchus claytoni* from soil around stunted maize (*Zea mays* L.), in Muscatine County, Iowa, and several other populations are given. Detailed morphometric data on *T. claytoni* based on topotypes collected from type locality and several other populations revealed that this species shows variations in the shape of tail in females, number of tail annules (and sometimes annules extending further back on the terminus, almost being an annulated terminus), position of phasmid, and shape of lip region. The subgenus *Bitylenchus* is proposed as a new synonym of *Tylenchorhynchus* and its species referred to the latter genus.

**Key words:** taxonomy, morphology, *Tylenchorhynchus*, new species, potato, *Solanum tuberosum*, wheat, *Triticum aestivum*, maize, *Zea mays* L.

The genus *Tylenchorhynchus* was established by Nathan A. Cobb in 1913 when he described *T. cylindricus* found in soil from reclaimed coastal swamp lands in southern California (2). In his excellent review of the genus *Tylenchorhynchus*, Allen (1) established its taxonomic criteria in 1955. Golden (3) raised the subfamily Tylenchorhynchinae Eliava, 1964 to family rank and provided a key to the six genera included at that time. In 1978 Hooper (5) discussed the history of the genus. In describing four

new *Tylenchorhynchus* species, Sturhan (14) recognized 73 valid species in the genus and indicated 10 additional forms as *species inquirendae*. By 1970, 96 species were described (11). Many of the species included under *Tylenchorhynchus* have now been placed in new genera by different workers (9,11). A most important character used in distinguishing these genera is the number of lines, ranging from three to six, in the lateral field. *Tylenchorhynchus* now contains those species having four lines in the lateral field. Tarjan (15) gave a valuable key and a table of diagnostic data on species. In 1982 Siddiqi and Jairajpuri (12) proposed resurrection of the subgenus *Bitylenchus* Filipjev, 1934 under the genus *Tylenchorhynchus* and Jairajpuri (6) gave a key to 16 species of the subgenus *Bitylenchus*. By 1984, 79 species of *Tylenchorhynchus* were described.

We describe here the two new species of *Tylenchorhynchus* from Pakistan and also present extensive morphometric data and

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some illustrations on populations of *Tylenchorhynchus claytoni* Steiner, 1937 (13).

#### MATERIALS AND METHODS

Specimens from Pakistan were sent by M. A. Maqbool to A. Morgan Golden for species identification in May 1982 and June 1983. These specimens represented two undescribed species. *T. quaidi* n. sp. were obtained from soil around roots of potato (*Solanum tuberosum*) from the National Nematological Research Centre, Karachi, Pakistan, and *T. tritici* n. sp. from soil around roots of wheat (*Triticum aestivum*) in Campbellpur, Pakistan. Formalin-fixed specimens of *Tylenchorhynchus claytoni* from D. C. Norton were obtained from soil around stunted maize (*Zea mays* L.) in Muscatine County, Iowa. Also, live and formalin-fixed specimens of several South Carolina populations of *T. claytoni*, including topotypes, were sent by S. A. Lewis. A BARC greenhouse culture of *T. claytoni* was included; this culture originated from College Park, Maryland, and was collected by Thelma Golden from soil around azaleas (*Rhododendron* sp.) in April 1976. Specimens of *T. claytoni* examined from the USDA Nematode Collection at Beltsville, Maryland, included paralectotypes collected by E. E. Clayton in July 1936. Males and females were recovered from soil sieving followed by Baermann funnel extraction, heat relaxed in an oven at 43 C for 12 minutes, and fixed in 3% formaldehyde. Procedures for preparing, measuring, and drawing specimens from the United States were the same as those used by Golden and Birchfield (4). The Pakistan specimens were recovered from soil in this same manner, killed by gentle heat, fixed in TAF, processed by slow method to and mounted in glycerine.

#### *Tylenchorhynchus quaidi* n. sp. (Figs. 1-7)

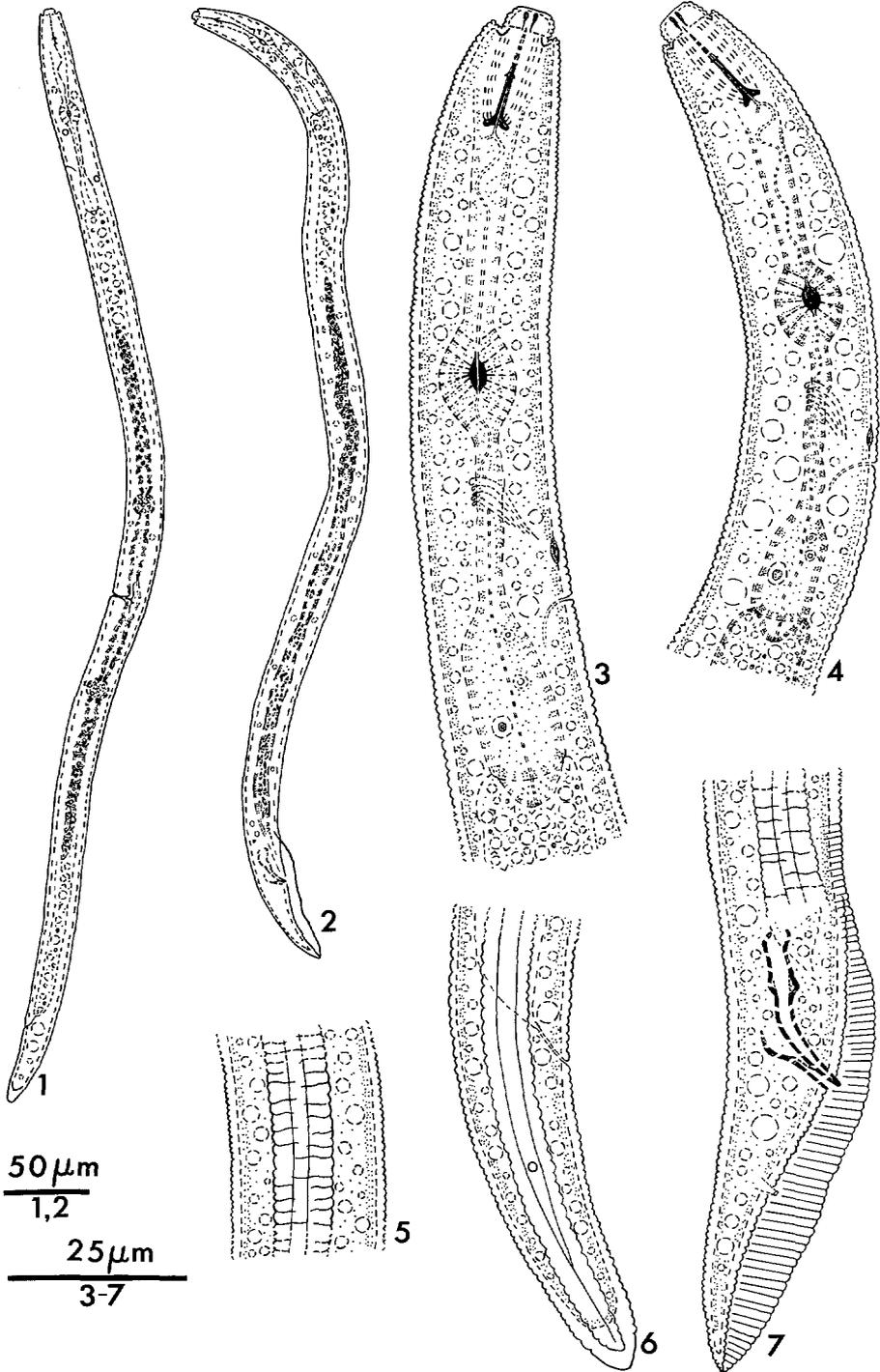
*Females* (24): Length 451-664  $\mu\text{m}$  (mean 567  $\mu\text{m}$ , standard deviation [SD] 59.1  $\mu\text{m}$ ); width 18.9-24.1  $\mu\text{m}$  (21.8  $\mu\text{m}$ , 1.5); a = 23.2-28.5 (25.8, 1.5); b = 4.3-5.8 (5.1, 0.3); c = 11.8-14.9 (13.3, 1); V = 50-56

(53, 1.3); stylet length 13.7-15.4  $\mu\text{m}$  (14.5  $\mu\text{m}$ , 0.6); dorsal esophageal gland orifice (DGO) 1.7-2.1  $\mu\text{m}$  (1.9  $\mu\text{m}$ , 0.2) from base of stylet, center of median bulb 43-58  $\mu\text{m}$  (50  $\mu\text{m}$ , 3.9) from anterior end; excretory pore 64-97  $\mu\text{m}$  (78  $\mu\text{m}$ , 8.1) from anterior end; anal body width 12.9-19.3  $\mu\text{m}$  (15.7  $\mu\text{m}$ , 1.7); tail/anal body width ratio 2.3-3.3 (2.7); phasmids 25-36  $\mu\text{m}$  (29  $\mu\text{m}$ , 3.1) from tail terminus; lateral field width 6.4-9  $\mu\text{m}$  (7.9  $\mu\text{m}$ ); annule width at midbody 0.8-1.2  $\mu\text{m}$  (1.0  $\mu\text{m}$ ).

*Holotype (female)*: Length 556  $\mu\text{m}$ ; width 22.3  $\mu\text{m}$ ; a = 24.9; b = 4.9; c = 13.9; V = 52.8; stylet length 15  $\mu\text{m}$ ; DGO 2.1  $\mu\text{m}$  from base of stylet; center of median bulb 51  $\mu\text{m}$  from anterior end; excretory pore 78  $\mu\text{m}$  from anterior end; anal body width 17.3  $\mu\text{m}$ ; phasmids 27  $\mu\text{m}$  from tail terminus; lateral field width 8.1  $\mu\text{m}$ .

*Description of females*: Body slightly straight to ventrally arcuate when killed; tapering only slightly towards extremities. Cuticle finely striated. Lateral fields areolated, marked with four incisures. Lip region set off, sunken, dome-shaped, with 5-6 annules. Cephalic framework lightly sclerotized. Stylet with well-developed basal knobs which are rounded and sloping backwards. Median esophageal bulb spheroid with prominent refractive valvular apparatus in the center. Nerve ring encircling esophagus slightly anterior to middle of isthmus. Hemizonid observed in only few specimens, 3.8  $\mu\text{m}$  long; occupies four body annules; situated seven annules anterior to distinct excretory pore. Basal esophageal bulb pyriform. Cardia small and conoid. Vulva a transverse slit; vagina at right angles to body axis with one half being sclerotized and other half unsclerotized. Spermatheca round filled with sperm. Ovaries amphidelphic, outstretched. Tail cylindrical with conoid, smooth terminus, bearing 31-41 annules. Phasmids located in anterior half of tail.

*Males* (3): Length 461-569  $\mu\text{m}$  (521  $\mu\text{m}$ , 55.2); width 19.3-21.5  $\mu\text{m}$  (20.4  $\mu\text{m}$ , 1.1); a = 23.8-26.5 (25.4, 1.4); b = 4.7-6 (5.1, 0.7); c = 12.9-13.7 (13, 0.1); stylet length 14.1-15  $\mu\text{m}$  (14.7, 0.5); DGO 1.7-2.1  $\mu\text{m}$



FIGS. 1-7. Drawings of *Tylenchorhynchus quaidi* n. sp. 1) Entire female. 2) Entire male. 3) Anterior portion of female. 4) Anterior portion of male. 5) Lateral field of female. 6) Tail of female. 7) Tail of male.

(1.9  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 45–54  $\mu\text{m}$  (48  $\mu\text{m}$ , 5.2) from anterior end; spicule length 23.6–25.3  $\mu\text{m}$  (24.1  $\mu\text{m}$ , 0.9); gubernaculum 11.6–13.7  $\mu\text{m}$  (12.3  $\mu\text{m}$ , 1.2); phasmids 23–27  $\mu\text{m}$  (25  $\mu\text{m}$ , 1.7) from tail terminus; anal body width 12.9–14.1  $\mu\text{m}$  (13.5  $\mu\text{m}$ , 0.6); excretory pore 62–84  $\mu\text{m}$  (72  $\mu\text{m}$ , 11) from anterior end.

*Allotype (male)*: Length 535  $\mu\text{m}$ ; width 20.6  $\mu\text{m}$ ; a = 25.9; b = 4.7; c = 13.7; stylet length 14.1  $\mu\text{m}$ ; DGO 2.1  $\mu\text{m}$  from base of stylet; center of median bulb 54  $\mu\text{m}$  from anterior end; spicules 23.6  $\mu\text{m}$ ; gubernaculum 11.6  $\mu\text{m}$ ; anal body width 13.7  $\mu\text{m}$ ; excretory pore 84  $\mu\text{m}$  from anterior end.

*Description of males*: Body similar to female, but slightly smaller. Lateral field areolated with four lines, 6.4–7.7  $\mu\text{m}$  wide near midbody. Testis single, outstretched. Bursa tylenchoid, finely crenate, enveloping entire tail, with transverse cuticular striae. Spicules ventrally arcuate, measured along median axis. Gubernaculum large, distinctly curved proximally. Phasmid located in anterior half of tail.

Twelve juveniles of unknown developmental stage were examined, and all showed the characteristic dome-shaped head as described in adults.

*Holotype (female)*: Collected April 1983 by M. A. Maqbool from soil around roots of potato (*Solanum tuberosum*) in experimental field of the National Nematological Research Centre (NNRC), Karachi, Pakistan. Slide T-411t deposited in the USDA Nematode Collection (USDANC) at Beltsville, Maryland.

*Allotype (male)*: Slide T-412t. Same data as holotype. USDANC, Beltsville, Maryland.

*Paratypes (males, females, juveniles)*: USDANC, Beltsville, Maryland, and National Collection at NNRC, University of Karachi, Karachi, Pakistan.

*Type host and locality*: From soil around roots of potato (*Solanum tuberosum*) from experimental field of the National Nematological Research Centre, Karachi, Pakistan.

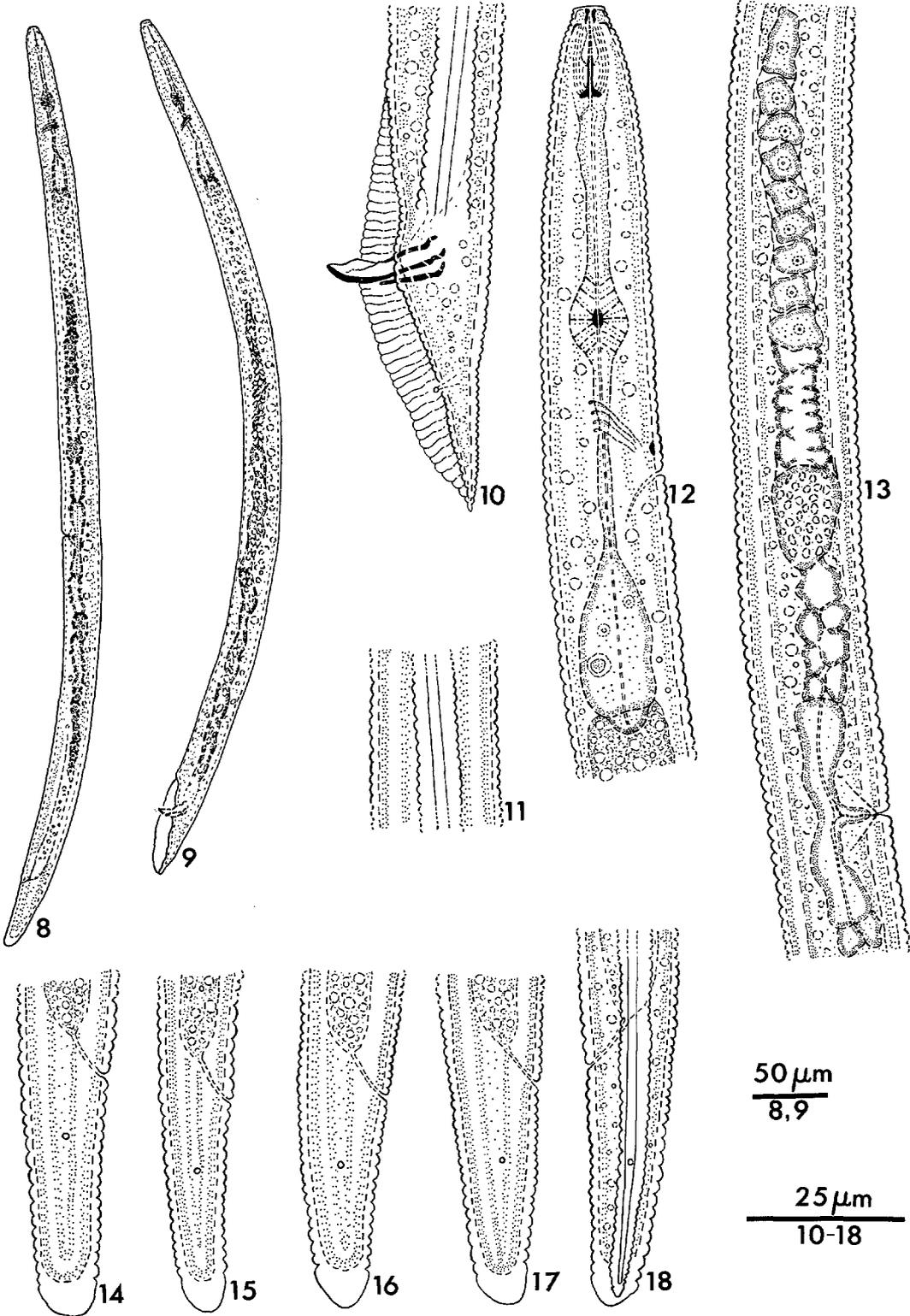
*Diagnosis*: *Tylenchorhynchus quaidi* n. sp. differs from all known species of *Tylenchorhynchus* by its peculiar sunken dome-shaped head. However, it is closely related to *T. goffarti* Sturhan, 1966 (14) and *T. ventrosignatus* Tobar-Jimenez, 1969 (16). It differs from *T. goffarti* in having a sunken dome-shaped head with 5–6 annules, areolation of lateral field, value of a and c, and by having half of vagina sclerotized and the other half unsclerotized; in *T. goffarti*, head rounded, set off by strong constriction, with 6–7 annules, lateral field not areolated, vagina unsclerotized, a = 33 (29–37), c = 16 (13–20). It differs from *T. ventrosignatus* in having sunken dome-shaped head with 5–6 annules, comparatively longer stylet, greater number of tail annules, areolation of lateral field, and by absence of wave-like structure near vulva; in *T. ventrosignatus* head set off by constriction, with four annules, stylet length 13.2  $\mu\text{m}$  (10.8–14.2  $\mu\text{m}$ ), tail annules 28–32, lateral field not areolated, and presence of wave-like structure near vulva).

The species name is given in honor of the founder of Pakistan, Quaidi-Azam Mohammad Ali Jinnah.

*Tylenchorhynchus tritici* n. sp.  
(Figs. 8–18)

*Females* (22): Length 525–658  $\mu\text{m}$  (mean 588  $\mu\text{m}$ , SD 32.7  $\mu\text{m}$ ); width 20–24  $\mu\text{m}$  (22  $\mu\text{m}$ , 1.4); a = 25.6–32.6 (27.8, 1.7); b = 4.5–5.5 (5.1, 0.2); c = 13.2–17.6 (16, 1); V = 53–59 (55, 1.2); stylet length 12.4–14.6  $\mu\text{m}$  (13  $\mu\text{m}$ , 0.5); DGO 2.1–2.5  $\mu\text{m}$  (2.2  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 47–53  $\mu\text{m}$  (51  $\mu\text{m}$ , 2) from anterior end; excretory pore 78–99  $\mu\text{m}$  (84  $\mu\text{m}$ , 5.6) from anterior end; anal body width 11.1–16.3  $\mu\text{m}$  (13.9  $\mu\text{m}$ , 1.3); tail/anal body width ratio 2.2–3.3 (2.6); phasmids 18–27  $\mu\text{m}$  (23  $\mu\text{m}$ , 2.4) from tail terminus; lateral field width 6–8  $\mu\text{m}$  (7  $\mu\text{m}$ ); annule width at midbody 1.5–2.1  $\mu\text{m}$  (1.7  $\mu\text{m}$ ).

*Holotype (female)*: Length 593  $\mu\text{m}$ ; a = 27.5; b = 5.1; c = 15.5; V = 57; stylet length 13  $\mu\text{m}$ ; DGO 2.1  $\mu\text{m}$  from base of stylet; center of median bulb 51.6  $\mu\text{m}$  from



$\frac{50 \mu\text{m}}{8,9}$

$\frac{25 \mu\text{m}}{10-18}$

anterior end; excretory pore 84  $\mu\text{m}$  from anterior end; anal body width 14.6  $\mu\text{m}$ ; phasmids 23.6  $\mu\text{m}$  from tail terminus; annule width at midbody 1.7  $\mu\text{m}$ .

*Description of females:* Body straight or slightly ventrally arcuate when relaxed. Cuticle with coarse transverse striae, increasing to 2.3  $\mu\text{m}$  on distal part of tail. Lateral field with four incisures. Lip region rounded, slightly set off from the body by increased width, with 2–3 transverse striae (occasionally only two). Labial framework lightly sclerotized with outer margins extending 2–3 annules into body. Stylet small and delicate; basal knobs rounded, slightly posteriorly directed, 3.4–4.3  $\mu\text{m}$  wide. Median esophageal bulb spheroid with refractive valvular apparatus in center. Nerve ring located slightly anterior to middle of isthmus; hemizonid two annules anterior to distinct excretory pore. Basal esophageal bulb with a small conoid cardia. Nucleus of dorsal gland conspicuous, in posterior half of bulb; nuclei of subventral glands inconspicuous, located in anterior half of bulb. Vulva a transverse slit, vagina straight and at right angle to body axis. Ovaries amphidelphic, outstretched. Spermatheca large, ovate or spherical, filled with sperm. Tail cylindrical with 15–23 annules, tapering regularly to rounded, smooth terminus. Phasmid usually in the anterior half of tail.

*Males (6):* Length 514–606  $\mu\text{m}$  (562  $\mu\text{m}$ , 31.7); width 18–22  $\mu\text{m}$  (20  $\mu\text{m}$ , 1.2); a = 26.2–29.3 (27.5, 1.1); b = 5.2–5.7 (5.3, 0.2); c = 16–19.7 (17.1, 1.4); stylet length 12.9–13.3  $\mu\text{m}$  (12.9  $\mu\text{m}$ , 0.1); DGO 1.7–2.1  $\mu\text{m}$  (1.9  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 44–51  $\mu\text{m}$  (49  $\mu\text{m}$ , 3) from anterior end; spicules 17.6–21.5  $\mu\text{m}$  (19.1  $\mu\text{m}$ , 1.3); gubernaculum 10.7–11.1  $\mu\text{m}$  (10.7  $\mu\text{m}$ , 0.1); phasmids 20–22  $\mu\text{m}$  (21  $\mu\text{m}$ , 0.8) from tail terminus; anal body width 11.6–12.9  $\mu\text{m}$  (12.6  $\mu\text{m}$ , 0.5);

excretory pore 75–86  $\mu\text{m}$  (80  $\mu\text{m}$ , 4.3) from anterior end.

*Allotype (male):* Length 567  $\mu\text{m}$ ; a = 29.3; b = 5.3; c = 17.1; stylet length 13  $\mu\text{m}$ ; DGO 1.9  $\mu\text{m}$  from base of stylet; center of median bulb 51  $\mu\text{m}$  from anterior end; spicules 21.5  $\mu\text{m}$ , gubernaculum 10.7  $\mu\text{m}$ ; tail 34  $\mu\text{m}$ ; phasmids 21  $\mu\text{m}$  from tail terminus; anal body width 11.6  $\mu\text{m}$ , excretory pore 78  $\mu\text{m}$  from anterior end.

*Description of males:* Body similar to female in general shape and morphology but slightly smaller. Lateral field with four lines, 6.02–6.4  $\mu\text{m}$  wide near midbody. Testis single outstretched. Bursa tylenchoid, enveloping entire tail with transverse cuticular striae. Spicules strong, ventrally arcuate, with offset capitulum. Gubernaculum curved proximally. Phasmid small located near middle of tail.

*Holotype (female):* Collected April 1979 by M. A. Maqbool from soil around roots of wheat (*Triticum aestivum*) from Campbellpur, Pakistan. Slide T-413t deposited in the USDANC at Beltsville, Maryland.

*Allotype (male):* On slide T-414t, same data as holotype. USDANC, Beltsville, Maryland.

*Paratypes (males and females):* USDANC, Beltsville, Maryland, and National Collection at NNRC, University of Karachi, Karachi Pakistan.

*Type host and locality:* From soil around the roots of wheat (*Triticum aestivum*) Campbellpur, Pakistan.

*Diagnosis:* *Tylenchorhynchus tritici* n. sp. is closely related to *T. ventrosignatus* Tobar-Jimenez, 1969 (16) and *T. nordiensis* Khan and Nanjapa, 1972 (7,8). It differs from *T. ventrosignatus* in having continuous lip region, number of head annules (2–3 vs. 4), coarse body annulation, absence of wave-like structure near vulva and by the shape of the tail (cylindrical with rounded terminus) and number of tail annules (15–23);

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FIGS. 8–18. Drawings of *Tylenchorhynchus tritici* n. sp. 8) Entire female. 9) Entire male. 10) Male tail. 11) Lateral field of female. 12) Anterior end of female. 13) Anterior gonad of female. 14–18) Variations in tail shape of females.

in *T. ventrosignatus* lip region set off with four annules, fine body annulation, presence of wave-like structure near vulva, differently shaped tail (subcylindrical) and 24–35 tail annules. It differs from *T. nordiensis* by stylet length, shape of stylet knobs, number of head annules, and lateral field not areolated in region of phasmid and also not fusing in posterior third of tail; in *T. nordiensis* stylet 11–13  $\mu\text{m}$ , stylet knobs anteriorly cupped, head with four annules, and lateral field areolated in region of phasmid, fusing in posterior third of tail.

#### MORPHOMETRICS OF

*Tylenchorhynchus claytoni* STEINER, 1937  
(Figs. 19–30)

*Specimens from Iowa (males and females)*: Collected 16 June 1981 by D. C. Norton from soil around roots of stunted maize (*Zea mays* L.), cultivar unknown, in Muscatine County, Iowa.

*Females (44)*: Length 516–734  $\mu\text{m}$  (mean 610  $\mu\text{m}$ , SD 57.5); width 21.5–30.9  $\mu\text{m}$  (25.8  $\mu\text{m}$ , 1.9); a = 21–27 (23.6, 1.7); b = 4–5.7 (4.7, 0.4); c = 16–22.3 (18, 1.4); V = 53–60 (57, 1.3); stylet length 18.1–20.2  $\mu\text{m}$  (19.1  $\mu\text{m}$ , 0.4); DGO 2.1–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.1) from base of stylet; center of median bulb 58–75  $\mu\text{m}$  (63  $\mu\text{m}$ , 3.8) from anterior end; excretory pore 94–115  $\mu\text{m}$  (102  $\mu\text{m}$ , 5.5) from anterior end; anal body width 12–21  $\mu\text{m}$  (15.8  $\mu\text{m}$ , 1.9); phasmids 23–38  $\mu\text{m}$  (29.9  $\mu\text{m}$ , 2.9) from tail terminus; annule width at midbody 1.7–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.2); lateral field width 6.4–8.6  $\mu\text{m}$  (7.2  $\mu\text{m}$ , 0.8).

*Males (21)*: Length 511–654  $\mu\text{m}$  (580  $\mu\text{m}$ , 37.8); width 22–24  $\mu\text{m}$ ; a = 22.2–27.5 (25.1, 1.4); b = 4.2–5.4 (4.6, 0.2); c = 12.2–18.5 (16.3, 1.6); stylet length 17.6–19.7  $\mu\text{m}$  (19.1  $\mu\text{m}$ , 0.5); DGO 1.7–2.1  $\mu\text{m}$  (1.9  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 59–69  $\mu\text{m}$  (62  $\mu\text{m}$ , 3.5) from anterior end; spicules 22–25.8  $\mu\text{m}$  (24.1  $\mu\text{m}$ , 0.9); gubernaculum 12.9–16  $\mu\text{m}$  (14.2  $\mu\text{m}$ , 0.8); phasmids 23–32  $\mu\text{m}$  (28  $\mu\text{m}$ , 2.5) from tail terminus; anal body width 12.9–17.2  $\mu\text{m}$  (15.1  $\mu\text{m}$ , 1.3); excretory pore 92–115  $\mu\text{m}$  (103.2  $\mu\text{m}$ , 5.7) from anterior end; annule width at midbody 1.7–2.7  $\mu\text{m}$  (1.9  $\mu\text{m}$ , 0.2); lateral field width 6–8.6  $\mu\text{m}$  (6.9  $\mu\text{m}$ , 0.8).

*BARC greenhouse culture (males and females)*: Collected by A. M. Golden from BARC greenhouse culture originally collected from a home in College Park, Maryland, by Thelma Golden in April 1976.

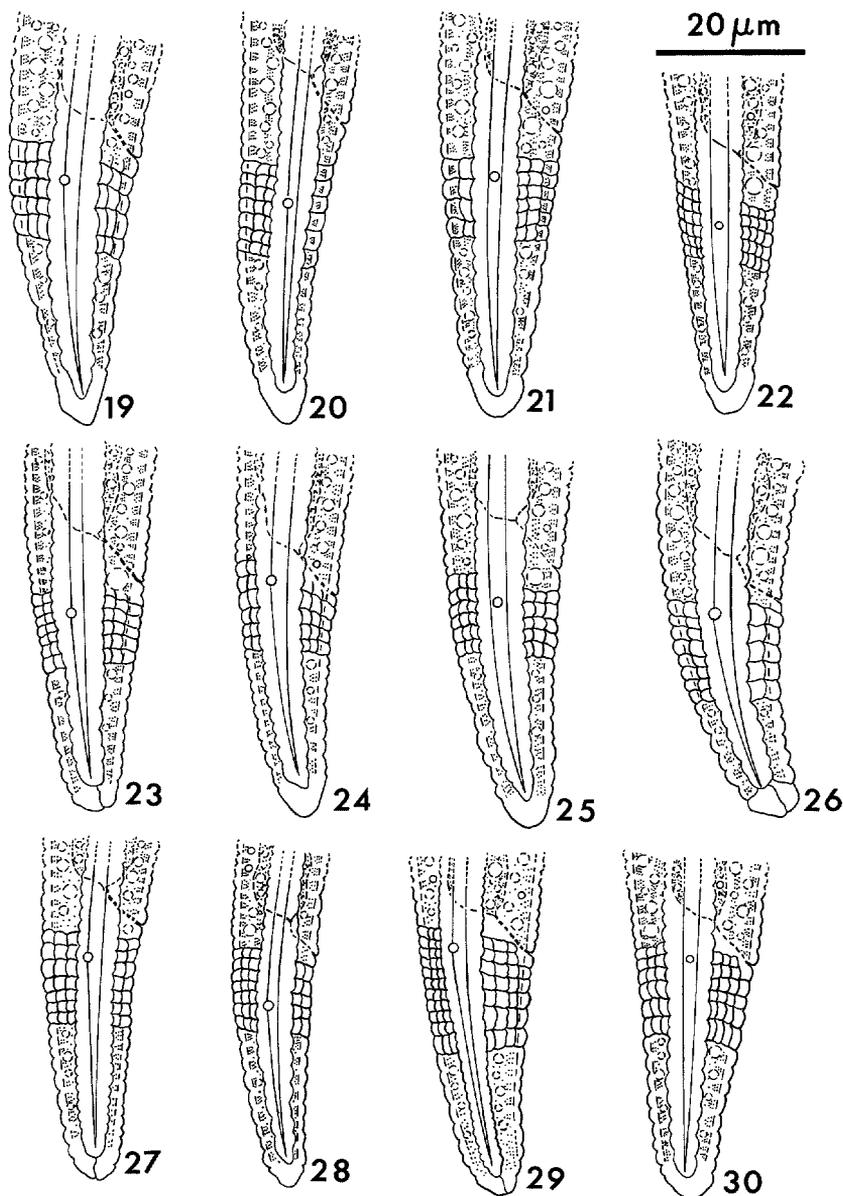
*Females (15)*: Length 638–721  $\mu\text{m}$  (676  $\mu\text{m}$ , 25.6); width 23.6–30.1  $\mu\text{m}$  (26.7  $\mu\text{m}$ , 2.1); a = 22.3–28.5 (25.3, 1.7); b = 4.7–5.6 (5, 0.2); c = 15.9–19.7 (17.6, 1.2); V = 54–58 (56, 1.2); stylet length 19.3–19.7  $\mu\text{m}$  (19.3  $\mu\text{m}$ , 0.1); DGO 2.1–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.1) from base of stylet; center of median bulb 61–72  $\mu\text{m}$  (66  $\mu\text{m}$ , 3.9) from anterior end; excretory pore 100–117  $\mu\text{m}$  (107.2  $\mu\text{m}$ , 5.3) from anterior end; anal body width 15.9–18.4  $\mu\text{m}$  (17.2  $\mu\text{m}$ , 0.7); phasmids 25–35  $\mu\text{m}$  (30  $\mu\text{m}$  2.6) from tail terminus; annule width at midbody 1.9–2.3  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.1); lateral field width 6.4–9  $\mu\text{m}$  (7.6  $\mu\text{m}$ , 1.1).

*Males (11)*: Length 564–734  $\mu\text{m}$  (644  $\mu\text{m}$ , 43.3); width 23.6–27  $\mu\text{m}$  (25  $\mu\text{m}$ , 1.2); a = 23.9–28.5 (25.7, 1.3); b = 4.4–5.3 (4.9, 0.2); c = 14.6–18.4 (16.5, 1); stylet length 18.9–19.7  $\mu\text{m}$  (19.3  $\mu\text{m}$ , 0.1); DGO 1.7–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 60–72  $\mu\text{m}$  (64  $\mu\text{m}$ , 3.7) from anterior end; spicules 24.5–26.2  $\mu\text{m}$  (25.6  $\mu\text{m}$ , 0.5); gubernaculum 15–16.3  $\mu\text{m}$  (15.4  $\mu\text{m}$ , 0.4); phasmids 23–34  $\mu\text{m}$  (27  $\mu\text{m}$ , 3.1) from tail terminus; anal body width 15–17.2  $\mu\text{m}$  (15.7  $\mu\text{m}$ , 0.8); excretory pore 99–119  $\mu\text{m}$  (106  $\mu\text{m}$ , 6.6) from anterior end; annule width at midbody 2–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.1); lateral field width 6.4–9.4  $\mu\text{m}$  (7.7  $\mu\text{m}$ , 1.1).

*Topotypes (males and females)*: Collected September 1983 by S. A. Lewis from Old and New Pee Dee Station in Florence, South Carolina.

#### (a) *Specimens from Old Station*

*Females (15)*: Length 589–753  $\mu\text{m}$  (667  $\mu\text{m}$ , 47.8); width 21–30  $\mu\text{m}$  (26  $\mu\text{m}$ , 2.4); a = 22.1–27.8 (25.4, 1.1); b = 4.3–5.7 (4.8, 0.4); c = 14.8–19.8 (16.8, 1.1); V = 53.9–59.9 (57.6, 1.3); stylet length 18.4–21  $\mu\text{m}$  (19.3  $\mu\text{m}$ , 0.5); DGO 1.7–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 63–73  $\mu\text{m}$  (67  $\mu\text{m}$ , 3.2) from anterior end; excretory pore 101–122  $\mu\text{m}$  (110.7  $\mu\text{m}$ , 5.8) from anterior end; anal body width 15.9–19.3  $\mu\text{m}$  (17.7  $\mu\text{m}$ , 0.9); phasmids 28–



FIGS. 19–30. Drawings of different populations of *Tylenchorhynchus claytoni* showing variations in tail shape and position of phasmid. 19–21) South Carolina populations. 22) Paralectotypes. 23–26) Maryland populations. 27–30) Iowa population.

34  $\mu\text{m}$  (31  $\mu\text{m}$ , 2.1) from tail terminus; annule width at midbody 2–3  $\mu\text{m}$  (2.4  $\mu\text{m}$ , 0.2); lateral field width 6.4–8.6  $\mu\text{m}$  (8  $\mu\text{m}$ , 0.9).

(b) *Specimens from New Station*

*Females* (9): Length 581–752  $\mu\text{m}$  (656  $\mu\text{m}$ , 53.1); width 21.5–25.8  $\mu\text{m}$  (23.3  $\mu\text{m}$ , 1.8); a = 26.9–29.3 (28, 1); b = 4.5–6.2 (5.1, 0.5); c = 15.4–18 (17, 1); V = 48–57 (54, 2.9); stylet length 18.4–19.3  $\mu\text{m}$  (19.2

$\mu\text{m}$ , 0.3); DGO 1.7–2.1  $\mu\text{m}$  (2  $\mu\text{m}$ , 0.1) from base of stylet; center of median bulb 61–65  $\mu\text{m}$  (63  $\mu\text{m}$ , 1.7) from anterior end; excretory pore 95–109  $\mu\text{m}$  (102  $\mu\text{m}$ , 4.1) from anterior end; anal body width 12.9–18.4  $\mu\text{m}$  (15.6  $\mu\text{m}$ , 1.5); phasmid 27–34  $\mu\text{m}$  (31  $\mu\text{m}$ , 2.2) from tail terminus; annule width at midbody 1.7–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.2); lateral field width 6.4–7.7  $\mu\text{m}$  (6.5  $\mu\text{m}$ , 0.4).

*Males* (8): Length 576–662  $\mu\text{m}$  (619  $\mu\text{m}$ ,

31.3); width 20.2–22.3  $\mu\text{m}$  (20.7  $\mu\text{m}$ , 0.7); a = 27.7–32.5 (29.8, 1.6); b = 4.6–5.5 (5, 0.3); c = 14.8–16.5 (15.9, 0.5); stylet length 18–19.3  $\mu\text{m}$  (18.7  $\mu\text{m}$ , 0.6); DGO 1.7–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 60–68  $\mu\text{m}$  (62  $\mu\text{m}$ , 2.8) from anterior end; spicules 22–24  $\mu\text{m}$  (23  $\mu\text{m}$ , 0.7); gubernaculum 12.9–14.1  $\mu\text{m}$  (13.6  $\mu\text{m}$ , 0.4); phasmids 26–32  $\mu\text{m}$  (30  $\mu\text{m}$ , 2) from tail terminus; anal body width 12.9–15.1  $\mu\text{m}$  (13.7  $\mu\text{m}$ , 0.9); excretory pore 92–105  $\mu\text{m}$  (99  $\mu\text{m}$ , 4.4) from anterior end; lateral field width 6–6.4  $\mu\text{m}$  (6.3  $\mu\text{m}$ , 0.1).

*Specimens from South Carolina (males and females)*: Collected September 1983 by S. A. Lewis from Darlington County and Yauhanna, South Carolina.

(a) *Specimens from Darlington County*

*Females (15)*: Length 593–716  $\mu\text{m}$  (661  $\mu\text{m}$ , 35.8); width 21.5–26.2  $\mu\text{m}$  (23.5  $\mu\text{m}$ , 1); a = 25.1–31.5 (28, 1.7); b = 4.5–5.4 (4.8, 0.2); c = 15.3–19.3 (17.8, 0.9); V = 56–58 (56, 0.8); stylet length 18–19.3  $\mu\text{m}$  (19  $\mu\text{m}$ , 0.4); DGO 1.7–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.1) from base of stylet; center of median bulb 61–69  $\mu\text{m}$  (64  $\mu\text{m}$ , 2.5) from anterior end; excretory pore 95–115  $\mu\text{m}$  (105  $\mu\text{m}$ , 5.2) from anterior end; anal body width 13.7–17.2  $\mu\text{m}$  (15.4  $\mu\text{m}$ , 1); phasmids 28–34  $\mu\text{m}$  (30  $\mu\text{m}$ , 1.6) from tail terminus; annule width at midbody 2–2.6  $\mu\text{m}$  (2.3  $\mu\text{m}$ , 0.1); lateral field width 6.4–9.4  $\mu\text{m}$  (7  $\mu\text{m}$ , 0.9).

*Males (12)*: Length 535–659  $\mu\text{m}$  (623  $\mu\text{m}$ , 37.5) width 19.3–23.6  $\mu\text{m}$  (21.8  $\mu\text{m}$ , 1.4); a = 26.3–30 (28.5, 1.1); b = 4.3–5.2 (4.7, 0.2); c = 15.3–19.6 (17, 1.3); stylet length 18–19.3  $\mu\text{m}$  (18.5  $\mu\text{m}$ , 0.7); DGO 1.7–2.1  $\mu\text{m}$  (1.9  $\mu\text{m}$ , 0.2) from base of stylet; center of median bulb 62–69  $\mu\text{m}$  (64  $\mu\text{m}$ , 2.3) from anterior end; spicules 21–23  $\mu\text{m}$  (22  $\mu\text{m}$ , 0.9); gubernaculum 12.9–15  $\mu\text{m}$  (13.6  $\mu\text{m}$ , 0.7); phasmids 25–34  $\mu\text{m}$  (28  $\mu\text{m}$ , 2.3) from tail terminus; anal body width 12–15  $\mu\text{m}$  (13.4  $\mu\text{m}$ , 0.8); excretory pore 94–107  $\mu\text{m}$  (103  $\mu\text{m}$ , 3.7) from anterior end; lateral field width 5.1–7.7  $\mu\text{m}$  (6.4  $\mu\text{m}$ , 0.5).

(b) *Specimens from Yauhanna*

*Females (10)*: Length 559–662  $\mu\text{m}$  (616  $\mu\text{m}$ , 28.4); width 21.5–24  $\mu\text{m}$  (22.5  $\mu\text{m}$ , 0.9) a = 26–29.6 (27.3, 1.2); b = 4.4–5 (4.7, 0.2); c = 15.3–18.1 (16.8, 0.9); V = 55.3–

59 (57.1, 1.2); stylet length 19.3–19.7  $\mu\text{m}$  (19.3  $\mu\text{m}$ , 0.1); DGO 2.1–2.5  $\mu\text{m}$  (2.1  $\mu\text{m}$ , 0.1) from base of stylet; center of median bulb 60–70  $\mu\text{m}$  (65  $\mu\text{m}$ , 3) from anterior end; excretory pore 94–112  $\mu\text{m}$  (103  $\mu\text{m}$ , 0.2) from anterior end; anal body width 14.6–17.2  $\mu\text{m}$  (15.5  $\mu\text{m}$ , 0.8); phasmids 25–34  $\mu\text{m}$  (30  $\mu\text{m}$ , 2.9) from tail terminus; annule width at midbody 1.9–2.5  $\mu\text{m}$  (2.2  $\mu\text{m}$ , 0.2); lateral field width 6.4–8.1  $\mu\text{m}$  (6.7  $\mu\text{m}$ , 0.5).

*Paralectotypes (females and males)*: Collected in 1936 by E. E. Clayton at Florence, South Carolina. Slides T-966p–T-968p USDANC at Beltsville, Maryland. (New designation, but Loof (10) had earlier designated a holotype and an allotype from this same material.)

*Females (4)*: Length 525–664  $\mu\text{m}$  (604  $\mu\text{m}$ , 58.1); width 23.6–27.9  $\mu\text{m}$  (24.9  $\mu\text{m}$ , 2); a = 21.7–28.1 (24.3, 2.9); b = 5.3–5.5 (5.4, 0.1); c = 15.2–17 (16.5, 1); V = 56.7–57.7 (57, 0.4); stylet length 18.4–18.9  $\mu\text{m}$  (18.5  $\mu\text{m}$ , 0.2); center of median bulb 51–66  $\mu\text{m}$  (58  $\mu\text{m}$ , 6.4) from anterior end; excretory pore 91–101  $\mu\text{m}$  (96  $\mu\text{m}$ , 5) from anterior end; anal body width 14.1–17.2  $\mu\text{m}$  (15.7  $\mu\text{m}$ , 1.4); annule width at midbody 1.9–2.3  $\mu\text{m}$  (2  $\mu\text{m}$ , 0.1).

*Males (4)*: Length 518–654  $\mu\text{m}$  (586  $\mu\text{m}$ , 55.6); width 21.5–30.1  $\mu\text{m}$  (24.2  $\mu\text{m}$ , 4); a = 21.7–27.1 (24.3, 2.2); c = 15.9–19.1 (16.8, 1.5); stylet length 18–18.5  $\mu\text{m}$  (18.2  $\mu\text{m}$ , 0.2); excretory pore from anterior end 88–93  $\mu\text{m}$  (90  $\mu\text{m}$ , 3.5); spicules 21.5–22.3  $\mu\text{m}$  (21.9  $\mu\text{m}$ , 0.4); gubernaculum 12.9–13.7  $\mu\text{m}$  (13.1  $\mu\text{m}$ , 0.4); phasmids 23.6–25.8  $\mu\text{m}$  (24.8  $\mu\text{m}$ , 1.1) from tail terminus.

Specimens from all these collections are deposited in the USDA Nematode Collection, Beltsville, Maryland.

## DISCUSSION

Morphometric variations occur frequently in nature within the same or different populations of a species. In December 1981 D. C. Norton sent two slides containing specimens of *Tylenchorhynchus* sp. from Iowa to A. Morgan Golden for species identification. Specimens were first thought to represent an undescribed species closely related to *T. claytoni*. Spec-

imens were noted with 3–4 head annules (occasionally one more), tail annules 12–20 (mean 15), and a stylet of 18.1–20.2  $\mu\text{m}$  (mean 19). Of more importance, however, was that the Iowa specimens were shorter than *T. claytoni* populations previously described from the United States and the tail terminus was more blunt with annules extending further back on the terminus, sometimes being almost an annulated terminus. In addition, phasmids of the Iowa population were mostly located off center of the lateral field. Subsequently, more specimens from Iowa were studied and a detailed morphological examination was made of *T. claytoni* specimens collected from several locations, including topotypes from type locality, BARC greenhouse culture at Beltsville, and paralectotypes deposited at USDANC. It was found that this species shows variations in the shape of lip region, shape of female tail, number of annules on tail, and position of phasmids. The lip region was rounded or button shaped, offset by a slight constriction; the tail tapered regularly to a rounded, smooth to bluntly rounded terminus, sometimes with annules extending further back on the terminus, almost being an annulated terminus; tail with 12–20 annules; phasmids located either in the center or mostly off center of the lateral field. In view of the variations noted in different populations, the Iowa specimens fit well within the *T. claytoni* range and thus represent *T. claytoni* Steiner, 1937.

The species, *T. goffarti* and some others, were placed in the subgenus *Bitylenchus* by Jairajpuri (6). We believe this subgenus may create nomenclatural problems at generic and species level and hence synonymize *Bitylenchus* back to *Tylenchorhynchus*. All the species, including *T. (B.) depressus*, placed in *Bitylenchus* are transferred back to *Tylenchorhynchus*; and the single species, *Tylenchorhynchus (B.) depressus*, becomes *T. depressus* (Jairajpuri, 1982) n. comb.

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