Scanning electron microscopy observations on Telotylenchinae Siddiqi, 1960 (Nemata : Belonolaimidae).

3. The genus *Tylenchorhynchus* Cobb, 1913.

by Pierre BAUJARD, Danamou MOUNPORT & Bernard MARTINY

**Abstract**

Ten species of the genus *Tylenchorhynchus* were studied under SEM. Observations showed the great heterogeneity of the genus according to the head pattern and confirmed the absence of validity of some characters at the taxonomic level (number of incisures in the lateral field, presence vs absence of longitudinal ridges, presence vs absence of notch on the bursa). Four to five different head patterns can be recognized, corresponding to the cuticle ultrastructure patterns previously defined. *Bitylenchus* is considered as a junior synonym of *Tylenchorhynchus*, and *B. pratensis* and *B. serranus* are transferred to the genus *Tylenchorhynchus*.

**Keywords**: Nemata, Belonolaimidae, *Tylenchorhynchus*, morphology, scanning electron microscopy.

**Résumé**

 Dix espèces du genre *Tylenchorhynchus* ont été étudiées en microscopie électronique à balayage. Les observations révèlent une hétérogénéité considérable des structures céphaliques externes et confirment l’absence de validité de certains caractères morphologiques au niveau taxonomique (nombre d’incisures dans les champs latéraux, présence vs absence de crêtes longitudinales, présence vs absence d’échancreure sur la bursa). Les structures céphaliques externes peuvent être groupées en quatre à cinq types différents qui correspondent à ceux définis précédemment sur l’ultrastructure de la cuticule. *Bitylenchus* est considéré comme un synonyme mineur du genre *Tylenchorhynchus*, et les espèces *B. pratensis* et *B. serranus* sont transférées au genre *Tylenchorhynchus*.

**Mots-clé**: Nemata, Belonolaimidae, *Tylenchorhynchus*, morphologie, microscopie électronique à balayage.

**Introduction**

Recent studies on the taxonomy of the genus *Tylenchorhynchus* (Siddiqi, 1986; Fortuner & Luc, 1987) are principally based on morphological and biometrical characters observed in light microscopy. Of the 130 species listed in the genus *Tylenchorhynchus* (Fortuner & Luc, 1987), little is known on their morphology as seen under scanning electron microscopy (SEM). Previous studies (Sher & Bell, 1975; Lewis & Golden, 1981; Vovlas & Cham, 1981; Jairajpuri & Hunt, 1984; Sauer, 1985; Lopez & Salazar, 1987; Vovlas & Cheng, 1988; Rashid & Heyns, 1990; Zeidan & Geraert, 1990; Lal & Hines, 1991; Gomez Barcina et al., 1992) reveal great differences, particularly in the head face view, between species of *Tylenchorhynchus*. More recently, Mounport et al., (1993) compared the ultrastructure of the cuticle of nine species of the genus concluding that it might be composed of several genera which must be redefined on the basis of light and scanning electron microscopy. This work presents the results of observations on ten species belonging to the genus *Tylenchorhynchus*, some of them previously described and/or transferred in genera presently considered as synonyms of *Tylenchorhynchus* (see Fortuner & Luc, 1987): *Bitylenchus* Filip'ev, 1934, *Telotylenchus* Siddiqi, 1960, *Dolichorhynchus* Mulik & Jairajpuri, 1974, *Neodolichorhynchus* Jairajpuri & Hunt, 1984. Nine of these species were studied by Mounport et al. (1993).

**Material and methods**

**SPECIES STUDIED**


*Tylenchorhynchus germanii* (Golden, 1971).


*Tylenchorhynchus indicus* (Golden, 1971).

*Tylenchorhynchus microphasmis* Loof, 1960.

Fig. 1 – Tylenchorhynchus mashoodi females (A-D, G-I) and males (E-F, J-L). A and B, C and D, E and F: respectively in face and lateral view of the same specimen; G: vulvar region; H-L: tails; A-F: scale bar = 1 μm; G-L: scale bar = 10 μm.

Tylenchorhynchus sulcatus de Guiran, 1967.


Tylenchorhynchus vulgaris Upadhyay, SWARUP & Sethi, 1972.

Tylenchorhynchus phaseoli Sethi & SWARUP, 1968.
syn Dolichorhynchus (Dolichorhynchus) phaseoli (Sethi & SWARUP, 1968) MULK & JAIRAJPURI, 1974.
= Tylenchorhynchus sp. in MOUNPORT et al., 1993.

ORIGIN OF SPECIMENS

T. annulatus: two populations originating from Richard-Toll, Senegal in 1982 (“CSS” population) and from samples taken along the road Kaffrine-Koungheul, Senegal (“KK”) population in 1984 and paratypes of T. martini originating from the Riverside Nematode Collection, University of California, U.S.A.


T. microphasmis: The Netherlands (sent by Dr. F.C. ZOON).


PREPARATION OF SPECIMENS FOR SEM STUDIES

Except for the paratypes of T. martini and specimens of T. microphasmis, the other species were cultured at constant soil temperature and soil moisture (Table 1) on Sorghum vulgare L. in the laboratory since the sampling date, extracted by elutriation (SEINHORST, 1962), killed by gentle heating (60° C) during 30 seconds and then processed without fixation for SEM as described by BAUJARD and PARISELLE (1987). Specimens of T. microphasmis were obtained in fixative and processed by the same technique. Paratypes of T. martini and some specimens of T. indicus and T. ventralis were processed for SEM and photographed by Dr. BELL as described by SHER & BELL (1975).

In order to evaluate a possible variability in the morphological characters, several specimens extracted at different times were studied for each species from laboratory cultures (Table 1).

Table 1:
Laboratory culture conditions and number of specimens observed under SEM.

<table>
<thead>
<tr>
<th>Species</th>
<th>Soil temperature and moisture</th>
<th>Extraction date</th>
<th>Number of specimens observed (females-males)</th>
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<td>34°-10%</td>
<td>28.02.1986</td>
<td>36</td>
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<td></td>
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<td>11.05.1987</td>
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<td></td>
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<td>30</td>
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<td>T. annulatus “CSS” population</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>13.12.1986</td>
<td>30</td>
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<tr>
<td></td>
<td></td>
<td>23.01.1991</td>
<td>30</td>
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<td>20.11.1986</td>
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<td>01.12.1986</td>
<td>29-21</td>
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<td></td>
<td></td>
<td>25.05.1987</td>
<td>26-23</td>
</tr>
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<td></td>
<td></td>
<td>27.03.1990</td>
<td>30-30</td>
</tr>
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<td>T. indicus</td>
<td>34°-10%</td>
<td>08.12.1986</td>
<td>28-30</td>
</tr>
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<td>T. mashhoodi</td>
<td>34°-30%</td>
<td>19.03.1991</td>
<td>30-30</td>
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<td>T. sulcatus</td>
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<td>20-20</td>
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<td></td>
<td></td>
<td>26.03.1991</td>
<td>30-30</td>
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<td></td>
<td></td>
<td>24.01.1992</td>
<td>30-30</td>
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<tr>
<td>T. ventralis</td>
<td>34°-10%</td>
<td>12.12.1986</td>
<td>15-4</td>
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<td></td>
<td>12.03.1990</td>
<td>30-30</td>
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<tr>
<td>T. vulgaris</td>
<td>30°-10%</td>
<td>26.05.1988</td>
<td>30</td>
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<td></td>
<td>13.07.1992</td>
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<td>T. phaseoli</td>
<td>36°-10%</td>
<td>25.04.1988</td>
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Results

HEAD

T. mashhoodi (Fig.1, A-F), the two Senegalese populations of T. annulatus and T. martini paratypes (Fig. 2, A-I): head square like in lateral view; cephalic constriction absent; in front view, head rounded to laterally elongated with six more or less pronounced longitudinal depressions, two dorso-ventral and four submedial; three to four cephalic annuli present; oral aperture a dorso-ventral slit surrounded by a small rim itself surrounded by six labial sensilla; labial disc not prominent, squarish to four lobed, demarcated by an incisure interrupted by the amphid apertures; first cephalic annulus not differentiated into lip sectors; amphid aperture laterally situated at the edge of the labial disc, circular (occurrence: 27% in the “CSS” population and 17% in the “KK” population) to ovoid, the longer axis being dorso-ventrally orientated (occurrence: 73% in the
Fig. 2 – Tylenchorhynchus annulatus, females; A-F: "CSS" population, G-J, L: paratypes of T. martini; K, M: "KK" population. A-I: heads (A and B, C and D, E and F, G and H: respectively lateral and in front view of the same specimen); J-K: vulvar region (the white arrow shows the direction of the anterior region); L-M: tails; A-I: scale bar = 1 μm; J-M: scale bar = 10 μm.
Fig. 3 - TylENCOrhynchus annulatus, females of the "CSS" population. N and O, Q and P, R and S: respectively vulvar region and vulva of the same specimen (the white arrow shows the direction of the anterior region); T-W: tails; N, Q, R-W: scale bar = 10 μm; O, P, S: scale bar = 1 μm.
“CSS” population and 83 % in the “KK” population). No sexual dimorphism in head morphology.

*T. gladiolatus* (Fig. 4) and *T. vulgaris* (Fig. 6): head rounded in lateral view; cephalic constriction present; in front view, head rounded to laterally elongated with or without two dorso-ventral longitudinal depressions giving a bilobed appearance when present and two lateral longitudinal slits below the amphid aperture; six to ten cephalic annuli present; oral aperture circular surrounded by a small rim itself surrounded by 6 labial sensilla; labial disc non prominent, four lobed, demarcated by an incisure interrupted by the amphid apertures; in some specimens, this incisure is also interrupted ventrally and/or dorsally; some supplementary incisures present on the lobes of the labial disc giving the appearance of differentiated submedial lip sectors; first cephalic annulus not differentiated into lip sectors; amphid aperture circular, with a contour more or less convoluted, laterally situated at the edge of the labial disc, prolonged by a longitudinal incisure until the cephalic constriction.

*T. indicus* (Fig. 8), *T. ventralis* (Figs. 10: A-H, 11: O-T): head rounded in lateral view; cephalic constriction present; in front view, head rounded with two slight dorso-ventral longitudinal depressions giving a bilobed appearance and with two to seven short longitudinal slits below the amphids up to the fifth cephalic annulus; the transverse annulation disappears between these longitudinal slits; seven to eight cephalic annuli present; oral aperture dorso-ventrally elongated, without rim, surrounded by six labial sensilla; labial disc slightly demarcated, not prominent, squarish; first cephalic annulus without lateral sectors and with submedial sectors partially fused to the labial disc; amphid aperture circular, laterally situated at the edge of the labial disc. Sexual dimorphism present in head morphology: male heads with the four submedial lip sectors prominent separated or not from the labial disc by an incisure (Figs 8: C, E, G; 11: O-T); head face asymmetrical, the ventral side being wider than the dorsal one (Figs 8: E-G; 11: Q, P-T).

*Tylenchorkynchus microphasmis* (Figs. 12: A-D; 13: O-R): head morphology similar to that observed in *T. indicus* and *T. ventralis* except i) two dorso-ventral longitudinal depressions more pronounced (Fig. 12: B, D) and sometimes transformed into a deep incisure (Fig. 12: C) and ii) submedial lip sectors more prominent (Fig. 12: B-D) with a partial (Fig. 12: B) to complete incisure (Fig. 12: C-D) separating them from the labial disc. Sexual dimorphism as in *T. indicus* and *T. ventralis* with sometimes a complete disorganization of the labial disc and first cephalic annulus (Fig. 13: Q).

*T. phaseoli* (Fig. 14: A-D): head morphology similar to that of *T. microphasmis* except i) two dorso-ventral longitudinal depressions never transformed into incisures, ii) absence of longitudinal slits below the amphid apertures, iii) presence of a small cuticular rim around the amphid apertures, forming the two lateral lip sectors (Fig. 14: C-D), iv) rounded appearance of the labial disc demarcated by a circular groove (Fig. 14: B-D).

*T. germanii* (Fig. 16: A-K), *T. sulcatus* (Figs. 19: A-D; 20: O-R): head morphology similar to that of *T. microphasmis* except for i) small circular labial disc, ii) complete separation of the submedial lip sectors from the labial disc and iii) discreet dorso-ventral deformation of the male heads.

**LATERAL FIELD**

Three bands are regularly isolated, the areolations in the lateral fields: they are few, erratic and present only on the two outer bands in *T. annulatus* (Figs. 2: L-M; 3: N, Q, T-W), *T. indicus* (Fig. 9), *T. mashhoodi* (Fig. 1: G-L) and *T. ventralis* (Figs. 10: I-N; 11: U-V). In *T. vulgaris*, longitudinal incisures are observed only in the anterior region of the body, between the head and the beginning of the lateral fields (Figs. 6, 7). In *T. germanii*, *T. gladiolatus*, *T. microphasmis*, *T. sulcatus* and *T. phaseoli*, longitudinal ridges are observed all along the body; these ridges are contiguous in *T. gladiolatus* and well separated in the four other species (Figs. 4, 5, 12-20).

**LONGITUDINAL ORNAMENTATIONS OUTSIDE THE LATERAL FIELD**

No longitudinal ornamentations outside the lateral fields are observed in *T. annulatus* (Figs. 2: L-M; 3: N, Q, T-W), *T. indicus* (Fig. 9), *T. mashhoodi* (Fig. 1: G-L) and *T. ventralis* (Figs. 10: I-N; 11: U-V), *T. vulgaris* (Fig. 7) and the ridges in *T. germanii* (Fig. 17: M, R, U), *T. microphasmis* (Figs. 12: E, G; 13: S-T), *T. sulcatus* (Figs. 19: E-H; 20: S-T).

The central band/ridge ends on tail at or immediately posterior to phasmid level in all the species (Figs. 1: H-L, 2: L-M; 3: T-W; 5: J-M; 7: J-K; 9: K-L; 10: M-N; 13: K-M; 17: S-V; 19: K-N) except in *T. phaseoli* (Fig. 15: O-T) where the unique ridge of the lateral field reaches the tail end. Areolations in the lateral fields: they are few, erratic and present only on the two outer bands in *T. annulatus* (Figs. 2: L-M; 3: N, T-W) and *T. mashhoodi* (Fig. 1: H-L); in *T. gladiolatus* (Fig. 5), *T. indicus* (Fig. 9), *T. ventralis* (Figs. 10: I-N; 11: U-V), *T. vulgaris* (Fig. 7), *T. germanii* (Fig. 17: M, R, U), *T. microphasmis* (Figs. 12: E, G; 13: S-T) and *T. sulcatus* (Figs. 19: E-H; 20: S-T), the three bands are regularly areolated, the areola-
Fig. 4 – Tylenchorhynchus gladiolatus, females (A-D) and males (E-F) heads. A, B: in front views; C and D, E and F: respectively lateral and in front view of the same specimen; scale bar = 1 μm.
Fig. 5 – Tylenchorhynchus gladiolatus, females (G-L) and males (M-N). G-I : vulvar region (the white arrow shows the direction of anterior region); J-N : tails; scale bar = 10 μm.
tions being two times more spaced than the transverse body annulation.

VULVA AND VENTRAL ORNAMENTATIONS IN THE VULVAR REGION

In all the species studied, the vulva appeared as a transverse slit with two slightly prominent anterior and posterior lips; in some specimens of all these species, one or two non prominent lips (epiptygma) appearing white on SEM photographs are observed inside the vulvar slit (Figs. 1: G; 2: K; 3: N-S; 5: G-I; 7: F-I; 9: H-J; 10: I-L; 12: F, H-I; 15: H-K; 17: N-Q; 19: G). Lateral vulvar membranes (flaps) are absent in all the species; in the species with ridges, the transverse vulvar opening is always lined by two slightly indented longitudinal ridges: *T. gladiolatus* (Fig. 5: G-I), *T. microphasmis* (Figs. 12: F, H-I; 13: J), *T. phaseoli* (Fig. 15: J-K), *T. germanii* (Fig. 17: N-Q), *T. sulcatus* (Fig. 19: G, I).

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Fig. 6 – *Tylenchorhynchus vulgaris*, females heads. A, B, C: in front view; D: lateral view; D and E: respectively lateral and in front view of the same specimen; scale bar = 1 µm.
Fig. 7 – Tylenchorhynchus vulgaris, females. F-I: vulvar region (the white arrow shows the direction of anterior region); J-L: tails; scale bar = 10 μm.
Ventral ornaments in the vulvar region are present in all the species studied except in *T. phaseoli* where the ventral ridge reaches the vulva without any modification. These ornaments showed great variation in i) their occurrence in each species (absent or present in the same species or always present), ii) their pattern (variation of body width, longitudinal incisure or disorganization of the transverse annulation, iii) their localization (in front and/or behind vulva):

*T. annulatus*: ornaments can be absent (Fig. 3 : R) or present as a longitudinal incisure in front and behind vulva (Fig. 2 : J) or alteration of the transverse body annulation only behind (Fig. 2 : K) or behind and in front of the vulva (Fig. 3 : N, Q).

*T. germanii*: the ventral ridge subdivided in front of the vulva into two subventral ridges, the two previous subventral ridges being interrupted (Fig. 17 : N-Q); behind vulva, the same situation is present (Fig. 17 : O-Q) or not, the ventral ridge ending just in front of the vulva (Fig. 17 : N, P); alterations of the transverse body annulation occurred sometimes just behind the vulva on a short length (Fig. 17 : N-P).

*T. gladiolatus*: anomalies of the transversal body annulation are always present but only behind the vulva (Fig. 5 : G-I).

*T. indicus*: ornaments can be absent (Fig. 9 : J) or present as alterations of the transverse body annulation in front and behind the vulva (Fig 9 : H-I).

*T. mashhoodii*: a longitudinal incisure is present in front and behind the vulva (Fig. 1 : G).

*T. microphasmis*: ventral ridge subdivided into two subventral ridges in front and behind the vulva, the two previous subventral ridges being interrupted (Figs. 12 : H-I; 13 : J); no other ornaments occurred ventrally.
Fig. 9 – Tylenchorhynchus indicus, females (H-L) and males (M). H-J: vulvar region; K-M: tails; scale bar = 10 μm.
T. sulcatus: ventral ridge subdivided in front of the vulva into two subventral ridges, the two previous subventral ridges being interrupted; behind the vulva, the ventral ridge ends just in front of the vulva (Fig. 19: J); alterations of the transverse body annulation occurred both in front and behind the vulva (Fig. 19: I) or only behind the vulva (Fig. 19: J).

T. ventralis: in lateral view the body shows a widening in front of the vulva and a narrowing behind the vulva (Fig. 10: I-J); in ventral view, two groups (one in front and one behind the vulva) of ridges are longitudinally placed (Fig. 10: K-L); they correspond probably to the underlying musculature of the vagina (dilatatores vaginae); alterations of the transverse body annulation occurs on a short length just behind the vulva.

T. vulgaris: alterations of the transverse body annulation are always present (Fig. 7: F-I), variations occurring both in length (from 5 to 15 µm long) and in position (in front and/or behind the vulva).

FEMALE TAIL

Tail conoid to cylindrical with a rounded terminus in T. mashhoodi (Fig. 1: H-I), T. annulatus (Figs. 2: L-M; 3: T-W), T. gladiolatus (Fig. 5: J-L) or with a rounded to acute terminus in T. vulgaris (Fig. 7: J-L); tail conical with a rounded terminus in T. indicus (Fig. 9: K-L), T. ventralis (Fig. 10: M), T. microphasmis (Fig. 13: K-L), T. germanii (Fig. 17: S-V) and T. sulcatus (Fig. 19: K-N).

PHASMID

Phasmids punctiform in T. mashhoodi (Fig. 1: H-I), T. annulatus (Figs. 2: L-M; 3: U-W), T. gladiolatus (Fig. 5: J-L), T. indicus (Fig. 9: K-L), T. ventralis (Fig. 10: M), T. microphasmis (Fig. 13: K), T. germannii (Fig. 17: S, U, V) and T. sulcatus (Fig. 19: M-N). Phasmids wider in T. vulgaris (Fig. 7: J-K) and variable in diameter in T. phaseoli, from punctiform (Fig. 15: S-T) to wide (Fig. 15: O-P) with intermediate widths (Fig. 15: Q-R).

MALE COPULATORY APPARATUS

Bursa pelodera without distal notch in T. mashhoodi (Fig. 1: J-L), T. gladiolatus (Fig. 5: M-N), T. indicus (Fig. 9: M), T. ventralis (Fig. 11: U-V), T. microphasmis (Fig. 13: M), T. sulcatus (Fig. 20: T-V). Notch present or absent in the first extracted population of T. germannii, variable in depth when present (Fig. 18: W-AB); in the second extracted population, notch always absent.

Spicules never protruding on SEM observed specimens of T. indicus and T. ventralis; for the other bisexual species, spicules protruding with large velum and without peculiar characteristics except in T. mashhoodi where a short distal process is present at the distal end giving a bifid appearance to spicule tip (Fig. 1: K-L) and in T. gladiolatus where a minute notch is present ventrally at the distal end of the spicules (Fig. 5: M-N).

Gubernaculum only seen in bisexual species with protruding spicules. Protrusion of gubernaculum variable in T. mashhoodi (six males with protruded gubernaculum in ten males observed) and constant in T. gladiolatus, T. microphasmis, T. germannii and T. sulcatus. Gubernaculum in T. mashhoodi, T. microphasmis, T. germannii, T. sulcatus with three knobs, one distal and central, flattened, supporting the dorsal shaft of the spicule and two subdistal and lateral, rounded, inserted in a longitudinal groove present on the dorsal side of the velum (Figs. 16: L; 17: W, Z, AA; 20: S, U, V); in T. gladiolatus, only the distal knob, triangular in shape, protruding from the cloaca is observable.

MISCELLANEOUS OBSERVATIONS

In T. phaseoli, excretory pore in variable position, on or along the ventral ridge (Fig. 14: E-G); anus surrounded by a circle of cuticular blocks (Fig. 15: M-N).

Discussion

The head patterns observed in this study can be grouped into five types (Table 2):

Table 2: Characterizations of the five groups of species according to longitudinal body ornamentations and head features (+ = present; = absent, * = ventral and dorsal depressions strong; ? = undetermined).

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<th>Characters</th>
<th>Species groups</th>
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<td>longitudinal ornamentations on the cuticle outside the lateral fields</td>
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<tr>
<td>longitudinal depressions on head</td>
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<td>- rounded</td>
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Fig. 10 – Tylenchorhynchus ventralis, females. A-H: heads (A, C: respectively lateral and in front view of the same specimen); I-L: vulvar region (the white arrow shows the direction of anterior region); M-N: tails; A-H: scale bar = 1 μm; I-N: scale bar = 10 μm.
Type 1: head profile squarish; head continuous; five or less cephalic annuli; six longitudinal depressions slightly pronounced; no lateral incisure; labial disc rectangular with submedial lip sectors completely fused; no lateral lip sectors; no sexual dimorphism in head morphology. This type is observed here for *T. annulatus* (see also *LOPEZ & SALAZAR, 1987*) and *T. mashhoodi* and also in other species of the genus: *T. cylindricus*, type species of the genus (Fig. 5, A in *SHER & BELL, 1975*), *T. lamelliferus* (Fig. 3, C, D in *SHER & BELL, 1975*), *T. aduncus* (Fig. 1, A-D in *VOVLAS & CHAM, 1981*), *T. clarius* (Figs. 1, 2, p. 7 in *SAUER, 1985*), *Tylenchorhynchus* sp. (Fig. 1, 2, p. 8 in *SAUER, 1985*) *T. crassicaudatus* (Fig. 7, A in *ZEIDAN & GERAERT, 1990*), *T. clathrocutis* (Figs. 9, 10 in *LEWIS & GOLDEN, 1981*).

Type 2: head profile rounded; head set off; more than five cephalic annuli; four longitudinal depressions slightly pronounced; lateral incisures below the amphid aperture present; labial disc rectangular with submedial lip sectors more or less demarcated by an incomplete incisure; no lateral lip sectors; no sexual dimorphism in head morphology. This type is observed here for *T. gladiolatus* and *T. vulgaris* and also in other species and genera: *T. goffarti* (Fig. 5, B in *SHER & BELL, 1975*), *T. tobari* (Fig. 5-6, p. 8 in *SAUER, 1985*), *T. brevilineatus* (Fig. 3, A-D in *ZEIDAN & GERAERT, 1990*; Fig. 6, B in *RASHID & HEYNS, 1990*), *Bitylenchus serratius* (Figs. 9-11 in *GOMEZ BARCINA et al., 1992*).

Type 3: head profile rounded; head set off; more than five cephalic annuli; six longitudinal depressions present, the four submedial slightly pronounced and the dorsal and ventral ones well pronounced up to a complete incisure; lateral incisures absent; labial disc rounded with submedial lip sectors demarcated and completely separated; no lateral lip sectors; sexual dimorphism present in head morphology with a dorsoventral deformation of the head. This type is observed here for *T. germanii* and *T. sulcatus* and also in other species of the genus: *T. aff. obregonus* (Fig. 9, A-B in *ZEIDAN & GERAERT, 1990*).

Type 5: head profile rounded; head set off; more than five cephalic annuli; six longitudinal depressions present, the four submedial slightly pronounced and the dorsal and ventral ones well pronounced up to a complete incisure; lateral incisures absent; labial disc rounded with submedial lip sectors well demarcated completely or incompletely separated from the labial disc by an incisure; lateral lip sectors present; sexual dimorphism not determined (males absent). This type is observed here for *T. phaseoli* and also in other species and genera: *Tylenchorhynchus* sp. (Fig. 1-4, p. 9 in *SAUER, 1985*), *T. velatus* (Fig. 5-6, p. 9 in *SAUER, 1985*), *Tylenchorhynchus maximus* (Fig. 537 in *DE GRISSE, 1977*; Fig. 36-38 in *GOMEZ BARCINA et al., 1992*), *Bitylenchus pratensis* (Fig. 27 in *GOMEZ BARCINA et al., 1992*). The population of *T. phaseoli* studied by *SHER & BELL* (1975; Fig. 3, A, B) shows submedial lip sectors slightly less developed than in the Niger population and longitudinal body ridges fused at the anterior end just below the head vs separated in the Niger population.

Several species of the genus *Bitylenchus* redefined by *GOMEZ BARCINA et al. (1992)* show great differences in head morphology. The emendation of the genus states "cephalic region ... with lateral longitudinal indentations on annuli behind amphidial apertures ... and anteriormost lip annulus 6-sectored". At least three species did not share the first character, *B. maximus* (*ALLEN, 1955*); *SIDDIQI, 1986*, *B. pratensis* *GOMEZ BARCINA et al., 1992*, *B. velatus* (*SAUER & ANNELS, 1981*) *GOMEZ BARCINA et al., 1992*; whereas *B. serratius* *GOMEZ BARCINA et al., 1992* did not possess the second character. *Bitylenchus Filip'ev, 1934* is then considered a junior synonym of *Tylenchorhynchus*; *B. pratensis* and *B. serratius* are transferred to the genus *Tylenchorhynchus* as *T. pratensis* (*GOMEZ BARCINA et al., 1992*) n. comb. and *T. serratius* (*GOMEZ BARCINA et al., 1992*) n. comb.

This study supports the statements of *FORTUNER & LUC* (1987) regarding the validity of some characters currently used for identification purposes in the taxonomy of the genus: *T. phaseoli* showed only two lines (one ridge) in the lateral field, a unique feature in the Telotylenchinae confirmed by TEM (*MOUPOINT et al., 1993*); longitudinal ridges are present in several species (*T. gladiolatus*, *T. germanii*, *T. microphasmis*, *T. sulcatus*, *T. phaseoli*, *T. lamelliferus*) which showed strong differences in head morphology; lateral membranes at vulva did not exist, being confused under light microscopy with subventral longitudinal ridges; presence of notches on caudal alae appeared to be a variable character at the species level (*T. germanii*).

The SEM observations on the head morphology in the
Fig. 11 - Tylenchorhynchus ventralis, males. O-T: heads (O, Q: respectively lateral and in front view of the same specimen); U-V: tails; O-T: scale bar = 1 μm; U-V: scale bar = 10 μm.
Fig. 12 – Tylenchorhynchus microphasmis, females. A-D: heads (A, B: respectively lateral and in front view of the same specimen); E-G: excretory pore: A-D: scale bar = 1 μm; E-G: scale bar = 10 μm.
Fig. 13 – Tylenchorhynchus microphasmis, females (J-M) and males (O-T). J: vulvar region (the white arrow shows the direction or anterior region); K-M: tails; O-Q: heads; S-T: lateral field; O-R: scale bar = 1 μm; J-M, S-T: scale bar = 10 μm.
Scanning electron microscopy observations on Telotylenchinae

Fig. 14 — Tylenchorhynchus phaseoli, females. A-D : heads (A, B : respectively lateral and in front view of the same specimen); E-G : excretory pore; A-D : scale bar = 1 μm; E-G : scale bar = 10 μm.

genus *Tylenchorhynchus* revealed the great heterogeneity of this group; it is now possible to recognize at least four different types (five if the complete separation of the submedial lip sectors from the labial disc is considered as a stable characteristic) which might need a generic status; the grouping of the studied species according to the head morphology correspond to that proposed by Mounport et al. (1993) on the basis of the ultrastructure of the cuticle. More than 130 species are described in the genus *Tylenchorhynchus* as defined by Fortuner & Luc (1987); the SEM studies of the morphological characteristics and the reexamination of the species under light microscopy constitute a preliminary before any taxonomical changes in the genus could be proposed.

Acknowledgements

The authors thank Dr. F. C. Zoon for sending specimens of *T. microphasmis* and Drs. A. H. Bell and G. Ger- 

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Fig. 15 – Tylenchorhynchus phaseoli, females. H-L: vulvar region (the white arrow shows the direction or anterior region); M-N: anus; O-T: tails; H-L, O-T: scale bar = 10 μm; M-N: scale bar = 1 μm.
Fig. 16 – Tylenchorhynchus germanii, females (A-F) and males (G-L). A-K: heads (A-B, C-D, E-F, G-H: respectively lateral and in front view of the same specimen); L: spicules; scale bar = 1 μm.
Fig. 17 – Tylenchorhynchus germanii, females. M-R: vulvar region (the white arrow shows the direction or anterior region); S-V: tails; M-V: scale bar = 10 μm.
Fig. 18 - Tylenchorhynchus germanii, males. W-AB: tails; scale bar = 10 μm.
Fig. 19 - Tylenchorhynchus sulcatus, females. A-D: heads (A-B, C-D: respectively, lateral and in front view of the same specimen); E-J: vulvar region (the white arrow shows the direction or anterior region); K-N: tails; A-D: scale bar = 1 μm; E-N: scale bar = 10 μm.
Fig. 20 – Tylenchorhynchus sulcatus, males. O-R: heads (O-P, Q-R: respectively lateral and in front view of the same specimen); S-T: tails; O-R: scale bar = 1 μm; S-V: scale bar = 10 μm.