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A revised polytomous key for the identification of species of the genus *Longidorus* Micoletzky, 1922 (Nematoda : Dorylaimoidea)

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Summary – A revised polytomous key is presented for the identification of the 103 valid species in the genus *Longidorus* Micoletzky, 1922. The key is based upon the one by Romanenko (1978) using female characters (shape and width of lip region, shape of tail, length of body and odontostyle, distance of guiding ring from head end, index " a ") with the addition of amphid shape. The occurrence of males is also indicated. The species are listed, along with species synonymized, species renamed because of homonymy, species removed from the genus, and *species inquirendae.*

Résumé – ***Clé polytomique révisée pour l'identification des espèces du genre* Longidorus *Micoletzky, 1922 (Nematoda : Dorylaimoidea)*** – Une clé polytomique révisée pour l'identification des 103 espèces valides du genre *Longidorus* Micoletzky, 1922 est proposée. Cette clé s'inspire de celle publiée par Romanenko (1978) utilisant certains caractères des femelles (forme et largeur de la région labiale, forme de la queue, longueur du corps et de l'odontostyle, distance entre avant et anneau-guide, index a), caractères auxquels est ajoutée la forme de l'amphide. La présence/absence de mâles est également indiquée. Une liste des espèces valides est donnée, de même que des espèces placées en synonymie, de celles renommées par suite d'homonymie, de celles transférées à d'autres genres et enfin des *species inquirendae.*

Key-words : Identification, *Longidorus,* nematodes polytomous key.

The genus *Longidorus* Micoletzky, 1922 contains at present 103 species, several of which are important as vectors of viruses damaging higher plants; they are specific for the types/strains of viruses they can transmit (Taylor & Brown, 1981). Correct identification of species is therefore of paramount importance, but the genus is, in contrast to the related genus *Xiphinema* Cobb, 1913, stenomorph. The most recent general dichotomous key (Lamberti, 1975) is now wholly outdated. Rey *et al.* (1988) described a computer method for identifying the *Longidorus* species. Nevertheless, a polytomous key, not requiring a computer, has the advantage of being readily available and, as shown by Loof and Luc (1990) for *Xiphinema* species, is an effective means of identifying closely allied species with overlapping features. Romanenko (1978) was the first to publish such a key, which was revised and amended for use by participants of the European Plant Parasitic Nematode Survey by Hooper in 1980 and updated for them again in 1986. Navas *et al.* (1993*a*) gave a polytomous key, but only to illustrate phylogenetic relationships. A new key is necessary, since several dozens of new species have been described since 1986. In this paper we propose a polytomous key, using as main characters the shape of lip region, amphid base, and tail, supplemented by numerical characters.

The number before each species indicates the code reference number (CRN) of the entry on the code lattice (see below) thus enabling an immediate check of basic features pertaining to a particular species.

List of valid species

GENUS *LONGIDORUS* MICOLETZKY, 1922

= *Brevinema* Stegarescu, 1980 (type species *B. pisi*), synonymized by Coomans (1985);
= *Neolongidorus* Khan, 1987 (type species *N. himalayensis*), synonymized by Xu and Hooper (1990).

TYPE SPECIES

52. *L. elongatus* (de Man, 1876) Micoletzky, 1922
= *L. monohystera* Altherr, 1953.
= *L. menthasolanus* Konicek & Jensen, 1962.

OTHER SPECIES

16. *L. aetnaeus* Roca, Lamberti, Agostinelli & Vinciguerra, 1986.
32. *L. africanus* Merny, 1966.

43. *L. alvegus* Roca, Pereira & Lamberti, 1989.
18. *L. ampullatus* Jacobs & Heyns, 1987.
83. *L. apuloides* Rocca, 1996.
61. *L. apulus* Lamberti & Bleve-Zacheo, 1977.
95. *L. arenosus* Kankina & Ivanova, 1986.
71. *L. arthensis* Brown, Grunder, Hooper, Klingler & Kunz, 1994.
44. *L. athesinus* Lamberti, Coiro & Agostinelli, 1992.
29. *L. attenuatus* Hooper, 1961.
23. *L. auratus* Jacobs & Heyns, 1987.
31. *L. belloi* Andres & Arias, 1988.
35. *L. belondiroides* Heyns, 1967.
30. *L. breviannulatus* Norton & Hoffmann, 1975.
57. *L. caespiticola* Hooper, 1961.
10. *L. carpetanensis* Arias, Andres & Navas, 1986.
82. *L. closelongatus* Stoyanov, 1964.
75. *L. cohni* Heyns, 1969.
22. *L. congoensis* Aboul-Eid, 1970.
42. *L. conicaudatus* Khan, 1987.
34. *L. conicaudoides* Jacobs & Heyns, 1989
= *L. conicaudatus* Jacobs & Heyns, 1987 *nec* Khan, 1987.
70. *L. crassus* Thorne, 1974.
51. *L. crataegi* Roca & Bravo, 1996.
41. *L. curvatus* Khan, 1987.
90. *L. cylindricaudatus* Kozlowska & Seinhorst, 1979.
72. *L. diadecturus* Eveleigh & Anderson, 1982.
27. *L. distinctus* Lamberti, Choleva & Agostinelli, 1983.
54. *L. dunensis* Brinkman, Loof & Barbez, 1987.
59. *L. edmundsi* Hunt & Siddiqi, 1977.
101. *L. eridanicus* Roca, Lamberti & Agostinelli, 1985.
28. *L. euonymus* Mali & Hooper, 1974.
96. *L. fangi* Xu & Cheng, 1991.
66. *L. fasciatus* Roca & Lamberti, 1982.
40. *L. fragilis* Thorne, 1974.
73. *L. fursti* Heyns, Coomans, Hutsebaut & Swart, 1987.
20. *L. globulicauda* Dalmasso, 1969.
56. *L. goodeyi* Hooper, 1961.
= *L. elongatus apud* Goodey, 1951.
53. *L. henanus* Xu & Cheng, 1992.
79. *L. heynsi* Andrássy, 1970.
81. *L. himalayensis* (Khan, 1987) Xu & Hooper, 1990.
= *Neolongidorus himalayensis* Khan, 1987.
38. *L. indicus* Prabha, 1973.
63. *L. intermedius* Kozlowska & Seinhorst, 1979.
64. *L. iranicus* Sturhan & Barooti, 1983.
37. *L. ishrati* Javed, 1983.
85. *L. iuglandis* Roca, Lamberti & Agostinelli, 1985.
36. *L. jiangsuensis* Xu & Hooper, 1990.
68. *L. jonesi* Siddiqi, 1962.
= *Neolongidorus jonesi* (Siddiqi, 1962) Khan, 1987.
8. *L. juvenilis* Dalmasso, 1969.
1. *L. juveniloides* Jacobs & Heyns, 1987.
21. *L. kakamus* Jacobs & Heyns, 1987.
78. *L. kuiperi* Brinkman, Loof & Barbez, 1987.
7. *L. laevicapitatus* Williams, 1959.
25. *L. latocephalus* Lamberti, Choleva & Agostinelli, 1983.
6. *L. leptocephalus* Hooper, 1961.
86. *L. lignosus* Chizhov, Subbotin, Romanenko & Kruchina, 1991.
100. *L. litchii* Xu & Cheng, 1992.
33. *L. longicaudatus* Siddiqi, 1962.
46. *L. lusitanicus* Macara, 1986.
87. *L. macromucronatus* Siddiqi, 1962.
89. *L. macrosoma* Hooper, 1961.
92. *L. macroteromucronatus* Altherr, 1974.
77. *L. magnus* Lamberti, Bleve-Zacheo & Arias, 1982.
94. *L. major* Roca & d'Errico, 1987.
9. *L. makatinus* Jacobs & Heyns, 1987.
39. *L. martini* Merny, 1966.
12. *L. mirus* Khan, Chawla & Seshadri, 1972.
69. *L. mobae* Jacobs & Heyns, 1987.
60. *L. moesicus* Lamberti, Choleva & Agostinelli, 1983.
4. *L. monile* Heyns, 1966.
11. *L. moniloides* Heyns, 1966.
97. *L. nevesi* Macara, 1986.
47. *L. nirulai* Siddiqi, 1965.
65. *L. olegi* Kankina & Metlitskaya, 1983.
48. *L. orientalis* Loof, 1983.
102. *L. orongorongensis* Yeates, van Etteger & Hooper, 1992.
91. *L. paraelongatus* Altherr, 1974.
24. *L. paramirus* Darekar & Khan, 1983.
3. *L. paramonile* Jacobs & Heyns, 1982.
19. *L. pawneensis* Luc & Coomans, 1988.
98. *L. picenus* Roca, Lamberti & Agostinelli, 1985.
15. *L. pini* Andres & Arias, 1988.
13. *L. pisi* Edward, Misra & Singh, 1964
= *Xiphinema brevicaudatum apud* Siddiqi, 1959.
= *L. siddiqii* Aboul-Eid, 1970.
93. *L. poessneckensis* Altherr, 1974.
50. *L. profundorum* Hooper, 1966.
26. *L. protae* Lamberti & Bleve-Zacheo, 1977
= *L. attenuatus apud* Prota *et al.*, 1971.
74. *L. proximus* Sturhan & Argo, 1983.
80. *L. pseudoelongatus* Altherr, 1976.
49. *L. psidii* Khan & Khan, 1972.
55. *L. raskii* Lamberti & Agostinelli, 1993.
76. *L. reisi* Roca & Bravo, 1993.
2. *L. reneyii* Raina, 1966.
17. *L. rotundicaudatus* Jacobs & Heyns, 1987.
99. *L. saginus* Khan, Seshadri, Weischer & Mathen, 1971.
84. *L. silvae* Roca, 1993.
14. *L. sylphus* Thorne, 1939
= *L. striola* Merzheevskaya, 1951.
58. *L. taniwha* Clark, 1963.
62. *L. tardicauda* Merzheevskaya, 1951.
103. *L. tarjani* Siddiqi, 1962.
6. *L. trapezoides* Nasira & Maqbool, 1995.
5. *L. unedoi* Arias, Andres & Navas, 1986.

45. *L. vineacola* Sturhan & Weischer, 1964.
88. *L. vinearum* Bravo & Roca, 1995.

SPECIES TRANSFERRED TO OTHER GENERA

L. afzali Khan, 1964 : to *Paralongidorus.*
L. citri (Siddiqi, 1959) Siddiqi, 1962 : to *Paralongidorus.*
L. diversicaudatus (Micoletzky, 1927) Thorne & Swanger, 1936 : to *Xiphinema.*
L. georgiensis Tulaganov, 1937 : to *Paralongidorus.*
L. lutosus Heyns, 1965 : to *Paralongidorus.*
L. macramphis Altherr, 1950 : to *Longidorella.*
L. mammillatus (Schuurmans Stekhoven & Teunissen, 1938) Goodey, 1963 : to *Xiphinema.*
L. maximus (Bütschli, 1874) Micoletzky, 1922 : to *Paralongidorus.*
L. microdorus (de Man, 1880) Meyl, 1954 : to *Longidorella.*
L. multipapillatus Schuurmans Stekhoven & Teunissen, 1938 : to *Longidorella.*
L. nudus Kirjanova, 1951 : to *Paralongidorus.*
L. pachtaicus Tulaganov, 1938 : to *Xiphinema.*
L. pygmaeus (Steiner, 1914) Micoletzky, 1922 : to *Longidorella.*
L. remyi Altherr, 1963 : to *Paralongidorus.*
L. rotundatus (Schuurmans Stekhoven & Teunissen, 1938) Goodey, 1963 : to *Xiphinema.*
L. sandellus (Heyns, 1966) Khan, Chawla & Saha, 1978 : to *Paralongidorus.*
L. strelitziae Heyns, 1966 : to *Paralongidorus.*
L. utriculoides Corbett, 1964 : to *Paralongidorus.*

SYNONYMIZED SPECIES

L. menthasolanus Konicek & Jensen, 1961 : synonymised with *L. elongatus* by Siddiqi (1962).
L. monohystera Altherr, 1953 : synonymized with *L. elongatus* by Sturhan (1963).
L. siddiqi Aboul-Eid, 1970 : synonymized with *L. pisi* by Brown, Hooper and Saka (1982).
L. striola Kirjanova, 1951 : synonymized with *L. sylphus* by Lamberti (1975).

SPECIES RENAMED BECAUSE OF HOMONYMY

L. conicaudatus Jacobs & Heyns, 1987 : junior homonym of *L. conicaudatus* Khan, 1987; renamed *L. conicaudoides* by Jacobs and Heyns (1989).

SPECIES INQUIRENDAE

L. brevicaudatus (Schuurmans Stekhoven, 1951) Siddiqi, 1959.
L. meyli Sturhan, 1963.
= *L. maximus apud* Meyl, 1954.

Characters used in code

It must be stressed that the species are arranged in the key by key characters for the facilitation of quick recognition, but this does not presume to reflect phylogenetic relationships; this should become obvious when one considers that the sequence of characters is arbitrary; if we had chosen a different sequence, then the arrangement would have been a different one. In the cases where the character codes of two or three species may not be clearly different the reader is referred to Notes which give additional differences. The codes given apply to characters of females, except for *L. heynsi* in which only the male is known.

The number of usable characters is limited when compared to that in *Xiphinema* (see Loof & Luc, 1990). The female genital system, so divergent among *Xiphinema* species, is (as far as known at present) wholly uniform in *Longidorus*. Also, female tail shape shows a restricted range of variation. On the other hand, the lip region shows more distinguishable shapes than in *Xiphinema;* also the amphidial pouch, uniformly goblet-shaped in *Xiphinema,* is sac-like in *Longidorus* and differs among the species. In the latter genus the length of the odontophore is often difficult to assess reliably, hence we prefer to use only odontostyle length.

SHAPE OF LIP REGION

The lip region may be continuous, or offset by depression or expansion; its anterior margin may be rounded or flattened (Fig. 2). Usually, as in dorylaims generally, the neck tapers clearly anteriad so that the diameter of the lip region is much less than the body diameter at the base of the neck. In a few species, however, the neck tapers very little anteriad and the lip region is very wide.

SHAPE OF BASE OF AMPHIDIAL POUCH

The genus *Longidorus* is characterized by the combination of a sac-like amphidial pouch and minute, pore-

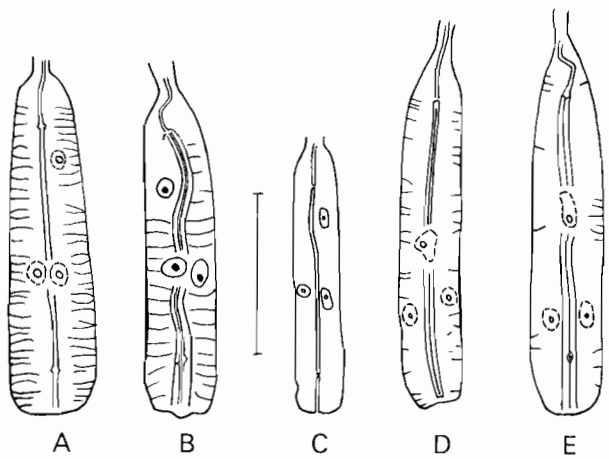

Fig. 1. *Location of pharyngeal gland nuclei. A-C : Normal arrangement : A :* L. jonesi; *B :* L. kuiperi; *C :* L. pawneensis. *D-E : Abnormal arrangement : D :* L. iranicus; *E :* L. proximus. *Redrawn from literature.* (Bar = 50 µm.)

like aperture. The base of the pouch may be simple, slightly indented or bilobed (symmetrically or asymmetrically, see Fig. 2). The shape of the pouch is unknown in four species.

SHAPE OF FEMALE TAIL

The tail is always short, so that the index " c " is of limited use. The tail may be hemispheroid, convex-conical, straight conical, elongate-conical and straight, or elongate-conical with tip bent ventrad (Fig. 3). Intraspecific variation is usually insignificant. In a few cases one may hesitate, e.g., whether the tail should be called hemispherical or broadly convex-conoid; in such cases both code numbers are given.

POSITION OF PHARYNGEAL GLAND NUCLEI

The normal position (Loof & Coomans, 1972) is : dorsal nucleus small, elongate, located in the anterior third of the bulb; ventrosublateral nuclei about halfway along the bulb (Fig. 1A-C). In some species, however, the dorsal nucleus lies halfway (and is then generally larger), whereas the ventrosublateral nuclei lie far posterior (Sturhan & Barooti, 1983 : Fig. 1D-E). This character, however, could not be used in the key, since it is unknown in 25 species and the abnormal position is known to occur in only five. Occasionally, however, it will be used in the Notes.

POSITION OF GUIDING RING

The distance of the guiding ring from the head end is fairly constant within species but may vary strongly between species.

STYLET RETRACTOR MUSCLES

Robertson and Taylor (1975) noted differences between species of *Longidorus* in presence/absence of stylet retractor muscles, and shape of pharyngeal retractor muscles. As these muscles were studied in only nine species, these characters cannot yet be used in the key, but in future they might prove useful.

MALE CHARACTERS

Males are unknown in many species. Several species have been described from such a small population that it cannot be said whether absence of males is accidental or real; often presence/absence of sperm is not mentioned in descriptions. Therefore we have not included male characters in the key, but occasionally we make use of them in Notes. Presence or absence of males is, however, indicated in the key.

ODONTOSTYLE LENGTH

For practical reasons we take odontostyle length as first character, being easily determined. Then follow other characters of the head end : lip region width, distance of guiding ring from head end, shape of lip region and shape of amphids; after these come body length, coefficient " a " and tail shape.

Explanation of the code

A : LENGTH OF ODONTOSTYLE

1 : under 60 µm	5 : 121-140 µm
2 : 61-80 µm	6 : 141-160 µm
3 : 81-100 µm	7 : over 160 µm
4 : 101-120 µm	

B : DIAMETER OF LIP REGION

1 : under 12 µm	4 : 20-23 µm
2 : 12-15 µm	5 : over 23 µm
3 : 16-19 µm	

C : DISTANCE OF GUIDING RING FROM ANTERIOR BODY END

1 : 17-20 µm	4 : 41-50 µm
2 : 21-30 µm	5 : 51 µm or more
3 : 31-40 µm	

D : SHAPE OF ANTERIOR REGION (Fig. 2)

1 : body tapering distinctly, lip region rounded, continuous (Fig. 2, A-C).
2 : body tapering distinctly, lip region rounded, offset by depression (Fig. 2, D-F).
3 : body tapering distinctly, lip region flattened, continuous or slightly offset by depression (Fig. 2, G-L).
4 : body tapering distinctly or subcylindrical, lip region distinctly offset by constriction or expanded (Fig. 2, M-O).

E : SHAPE OF AMPHIDIAL POUCH (Fig. 2)

1 : more or less pocket-shaped without distinct basal lobes (Fig. 2, G-I);
2 : more or less pocket-shaped, shallowly or distinctly bilobed, symmetrical (lobes of about equal length) (Fig. 2 B, E, F, K, M, O);
3 : more or less pocket-shaped, bilobed, asymmetrical, one lobe being shorter than the other or almost absent (Fig. 2 D, J);
4 : elongate, funnel-shaped, not lobed (Fig. 2, A, C, L);
5 : short, funnel to stirrup-shaped (Fig. 2 N).

F : BODY LENGTH

1 : less than 3 mm	4 : 7.1-9.0 mm
2 : 3.1-5.0 mm	5 : 9.1 mm or more
3 : 5.1-7.0 mm	

G : INDEX " a "

1 : 80 or less	3 : 121-160
2 : 81-120	4 : more than 160

H : TAIL SHAPE (Fig. 3)

1 : hemispherical to bluntly conoid, $c' < 1$ (Fig. 3 A-C);

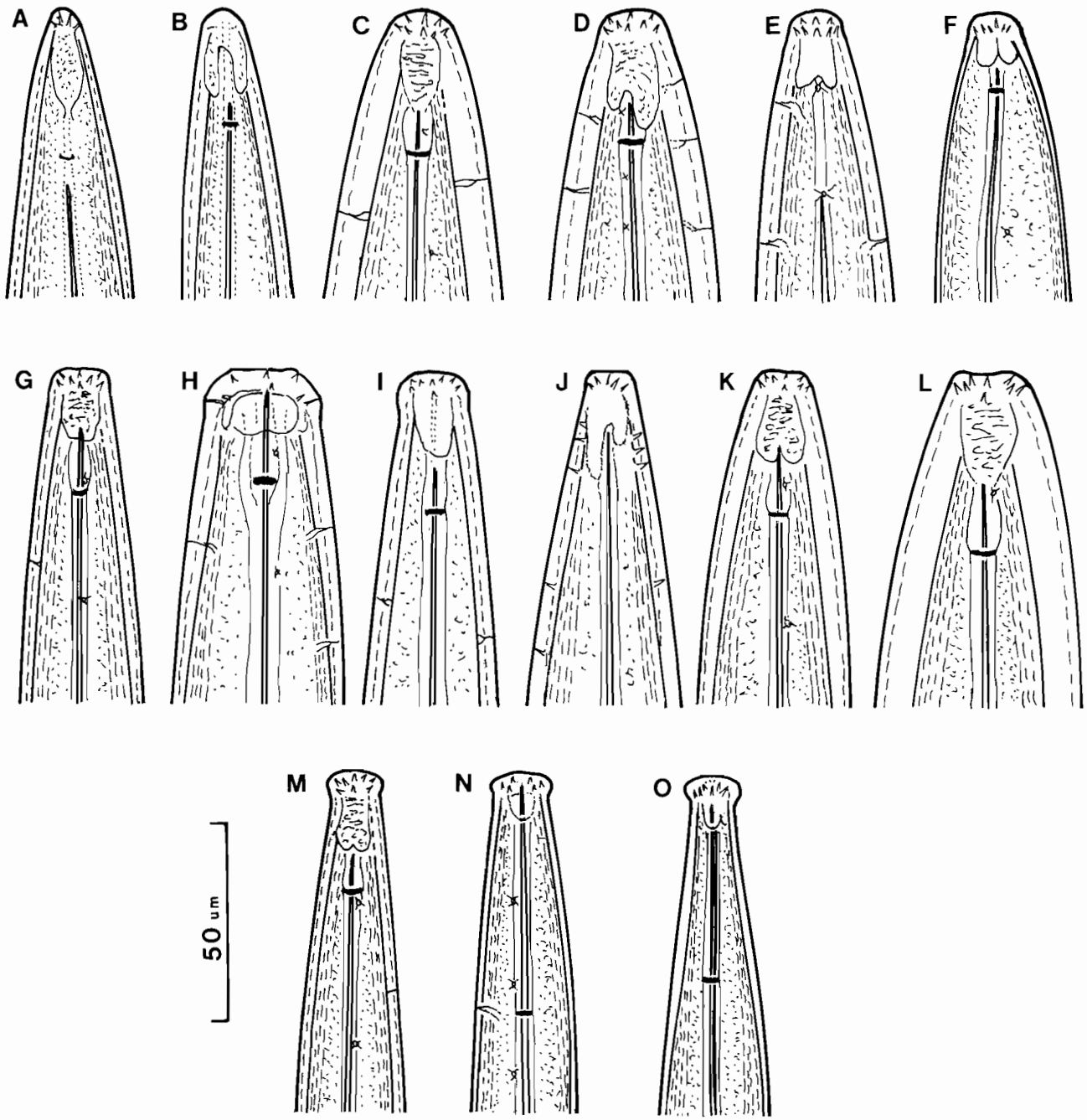

Fig. 2. *Shape of anterior end (code D). A-C : Code D 1; D-F : Code D 2; G-L : Code D 3; M-O : Code D – 4. Shape of amphidial pouch (code E). G-I : Code E 1; B, E, F, K, M, O : Code E 2; D, ♂ : Code E 3; A, C, L : Code E 4; N : Code E 5. A :* L. belondiroides; *B :* L. orientalis; *C :* L. caespiticola; *D :* L. goodeyi; *E :* L. litchii; *F :* L. juveniloides; *G :* L. elongatus; *H :* L. kuiperi; *I :* L. proximus; *♂ :* L. belloi; *K :* L. profundorum; *L :* L. macrosoma; *M :* L. attenuatus; *N :* L. fursti; *O :* L. mobae. *Redrawn from literature.*

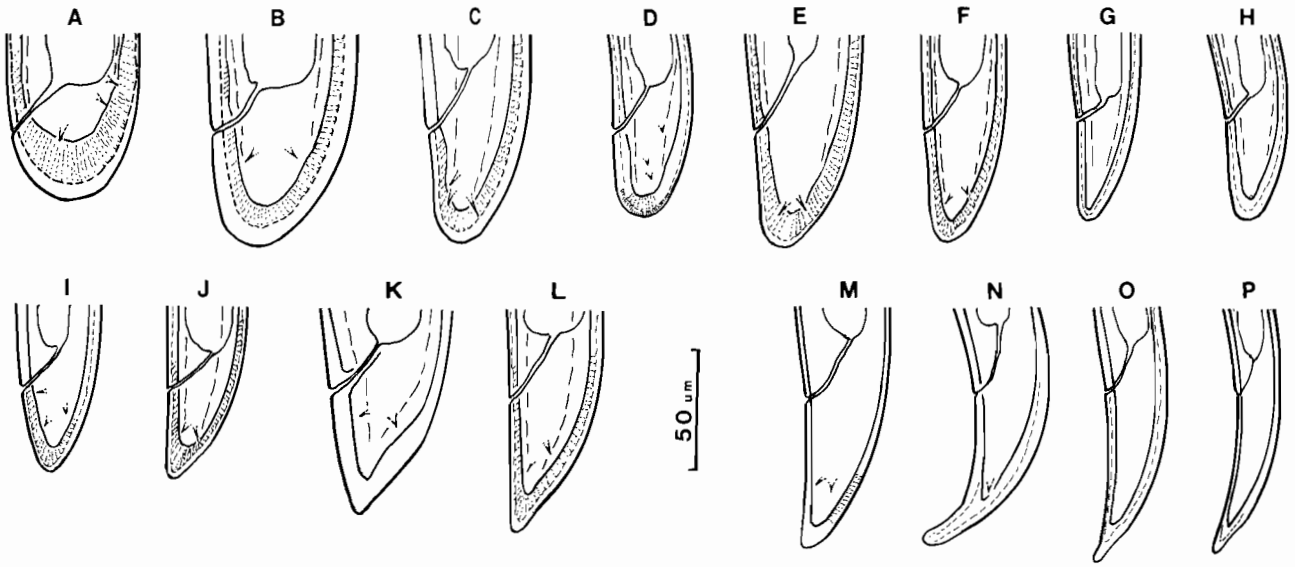

Fig. 3. *Tail shape (code H). A-C : Code H 1. A :* L. belondiroides; *B :* L. caespiticola; *C :* L. profundorum. *D-F : Code H 2. D :* L. protae; *E :* L. elongatus; *F :* L. closelongatus. *G-H : Code H 3. G :* L. mirus; *H :* L. laevicapitatus. *I-K : Code H 4. I :* L. arenosus; *J :* L. leptocephalus; *K :* L. indicus. *L-M : Code H 5. L :* L. attenuatus; *M :* L. globulicauda. *N-P : Code H 6. N :* L. nirulai; *O :* L. pini; *P :* L. longicaudatus. *Redrawn from literature.*

2 : rounded to bluntly conoid, c′ 1.0-1.5 (Fig. 3 D-F);
3 : rounded to bluntly conoid, c′ 1.6-2.0 (Fig. 3, G, H);
4 : conoid, c′ 1.0-1.5 (Fig. 3, I-K);
5 : conoid, c′ 1.6-2.0 (Fig. 3 L, M);
6 : conoid, c′ > 2.0 (Fig. 3 N-P).

I : Presence/absence of males

1 : males absent;
2 : males present;
12 : males absent in some populations, present in others.

Notes

Note 1

L. ampullatus, L. reneyii and *L. juvenilis.* These species can be differentiated as follows :

1. – L = 2.1-2.6 mm; width of lip region = 8 µm; odontostyle under 60 µm; tail under 35 µm ..... *L. reneyii*
   – L = 2.8-4.7 mm; width of lip region = 9-13 µm; odontostyle over 60 µm; tail over 40 µm 2
2. – Males numerous; female tail = 41-44 µm ..... *L. ampullatus*
   – Males unknown; tail = 45-65 µm .. *L. juvenilis*

L. ampullatus was described from one female (and some males) which makes evaluation of morphometrics difficult. There is a discrepancy in its description : the table of dimensions gives : ABW = 19 µm, tail length = 41 µm, hence c′ = 2.2. However, Fig. 3.3 shows ABW = 28 µm, tail length = 44 µm, hence c′ = 1.57. Dr. J. Heyns informed us that the specimen was already flattened at the time of its description; the drawing was made according to actual tail shape, the dimensions in the table were corrected with the formulae of Geraert (1961). For the code we have adopted these corrected values.

Note 2

L. makatinus, L. auratus and *L. rotundicaudatus* do not clearly differ in code characters. They can be distinguished as follows :

1. – Odontostyle 57-65 µm; GR = 24-27 µm; tail slightly bent ventrad ..... *L. makatinus*
   – Odontostyle = 70-100 µm; GR = 27-36 µm; tail straight 2
2. – c′ = 1.4-1.9; c = 77-120; tail convex-conoid, 33-41 µm long; GR = 27-33 µm ..... *L. auratus*
   – c′ = 0.7-1.0; c = 140-200; tail almost hemispherical, 23-29 µm long; GR = 33-36 µm ..... *L. rotundicaudatus*

The original description of *L. rotundicaudatus* gives c′ as 1.0 (0.7-1.7), but since tail length = 23-29 µm and ABW = 26-35 µm c′ can hardly be more than 1.0.

Note 3

L. pisi and *L. latocephalus.* Choleva *et al.* (1991) considered these species identical, but Navas *et al.* (1993*b*), after analysing morphometric data of various popula-

tions, regarded them as separate species. Heyns *et al.* (1984) noted characteristic granular bodies in the prerectum of *L. pisi*, and paratypes of *L. latocephalus* in the Rothamsted collection show similar bodies. These inclusions have not been reported for any other *Longidorus* species, which would strengthen the opinion of Choleva *et al.* (1991). However, there is some uncertainty about the shape of the amphids : they were reported simple in *L. latocephalus*, bilobed in various redescriptions of *L. pisi* (Brown *et al.*, 1982; Zeidan & Coomans, 1992); the original description did not describe or illustrate the shape of the amphid base and Prabha (1973, as *L. siddiqii*) gave it as simple.

NOTE 4

L. orientalis and *L. congoensis* can be distinguished by :
- body length : 4.0-6.2 *vs* 2.8-3.7 mm,
- coefficient " a " : 79-114 *vs* 50-61,
- coefficient " c " : 141-192 *vs* 90-98,
- odontostyle length : 96-113 *vs* 66-81 µm,
- guiding ring/lip region width : 2.7-3.0 *vs* 2.2.

NOTE 5

L. distinctus, L. attenuatus and *L. alvegus*. These three species have rounded lip regions, offset by a deep depression and hence appearing expanded; conoid, rather long (c′ = 1.5-2.9) tails; guiding rings at 26-33 µm and odontostyles measuring 71-93 µm. They can be distinguished as follows :

1. – Amphids symmetrically bilobed; c′ = 1.5-1.8 ..... *L. attenuatus*
   – Amphids asymmetrically bilobed; c′ = 1.7-2.9 2
2. – L = 3.1-5.5 mm; a = 88-127; c′ = 1.7-2.4; width of lip region = 12-13 µm ..... *L. distinctus*
   – L = 6.3-7.8 mm; a = 172-211; c′ = 2.0-2.9; width of lip region = 13-16 µm ..... *L. alvegus*

NOTE 6

L. africanus and *L. conicaudoides*. The female tail of *L. africanus* is ventrally concave with bluntly rounded terminus, whereas in *L. conicaudoides* it is dorsally and ventrally convex with a narrower, slightly offset terminus.

NOTE 7

L. conicaudatus and *L. elongatus*. Note that in Khan (1987) Figs 2 and 3 have been reversed. The description of *L. conicaudatus* says : amphids asymmetrically bilobed, but the illustration shows them to be symmetrical. The only difference between these species appears the shape of the lip region : flattened in *L. elongatus*, rounded in *L. conicaudatus*. In *L. elongatus* there are about four ventral cervical pores in the odontostyle region, in *L. conicaudatus* they were reported as " not seen " so this is not distinctive. The ventral tail contour is concave in *L. conicaudatus*, straight to slightly concave in *L. elongatus*. Lip region width is 12-13 µm in *L. elongatus*, but Coiro *et al.* (1989) report a female in which it is 18 µm.

NOTE 8

L. athesinus, L. goodeyi and *L. henanus*. These very similar species can be distinguished as follows :

1. – Amphid base strongly asymmetrical (44 %); tail = 50-57 µm ..... *L. goodeyi*
   – Amphid base slightly asymmetrical (11 %); tail = 33-52 µm 2
2. – Guiding ring 32-38 µm from ant. end; odontostyle = 83-94 µm; a = 56-88 ..... *L. athesinus*
   – Guiding ring 39-46 µm from ant. end; odontostyle = 97-103 µm; a = 99-127 ..... *L. henanus*

Tail length of *L. goodeyi* was computed from Hooper's (1961) data : L =5.6-7.7 mm, c = 99-154; however, the population of *L. goodeyi* described by Lamberti *et al.* (1982) had L = 5.6-6.1 mm, c= 169-188 which would give a tail length of 32-33 µm.

NOTE 9

L. elongatus, L. henanus, L. dunensis, L. cohni and *L. apulus* may be distinguished as follows :

1. – Lip region flattened, continuous or offset by slight depression 2
   – Lip region rounded, offset by depression 3
2. – Lip region width = 12-13 µm; a = generally under 120 ..... *L. elongatus*
   – Lip region width = 14-17 µm; a = generally over 120 ..... *L. apulus*
3. – a = 160-225; tail of J2 = 60-64 µm; amphids base shallowly bilobed; location of pharyngeal gland nuclei abnormal (Fig. 1) ..... *L. cohni*
   – a = 80-160; tail of J2 under 55 µm; location of pharyngeal gland nuclei normal 4
4. – Lip region appearing somewhat expanded; GR = 29-33 µm; lateral body pores on each body side 320-370, of which about 20 in neck region; dorsal cervical pores none or one ..... *L. dunensis*
   – Lip region not appearing expanded; GR = 39-46 µm; lateral body pores on each body side 100-130, of which 10-14 in neck region; dorsal cervical pores one to three ..... *L. henanus*

NOTE 10

L. goodeyi. A redescription of this species (Lamberti *et al.*, 1982) differs in several respects from the original description. Lip region width is 13-14 µm *vs* 17-18; c = 169-188 *vs* 99-154; tail length = 32-33 µm *vs* 50-57. The identity of this population (from the island of Malta) therefore appears uncertain and the code is based solely on the original description.

Polytomous key to species of *Longidorus*

	A	B	C	D	E	F	G	H	I
1. *juveniloides*	1	1	1	2	2	12	12	4	2
2. *reneyii*[1]	1	1	2	2	2	1	1	5	1
3. *paramonile*	1	1	2	3	2	2	3	2	1
4. *monile*	1	1	2	4	2	2	2	2	2
5. *unedoi*	12	1	2	4	3	3	3(4)	45	2
6. *leptocephalus*	12	1	23	3	2	23	13	4	12
7. *laevicapitatus*	12	12	2	1	2	1	1	23	1
8. *juvenilis*[1]	12	12	2	2	2	12	23	56	1
9. *makatinus*[2]	12	12	2	2	2	2	23	2	2
10. *carpetanensis*	12	12	34	4	3	2	2	56	2
11. *moniloides*	12	23	2(3)	3	2	2	1	12	2
12. *mirus*	123	1	2	2	2	2	12	23	1
13. *pisi*[3]	123	1	34	4	12	12	23	56	12
14. *sylphus*	2	1	2	1	?	2	2	2	1
15. *pini*	2	1	2	3	2	23	23	6	1
16. *aetnaeus*	2	1	2	3	3	12	123	56	12
17. *rotundicaudatus*[2]	2	1(2)	3	2	2	2	2	12	2
18. *ampullatus*[1]	2	2	2	2	2	1	2	6	2
19. *pawneensis*	2	2	2	2	2	23	2	4	1
20. *globulicauda*	2	2	23	4	1	3	2	5	1
21. *kakamus*	2	23	2(3)	4	1	34	5	45	2
22. *congoensis*[4]	23	1	2	1	2	12	1	1	1
23. *auratus*[2]	23	1	23	2	2	2	23	23	1
24. *paramirus*	23	1	4	1	2	2	2	4	1
25. *latocephalus*[3]	23	1	3(4)	4	1	2	34	56	12
26. *protae*	23	12	2	3	2	34	34	2	1
27. *distinctus*[5]	23	12	23	2	3	23	23	56	2
28. *euonymus*	23	12	23	4	2(3?)	34	234	23	1
29. *attenuatus*[5]	23	23	23	4	2	34	234	45	12
30. *breviannulatus*	23	3	2	2	2	2-3	2	2	1
31. *belloi*	234	1	23	3	3	3-4	123	12	2
32. *africanus*[6]	234	12	23	2	2	1-2	123	45	1
33. *longicaudatus*	3	1	2	23	?	1	1	6	1
34. *conicaudoides*[6]	3	1	23	2	2	2	12	45	1
35. *belondiroides*	3	1	3	1	4	2	1	1	2
36. *jiangsuensis*	3	1	3	1	2	2	2	1	1
37. *ishrati*	3	1	3	2	4	2	2	45	1
38. *indicus*	3	1	3	2	2	2	1	4	1
39. *martini*	3	12	5	4	1	2	23	12	1
40. *fragilis*	3	2	2	1	?	3	2	56	1
41. *curvatus*	3	2	3	1	2	2	12	6	1
42. *conicaudatus*[7]	3	2	3	1	2	3	2	2	1
43. *alvegus*[5]	3	23	23	2	3	34	45	56	1
44. *athesinus*[8]	3	23	3	1	3	23	12	12	2
45. *vineacola*	3	3	23	2	3	4	3	1	2
46. *lusitanicus*	3	34	23	3(4?)	3	234	2	1	2
47. *nirulai*	34	1	2	3	2	2	2	6	2
48. *orientalis*[4]	34	1	2-3	1	2	23	2	1	1
49. *psidii*	34	12	3	1	2	12	1	1	1
50. *profundorum*	34	2	34	3	2	34	2	1	2

[1], [2], [3], ... see Notes.

	A	B	C	D	E	F	G	H	I
51. *crataegi*	34	23	3	1	3	34	12	1	2
52. *elongatus*[7,9]	34	23	3	3	2	23	12	2	12
53. *henanus*[8,9]	34	23	34	2	3	3	23	12	1
54. *dunensis*[9]	34	23	23	2	2	34	3	2	1
55. *raskii*	34	3	3	1	2	34	12	1	2
56. *goodeyi*[8,10,11]	34	3	3	2	3	34	12	1	1
57. *caespiticola*	34	3	34	1	4	34	12	1	2
58. *taniwha*	34	3	45	1	2	2	12	1	2
59. *edmundsi*	34	5	2	1	2	23	23	1	2
60. *moesicus*[11,12]	35	12	23	1	3	34	23	12	1
61. *apulus*[9]	35	23	23	3	23	34	3	2	1
62. *tardicauda*[14]	4	1	?	3	1	23	2	1	1
63. *intermedius*	4	12	23	1,3	2	2	12	2	1
64. *iranicus*[12]	4	12	3	1	2	3	2	1	1
65. *olegi*[12]	4	2	3	1	2	4	2	1	2
66. *fasciatus*	4	2	3	1	3	34	23	1	1
67. *trapezoides*[13]	4	2	3	2	3	34	23	1	1
68. *jonesi*	4	2	5	1	1	2	1	1	1
69. *mobae*	4	2	5	4	2	23	35	23	2
70. *crassus*	4	3	3	3	?	24	2	1	1
71. *arthensis*	4	23	3	1	2	3	12	12	2
72. *diadecturus*[15]	4	23	5	2	5	2	12	1	1
73. *fursti*	4	23	5	4	5	2	23	12	1
74. *proximus*[19]	4	3	3	3	1	34	23	1	12
75. *cohni*[9,16]	4	3	3	2	2	4	45	2,4	2
76. *reisi*	4	3	3	4	2(3)	35	45	6	1
77. *magnus*	4	34	4	1	3	5	12	1	1
78. *kuiperi*	4	5	23	3	1	34	34	1	2
79. *heynsi*	4	4	5	2	2	4	2	1	2
80. *pseudoelongatus*	45	2	23	4	4	3	12	1	1
81. *himalayensis*	45	2	5	2	2	2	2	1	1
82. *closelongatus*[16]	45	23	2	4	2	(2)34	24	2,4	1
83. *apuloides*	45	23	3	2	3	45	34	12	2
84. *silvae*[17]	45	23	34	1	3	34	2(3)	1	1
85. *iuglandis*[12,17]	45	23	34	1,2	2	34	12	1	2
86. *lignosus*	45	3	3	3	1	23	1	1	2
87. *macromucronatus*[15]	45	3	5	3	1	2	2	1	1
88. *vinearum*[18]	45	35	34	2	3	45	12	1	2
89. *macrosoma*[17]	46	4	34	3	4	45	13	1	2
90. *cylindricaudatus*	5	2	3	2	2	23	12	1	1
91. *paraelongatus*	5	23	3	23	1	34	2	2	2
92. *macroteromucronatus*[17]	5	3	4	1	?	4	12	1	1
93. *poessneckensis*	5	34	3	1	1	35	2	1	1
94. *major*[18]	5	45	34	2	3	45	2	1	1
95. *arenosus*	56	3	2	4	2	45	5	4	2
96. *fangi*[15]	56	3	5	2(3?)	5	23	2	12	1
97. *nevesi*[17]	56	34	3(4)	1	3	35	12	1	2
98. *picenus*[17]	56	(3)4	34	1	3	34	2	1	2
99. *saginus*	56	45	23	3	3	23	23	1	2
100. *litchii*	57	2	5	2	2	23	1(2)	1	2
101. *eridanicus*	67	12	34	1	4	23	2	1	1
102. *orongorongensis*	67	4	5	1	4	34	2	1	2
103. *tarjani*	7	5	3	2	2	3	2	12	2

NOTE 11

L. goodeyi and *L. moesicus*. If the Maltese population of Lamberti *et al.* (1982) really is *L. goodeyi*, then the two species cannot be separated reliably. The original descriptions indicate a difference in odontostyle length : *L. goodeyi* 96-109 µm, *L. moesicus* 115-124 µm, but the numerous redescriptions of *L. moesicus* give a range of 94-124 µm. In *L. goodeyi* the amphids are strongly asymmetrical, in *L. moesicus* slightly so. There is no information about amphid shape of the Maltese population of *L. goodeyi*.

NOTE 12

L. iranicus, L. iuglandis, L. moesicus and *L. olegi*. These species are difficult to separate : all have long bodies (5-9 mm), odontostyles of 94-124 µm, very short tails (29-51 µm, c = 146-258), lip regions rounded and amphid bases symmetrically bilobed (the original description of *L. moesicus* says : amphids more or less asymmetrically bilobed, but the illustration suggests they are practically symmetrical). The width of the lip region of *L. olegi* was not given in the original description, but can be computed from original Figures 2 and 3 as 14-15 µm. Key :

1. – Amphid base deeply bilobed (43-45 %) .... *L. olegi*
   – Amphids base shallowly bilobed (< 30 %) ... 2
2. – Width of lip region = 14-17 µm; c′ = 0.6-0.7; spicules = 92-102 µm; supplement number = 11-14 ..... *L. iuglandis*
   – Width of lip region = 10-14 µm; c′ = 0.7-1.3 3
3. – Lip region continuous; odontophore mostly = 55-74 µm (but in some populations as short as 38-44 µm); spicules = 59-70 µm; supplement number = 17; arrangement of pharyngeal gland nuclei unknown; tail asymmetrical, ventral contour straight ..... *L. moesicus*
   – Lip region mostly offset by depression, but occasionally continuous; odontophore = 44-48 µm; males unknown; arrangement of pharyngeal nuclei abnormal (Fig. 1); tail more symmetrical, ventral contour convex ..... *L. iranicus*

NOTE 13

L. trapezoides is distinct from all other species by the high, angular, trapezoid lip region, a unique feature in Longidoridae. Apart from this (code D) the codes are identical to those for *L. fasciatus*, from which it further differs by the amphid base being hardly bilobed *vs* deeply bilobed. The codes are also similar to those for *L. similis*, but *L. trapezoides* differs from that species by being smaller (5.8-7.2 *vs* 7.4-10.2 mm) and by the shorter J-4 tail (34-36 *vs* 44-61 µm, c = 142-145 *vs* 85-128, c′ = 0.8-0.9 *vs* 1.3-1.6).

NOTE 14

L. tardicauda. Data partly from the redescription by Kankina (1978).

NOTE 15

L. fangi, L. diadecturus and *L. macromucronatus*.
This is a group of very similar species with guiding ring far backward (4 × lip region width or more). They can be distinguished as follows :

1. – Odontophore = 78-95 µm; Stylet = 207-232 µm ..... *L. fangi*
   – Odontophore = 55-77 µm; Stylet = 168-200 µm 2
2. – Odontophore = 55-66 µm; tail = 25-29 µm, c = 122-177 ..... *L. diadecturus*
   – Odontophore = 67-77 µm; tail = 21-22 µm, c = 190-230 ..... *L. macromucronatus*

The difference in length and shape of mucro has no taxonomic importance.

NOTE 16

L. closelongatus and *L. cohni*. The former species is smaller (5.3-7.3 *vs* 7.8-8.8 mm), has a shorter spear (156-163 *vs* 170-183 µm) and is less slender (a = 123-151 *vs* 160-225). Males are unknown in *L. closelongatus*, known in *L. cohni*. Both species show the abnormal location of the oesophageal gland nuclei (Fig. 1).

NOTE 17

L. iuglandis, L. macrosoma, L. macroteromucronatus, L. nevesi and *L. picenus*. These species can be distinguished as follows :

1. – Lip region continuous, flattened to slightly concave; amphids elongate-funnel shaped, base not lobed ..... *L. macrosoma*
   – Lip region rounded, amphid base bilobed (unknown in *L. macroteromucronatus*) 2
2. – Lip region width = 14-17 µm; odontostyle = 110-133 µm 3
   – Lip region width = 16-22 µm; odontostyle = 131-152 µm 4
3. – GR = 31-41 µm; uteri without sperm; odontophore = 71-80 µm; amphid base practically symmetrical; V = 51-57; J1 tail = 32-38 µm, without offset cylindrical part, c = 78-91, c′ = 1.0-1.1 ..... *L. iuglandis*
   – GR = 37-44 µm; uteri with sperm; odontophore = 45-70 µm; amphid base distinctly asymmetrical; V = 45-51; J1 tail = 57-67 µm, with offset cylindrical part, c = 28-37, c′ = 2.5-3.3 ..... *L. silvae*
4. – Hyaline terminal tail part = 12-14 µm; spicules = 103-112 µm; J1 tail = 44-46 µm, with long digitate distal part; in J1 L = 1.7-1.8 µm,

odontostyle = 77-82 µm, replacement odontostyle = 83-90 µm ..... *L. picenus*

– Hyaline terminal tail part = 14-18 µm; spicules = 87-100 µm; J1 tail = 25 µm, bluntly conoid, not digitate; in J1 L = 1.2 mm, odontostyle = 60 µm; replacement odontostyle = 74 µm ..... *L. nevesi*

Amphid shape of *L. macroteromucronatus* is uncertain: " un lobe, deux lobes? ". Lip region width is 17 µm. The very long mucro (23 µm) is, of course, not a sound taxonomic character. Therefore, the species could not be inserted in the above key.

NOTE 18

L. major and *L. vinearum*. All dimensions are almost identical, as well as the numbers of cervical pores. In *L. vinearum* males are common and the female uteri contain sperm; in *L. major* no males were found, but presence/absence of sperm in the uteri was not noted. Examination of paratypes by one of us (D.J.H.) confirmed the peculiar outline of the anterior region in *L. major,* with the lip region more flattened and more offset than in *L. vinearum*. Sperm could not be found in these paratypes, but due to the dense intestinal contents we cannot be certain. Apparently there are only some small differences in the juveniles : the J1 tail of *L. major* appears more distinctly digitate than that of *L. vinearum;* the J2 tail of *L. major* is elongate-hemispherical, of *L. vinearum* more conoid; in the J1 to J3 of *L. vinearum* the tail is shorter than that of *L. major*, and in all four juvenile stages the lip region width is greater in *L. major* than in *L. vinearum*.

NOTE 19

L. proximus. The type population contained 33 females but no males. Roca (1986) described a population from Greece in which males were as numerous as females.

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