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# An illustrated key to nematodes found in fresh water

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Formal training in identification of the nematodes encountered in fresh, brackish or salt waters is offered in relatively few academic institutions. Usually, information must be sought in abstruse books and reprints which may be difficult to obtain, and may contain confusing morphological terminology.

The key that follows is based on published reports of nematodes found in fresh water and, in part, fresh water intruded by salt water. It was devised with the intent of offering brief, relatively simple choices and providing the user with visual illustrations of specific nematode morphology. Original drawings, photocopies of published drawings, and redrawings of original illustrations were used. The key was constructed in order that those with biological training could use it without undue difficulty. It is scheduled for inclusion in "Standard Methods for the Examination of Water and Wastewater," 15th edition.

## ACKNOWLEDGMENTS

**Credits.** The two references most frequently used for photocopy and redrawing were "Soil and Freshwater Nematodes" by T. Goodey<sup>13</sup> and "An Introduction to Nematology. Section I: Anatomy" by B. G. Chitwood and M. B. Chitwood.<sup>7</sup>




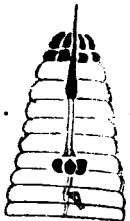
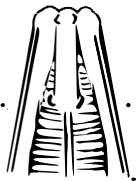


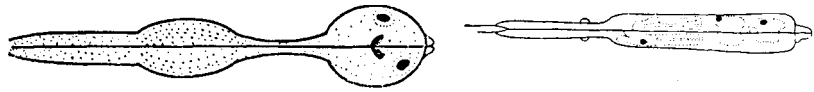
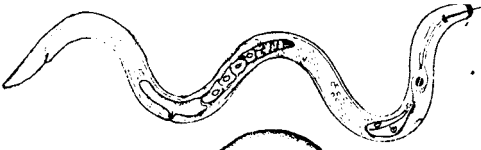

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## REFERENCES

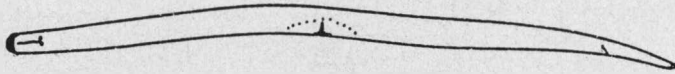
1. Allen, M. W., and Noffsinger, E. M., "Revision of the Genus *Anaplectus* (Nematoda: Plectidae)." *Proc. Helminth. Soc. Wash.*, 35, 1, 77 (1968).
2. Andrassy, I., "Nematoden aus dem Psammon des Adige-Flusses, I." *Mem. Mus. Civ. Stor. Nat., Verona*, 7, 163 (1959).
3. Andrassy, I., "Fauna Paraguayensis 2. Nematoden aus den Galeriewaldern des Acaray-Flusses." *Opusc. Zool. Bpest.*, 8, 2, 167 (1968).

4. Andr ssy, I., "Nematoden aus strand- und h henbiotopen von Kuba." *Acta Zool. Hung.*, **19**, 3-4, 233 (1973).
5. Calaway, W. T., "Nematodes in Wastewater Treatment." *Jour. Water Poll. Control Fed.*, **35**, 8, 1006 (1963).
- ➔ 6. Chitwood, B. G., "A Preliminary Contribution on the Marine Nemas (Adenophorea) of Northern California." *Trans. Amer. Micr. Soc.*, **79**, 347 (1960).
7. Chitwood, B. G., and Chitwood, M. B., "An Introduction to Nematology, Section I: Anatomy." (Rev. Ed., 1950). Monumental Printing Co., Baltimore, Maryland, 213 pp. (1937).
8. Chitwood, B. G., and Tarjan, A. C., "A Redescription of *Atylenchus decalineatus* Cobb, 1913 (Nematoda: Tylenchinae)." *Proc. Helminth. Soc. Wash.*, **24**, 1, 48 (1957).
9. Edward, J. C., and Misra, S. L., "*Criconema vishwanathum* n. sp. and Four Other Hitherto Described Criconematinae." *Nematologica*, **11**, 4, 566 (1966).
10. Engelbrecht, R. S., and Austin, J. H., "Nematodes and Their Detection in Public Water Supplies." Kentucky-Tennessee Sect., Amer. Water Works Assn. (Sept. 1964).
11. Ferris, V. R., *et al.*, "General of Freshwater Nematodes (Nematoda) of Eastern North America." Biota of Freshwater Ecosystems: Identification Manual No. 10, U. S. Environmental Protection Agency, **38** pp. (1973).
12. Gerlach, S. A., "Brasilianische Meeres-Nematoden 1." *Bol. Inst. Oceanog.*, **5**, 1-2, 3 (1954).
13. Goodey, T., "Soil and Freshwater Nematodes." The Methuen Co., London & John Wiley, N. Y., 2nd Ed. (Revised by J. B. Goodey), 544 pp. (1963).
14. DeGrisse, A., "Bijdrage tot de morfologie en de systematiek van Criconematidae (Taylor, 1936) Thorne, 1949 (Nematoda)." Plantenatlas Sleutel, Gent, 143 pp. (1963).
15. Hopper, B. E., and Meyers, S. P., "Foliicolous Marine Nematodes on Turtle Grass, *Thalassia testudinum* K nig, in Biscayne Bay, Florida." *Bull. Marine Sci.*, **17**, 471 (1967).
16. Loof, P. A. A., "The Nematode Collection of Dr. J. G. de Man." *Meded. Lab. Fytopath.*, **190**, 169 (1961).
17. Luc, M., "*Dolichodorus profundus* n. sp. (Nematoda-Tylenchida)." *Nematologica*, **5**, 1, 1 (1960).
18. Mulvey, R. H., and Jensen, H. J., "The Mononchidae of Nigeria." *Can. J. Zool.*, **45**, 667 (1967).
19. Peters, B. G., "A Biological Investigation of Sewage." *Jour. Helminth.*, **8**, 3, 133 (1930).
20. Thorne, G., "A Monograph of the Nematodes of the Superfamily Dorylaimoidea." *Capita. Zool.*, **8**, 1(1939).
21. Thorne, G., "Nematodes of Puerto Rico: Belondiroidea New Superfamily, Leptonchidae, Thorne, 1935, and Belonenchidae New Family (Nemata, Adenophorea, Dorylaimida)." Univ. Puerto Rico Agr. Exp. Sta. Tech. Paper, **39**, 51 pp. (1964).
22. Ward, H. B., and Whipple, G. C., "Fresh Water Biology." 2nd Ed. John Wiley & Sons, Inc., N. Y., 1248 pp. (1959).

KEY TO NEMATODES FOUND IN FRESH WATER

1.	Cephalic setae indistinct or absent.....		.....2
	Cephalic setae absent but setae-like head appendages present.....		.....64
	Cephalic setae present.....		.....69
2.(1)	Stylet present.....		.....3
	Stylet absent.....		.....38
3.(2)	Base of stylet knobbed or flanged .....		.....4
	Stylet knobs or flanges absent.....		.....29
4.(3)	Valvate median esophageal bulb present.....		.....5
	Valvate median esophageal bulb absent.....		.....22
5.(4)	Females eel-like..		...6
	Females swollen.....		.....21

6.(5) Vulva at mid-body.....7



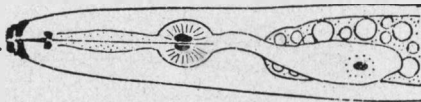
Vulva on lower third of body.....14



7.(6) Esophagus not overlapping intestine.....8



Esophagus overlapping intestine.....11

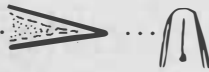


8.(7) Stylet length less than  $50\mu$  .....9

Stylet length greater than  $80\mu$ .....Dolichodorus

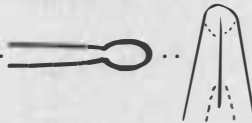


9.(8) Tail terminus pointed.....Tetylenchus

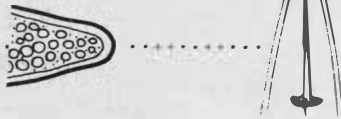


Tail terminus not pointed.....10

10.(9) Tail terminus knobbed.....Psilenchus



Tail terminus never knobbed or pointed.....Tylenchorhynchus



11.(7) Labium offset.....12



Labium flattened amalgamated or nearly so.....13




12.(11) Stylet massive,  $40-50\mu$  long... ..Hoplolaimus



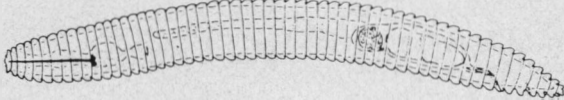
Stylet long & thin, greater than  $90\mu$  long... ..Belonolaimus



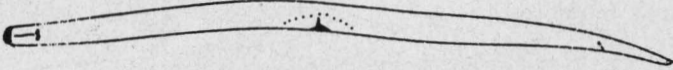
13.(11) Body 0.5-1 mm..... ....Radopholus


Body 2-3 mm long .....Hirshmaniella

14. (6) Cuticle heavily annulated, stylet elongate.....15



Cuticle not heavily annulated, stylet short.....17



15.(14) Cuticular sheath absent..... ....16

Cuticular sheath present... .....Hemicycliophora

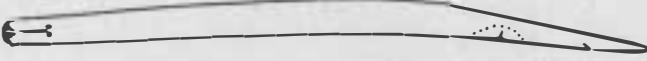
16.(15) Annules with cuticular spines or scales.....Criconema



Annules plain without spines or scales.....Criconemoides





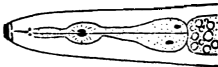

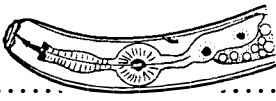

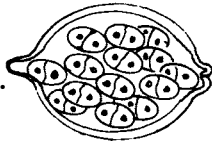
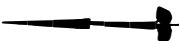
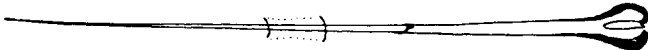






17.(14) Body death position straight.....18



Body death position spiral..... .....Helicotylenchus

18.(17) Median esophageal bulb distinct but not pronounced..... .....19

Median esophageal bulb well-developed..... .....Aphelenchoides

- 19.(18) Esophagus overlapping intestine..........20
- Esophagus not overlapping intestine..........Tylenchus
- 20.(19) Median bulb and valves small, stylet usually weak..........Ditylenchus
- Median bulb valves and stylet well developed, Labium flattened..........Pratylenchus
21. (5) Female body white without eggs..........Meloidogyne
- Female body brown, usually with eggs..........Heterodera
22. (4) Stylet short, less than 100 $\mu$ ..........23
- Stylet long, greater than 100 $\mu$ ..........Xiphinema
- 23.(22) Stylet complex..........24
- Stylet simple..........25
- 24.(23) Stylet with anterior arch-like portion..........Diphtherophora
- Stylet with dorsal thickening piece..........Tylencholaimellus
- 25.(23) Stylet knobs elongate, flange-like..........26
- Stylet knobs round..........27

26.(25) Filiform tail.....Aulolaimoides



Round tail.....Enchodelus



27.(25) Tail rounded.....28



Tail pointed...Nothotylenchus



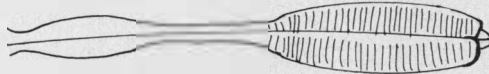
28.(27) Basal part esophagus elongate.....Tylencholaimus



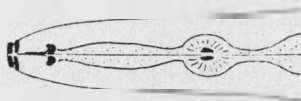
Basal part esophagus oval.....Doryllium



29. (3) Valvate median esophageal bulb absent.....30



Valvate median esophageal bulb present.....37



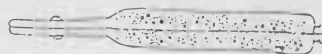
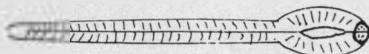
30.(29) Stomal walls not cuticularized.....31



Stomal walls cuticularized  
(Actinolaimus, Metactinolaimus,  
Paractinolaimus).....Actinolaiminae

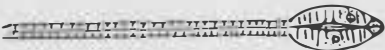


31.(30) Esophagus with basal expansions.....32




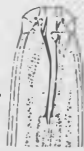
Esophagus expanding uniformly .....Oionchus




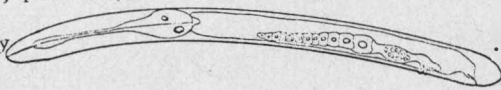
32.(31) Terminal fifth or sixth  
of esophagus an ovoid  
bulb.....  ..33

Posterior third of  
esophagus swollen.....  ..36


33.(32) Stylet axial, positioned  
centrally.....  .....34


Stylet not axial originating  
from tooth in stoma wall.....  .....Campydora


34.(33) Gonads paired.... .....35  
Vulva usually  
near mid  
body.... 

Gonad single, posterior  
to vulva.  
Vulva usually  
posterior to  
mid body....  .....Tyleptus


35.(34) Stylet slender.. .....Leptonchus

Stylet not slender.....  .....Dorylaimoides



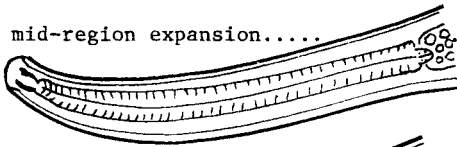
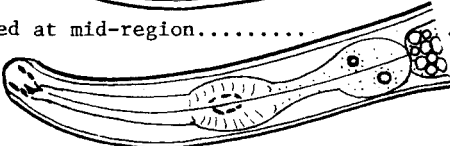








36.(32) Stylet axial, positioned centrally  
(Dorylaimus, Eudorylaimus, Labronema,  
Mesodorylaimus, Thornia, Laimydorus,  
Prodorylaimus).....  Dorylaiminae


Stylet not axial, originating  
from tooth in stoma wall.....  .....Nygolaimus

37.(29) Tail pointed..  .....Seinura


Tail rounded.....  .....Aphelenchus



38. (2) Teeth present , prominent.....		.....39
Teeth absent, minute, or indistinct.....		.....50
39.(38) Esophagus without mid-region expansion.....		.....40
Esophagus expanded at mid-region.....		.....49
40.(39) Tail pointed or tapering...		.....41
Tail rounded.....		.....47
41.(40) Male tail without setae.....		.....42
Male tail with setae.....		..... <u>Oncholaimus</u>
42.(41) Stoma with denticles.....		.....43
Stoma without denticles..		.....45
43.(42) Denticles scattered or in longitudinal rows.....		.....44
Denticles in transverse rows.....		..... <u>Myionchulus</u>

44.(43) Denticles situated on longitudinal rib of stoma..........Prionchulus

Denticles scattered on stoma wall..........Sporonchulus

45.(42) Tooth anteriorly directed..........46

Tooth retrorse..........Anatonchus

46.(45) Tooth in basal part of stoma..........Iotonchus

Tooth in anterior part of stoma..........Mononchus

47.(40) Stoma with prominent medial or apical tooth.......48

Stoma with small basal tooth..........Bathyodontus

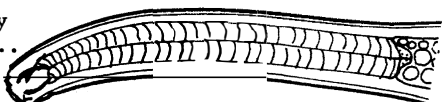
48.(47) Stoma with 3 teeth, without small basal tooth, caudal glands terminal..........Enoplocheilus

Stoma with large anterior & small basal tooth, caudal glands ventral..........Mononchulus

49.(39) Lip region with rib-like armature..........Mononchoides

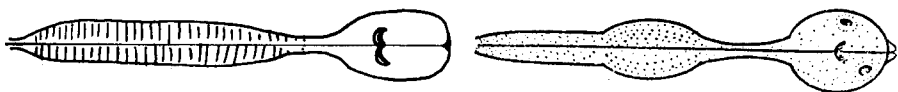
Lip region without rib-like armature..........Diplogaster

50.(38) Esophagus with basal expansions..........51

Esophagus uniformly cylindrical..........60

51.(50) Esophagus without mid-region expansion..52

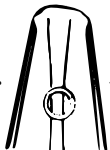
Esophagus expanded at mid-region.....55



52.(51) Amphids distinct........53

Amphids indistinct..........54

53.(52) Stoma walls anteriorly inflated with minute tooth..........Microilaimus

Stoma walls without tooth and with straight, tapering sides........Leptolaimus

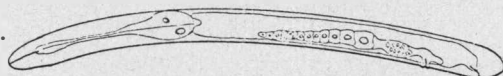
54.(52) Stoma with 3 rod-like thickenings..........Rhabdolaimus

Stoma without rod-like thickenings........Monochromadora

55.(51) Gonads paired....56



Gonads single...58



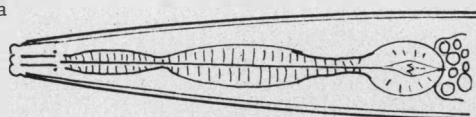
56.(55) Stomal walls straight amalgamated.....57



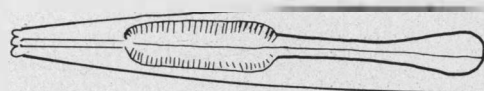
Stomal walls separated, not straight.....Alloionema



57.(56) Moderately swollen metacarpus, stoma not excessively elongate.....Rhabditis



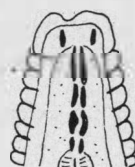
Elongate, cylindrical metacarpus, stoma elongate.....Cylindrocorpus



58.(55) Tail with sharp terminus.....59



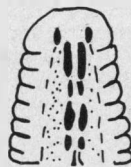
Tail bluntly conical.....Cephalobus



59.(58) Anterior part of stoma a broad, open chamber....Panagrolaimus



Stoma narrow, collapsed.....Eucephalobus



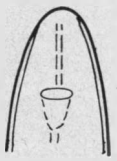
60.(50) Stoma absent or indistinct.....61



Stoma distinct.....63

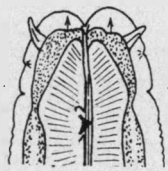


61.(60) Lip region narrow,  
tooth absent.....



.....62

Lip region broad, small  
denticle apparent in  
stomal area.....



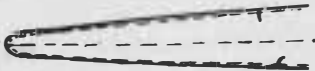
...Tripyla

62.(61) Amphid aperture  
appearing as large  
slit.....



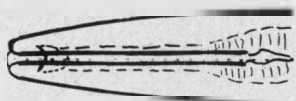
.....Amphidelus

Amphid aperture  
appearing as  
minute pores.....



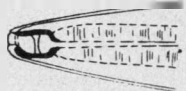
.....Alaimus

63.(60) Stoma narrow and long.....



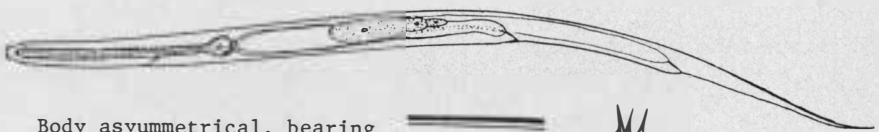
.....Cryptonchus

Stoma wide and shallow..



.....Bathyonchus

64. (1) Body symmetrical.....65



Body asymmetrical, bearing  
series of protuberances on  
side.....



.....Bunonema

65.(64) Lip appendages not  
elaborate.....



.....66

Lip appendages elaborate.....



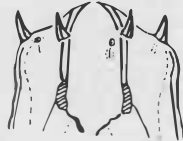
.....68

- 66.(65) Lateral lip appendages  
thorn-like directed  
laterally.....Diploscapter



Lateral lip appendages  
not thorn-like or  
directed laterally.....67

- 67.(66) Papillae or setae  
horn-like.....Macrolaimus



Lips flap-like and pointed  
anteriorly.....Teratocephalus



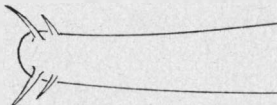
- 68.(65) Lip appendages forked  
and elaborately fringed.....Acrobeles



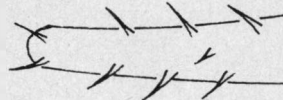
Lip appendages membranous  
and wing-like.....Wilsonema



69. (1) post-cephalic setae absent.....70



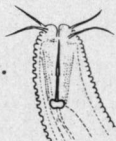
Post-cephalic setae present.....92  
(may be very faint Ex. Tobrilus)



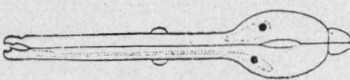
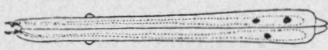


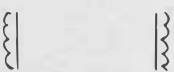

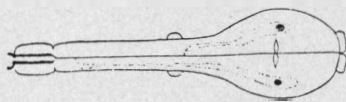



- 70.(69) Stylet absent... ..71

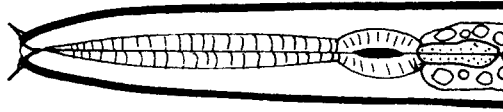


Stylet present.....91



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- 77.(76) Esophageal-intestinal valve elongate.....Paraplectonema



- Esophageal-intestinal valve shortened.....Paraphanolaimus



- 78.(75) Labial region characteristically flap-like.....Euteratocephalus



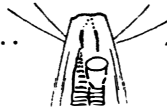
- Labial region not flap-like, lips bluntly rounded.....Ethmolaimus



- 79.(74) Amphids oval.....Greenenema



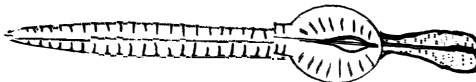
- Amphids stirrup-shaped.....Chronogaster



- 80.(73) Esophageal-intestinal valve shortened.....81



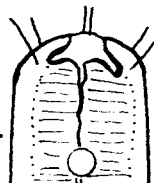
- Esophageal-intestinal valve elongate.....Desmolaimus



- 81.(80) Excretory pore and large excretory gland present.....Domorganus



- Excretory pore and gland indistinct or absent.....Monhystera





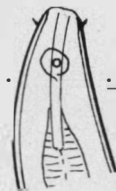
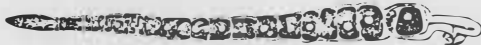
82.(72) Stoma wide and shallow,  
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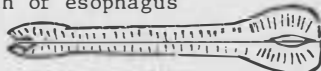
84.(83) Amphids inconspicuous.....Tripyla



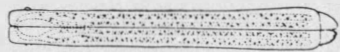
Amphids conspicuous... .....Aphanolaimus



85.(71) Terminal fifth or sixth of esophagus  
an ovoid bulb.....86



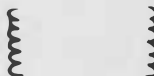
Esophagus uniformly cylindrical,  
stoma with massive teeth.....Ironus



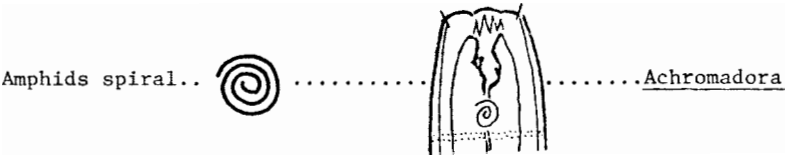
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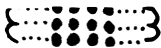
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88.(87) Four longitudinal rows of cuticular markings present..... .. Chromadora



No longitudinal rows of cuticular markings present.....  ..... Prochromadorella



89.(86) Amphids distinct. ....90



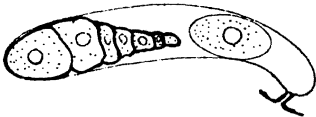
Amphids indistinct..... .. Butlerius



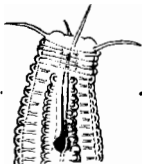
90.(89) Female gonad double, amphid hook-shaped..... .. Anonchus



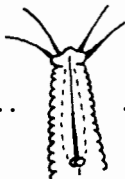
Female gonad single, amphid circular..... .. Monhystrella



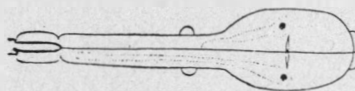
91.(70) Lip region annulated, not set off..... .. Atylenchus



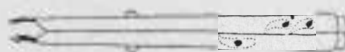
Lip region smooth, set off..... .. Eutylenchus



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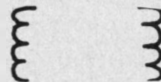
Esophagus uniformly cylindrical.....98



93.(92) Cuticular punctation present, amphids not circular.....94



Cuticular punctation absent, amphids circular.....97



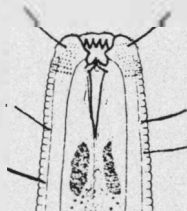
94.(93) Ocelli (eye spots) present.....95



Ocelli absent.....96



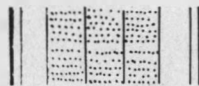
95.(94) Stoma with three equal-sized teeth.....Chromadorina



Stoma with at least one large tooth.....Punctodora



96.(94) Cuticle with lateral longitudinal rows of punctation .....Hypodontolaimus



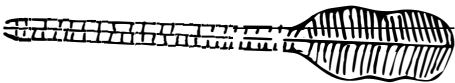
Cuticle without lateral differentiations.....Chromadorita



97.(93) Esophageal bulb valvate.....Prodesmodora



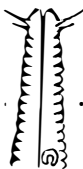
Esophageal bulb without valves.....Odontolaimus



98.(92) Amphid anterior on body.....99



Amphid posteriorly located.....Bastiania



99.(98) Amphid spiral.....Paracyatholaimus



Amphid cup-shaped or obscure .....100

100.(99) Stomal teeth massive.....Oncholaimus



Stomal teeth small....Tobrilus

