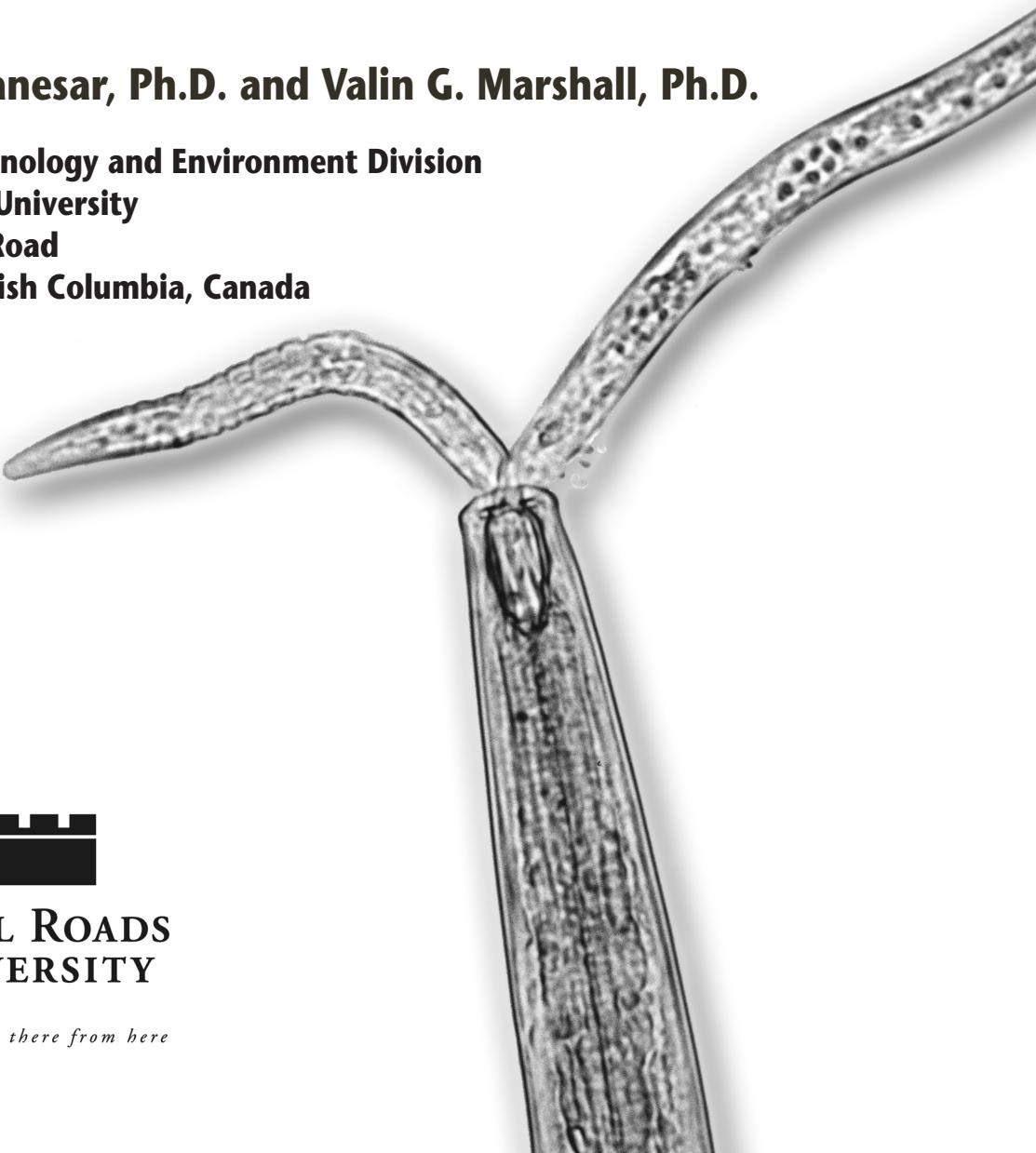


MONOGRAPH OF SOIL NEMATODES FROM COASTAL DOUGLAS-FIR FORESTS IN BRITISH COLUMBIA

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Cover: A mononchid nematode preying on a smaller nematode, and a forest harvested by the shelterwood method.

Foreword

I am pleased to write the foreword to the Monograph of soil nematodes from coastal Douglas-fir forests in British Columbia for two reasons. First, Royal Roads University, a relatively new university in British Columbia, has many of its goals related to environmental management. A major objective of its Science, Technology and Environment Division is to gain a better understanding of the interactions between human activity and the biosphere, including biodiversity, conservation, and ecosystem health. Also, the forest industry in British Columbia is entering an important phase of producing wood and other forest products with long-term sustainability in view. Thus, Royal Roads University is supportive of research that contributes to addressing environmental issues.

Secondly, nematodes are important in many interesting ways, notably as parasites of humans and plants, as decomposers, and as helpers in the advancement of knowledge. The free-living nematode, *Caenorhabditis elegans*, has been in the news recently with the scientific breakthrough of using it, to map for the first time, the complete genome of a multicellular animal. This knowledge gained from a simplified metazoan, which shares all the essential characteristics central to human biology, could lead, for example, to a better understanding of aging in humans. However, the contribution of nematodes to human welfare is not limited to their use as biological models only. In every square metre of soil, millions of these tiny creatures are quietly consuming organic matter, thereby contributing to decomposition, a critical process in maintaining soil fertility and supporting plant growth. We may even gain a new respect for these creatures knowing that when we stroll across a lawn or any piece of ground, each step is supported on the backs of hundreds of species of nematodes, among other groups of organisms living in the soil. Hence a better understanding of our local soil fauna is a prerequisite to a better appreciation of the soil environment.

Tony Boydell, Ph.D.
Dean, Science, Technology and Environment Division
Royal Roads University

March 2003

Preface

The history of nematodes dates back to ancient times. The intestinal roundworm, *Ascaris lumbricoides*, was apparently known to the Chinese about 5,000 years ago. This nematode, and the Guinea worm, *Dracunculus medinensis*, the dreaded nematode parasite of humans, seems to have been mentioned by the Egyptians about 3,500 years ago. Moses' fiery serpent mentioned in the Bible may also have been the Guinea worm. A few hundred years BCE, Hippocrates and Aristotle mentioned the human pinworm, *Enterobius vermicularis*, and Aristotle is on record as being the first person to describe nematodes. However, serious study of nematodes began only in the 1850s, with the availability of the light microscope, and primarily among the Europeans. Landmarks in this process included major works from France, Germany and England. North Americans, notably N. A. Cobb in the USA, entered the field some 50 years later.

In Canada, serious study of nematodes is even more recent, and was initially of interest primarily to entomologists and other biologists. Work on nematodes accelerated only after the 1940s with the establishment of a Nematology Laboratory in the Canada Department of Agriculture at Ottawa. Essentially all the work in that department was devoted to nematode parasites related to agriculture. Among eminent nematologists at Ottawa were Dr. R. H. Mulvey, Dr. R. V. Anderson and Dr. B. A. Ebsary. Unfortunately, the Ottawa nematology unit now appears to be an "endangered species." In British Columbia, Dr. J. M. Webster at Simon Fraser University has published extensively on nematodes. Similarly, Dr. R. C. Anderson at the University of Guelph was pre-eminent in the study of nematode parasites of vertebrates.

Despite the distinguished history of contributions to nematology in Canada, reference works on free-living nematodes do not exist for any of the Provinces. This Monograph is the first compendium on soil nematodes of British Columbia. It records information on 48 species in 27 families in nine orders of nematodes from coastal Douglas-fir ecosystems in the Province.

Although many nematode species are of great economic importance as serious pests of plants and as parasites of animals, most free-living nematodes contribute substantially to nutrient cycling and are therefore vital for sustainable forestry and agriculture. Recent estimates suggest several million nematode species worldwide.

With many years of experience in nematology and soil zoology research, the authors have recognized that the lack of taxonomic reference works is greatly hampering ecological studies in many areas of soil fauna research. The majority of these species are undescribed, and most biologists now agree that taxonomy is facing a crisis because of the dwindling number of systematists. The declining number of specialists increases the importance for creating regional faunal inventories. This Monograph is a reasonably comprehensive reference work, and it is hoped that it will be useful for future studies on biodiversity in soil ecosystems, and in using soil nematodes as bioindicators of soil ecological conditions.

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March 2003

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SECTION 1: INTRODUCTION

The Monograph of Soil Nematodes from Coastal Douglas-fir Forests in British Columbia was developed from specimens collected at Roberts Creek, on the mainland approximately 40 km northwest of Vancouver, and from three chronosequences, about 30 km north of Victoria, on Vancouver Island (Panesar et al. 2000, 2001). The Monograph records 48 species in 27 families and nine orders of nematodes. For each species, detailed information is given on the synonymy, description, identification key, biology, distribution, habitat, and miscellaneous information. Photographs or line drawings are provided for each species. Eighteen of the 48 species are probably new to science. The majority of these nematodes contributes to nutrient cycling and is therefore vital for sustainable forestry. The monograph is a reasonably comprehensive reference work and will be useful for future studies using soil nematodes as bioindicators of soil ecological conditions.

Importance of Nematodes. Nematodes, like the Acari and Insecta, are ubiquitous occupying all possible niches in animals, plants, freshwater, saltwater, in soil and other terrestrial habitats from pole to pole, and display a remarkable array of life styles and life histories within these niches. Cobb (1927), paraphrasing some of his earlier concepts, poetically described the importance of nematodes thus: "If all the other matter of the universe could be magically swept away and we could then, as disembodied spirits, revisit these scenes we should find them still recognizable We could recognize lakes, rivers, and oceans by the nemas particular to them. So, too, we could recognize the soil and tell where there had been one kind of soil and where another. We could recognize the cities by accumulations of nemas peculiar to human beings, domesticated animals and domesticated plants." Until recently, it was thought that insects were by far the most species-rich multicellular animal group, but revised estimates now show that nematodes rival the insects in diversity. These estimates range anywhere from a million to several million species worldwide (Viglierchio 1991; Coomans 2000; De Ley 2000). If these nematodes are roughly grouped by habitat, 50% are marine inhabitants, 25% are freeliving in soil, 15% are animal parasites, and 10% are plant parasites (Viglierchio 1991).

Nematodes impact our lives in significant ways. All plants and animals are attacked by one or more species of parasitic nematodes. Many nematode species cause serious damage to our food and fibre crops, ornamental plants, turf, and greenhouse plants (Chitwood & Chitwood 1950; Webster 1972; Sasser 1989). According to Viglierchio (1991), 5-10% of agricultural production is lost to nematodes in developed countries with higher losses in less developed countries. Worldwide losses to 21 important crops were estimated at \$77 billion (US) based on 1987 production figures (Sasser & Freckman 1987). Similarly, Barker et al. (1994) estimated the annual loss to U. S. growers from plant-parasitic nematodes at about \$8 billion, and nearly \$78 billion loss worldwide. Many other nematode species are detrimental parasites to humans and their domestic animals (Chitwood & Chitwood 1950; Beaver et al. 1984; Anderson 2000). Losses to live stock production are similar to those mentioned above for plants (Viglierchio (1991). Human misery caused by nematode parasitism, particularly in tropical regions, includes dracunculiasis, filariasis, elephantiasis, onchocerciasis, ascariasis, trichinosis, hookworm disease, and the common pinworm, the most cosmopolitan species in humans.

Introduction

Although a nematode parasite of the sperm whale, *Placentonema gigantissima*, may reach 10 metres, the majority of animal parasitic nematodes are relatively much smaller, and the free-living nematodes are essentially tiny, usually less than 5 mm. Most people would not have seen these free-living nematodes because of their small size and cryptic habitats. Even so, many farmers are likely to be familiar with the potato cyst nematode just as pet owners would know of the dog heartworm. It is likely that nematodes originated during the Precambrian to Cambrian period about 650 to 450 million years ago (mya). Nematode fossils are known from amber of about 120 to 20 mya, and Poinar (1984) has mentioned one such record at 40 mya.

Nematodes are the most abundant soil metazoans with densities sometimes approaching 30×10^6 nematodes m^{-2} (Volz 1951), and densities between one-tenth to one-fifth of that figure are commonly found. Thus nematodes occupy a central position in the soil foodweb. Their trophic and other interactions with cohabiting bacteria, protozoa, fungi and microarthropods have important influences on essential soil processes and plant growth (DeAngelis 1992; Coleman & Crossley 1996; Ekschmitt et al. 1999). Nematodes offer practical advantages for monitoring ecological changes in soil conditions following man-made or natural disturbances (Bongers 1990; Korthals et al. 1996; Wasilewska 1997; Bongers & Bongers 1998; Ettema et al. 1999). They have been used increasingly as bioindicators of ecosystem stress or environmental impacts, on the basis of measures of their diversity at the levels of their species or genera or a combination of the two (Hánél 1998; Neher & Olson 1999; Hoeksema et al. 2000; Neher 2001; Blakely et al. 2002).

Based on the direct or indirect damage by nematodes to our livelihood, Barker et al. (1994) identified several key priorities for research in nematology: (a) develop environmentally and economically sound management options; (b) maintain biological diversity; (c) promote beneficial use of nematodes; and (d) advance our knowledge of basic nematode biology, including taxonomy and systematics, through integration of existing and new technologies. This monograph embraces the last one of these priorities.

Sites and Soils of British Columbia Nematode Collections. Soil nematodes for this monograph were collected from two areas in southwestern British Columbia where Douglas-fir, *Pseudotsuga menziesii* (Mirb. Franco), was the dominant tree species. However, these sites fall within the Coastal Western Hemlock Biogeoclimatic Zone (Klinka et al. 1991). The first area was at the Roberts Creek Study Forest ($49^\circ 27' N$, $123^\circ 41' W$), approximately 40 km northwest of Vancouver, British Columbia. The soil there is a humoferric podzol (see Panesar et al. 2000). The second area comprised three Douglas-fir chronosequences on Vancouver Island, between 20 to 40 km northwest of Victoria. The soil types for the sites are orthic dystric brunisols for Victoria Watershed South ($48^\circ 34' N$, $123^\circ 39' W$), humoferric podzols and dystric brunisols for Victoria Watershed North ($48^\circ 38' N$, $123^\circ 43' W$) and humoferric podzols for Koksilah ($48^\circ 39' N$, $123^\circ 46' W$) (see Panesar et al. 2001).

These various soil types and the Coastal Western Hemlock Biogeoclimatic Zone represent a large part of the Province. Hence the nematode taxa discussed herein probably form a major part of the soil nematode fauna of British Columbia. Currently, very little information is available on soil nematodes in the Province (Scudder 1996). Furthermore, the wide geographical distribution of many species (e.g. *Aphelenchus avenae*, *Clarkus papillatus*,

Prionchulus muscorum) suggests that the Monograph would be useful for determining forest soil nematode species from other regions of Canada.

Nematode Extraction and Examination. Nematodes were extracted by a modified Baermann funnel method (after Sohlenius 1977), in which 2-ply Kleenex® tissue was used instead of filter paper and overhead heat was not applied to the sample. The nematodes that migrated across the tissue over a 20-hour extraction period at room temperature ($20\pm2^{\circ}\text{C}$) were collected. Batches of the extracted nematodes were inactivated in a water bath at $60\text{-}70^{\circ}\text{C}$, fixed in FA 4:1 fixative (Hooper 1986), cleared in a glycerol-ethanol solution by slow evaporation of the ethanol (Seinhorst 1959) and stored in anhydrous glycerol. Microscopic examination and photographing of the nematodes was done in glycerol mounts.

Importance of the Douglas-fir Soil Nematodes. The majority of nematode species found in Douglas-fir ecosystems in British Columbia are essentially involved in nutrient cycling and therefore deserves to be preserved for sustainable forestry. Several species are of "economic importance." *Xiphinema bakeri* is a pest, especially in forest nurseries (Sutherland 1974), and in strawberry fields (Dropkin 1980). *Ditylenchus myceliophagus* is a destroyer of mushrooms in commercial operations (SON 1984), and *Aphelenchus avenae* has been considered as a pest of the mushroom industry (Webster 1972) and a plant pathogen (SON 1984), as well as a biocontrol agent for fungal root diseases (Sasser & Jenkins 1960). Other plant parasites in the family Tylenchidae, such as *Psielenchus* sp. and *Tylenchus* sp. have the potential to be pests.

Monograph Style and Abbreviations. The Monograph is divided into eight Sections: an Introduction (Section 1), a Systematic Catalogue of Species (Section 2), Key to British Columbia Taxa (Section 3), a Glossary (Section 4), Links to other useful websites (Section 5), References to all citations in the text (Section 6), an Index to nematode taxa (Section 7) and Figures (Section 8).

For each taxon at the genus or the species level within Section 2, information is organized under subsections that include Combination/Synonymy, Remarks, Description, Identification Key, Biology, Distribution, Habitat, Miscellaneous Information, and Additional References. Citations under these subsections are listed chronologically, and the authors' names for references within a given year appear alphabetically (the one exception to chronology is mentioned under "Biology"; see below). The first author's name is followed by the year of the publication under reference, which is followed by a colon, a page number and often a figure number. The page number given is for the major place in the text where the pertinent information appears. In cases where the original reference was not available for consultation, page numbers for the full text are given. Where information on a genus or species for a particular subsection was unavailable from the published literature available to us, or where the taxon was not identified to a particular species, that subsection was excluded altogether. Hence, not all sections, nor subsections, are mentioned for all of the species.

Combination/Synonymy: Nomenclatural rules follow those published in the 1999 Code of Zoological Nomenclature (ICZN 1999). Goodey (1963) and Tarjan & Hopper (1974) greatly facilitated the development of the bibliography on synonyms. Synonymic names from these

Introduction

authors seem to be generally accepted by other workers, but we have modified their lists where more recent studies have questioned the status of certain species. Where there might be disagreement, this is explained in the section headed "Remarks." This section also includes pertinent remarks of a general taxonomic nature for the particular species. Each species name is accompanied by the authority and year of publication, and is then followed by the literature reference to the description. Synonyms are treated similarly, but with the added reference of the reviser. New combinations are simply followed by a comma and a reference to the recombiner.

Description: Two sets of information are included here: a figure for the British Columbian specimen when a suitable photograph was obtained, or a drawing and references to literature that describe the species in question. Where information was available, it is listed under sex and developmental stages.

Identification Key: References are listed for authors who have provided a key including the species in question.

Biology: References are given for biological information such as life-cycle, feeding habits, and c-p rating. For feeding habits we have listed Yeates et al. (1993) as the cardinal reference and is given first in the listing; earlier and later references on feeding are then given chronologically. The c-p rating classifies nematodes on an *r*- to *K*-strategy continuum, where generally c-p1 species have the highest and c-p5 the lowest reproduction rate (Bongers 1990). The numerical proportions of the nematode taxa on the *r-K* continuum depend on environmental conditions. An important parameter to measure the impact of disturbances and to monitor changes in below-the-ground ecosystems is the Maturity Index (Bongers 1990), which is based on the proportion of colonizers (*r*-strategists; lower c-p values) and persisters (*K*-strategists; higher c-p values).

Distribution: Information is recorded in Zoogeographical Regions developed for mites by Lee (1970) who recognized eight major regions: Palaearctic, Nearctic, Neotropical, Ethiopian, Oriental, Australian, Subantarctic, and Antarctic. A "Cosmopolitan" category is added when this information is given explicitly and not because of our own conclusion. Common two-letter abbreviations are used for Provinces in Canada and States of the United States of America.

Habitat: This lists information under major "biomes" with supplemental information about specific habitats in the soil.

Miscellaneous Information: Information that is not conveniently included in the previous subsections is given under specific headings, including Culture, Economic Importance, Morphology, Physiology and Teratology.

Additional References: Other related references, especially at the generic or family level, that have relevance to the species are included here.

Bibliographic Scope. The references represent an eclectic list of papers relevant to the British Columbia soil nematode species treated here. Articles were chosen to allow the reader to trace name changes in the species, compare published species descriptions with our own, confirm the widest distribution of a particular species, and provide ecological information that could be a basis for soil management and applied research.

SECTION 2: SYSTEMATIC CATALOGUE OF SPECIES

There is no general agreement as to how the phylum Nematoda should be classified (Lorenzen 1983; Maggenti 1983). Similarly, the number of recognized orders are in a state of flux, ranging from 25 (Inglis 1983) to as low as four (Adamson 1987). The latter author accepted only Dorylaimida, Mononchida, Rhabditida, and Tylenchida as being valid orders. We have taken a more conservative approach, following the arrangement of Poinar (1983). He listed two classes of nematodes: Adenophorea and Secernentea. The Adenophorea include mostly free-living, microbotrophic, aquatic nematodes, although this class also contains some plant-parasitic and animal-parasitic genera. The Secernentea show a greater diversity of habitats, including free-living, microbotrophs, plant parasites, invertebrate parasites and vertebrate parasites. Secernentea are poorly represented in marine and freshwater habitats. The orders are arranged "phylogenetically" within these classes with the most primitive group listed first. We have also followed Poinar's (1983) listing of families. However adjustments had to be made for taxa not treated by Poinar (1983), especially the families Alaimidae, Prismatolaimidae and Qudsianematidae, and the suborder Cephalobina. Maggenti (1982) placed Tripylidae, Ironidae and Prismatolaimidae in the suborder Tripylina in the order Enoplida, and Alaimidae in the suborder Alaimina in the order Dorylaimida. The more recently created family Qudsianematidae Jairajpuri, 1965 has been placed in the Dorylaimida where it seems to belong. A main reference to the diagnostic characteristics for a family is given under the family name. For convenience, genera and species within families are herein arranged alphabetically.

Class Adenophorea

Hooper 1978: 20-23 (abbreviated classification to orders, suborders and superfamilies in this class). Litvaitis et al. 2000: 911-922 (revision of the taxonomy of Adenophorea by using characters independent of morphology, life histories or ecology: use of nucleotide sequencing to construct and infer phylogenies within the Adenophorea).

ORDER ARAEOLAIMIDA

Hooper 1978: 20 (abbreviated description of this order); Heip et al. 1982: 5; 25, Table 3 (systematics and ecology of free-living, marine Araeolaimida).

Suborder Araeolaimina

Family Diplopeltidae Filipjev, 1918

Definitions, descriptions or diagnostic characteristics of this family: Maggenti (1982: 896), Bongers (1988: 263; attributes this family to de Coninck & Schuurmans Stekhoven, 1933). Several synonymys for the family Diplopeltidae are Axonolaimidae Schuurmans Stekhoven & de Connick, 1933 (Goodey 1963: 318; Lorenzen 1981: 90), Araeolaimidae (Grassé 1965b: 605; Lorenzen 1981: 90) and Cylindrolaimidae Micoletzky, 1922 (Andrássy 1976: 114).

***Cylindrolaimus melancholicus* de Man, 1880**

Cylindrolaimus melancholicus de Man, 1880: de Man 1880: 1-104

REMARKS

Mulvey (1969: 368) discussed the validity of 11 species of *Cylindrolaimus* listed by Goodey (1963: 318). On the basis of several comparative measurements and other characteristics of females (p. 368, Table 1), Mulvey considered five of the 11 species, including *C. melancholicus*, as possibly valid. The five species could be separated into two groups on the basis of ratio of stomatal length to head diameter, but further separation was difficult due to confusion about number of ovaries in each species reported in the literature.

DESCRIPTION**British Columbia Material**

Fig. 1, after Goodey (1963: 320). This species was identified by use of the key in Bongers (1988: 263) and by making comparisons with published descriptions and illustrations of species in the genus *Cylindrolaimus*, including those cited below. It agreed with the description in Goodey (1963: 320).

Other Descriptions

Female: Goodey 1963: 318; 320, Fig. 174 A; Mulvey 1969: 367, Figs. 4-7 (head region, tail, oesophageal-intestinal junction, reproductive tract; 368, Table 1 (morphometry; morphometric comparison with 4 other species of *Cylindrolaimus*); Bongers 1988: 263.

Male: Goodey 1963: 318; 320, Fig. 174 D (posterior end); Bongers 1988: 263.

Misc.: Goodey 1963: 320, Fig. 174 B-C (head end, dorsal and lateral aspects).

IDENTIFICATION KEY

Bongers 1988: 263 (Key to 2 species, including *C. melancholicus*, in the genus *Cylindrolaimus*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 320.

c-p rating: 3: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Mulvey 1969: 365 (Canada - NT); Bongers 1988: 263-4 (Canada).

Paleartic: Bongers 1988: 263-4 (N. W. Europe).

HABITAT

Misc.: Goodey 1963: 318 (freshwater, soil); Mulvey 1969: 368 (about wet grass, humus, moss).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 88 (Key to 12 genera, including *Cylindrolaimus* de Man, 1880, in the subfamily *Cylindrolaiminae* Micoletzky, 1922); Bongers 1988: 263 (Key to 2 genera, including *Cylindrolaimus*, in the family Diplopeltidae de Conink & Schuursman Stekhoven, 1933; 263 (Key to 2 species, including *C. melancholicus*, in the genus *Cylindrolaimus*).

Family Bastianidae de Coninck, 1935

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 316), Maggenti (1982: 897), Bongers (1988: 276).

***Bastiania* sp.**

DESCRIPTION

British Columbia Material

Fig. 2. The British Columbia specimens could not be identified to species level by use of available keys. They were identified to genus by use of the key in Bongers (1988: 277), and by comparisons with published descriptions and illustrations of this genus from several sources, including those cited below. The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 316 (the type species for this genus is *Bastiania gracilis* de Man, 1876); 317, Fig. 173 A-B (head end and male tail of *B. gracilis*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 319.

c-p rating: 3: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Mulvey 1969: 365 (Keys to females of 5 species and males of 5 species in the genus *Bastiania* de Man, 1876); Bongers 1988: 277 (Key to 2 genera, including *Bastiania*, in the family Bastianidae de Coninck, 1935; 277 (Key to 2 species in the genus *Bastiania*).

Misc.: Goodey 1963: 316 (diagnostics characters of the genus *Bastiania*); Bongers 1988: 277 (diagnostic characters of the genus *Bastiania*).

Family Plectidae Örley, 1880

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 291), Heyns (1971: 117), Maggenti (1982: 897), Bongers (1988: 249).

***Chronogaster longicollis* (von Daday, 1899)**

Cephalobus longicollis von Daday, 1899; von Daday 1899: 557-572

Chronogaster longicollis, Andrassy 1958b: 7-11

Chronogaster gracilis N. A. Cobb, 1913; N. A. Cobb 1913: 443; T. Goodey 1963: 300

REMARKS

(1) Heyns & Coomans (1980: 187) discussed the synonymy of *C. gracilis* N. A. Cobb, 1913 at the generic and species levels. They cited Andrassy (1958b) as having examined the type material of *Cephalobus longicollis* von Daday, 1899 and having transferred *Cephalobus longicollis* to *Chronogaster*. Because of priority, the name of the type species thus became *Chronogaster longicollis*. (2) Raski & Maggenti (1984:123-125) cast doubt as to conspecificity of *Chronogaster gracilis* and *C. longicollis* for several reasons, but considered it wisest to accept the synonymy as proposed by Andrassy (1958b) until final resolution was achieved by new collections of males and females from the type localities. (3) Bongers (1988: 257) placed the genus *Chronogaster*-

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ter Cobb, 1913 in the family Leptolaimidae Öerley, 1880, and Lorenzen (1981: 144) placed *C. typica* in the same family.

DESCRIPTION

British Columbia Material

Fig. 3, after Raski & Maggenti (1984: 119). This species was identification by use of the keys in Heyns & Coomans (1983: 264) and Raski & Maggenti (1984: 128). It agreed with the description in Raski & Maggenti (1984: 119).

Other Descriptions

Female: Cobb 1913: 443-444 (n. g., n. sp.: striae, lips, amphids, pharynx = stoma, oesophagus, cardiac bulb, spinneret); Heyns & Coomans 1980: 194, Table 1 (morphometrical data on 12 diagnostic characters for *C. longicollis* = *C. gracilis*); Raski & Maggenti 1984: 119, Fig. 1 E, J (anterior end; tail); 124, Fig. 3 D-F (SEM of anterior end and tail terminus); 125-126 (dimensions and descriptions of various body regions and structures).

Male: Cobb 1913: 444 (n. g., n. sp.: spicula, supplementary organs); Heyns & Coomans 1980: 194, Table 1 (only 2 biometrical data given, in so far as these deviate from that of female, i.e. de Man's ratio c, and absence of lateral lines).

Egg: Cobb 1913: 444.

Misc.: Chitwood & Chitwood 1950: 110, Fig. 104 O (intestine, cross-sectional morphology); Heyns & Coomans 1980: 207, Fig. 6 (schematic drawing of head and tail of *C. longicollis* = *C. gracilis*); Andrassy 1957: 3-12 (cited in Heyns & Coomans 1980, p. 187: review of the genus *Chronogaster*, with detailed descriptions of *C. gracilis* (= *C. longicollis*) and *C. typica*).

IDENTIFICATION KEY

Heyns & Coomans 1983: 264 (Key to females of 23 species of *Chronogaster*, including *C. longicollis* = *C. gracilis*); Raski & Maggenti 1984: 128 (Key to 31 species of *Chronogaster*, including *C. longicollis*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 320.

c-p rating: 2: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Cobb 1913: 432, 444 (USA - DC, VA, MI); Cobb 1915: 24 (USA - MI); Raski & Maggenti 1984: 125 (USA - FL).

HABITAT

Agroecosystems: Cobb 1913: 444 (agricultural farm located on river).

Misc.: Cobb 1915: 25 (in sand and mud near creek and crayfish burrows; among rushes, moss, algae; in bog among sphagnum).

MISC. INFORMATION

Morphology: Heyns & Coomans 1980: 188-197, Table 1 (review of comparative morphology and diagnostic characters of several *Chronogaster* species, including *C. longicollis* (= *C. gracilis*)).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 84 (Key to 6 species in the genus *Chronogaster* Cobb, 1913); Heyns & Coomans 1980: 194, Table 1 (comparative data on 12 morphometrical and other diagnostic characters for 20 *Chronogaster* species, including *C. longicollis* (= *C. gracilis*); useful

as a Tabular Key); Bongers 1988: 257 (Key to 4 genera, including *Chronogaster*, in the family Leptolaimidae Öerley, 1880; 257: Key to 3 species in the genus *Chronogaster*).

***Plectus parietinus* Bastian, 1865**

Plectus parietinus Bastian, 1865; Bastian 1865: 73-184

Plectus cirratus form *parietinus* Bastian, 1865; Bastian 1865: 73-184; Micoletzky 1922a: 1-650

Plectus parietinus var. *australis* N. A. Cobb, 1898; N. A. Cobb 1898: 397; Micoletzky 1922a: 1-650

Plectus fusiformis Bastian, 1865; Bastian 1865: 121; Maggenti 1961b: 142

Plectus velox Bastian, 1865; Bastian 1865: 119; Maggenti 1961b: 142

Plectus ornatus Bütschli, 1873; Bütschli 1873: 90; Micoletzky 1922a: 1-650

Plectus intermedius N. A. Cobb, 1893; N. A. Cobb 1893b: 827; Maggenti 1961b: 142

Plectus antarcticus de Man, 1904; de Man 1904b: 8; Maggenti 1961b: 142

Plectus (Plectoides) antarcticus, T. Goodey 1963: 293

Plectus patagonicus de Man, 1904; de Man 1904a: 41; Micoletzky 1922a: 1-650

Plectus (Plectoides) patagonicus, T. Goodey 1963: 293

Plectus hawaiiensis N. A. Cobb, 1906; N. A. Cobb 1906: 184; Maggenti 1961b: 142

Plectus naticochensis Steiner, 1920; Steiner 1920: 13; Maggenti 1961b: 142

Plectus pusteri Fuchs, 1930; Fuch 1930: 530; Maggenti 1961b: 142

ADDITIONAL COMBINATION/SYNONYMY

Maggenti (1961b: 142, 144).

DESCRIPTION

British Columbia Material

Fig. 4. This species was identified by use of the keys and descriptions in Maggenti (1961b: 141), Maslen (1979: 224), Ebsary (1985: 2399) and Bongers (1988: 251).

Other Descriptions

Female: Chitwood & Chitwood 1950: 20, Fig. 15 C (tail); Sasser & Jenkins 1960: 147, Fig. 1 (whole body); Maggenti 1961a: 127, Fig. 5 A (reproductive system); Maggenti 1961b: 142, Figs. 1, 2 C (whole body, tail); Heyns 1971: 118, Fig. 78 C (tail); Mulk & Coomans 1978a: 595; Maggenti 1982: Plate 78 (head with amphid; posterior oesophageal bulb); Bongers 1988: 253, Fig. 42.2.9 (posterior end in outline).

Male: Maggenti 1961a: 127, Fig. 5 B (reproductive system); Maggenti 1961b: 142, Fig. 2 D-F (tail; preanal tubuli, spicule); Maggenti 1982: Plate 78 (tail showing dorsal apophysis of gubernaculum, and preanal supplements); Bongers 1988: 253, Fig. 42.2.9 (posterior end in outline).

Egg: Maggenti 1961a: 128-129, Fig. 5 C-J (eggs laid in single-cell stage; embryology through 2-, 4-, 8-cell stages, gastrula, "tadpole" stage, pre-larva, and fully developed larva ready for hatching; developmental time from single-cell stage to hatching, in laboratory cultures at 50-55° F, was 16-18 days); Maggenti 1961b: 142 (mean size 35-48 µm x 52-70 µm).

Misc.: Chitwood & Chitwood 1950: 20, 15 A-B (oesophageal and stomatal regions); Maggenti 1961: 142, Fig. 2 A-B (anterior end; spinneret); Andrassy 1967b: 83 (the calculated average body-weight of adult females was 1.930 µg; for comparison, the calculated average body-weight for adult females of 50 free-living nematode species was 1.628 µg, with a range of 0.025-15.001 µg); Heyns 1971: 118, Fig. 78 A-B (head end, oesophageal region); Spaull

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1973c: 26, Table V (mean weight of adult females 3.43 µg); Lorenzen 1981: 144, Fig. 21 A (basal bulb and valve apparatus of pharynx).

IDENTIFICATION KEY

Maggenti 1961b: 141 (Key to 16 species of *Plectus*, including *P. parietinus*); Maslen 1979: 224 (Key to 5 species of *Plectus*, including *P. parietinus*); Ebsary 1985: 2399 (Key to 37 species of *Plectus*, including *P. parietinus*); Bongers 1988: 251 (Key to 14 species of *Plectus*, including *P. parietinus*).

BIOLOGY

Life-cycle: Maggenti 1961a: 129 (development from egg to adult female, in laboratory cultures at 50-55° F, required 45-55 days); Evans & Womersley 1980: 201 (slow breeder; generation time, 60 days, egg to egg).

Feeding habit: Bacterivore: Yeates et al. 1993: 323; Heyns 1971: 119; Yeates 1979: 221 (ingested 5000 cells of *Acinetobacter* sp. per minute, a daily rate of 650% of body weight).

c-p rating: 2: Bongers 1990: 15.

Culture: Maggenti 1961a: 128 (on Asparagine-mannitol agar at 50-55° F).

Misc.: Spaull 1973b: 95 (abundance: $4.13 \times 10^3 \text{ m}^{-2}$ in a mixed community of carpet-forming mosses); Yeates 1973: 181, Fig. 2 (percentage contribution of juveniles, non-gravid females, and gravid females to monthly abundance and biomass for this species); 182 (population structure: juveniles 67%, females 11%, gravid females 23%, males 0%); 184 (vertical distribution to 6 cm soil depth: 76% in litter, 24% below litter); 184 (mean individual weight 0.89 µg); Popovici 1984: 207 (mean individual wet mass of adults 1.4608 µg).

DISTRIBUTION

Nearctic: Maggenti 1961b: 144 (Canada; USA - CA, CO, CT, HI, ID, KS, KY, NJ, NV, WI); Smolik 1974: 8 (USA - SD); Baird & Bernard 1984: 382 (USA - TN); Al-Banna & Gardner 1996: 975 (USA - CA).

Palearctic: Maggenti 1961b: 144 (UK, Ireland, Netherlands); Wasilewska 1970: 435 (Poland); Yeates 1970: 105 (Orkney Islands); Yeates 1972b: 179 (Denmark); Yeates 1973: 180 (Denmark); Sohlenius 1979: 33 (Sweden); Jacobs 1984: 269 (Balearic Islands); Popovici 1984: 205 (Romania); Zullini & Peretti 1986: 403 (Italy); Bongers 1988: 253 (Netherlands); Šály 1989: 48 (Czechoslovakia); Háněl & Šimek 1993: 110 (Czech Republic); Sohlenius 1993: 263 (Sweden); Hodda & Wanless 1994: 116 (England); Háněl 1996: 15 (Czech Republic: Beskydy Mountains); Alphei 1998: 10 (Germany); Háněl 1998: 37 (Czech Republic: South Moravia); Sohlenius & Boström 1999: 698 (northern Sweden).

Ethiopian: Heyns 1971: 119 (South Africa); Mulk & Coomans 1978a: 593 (Kenya: Mount Kenya); Jacobs 1984: 269 (Kenya).

Australian: Maggenti 1961b: 144.

Antarctic: Maggenti 1961b: 144; Spaull 1973a: 178 (Signy Island); Spaull 1973b: 95 (Signy Island); Maslen 1979: 209, 210, 215 (found on 12 islands of maritime Antarctic, and 2 islands of continental Antarctic); Maslen 1981: 60 (Signy Island).

Cosmopolitan: Bongers 1988: 253.

HABITAT

Agroecosystems: Baird & Bernard 1984: 380 (soybean-wheat crops); Šály 1989: 52 (herbicide-treated vineyards); Háněl & Šimek 1993: 111 (roots of red clover, *Trifolium pratense* L.); Al-Banna & Gardner 1996: 975 (California native grape, *Vitis californica*).

Forest: Wasilewska 1970: 435 (afforested dunes: found in three of six successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Yeates 1972b: 181 (beech forest, *Fagus sylvatica* L.); Yeates 1973: 180 (beech forest); Sohlenius 1979: 31 (Scots pine forest); Popovici 1984: 205 (beech forest, Western Carpathians; 1300 m); Sohlenius 1993: 265, 266 (Scots pine forest: from old stand and clearcut area; podzol soil); Háněl 1996: 18 (134 year old spruce forest); Háněl 1998: 41 (linden-oak and hornbeam-linden forest); Alphei 1998: 11 (beech forest: moder soils).

Grassland: Smolik 1974: 8; Yeates 1970: 105 (maritime turf); Hodda & Wanless 1994: 121 (chalk grasslands); Háněl 1998: 41 (meadow).

Tundra: Sohlenius & Boström 1999: 696 (peat from ombrotrophic mire).

Misc.: Maggenti 1961b: 144 (neotype female collected from Pearlwort, *Sagina* spp., in Berks, UK); Spaull 1973a: 178 (cushion-forming and other mosses; peat and soil underlying vascular plants); Spaull 1973b: 95 (a mixed community of 3 species of carpet-forming mosses); Maslen 1979: 208 (moss communities); Maslen 1981: 60 (moss turf and moss carpet); Mulk & Coomans 1978a: 595 (bryophyte: a *Leptodontium* sp. on soil among *Erica*-bushes at elevation of 3,240 m, Mount Kenya); Jacobs 1984: 269 (aquatic - pond, pools, temporal water; marshy, swampy soil and hygroscopic zone; non-aquatic - associated with algae; terrestrial); Zullini & Peretti 1986: 405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Bongers 1988: 253 (one of the most common species in both aquatic and terrestrial habitats).

MISC. INFORMATION

Morphology: Maggenti 1961a: 118-128, Figs. 1-3 (cross-sectional morphology at many levels through all body regions from head to tail); 125, Fig. 4 A (excretory system and associated glands); Grassé 1965a: 115, Fig. 157 (transverse section through vulva, vagina and vaginal musculature); 185, Fig. 251 (transverse section through rectal region); 190, Fig. 261 (excretory system); Lorenzen 1983: 18, Fig. 2 (b) (valve or valvular apparatus in basal bulb; possible function as a pump during ingestion of fluid food).

Systematics: Sanwal 1969: 103, Table 1 (a discussion of the systematic position of 24 genera, including *Plectus*, in the classifications of various authors).

Physiology: Yeates 1973: 184 (oxygen consumption: 117 ml O₂ m⁻²).

ADDITIONAL REFERENCES

Key: Bongers 1988: 249 (Key to 4 genera, including *Plectus* Bastian, 1865, in the family Plectidae Örley, 1880).

***Wilsonema* sp.**

DESCRIPTION

British Columbia Material

Fig. 5. The British Columbia specimens could not be identified to species level by use of available keys. They were identified to genus by use of the keys in Anderson (1966: 934) and Bongers (1988: 249), and by comparisons with published descriptions and illustrations of this genus from several sources, including those cited below. The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 303 (the type species for this genus is *W. capitatum* Cobb, 1913); 303 (in place of the type species, *W. auriculatum* (Bütschli, 1873) Cobb, 1913 is described); 303, Fig. 164 A-C (description; oesophageal region, anterior end, and female tail end of *W. auriculatum*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 324.

c-p rating: 2: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Anderson 1966: 934 (Key to 3 genera, including *Wilsonema* Cobb, 1913, in the subfamily Wilsonematinae); Bongers 1988: 249 (Key to 4 genera, including *Wilsonema*, in the family Plectidae Örley, 1880; 256 (Key to 2 species in the genus *Wilsonema*).

Misc.: Goodey 1963: 303 (diagnostic characters of the genus *Wilsonema*); Bongers 1988: 255 (diagnostic characters of the genus *Wilsonema*).

Family Teratocephalidae Andrassy, 1958

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 287), Bongers (1988: 225).

***Teratocephalus subvexus* Anderson, 1969**

Teratocephalus subvexus Anderson, 1969; Anderson 1969: 835

DESCRIPTION**British Columbia Material**

Fig. 6. This species was identified using the key and description in Anderson (1969: 835, 839).

Other Descriptions

Female: Anderson 1969: 835-836; 834, Fig. 4 A-E (gravid female; reproductive system; tail end); 835, Fig. 5 A-J (anterior region; head views; *en face* view; cuticular ridges and lateral fields in cross-sections).

Egg: Anderson 1969: 835 (egg size 37-43 μ x 2-14 μ).

IDENTIFICATION KEY

Anderson 1969: 839 (Key to 9 species, including *T. subvexus*, in the genus *Teratocephalus*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 324.

c-p rating: 3: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Anderson 1969: 835-836 (Canada - NT, QC).

HABITAT

Misc.: Anderson 1969: 835-836 (moss and soil from a pond; marsh at lake edge).

ADDITIONAL REFERENCES

Key: Bongers 1988: 225 (Key to 3 genera, including *Teratocephalus* de Man, 1876, in the family Tertocephalidae Andrassy, 1958; 225 (Key to 3 species in the genus *Teratocephalus*).

Morphology: Boström 1989: 188, Table 1 (key cuticular structures and body orifices in the genus *Teratocephalus* as revealed by SEM; comparisons made with the genus *Metateratocephalus*).

ORDER MONHYSTERIDA

Hooper 1978: 20 (abbreviated description of this order); Andrassy (1981) revised the order Monhysterida inhabiting soils and freshwater. Heip et al. 1982: 5; 27, Table 5 (systematics and ecology of free-living, marine Monhysterida).

Family Monhysteridae de Man, 1876

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 330-331), Heyns (1971: 123), Maggenti (1982: 903), Bongers (1988: 240).

***Monhystera dispar* Bastian, 1865**

Monhystera dispar Bastian, 1865; Bastian 1865: 73-184

Monhystera crassa Bütschli, 1873; Bütschli 1873: 63; Tarjan & Hopper 1974: 83

DESCRIPTION

British Columbia Material

Fig. 7. This species was not identified from a particular key, but was determined by comparisons with published descriptions and illustrations of species in the genus *Monhystera* from several sources, including Mulvey (1969: 377) and others as cited below.

Other Descriptions

Female: Mulvey 1969: 377.

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 322 (also, substrate ingestion may be incidental to bacterial feeding).

c-p rating: 2: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Mulvey 1969: 365 (Canada - NT).

Paleartic: Allgén 1925: 1-40 (Sweden).

HABITAT

Misc.: Mulvey 1969: 378 (about the roots of grass growing in wet areas, moss and wet humus).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 78 (Key to 15 genera, including *Monhystera* Bastian, 1865, in the subfamily Monhysterinae); Bongers 1988: 240 (Key to 4 genera, including *Monhystera*, in the family Monhyspteridae).

Description: Mulvey 1969: 377-378 (brief descriptions of three *Monhystera* spp., including *M. dispar*).

Morphology: Geraert et al. 1981: 150-153, Figs. 1-2 (structure of female genital system in three *Monhystera* spp.); Geraert 1983: 81; 82, Fig. 4 (female reproductive system in a *Monhystera* sp.).

Order MONHYSTERIDA

Survival strategy: Jacob & Heyns 1990: 109-111 (discussion of a sulphide detoxification system in the genus *Monhystera* in relation to adaptation and survival in thiobiotic habitats).

Culture: Geraert et al. 1981: 149 (culture methods for three *Monhystera* spp.).

***Monhystrella* sp.**

DESCRIPTION

British Columbia Material

Fig. 8, after Goodey (1963: 335). The British Columbia specimens could not be identified to species level by use of available keys. They were identified to genus by comparisons with published descriptions and illustrations of this genus from various sources, including Goodey (1963: 335). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 336 (the type species for this genus is *M. plectoides* Cobb, 1918); 336 (in place of the type species, *M. ginlingensis* Hoeppli & Chu, 1932 was chosen for description); 335-336, Fig. 184 A-C (description; whole body of female, anterior end, and *en face* view of *M. ginlingensis*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 322 (also, substrate ingestion may be incidental to bacterial feeding).

c-p rating: 2: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Bongers 1988: 245 (Key to 2 species in the genus *Monhystrella* Cobb, 1918).

Misc.: Goodey 1963: 335 (diagnostic characters of the genus *Monhystrella*).

***Theristus* sp.**

REMARKS

Bongers (1988: 245-246) placed the genus *Theristus* Bastian, 1865 in the family Xylidae Chitwood, 1951.

DESCRIPTION

British Columbia Material

Fig. 9, after Bongers (1988: 246) and Andrassy (1976: 98). The British Columbia specimens could not be identified to species level by use of available keys. They were identified to genus by comparisons with published descriptions and illustrations of the genus from various sources, including Andrassy (1976: 98) and Bongers (1988: 246). The following information relates mostly to the genus.

Other Descriptions

See below under "Additional References: Morphology:"

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 324 (also, substrate ingestion and feeding on algae, fungal spores and yeast cells is incidental to bacterial feeding).

c-p rating: 2: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Hopper 1968: 1110 (Key to males of 4 species of *Theristus* (*Daptonema*) *buetschlii* group); Bongers 1988: 246 (Key to 2 species in the genus *Theristus* Bastian, 1865).

Morphology: Grassé 1965a: 214, Fig. 287 A-C (*Theristus normandicus*: anterior part, cloacal region of male and spicular apparatus, tail and cloacal region); 214, Fig. 287 D-E (*Theristus acer*: female whole body, cloacal region of male and spicular apparatus); Andrassy 1976: 98, Fig. 33 A-B (*Theristus setosus* (Bütschli, 1987) Filipjev, 1922: female whole body, male tail region); Decraemer & Coomans 1978: 512-515, Fig. 1 (male of *T. quadripapillatus* n. sp.: morphometry and drawings; useful for morphology of male *Theristus* in general); Bongers 1988: 246, Fig. 38.2.1 (*Theristus agilis* (de Man, 1880): description; anterior end, female tail, male tail); Heyns & Coomans 1989: 95-98 (on a freshwater species of *Theristus* from South West Africa/Namibia).

Misc.: Bongers 1988: 246 (diagnostic characters of the genus *Theristus* Bastian, 1865).

ORDER CHROMADORIDA

Hooper 1978: 20 (abbreviated description of this order). Heip et al. 1982: 7; 29, Table 7 (systematics and ecology of free-living, marine Chromadorida).

Family Chromadoridae Filipjev, 1917

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 345-346), Maggenti (1982: 898), Bongers (1988: 265).

Punctodora* sp.*DESCRIPTION****British Columbia Material**

Fig. 10, after Goodey (1963: 353). The British Columbia specimens could not be identified to species level by use of available keys. They were identified to genus by use of the keys in Hopper & Cairns (1959: 91) and Bongers (1988: 266). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 352 (the type species for this genus is *Punctodora ratzeburgensis* (Linstow, 1876) Filipjev, 1930); 352-353, Fig. 195 A-D (description; oesophageal region, tail end, anterior end, and spicular region of *P. ratzeburgensis*).

BIOLOGY

Feeding habit: Bacterivore (possibly also feeds on unicellular eucaryotes - diatoms or other algae): Yeates et al. 1993: 319.

c-p rating: 3: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 91 (Key to 25 genera, including *Punctodora* Filipjev, 1930, in the subfamily Chromadorinae Micoletzky, 1922); Hopper 1963b: 1124 (Key to 3 species of *Punctodora*); Bongers 1988: 266 (Key to 3 genera, including *Punctodora*, in the family Chromadoridae Filipjev, 1917).

Order CHROMADORIDA

Morphology: Hopper 1963b: 1121-1124, Figs. 1-9 (both sexes of *P. exochopora* n. sp.: useful for comparing morphology with other species in the genus).

Misc.: Goodey 1963: 352 (diagnostic characters of the genus *Punctodora*); Bongers 1988: 267 (diagnostic characters of the genus *Punctodora*).

Family Cyatholaimidae Filipjev, 1918

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 356), Bongers (1988: 272).

Achromadora ruricola (de Man, 1880)

Cyatholaimus ruricola de Man, 1880; de Man 1880: 1-104

Achromadora ruricola, Micoletzky 1925: 57-310

Chromadora minima N. A. Cobb, 1893; N. A. Cobb 1893a: 252-308; T. Goodey 1963: 359

Achromadora minima, N. A. Cobb 1913: 441

Cyatholaimus minima, Micoletzky 1922a: 1-650

REMARKS

(1) Loof (1964b: 243) gave the justification for the synonymy of *Chromadora minima* Cobb, 1993 with *Achromadora ruricola* (de Man, 1880). However, he left the possibility that, on further detailed examination concerning preanal papillae, the two species might prove to be different; he nevertheless considered the synonymization of *C. minima* with *A. ruricola* to be well founded. (2) Bongers (1988: 269) placed the genus *Achromadora* in the family Achromadoridae Gerlach & Riemann, 1973, but we have left it in Cyatholaimidae following earlier authors, for example Goodey (1963: 359). Mulvey (1969: 372, Table 2) discussed the genus *Achromadora* with regard to nine species, including *A. ruricola*, on the basis of measurements of females, but also including a male of *A. ruricola*. He placed these species in the subfamily Cyatholaiminae (p. 369).

DESCRIPTION

British Columbia Material

Fig. 11, after Goodey (1963: 359). This species was identified by use of the keys in Mulvey (1969: 372) and Bongers (1988: 270). It agreed with the description in Goodey (1963: 359).

Other Descriptions

Female: Goodey 1963: 359; Loof 1964b: 243; Mulvey 1969: 369, Figs. 8, 10 (anterior region, tail); Bongers 1988: 270-271; 270, Fig. 50.1.3 (tail end).

Male: Goodey 1963: 359, Fig. 198 C; Loof 1964b: 243; Mulvey 1969: 369, Fig. 9 (tail, spicule, gubernaculum); Bongers 1988: 270-271.

Misc.: Goodey 1963: 359, Fig. 198 A-B (anterior part and stomatal region); Andrassy 1967b: 83 (the calculated average body-weight of adult females was 0.125 µg; for comparison, the calculated average body-weight for adult females of 50 free-living nematode species was 1.628 µg, with a range of 0.025-15.001 µg); Bongers 1988: 270, Fig. 50.1.3 (anterior part).

IDENTIFICATION KEY

Mulvey 1969: 372 (Key to females of 7 species, including *A. ruricola*, in the genus *Achromadora* Cobb, 1913,); Bongers 1988: 270 (Key to 5 species, including *A. ruricola*, in the genus *Achromadora*).

BIOLOGY

Feeding habit: Bacterivore (possibly also feeds on unicellular eucaryotes - diatoms or other algae): Yeates et al. 1993: 319; Goodey 1963: 360 (blue-green algae, green algae, diatoms).
c-p rating: 3: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Mulvey 1969: 365 (Canada - NT); Al-Banna & Gardner 1996: 974 (USA - CA).
Paleartic: de Man 1880: 1-104; de Man 1884: I-206; Gadea 1955: 77-104; Bongers 1988: 270 (Netherlands); Zullini & Peretti 1986: 403 (Italy); de Goede 1996: 228 (Netherlands); Ruess et al. 1996: 52 (Scotland: species considered as comparable to *A. ruricola*); Armendáriz et al. 1996: 566 (Spain).
Neotropical: Loof 1964b: 243 (Venezuela).
Ethiopian: Jacobs 1984: 272 (Tanzania, Kenya, Zaire).

HABITAT

Agroecosystems: Loof 1964b: 203; Al-Banna & Gardner 1996: 974 (California native grape, *Vitis californica*).
Forest: de Goede 1996: 228 (Scots pine forest); Ruess et al. 1996: 57 (natural and acidified soil in Sitka spruce forest: species considered as comparable to *A. ruricola*); Armendáriz et al. 1996: 561 (soil under *Pinus nigra*).
Tundra: Mulvey 1969: 370.
Misc.: Mulvey 1969: 370 (about roots of grass, wet humus, muck soil, wet and dry moss); Jacobs 1984: 272 (in pond, pools, temporal waters, lakes, phreatic water, psammon, marshy swampy soil and hygroscopic zone, thermal water and hot springs, on leafs and stems of water plants, among algae and mosses in water or near water in humid places); Zullini & Peretti 1986: 405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Bongers 1988: 271 (common in wet meadows and freshwater).

***Ethmolaimus pratensis* de Man, 1880**

Ethmolaimus pratensis de Man, 1880; de Man 1880: 1-104

Ethmolaimus tetricus von Daday, 1896; von Daday 1896: 402-415; Hirschmann 1952: 313-436

Chromadora revaliensis G. Schneider, 1906; G. Schneider 1906: 1-40; Hirschmann 1952: 313-436

Ethmolaimus revaliensis, T. Goodey 1963: 361

Ethmolaimus lemani Hofmänner, 1913; Hofmänner 1913: 635; Hirschmann 1952: 313-436

Chromadora foreli Hofmänner, 1913; Hofmänner 1913: 637; Micoletzky 1922a: 1-650

Ethmolaimus foreli, T. Goodey 1963: 361

Triodontolaimus alpinus Micoletzky, 1913; Micoletzky 1913: 111; Micoletzky 1922a: 1-650

Chromadora (Parachromadora) alpina, Micoletzky 1914: 492

Ethmolaimus americanus N. A. Cobb, 1914; N. A. Cobb 1914: 96; Hirschmann 1952: 313-436

Ethmolaimus gracilicaudatus N. A. Cobb in M. V. Cobb, 1915; M. V. Cobb 1915: 41; Micoletzky 1922a: 1-650

Ethmolaimus arcticus Steiner, 1916; Steiner 1916: 60; Hirschmann 1952: 313-436

Ethmolaimus maduei Micoletzky, 1922; Micoletzky 1922b: 556; Hirschmann 1952: 313-436

Order CHROMADORIDA

REMARKS

Bongers (1988: 271-272) placed *Ethmolaimus pratensis* de Man, 1880 in the family Ethmolaimidae Filipjev & Schuurmans Stekhoven, 1941; Jensen (1994: 8) regarded *E. pratensis* to be closely related to *E. parapratensis*, but also regarded the latter to be a good species.

DESCRIPTION

British Columbia Material

Fig. 12, after Goodey (1963: 361) and Bongers (1988: 272). This species was not identified from a particular key, but was determined by comparisons with published descriptions and illustrations of species in the genus *Ethmolaimus* from several sources, including Goodey (1963: 361), Bongers (1988: 272) and Jensen (1994: 3-4).

Other Descriptions

Female: Goodey 1963: 361; Mulvey 1969: 372; Bongers 1988: 272; 272, Fig. 51.1.1 (posterior part); Jensen 1994: 12, Fig. 8 C-D (anterior end: cephalic sense organs in three separate crowns; large amphids; a two part mouth cavity with a large dorsal tooth and two transverse flange-like subventral teeth; this dentation type separates *E. pratensis* from all other *Ethmolaimus* species); 12, Fig. 8 F (oesophageal region); 12, Fig. 8 G (tail region).

Male: Goodey 1963: 362; Bongers 1988: 272; 272, Fig. 51.1.1 (posterior part: spicules, ventral supplements); Jensen 1994: 4, Fig. 2 (left lateral view of head end, and tail end with copulatory apparatus); 12, Fig. 8 A-B (anterior end: features similar to female, as above); 12, Fig. 8 H (copulatory apparatus); 12, Fig. 8 I (whole body).

Larvae: Jensen 1994: 12, Fig. 8 E (anterior end: features similar to female, as above).

Misc.: Grassé 1965b: 637, Fig. 442 A-B (ventral and lateral aspect of anterior end); Bongers 1988: 272, Fig. 51.1.1 (anterior part, head end); Jensen 1994: 4, Fig. 2; (anterior end with cephalic sense organs in three separate crowns, large amphids, a two part mouth cavity with one dorsal and two subventral teeth); 9, Fig. 6 A (photograph of head end, lip region not set off).

IDENTIFICATION KEY

Jensen 1994: 4 (pictorial Key to 6 species of *Ethmolaimus*, including *E. pratensis*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 321 (possibly also feeds on unicellular eucaryotes - diatoms or other algae); Nielson 1949: 86 (natural populations always have bacteria in the gut).

c-p rating: 3: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Fisher 1968: 7 (cited in Esser & Buckingham 1987: N. America; Lake Champlain); Mulvey 1969: 365 (Canada - NT); Bongers 1988: 272 (North America).

Paleartic: Allgén 1925: 1-40 (Sweden); Bongers 1988: 272 (Europe; Netherlands); Háněl 2002: 188 (Czech Republic: Novohradské hory Mountains).

Ethiopian: Jacobs 1984: 272 (Kenya).

Oriental: Bongers 1988: 272 (Indonesia).

Cosmopolitan: Goodey 1963: 362.

HABITAT

Agroecosystems: Bongers 1988: 272 (meadow).

Forest: Háněl 2002: 188 (waterlogged climax spruce forest).
Misc.: Goodey 1963: 362 (moist meadow soil; in alpine lakes, freshwater and their sandy shores); Mulvey 1969: 373 (about roots of grass, wet humus soil, wet moss); Jacobs 1984: 272 (aquatic - lakes, phreatic water, psammon, on leafs and stems of water plants; non-aquatic - terrestrial, bryoedaphic and lichenedaphic, dunes, beaches, shores, decomposed plants, dry riverbeds and wells); Fisher 1968: 7 (lake); Bongers 1988: 272 (sandy shores).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 91 (Key to 3 genera, including *Ethmolaimus* de Man, 1880, in the subfamily Ethmolaiminae Filipjev & Stekhoven, 1941).
Misc.: Jensen 1994: 3, Fig. 1 (evolutionary trend towards a reduction of cephalic sense organs in *Ethmolaimus* species; the cephalic organs are most highly developed in *E. hirsutus*, *E. intermedius* and *E. pratensis*).

ORDER ENOPLIDA

Hooper 1978: 21 (abbreviated description of this order). Heip et al. 1982: 7; 30, Table 8 (systematics and ecology of free-living, marine Enoplia).

Suborder Enopolina

Family Tripylidae de Man, 1876

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 383), Heyns (1971: 127), Maggenti (1982: 884), Bongers (1988: 286). Brzeski & Winiszewska-Ślipińska 1993: 12-52 (review of the family Tripylidae).

***Tripyla affinis* de Man, 1880**

Tripyla affinis de Man, 1880; de Man 1880: 1-104

Tripyla papillata Bütschli, 1873; Bütschli 1873: 52; Micoletzky 1922a: 1-650

Tripyla tatica Stefański, 1924; Stefański 1924b: 539-553; Brzeski 1963: 309-315

REMARKS

(1) According to Tarjan and Hopper (1974), Micoletzky (1922a) synonymized *Tripyla papillata* Bütschli, 1873 with *Tripyla affinis* de Man, 1880, but gave no reason why the older name was not used. (2) Mulvey (1969: 376) discussed the genus *Tripyla* with reference to the earlier literature on validity of species, and synonymy at the generic and species levels, but did not mention *T. papillata*.

DESCRIPTION

British Columbia Material

Fig. 13, after Goodey (1963: 384). This species was identified by use of the keys in Bongers (1988: 287) and Brzeski & Winiszewska-Ślipińska (1993: 18). It agreed with the description in Goodey (1963: 384).

Other Descriptions

Female: Goodey 1963: 384; Mulvey 1969: 376, Figs. 18-20 (tail region, head region, *en face* view at level of lips); Southey 1978a: 257, Fig. 12.11 A (whole body); Bongers 1988: 287, Fig.

Order ENOPLIDA

62.1.1 (whole body in outline); Bussau 1990b: 205, Fig. 12 B, C (genital region; whole body); Brzeski & Winiszewska-Ślipińska 1993: 19-21, Table 1, Fig. 1 D-F (diagnostic morphology; morphometrics; vagina; tail region; spinneret).

Male: Goodey 1963: 384; Southey 1978a: 257, Fig. 12.11 C (posterior part with spicular apparatus); Bongers 1988: 287; Bussau 1990b: 205, Fig. 12 A, D, E (anterior region; tail region with spicules; detail of spicular apparatus); Brzeski & Winiszewska-Ślipińska 1993: 19-21, Table 1, Fig. 1 G (diagnostic morphology; morphometrics; spicular region).

Misc.: Brzeski 1964: 157-178 (revised the genus *Tripyla* and redescribed and illustrated all the previously described species); Wasilewska 1971: 660 (average body weight of female 1.413 µg); Southey 1978a: 257, Fig. 12.11 B (anterior part with head papillae); Bongers 1988: 287, Fig. 62.1.1 (anterior end in outline); Brzeski & Winiszewska-Ślipińska 1993: 19-21, Table 1, Fig. 1 A-C, F (diagnostic morphology; morphometrics; cardiac and anterior regions).

IDENTIFICATION KEY

Brzeski 1964: 157-178 (Key to 6 species, including *T. affinis* Bastian, 1865, in the genus *Tripyla*); Bongers 1988: 287 (Key to 5 species of *Tripyla*, including *T. affinis*); Brzeski & Winiszewska-Ślipińska 1993: 18 (Key to 17 species of *Tripyla*, including *T. affinis*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 323; Goodey 1963: 385 (on small nematodes).

c-p rating: 3: Bongers 1990: 15.

Misc.: Yeates 1973: 182 (population make-up: juveniles 63%, females 5%, gravid females 19%, males 14%); 184 (vertical distribution: 19% in litter, 81% below litter, to 6 cm soil depth); 184 (mean individual weight: 0.821 µg); Popovici 1984: 208 (mean individual wet mass of adults: 2.6826 µg).

DISTRIBUTION

Nearctic: Cobb 1915: 24 (USA - MI); Mulvey 1969: 376 (Canada - NT).

Paleartic: Goodey 1963: 385 (U. K.); Wasilewska 1970: 436 (Poland); Wasilewska 1971: 652 (Poland); Yeates 1972b: 179 (Denmark); Yeates 1973: 180 (Denmark); Popovici 1984: 205 (Romania); Bongers 1988: 287 (Netherlands); Arpin & Ponge 1986: 396, Table 1 (France); Bussau 1990a: 165 (Germany, Denmark); Brzeski & Winiszewska-Ślipińska 1993: 19 (Poland); Háněl 1999: 93, Table 1 (Czech Republic: Trojmezná hora Reserve); Háněl 2002: 188 (Czech Republic: Šumava Mountains).

Ethiopian: Jacobs 1984: 272 (Zaire).

Antarctic: Yeates 1970: 105 (Orkney Islands).

Cosmopolitan: Bongers 1988: 287.

HABITAT

Agroecosystems: Brzeski & Winiszewska-Ślipińska 1993: 19 (in wet soil habitats, especially meadow soils).

Forest: Wasilewska 1970: 436 (afforested dunes: found in four intermediate stages of six successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Wasilewska 1971: 652 (afforested dunes); Yeates 1972b: 181 (beech forest, *Fagus sylvatica* L.); Yeates 1973: 180 (beech forest); Popovici 1984: 205 (beech forest, Western Carpathians; 1300 m); Arpin & Ponge 1986: 396, Table 1 (oak and pine plantations); Háněl 1999: 93, Table 1 (spruce woodland); Háněl 2002: 188 (oligotrophic acid climax and eutrophic spruce forests).

Grasslands: Yeates 1970: 105 (maritime turf); Háněl 1999: 93, Table 1 (grassy upland).
Misc.: Cobb 1915: 26 (in sand and mud near creek bank and crayfish burrows; among moss in beach pool); Goodey 1963: 385 (loam soils); Mulvey 1969: 376 (wet and dry moss and grass roots); Jacobs 1984: 272 (aquatic - marshy, swampy, soil and hygropetric zone; non-aquatic - associated with moss, terrestrial); Bongers 1988: 287 (in terrestrial and fresh-water mosses); Bussau 1990a: 165 (rare in sandy beaches, but abundant in white dunes and their vegetational zone).

ADDITIONAL REFERENCES

Key: Bongers 1988: 286 (Key to 3 genera, including *Tripyla*, in the family Tripylididae de Man, 1876).

Family Ironidae de Man, 1876

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 388-389), Heyns (1971: 129), Bongers (1988: 280). Coomans & van der Heiden (1978) made a critical appraisal of the similarities and differences between the family Ironidae and the order Dorylaimida, and presented possible evolutionary pathways of the two taxa (p. 9, Fig. 1); they concluded that Ironidae are closely related to the Enoploidea and should be included in the order Enoplida.

***Cryptonchus tristis* (Ditlevsen, 1911)**

Cylindrolaimus tristis Ditlevsen, 1911; Ditlevsen 1911: 235

Ditlevsenia tristis, Micoletzky 1925: 57-310

Cryptonchus tristis, Filipjev 1934b: 1-63

Cryptonchus nudus N. A. Cobb, 1913; N. A. Cobb 1913: 441; T. Goodey 1963: 391

Gymnolaimus nudus, Timm, 1957: 4-10 [= *Cylindrolaimus abnormis* (Allgén, 1933: 312-320)]; Schuurmans Stekhoven 1951: 1-77

ADDITIONAL COMBINATION/SYNONYMY

Anderson (1968b: 941).

REMARKS

Anderson (1968b: 939) provided reasonable doubt concerning the position of the genus *Cryptonchus* in the family Ironidae. He, nevertheless, suggested that the genus be allowed to remain in the family Ironidae until certain features of the dorsal oesophageal gland were further resolved and other species were studied in more detail. Although Bongers (1988: 294) placed the genus *Cryptonchus* in the family Bathyodontidae Clark, 1961 (Clark 1961: 123-150), we have followed the suggestion of Anderson.

DESCRIPTION

British Columbia Material

Fig. 14, after Anderson (1968b: 938). This species was not identified from a particular key, but was determined by comparisons with published descriptions and illustrations of species in the genus *Cryptonchus* from several sources, as cited below. It agreed with the description in Anderson (1968b: 938).

Other Descriptions

Female: Anderson 1968b: 941; 936, Fig. 1 A-C (gravid female, posterior region, reproductive system); Bongers 1988: 295; 295, Fig. 64.2.1 (posterior region).

Male: Anderson 1968b: 942; 940, Fig. 3 A-D (reproductive system; posterior region showing tail, spicular region with copulatory glands; whole body); Bongers 1988: 295; 295, Fig. 64.2.1 (posterior region with spicular apparatus).

Misc.: Anderson 1968b: 938, Fig. 2 A-L (anterior region, including oesophageal-intestinal junction, and associated structures: longitudinal views and cross-sections); 940, Fig. 4 (Plate 1 A-D: photomicrographs of stoma and associated structures; laterodorsal view and cross-sections); Bongers 1988: 295, Fig. 64.2.1 (anterior region).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 320.

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Anderson 1968b: 935 (Canada - Sable Island, South-East of Halifax, NS).

Palearctic: Allgén 1925: 1-40 (Sweden); Bongers 1988: 295 (Europe, Japan).

HABITAT

Misc.: Anderson 1968b: 935 (pond on sandbar island in Atlantic Ocean, off NS, Canada).

Family Prismatolaimidae Micoletzky, 1922

Definitions, descriptions or diagnostic characteristics of this family: Maggenti (1982: 884), Bongers (1988: 278).

***Prismatolaimus intermedius* (Bütschli, 1873)**

Monhystera intermedius Bütschli, 1873; Bütschli 1873: 67

Prismatolaimus intermedius, de Man 1880: 1-104

Prismatolaimus hawaiiensis Cobb, 1906; Cobb 1906: 163-195; Micoletzky 1922a: 1-650

Prismatolaimus hsuei Wu & Hoepli, 1929; Wu & Hoepli 1929: 40; Andrassy 1960: 201-216

ADDITIONAL COMBINATION/SYNONYMY

Mulk & Coomans (1978b: 156, addendum).

DESCRIPTION

British Columbia Material

Fig. 15. This species was identified by use of the key and description in Bongers (1988: 278), and by comparisons with the descriptions and illustrations in Mulk & Coomans (1978b: 147).

Other Descriptions

Female: Mulvey 1969: 378; Mulk & Coomans 1978b: 147; 148, Fig. 1 A-E (tail, anterior end, amphid, oesophageal-intestinal junction, reproductive system); Bongers 1988: 279; 279, Fig. 58.1.2 (tail); Zeidan & Geraert 1990: 297-299; 297, Fig. 8 A-F (anterior end and esophageal region; *en face* view; genital system; tail region; entire body showing distribution of somatic setae); 298, Fig. 9 A-H (variation in cardia); 298, Fig. 9 I-P (tail region: variation in number and distribution of somatic setae, and in tailtip curvature).

Male: Bongers 1988: 279.

Misc.: Chitwood & Chitwood 1950: 73, Fig. 62 A (cephalic region, including *en face* view); Andrassy 1967b: 83 (the calculated average body-weight of adult females was 0.135 µg; for comparison, the calculated average body-weight for adult females of 50 free-living nematode species was 1.628 µg, with a range of 0.025-15.001µg); Bongers 1988: 279, Fig. 58.1.2 (anterior end).

IDENTIFICATION KEY

Bongers 1988: 278 (Key to 4 species, including *P. intermedius*, in the genus *Prismatolaimus* de Man, 1880).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 323.

c-p rating: 3: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Mulvey 1969: 378 (Canada - NT).

Palearctic: Wasilewska 1970: 436 (Poland); Arpin 1975: 494 (France); Zullini & Peretti 1986: 405 (Italy); Bongers 1988: 279 (Netherlands); Šály 1989: 48 (Czechoslovakia); Ruess & Funke 1992: 231 (Germany); Hodda & Wanless 1994: 116 (England); Ruess 1995: 107 (Germany); de Goede 1996: 228 (Netherlands); Ruess et al. 1996: 52 (Scotland); Háněl 1996: 15 (Czech Republic: Beskydy Mountains); Armendáriz et al. 1996: 566 (Spain); Alphei 1998: 10 (Germany); Háněl 1998: 37 (Czech Republic: South Moravia); Ruess et al. 1999: 514 (Sweden: northern Swedish Lapland).

Ethiopian: Mulk & Coomans 1978b: 145 (Kenya: Mount Kenya); Jacobs 1984: 274 (Zaire, Tanzania, Kenya); Zeidan & Geraert 1990: 299 (Sudan: Wadigalol).

Cosmopolitan: Bongers 1988: 279.

HABITAT

Agroecosystems: Šály 1989: 52 (herbicide-treated vineyards).

Forest: Wasilewska 1970: 436 (afforested dunes: found in all of six successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Arpin 1975: 501 (oak forest, with *Molinia* and *Polytrichum* spp.; acid soil, pH 3); Ruess & Funke 1992: 233 (spruce forest soil: natural and acidified); Ruess 1995: 110 (*Picea abies* stands); Ruess et al. 1996: 57 (natural and acidified soil in Sitka spruce forest); Háněl 1996: 19 (5 and 52 year old spruce forests); de Goede 1996: 228 (Scots pine forest); Armendáriz et al. 1996: 561 (*Pinus nigra* soil); Alphei 1998: 11 (beech forest: mull soils); Háněl 1998: 43 (oak-linden forest).

Grasslands: Hodda & Wanless 1994: 121 (chalk grasslands); Háněl 1998: 43 (floodplain meadow).

Tundra: Ruess et al. 1999: 515 (subalpine heath, elevation 450 m; soil type gelic gleysol with, well-developed humus layer; vegetation mainly dwarf shrubs).

Misc.: Mulvey 1969: 378 (wet humus soil and moss); Arpin 1975: 517 (park, with *Carpinus*, *Mercurialis* and *Hedera* spp.; calcareous soil, pH 8); Mulk & Coomans 1978b: 149 (rhizospheres of *Cheilanthes farinosa*, *Arachnoides foliosa*, *Polystichum setiferum*, *Asplenium monanthes*, *Lobelia keniensis* and *Senecio keniodendron*, at altitudes between 2600 m and 3985 m and humid conditions); Jacobs 1984: 274 (aquatic - rivers and streams, potamon, lakes, phreatic water, psammon, marshy, swampy soil and hygroscopic zone, on leafs and stems of water plants, humid places; non-aquatic - associated with higher plants, terrestrial); Zullini & Peretti 1986:

Order DORYLAIMIDA

405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Zeidan & Geraert 1990: 299 (fresh-water pool).

ADDITIONAL REFERENCES

Key: Heyns 1971: 125 (Key to 2 genera, including *Prismatolaimus*, in the family Monhysteridae).

ORDER DORYLAIMIDA

General morphological characteristics of dorylaims in general: Thorne & Swanger (1936), Thorne (1939), Tjepkema et al. (1971), Jairajpuri & Ahmad (1992). Hooper 1978: 21 (abbreviated description of this order); Anderson & Mulvey 1979: 19, 31 (Key to 4 genera of plant-parasitic nematodes in Canada in this order); Siddiqi 1983: 119-123, Fig. 3 (evolutionary trends in the structure and development of the odontostylet in this order, in relation to its gradual attenuation and giving rise to the plant-parasitic type of odontostylet; the evolutionary lines shown are for the dorylaimoid, the longideroid and the tylencholaimoid types of plant-feeding odontostylets).

Suborder Dorylaimina

Thorne 1960: 226 (Key to 21 genera in the superfamily Dorylaimoidea, including 10 of the genera listed below under this order); Siddiqi 1969: 89-92 (on superfamily Dorylaimoidea: revised classification with 6 families; diagnosis for genera within 12 dorylaimid groups, based on morphological characteristics pertaining to body wall, lip region, spear, spear extension, oesophagus, intestine, spicules; emended diagnosis of superfamily Dorylaimoidea); Hooper 1978: 21 (abbreviated description of this suborder); Geraert 1983: 79-81, Fig. 3 (female reproductive system in this suborder; structure of female genital system useful in elucidating the systematic position of some genera or families).

Family Dorylaimidae de Man, 1876

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 395), Heyns (1971: 139), Maggenti (1982: 888), Bongers (1988: 309), Jairajpuri & Ahmad (1992: 71).

***Discolaimus* sp.**

REMARKS

Bongers (1988: 359, 362) placed the genus *Discolaimus* Cobb, 1913 in the family Discolaimidae Siddiqi, 1969), as is also done in Section 6 herein.

DESCRIPTION

British Columbia Material

Fig. 16, after Heyns (1971: 152) and Jairajpuri & Ahmad (1992: 158). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Heyns (1971: 153), Bongers (1988: 359) and Jairajpuri & Ahmad (1992: 156). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 415 (the type species for the genus is *D. texanus* Cobb, 1913); 415 (in place of the type species, an account of *D. major* Thorne, 1939 is given); 416, Fig. 229 A-D (oesophageal region, anterior end, *en face* view, and female tail of *D. major*).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 320.

c-p rating: 4: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Thorne 1939: 44 (Key to 5 species in the genus *Discolaimus* Cobb, 1913); Hopper & Cairns 1959: 140 (Key to 7 species in the genus *Discolaimus*); Heyns 1971: 153 (Key to 3 genera, including *Discolaimus*, in the subfamily *Discolaiminae* in the family *Dorylaimidae*); Thorne 1974: 67 (Key to 3 species of *Discolaimus* from the Northern Great Plains, USA); Bongers 1988: 359 (Key to 3 genera, including *Discolaimus*, and 1 species in the family *Discolaimidae*); Jairajpuri & Ahmad 1992: 156 (Key to 5 genera, including *Discolaimus*, in the subfamily *Discolaiminae*; diagnosis of the genus *Discolaimus*).

Morphology: Coomans 1964: 603, Figs. 2-3 (structure of female gonads of *Discolaimus* sp.); Yeates 1972a: 345, Fig. 2 Q (oesophageal-intestinal junction of *Discolaimus* sp.).

Misc.: Goodey 1963: 415 (diagnostic characters of the genus *Discolaimus*); Bongers 1988: 362 (diagnostic characters of the genus *Discolaimus*).

***Dorylaimus helveticus* Steiner, 1919**

Dorylaimus fecundus N. A. Cobb, 1914; N. A. Cobb, 1914: 88

Dorylaimus fecundus subsp. *helveticus* Steiner, 1919 [new rank]; Steiner 1919: 167

Dorylaimus helveticus, Thorne & Swanger 1936: 42

ADDITIONAL COMBINATION/SYNONYMY

Andrássy (1958c: 1-362).

REMARKS

According to Tarjan & Hooper (1974: 98), Cobb (1914) described another species with the trinomen *Dorylaimus stagnalis fecundus*, a synonym of *Dorylaimus fecundus*, and this may have necessitated the creation of the new name, *D. helveticus*, for the latter species.

DESCRIPTION**British Columbia Material**

Fig. 17, after Thorne & Swanger (1936: 171). This species was identified by use of the keys in Thorne & Swanger (1936: 17) and Hopper & Cairns (1959: 144), and it agreed with the description in the former reference.

Other Descriptions

Female: Thorne & Swanger 1936: 42.

Male: Thorne & Swanger 1936: 42; 171, Fig. 28 D (posterior region, spicules, supplements); 171, Fig. 28 A (cross section through supplements).

Misc.: Thorne & Swanger 1936: 171, Fig. 28 (head end with stomal structures); 171, Fig. 28 B-C (cross sections through mid-body and near nerve ring).

Order DORYLAIMIDA

IDENTIFICATION KEY

Thorne & Swanger 1936: 17 (Key to 185 species, including *D. helveticus*, in the genus *Dorylaimus* Dujardin, 1845.); Hopper & Cairns 1959: 144 (Key to 186 species, including *D. helveticus*, in the genus *Dorylaimus*).

BIOLOGY

Feeding habit: Omnivore: Yeates et al. 1993: 320.

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Thorne & Swanger 1936: 43 (Canada - ON; USA - MT).

Paleartic: Thorne & Swanger 1936: 43 (Switzerland, Russia).

HABITAT

Misc.: Thorne & Swanger 1936: 43 (aquatic: among moss and algae).

MISC. INFORMATION

Morphology: Grassé 1965a: 59, Fig. 80 A-B (transverse sections showing longitudinal ridges, pre-anal papillae of male).

ADDITIONAL REFERENCES

Key: Heyns 1971: 141 (Key to 10 genera, including *Dorylaimus*, in the subfamily Dorylaiminae in the family Dorylaimidae).

Description: Bongers 1988: 309 (brief description of the family Dorylaimidae de Man, 1876 and the genus *Dorylaimus* Dujardin, 1845).

Morphology: Siddiqi 1969: 91, Fig. 4 Q (oesophageal-intestinal junction in juvenile of *Dorylaimus* sp.).

***Labronema thornei* Ferris, 1968**

Labronema thornei Ferris, 1968; Ferris 1968: 280

DESCRIPTION

British Columbia Material

Fig. 18, after Ferris (1968: 282). This species was not identified from a particular key, but was determined by comparisons with published descriptions and illustrations of species in the genus *Labronema* from several sources, including Thorne (1939: 23, 26) and Ferris (1968: 280). Since Ferris (1968: 283) considered *L. thornei* to be close to *L. uniforme* Thorne 1939, the identification key in Thorne (1939: 23) for species of *Labronema*, including *L. uniforme*, facilitated the identification.

Other Descriptions

Female: Ferris 1968: 281, Table 1 (morphometrics; descriptions of various body regions and structures); 282, Fig. 5 K-L (tail, head end).

Larvae: Ferris 1968: 281, Table 1 (morphometrics of larval stages L1-L4); 282, Fig. 5 G-J (tails of larval stages L1-L4).

BIOLOGY

Feeding habit: Omnivore or predator: Yeates et al. 1993: 321; 318 (animal predation by sucking body fluids through the stylet). Predator: Small 1987: 192 (nematophagus: feeding on rhabditids and cephalobids).

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Ferris 1968: 283 (USA - IN).

HABITAT

Misc.: Ferris 1968: 283 (muddy stream bed in wooded area).

ADDITIONAL REFERENCES

Key: Thorne 1939: 23 (Key to 9 species in the genus *Labronema* Thorne, 1939); Hopper & Cairns 1959: 142 (Key to 10 species in the genus *Labronema*); Heyns 1971: 141 (Key to 10 genera, including *Labronema*, in the subfamily Dorylaiminae in the family Dorylaimidae); Thorne 1974, 62 (Key to 4 species in the genus *Labronema* from the Northern Great Plains, USA); Bongers 1988: 324 (Key to genera and species in the family Qudsianematidae Jairajpuri, 1965, including the genus *Labronema*; Jairajpuri & Ahmad 1992: 126 (Key to 15 genera, including *Labronema*, in the subfamily Qudsianematinae)).

Description: Bongers 1988: 336 (description of the genus *Labronema*).

Morphology: Coomans 1964: 606, Fig. 4 (structure of female gonad of *Labronema* sp.); Geraert et al. 1980: 264; 265, Fig. 6 (structure of female reproductive system of *Labronema* sp.).

***Pungentus* sp.**

DESCRIPTION

British Columbia Material

Fig. 19, after Thorne & Swanger (1936: 171). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Heyns (1971: 141), Bongers (1988: 324) and Jairajpuri & Ahmad (1992: 175). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 413 (the type species for this genus is *P. pungens* Thorne & Swanger, 1936); 413 (in place of the type species, *P. thornei* T. Goodey, 1943 is described); 413-414, Fig. 228 A-F (description; anterior body region up to vulval area, anterior end, *en face* view, female tail end, and lateral and ventral views of vulva of *P. thornei*).

BIOLOGY

Feeding habit: Plant-parasitic: Yeates et al. 1993: 323; 317 (ectoparasite on plants); 323 (also considered as feeding by animal predation and omnivory).

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Paleartic: Hansson et al. 1990: 41-83 (Sweden).

HABITAT

Agroecosystem: Hansson et al. 1990: 41-83.

ADDITIONAL REFERENCES

Key: Thorne & Swanger 1936: 134 (Key to 3 species in the genus *Pungentus* Thorne & Swanger 1936); Thorne 1939: 50 (Key to 11 species in the genus *Pungentus*); Hopper & Cairns 1959: 139 (Key to 12 species in the genus *Pungentus*); Heyns 1971: 141 (Key to 10 genera, including *Pungentus*, in the subfamily Dorylaiminae in the family Dorylaimidae); Bongers 1988: 324 (Key

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to 4 genera, including *Pungentus*, in the family Nordiidae Jairajpuri & Siddiqi, 1964); 322 (Key to 3 species in the genus *Pungentus*); Jairajpuri & Ahmad 1992: 175 (Key to 7 genera, including *Pungentus*, in the subfamily Pungentinae).

Morphology: Yeates 1972a: 345, Fig. 2 P (oesophageal-intestinal junction in *Pungentus* sp.); Geraert et al. 1980: 260; 263, Fig. 6 (structure of female reproductive system).

Misc.: Goodey 1963: 413 (diagnostic characters of the genus *Pungentus*); Bongers 1988: 321 (diagnostic characters of the genus *Pungentus*).

***Tylencholaimus* sp.**

DESCRIPTION

British Columbia Material

Fig. 20. The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Heyns (1971: 163), Bongers (1988: 363) and Jairajpuri & Ahmad (1992: 302). The following information relates mostly to the genus. Note: In Section 6, this genus is placed under Tylencholamidae as per Jairajpuri & Ahmad (1992: 301).

Other Descriptions

Misc.: Goodey 1963: 439 (the type species for this genus is *T. mirabilis* (Bütschili, 1873) de Man, 1876); 439 (in the place of the type species, *T. teres* Thorne, 1939 is described); 439-441, Fig. 247 A-C (description; anterior end, female tail, male tail region of *T. teres*).

BIOLOGY

Feeding habit: Fungivore: Yeates et al. 1993: 324.

c-p rating: 4: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Thorne 1939: 55 (Key to 10 species of *Tylencholaimus*); Hopper & Cairns 1959: 157 (Key to 13 species in the genus *Tylencholaimus*); Heyns 1971: 163 (Key to 3 genera, including *Tylencholaimus*, in the family Dorylaimidae); Thorne 1974: 91 (Key to 3 species of *Tylencholaimus* subfamily Tylencholaiminae from the Northern Great Plains, USA); Bongers 1988: 363 (Key to 7 genera, including *Tylencholaimus*, in the family Leptonchidae); Jairajpuri & Ahmad 1992: 302 (Key to 8 genera, including *Tylencholaimus*, in the subfamily Tylencholaiminae); 304 (Key to 7 subgenera, including *T. (Tylencholaimus)* in the genus *Tylencholaimus*); Santiago & Coomans 1996b: 446-449 (Keys to 9 didelphic, 30 prodelphic and 3 opisthodelphic species of *Tylencholaimus*); 450 (diagnosis of subfamily Tylencholaiminae).

Taxonomy: Santiago & Coomans 1994a: 32-68 (revision of 10 didelphic species in the genus *Tylencholaimus*); Santiago & Coomans 1994b: 157-185 (revision of 7 prodelphic species of *Tylencholaimus*); Santiago & Coomans 1994c: 186-213 (revision of 8 prodelphic species of *Tylencholaimus*); Santiago & Coomans 1994d: 348-368 (revision of 6 prodelphic species of *Tylencholaimus*); Santiago & Coomans 1996a: 417-439 (revision of 2 prodelphic and 3 opisthodelphic species of *Tylencholaimus*).

Misc.: Goodey 1963: 439 (diagnostic characters of the genus *Tylencholaimus* de Man, 1876); Bongers 1988: 368 (diagnostic characters of the genus *Tylencholaimus*); Santiago & Coomans 1996b: 440-454 (morphology, taxonomy, intrageneric relationships, etc. of *Tylencholaimus* species; includes Key to species, see above).

Family Aporcelaimidae Heyns, 1965

Definitions, descriptions or diagnostic characteristics of this family: Heyns (1971: 173), Bongers (1988: 337), Jairajpuri & Ahmad (1992: 105).

***Aporcelaimellus obscurus* (Thorne & Swanger, 1936)**

Dorylaimus obscurus Thorne & Swanger, 1936; Thorne & Swanger 1936: 112

Eudorylaimus obscurus, Andrassy, 1959: 191-240

Aporcelaimus obscurus, J. B. Goodey, 1961: 101-106

Aporcelaimellus obscurus, Heyns 1966: 1-51

Dorylaimus obtusicaudatus of Thorne 1927; Thorne & Swanger 1936: 118; T. Goodey 1963: 420

DESCRIPTION

British Columbia Material

Fig. 21, after Southey (1978b: 261). This species was identified by use of the key in Thorne (1974: 12), and by comparisons with published descriptions and illustrations from several sources, as cited below. It agreed with the description in Southey (1978b: 261).

Other Descriptions

Female: Tjepkema et al. 1971: 40-43; 42, Fig. 13 A-H (variations in lip shape and tails; vulval region); Thorne 1974: 12-14, Fig. 4 A-B, E-N (head end, amphid; tail; oesophagus, oesophageal gland nuclei; vagina, vulva; cardiac region, variation in tail); Southey 1978a: 261, Fig. 12.14 (anterior end; whole body); Ahmad & Jairajpuri 1982: 53; Jairajpuri & Ahmad 1992: 110, Fig. 37 L (tail end).

Male: Tjepkema et al. 1971: 40; Thorne 1974: 12-13, Fig. 4 C-D (tail, spicules, supplements); Southey 1978a: 261, Fig. 12.14 (tail); Jairajpuri & Ahmad 1992: 110, Fig. 37 M (posterior end).

Egg: Thorne 1974: 12 (size variation).

Misc.: Tjepkema et al. 1971: 41, Table 9 (morphometric and other characteristics of 20 species of *Aporcelaimellus*, including *A. obscurus*, from their original descriptions; includes males for *A. obscurus* and 9 other species); Jairajpuri & Ahmad 1992: 111, Fig. 37 G, I-K (anterior end; oesophageal-intestinal junction).

IDENTIFICATION KEY

Thorne 1974: 12 (Key to 11 species, including *A. obscurus*, in the genus *Aporcelaimellus*).

BIOLOGY

Feeding habit: Omnivorous or Predator: Yeates et al. 1993: 319; Tjepkema et al. 1971:38 (on the nematode *Panagrellus redivivus* by puncturing the prey and sucking out body fluids); Small 1987: 190 (preys on eggs of the plant-parasitic nematode *Heterodera schachtii*).

c-p rating: 5: Bongers 1990: 15.

Culture: Ferris & Ferris 1989: 312, Table 2 (the Indiana isolate of *A. obscurus* reproduced in agar cultures while feeding on nematodes, mites, and enchytraeid egg capsules, but not on algae or protozoa; other isolates maintained on the nematode *Panagrellus redivivus*).

Misc.: Webster 1972: 479 (citing Tjepkema 1969: 29: a mermithid nematode was found parasitizing and killing over one-third of a population of *A. obscurus* females and larvae).

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DISTRIBUTION

Nearctic: Tjepkema et al. 1971: 40 (USA - IN, UT); Johnson et al. 1972: 178 (USA - IN); Johnson et al. 1974: 123, 119, Table 1 (USA - IN); Thorne 1974: 5 (USA - Northern Great Plains: ND, SD, NE, MT); Baird & Bernard 1984: 383 (USA - TN); Esser & Buckingham 1987: 482 (North America); Al-Banna & Gardner 1996: 974 (USA - CA).

Palearctic: Arpin 1975: 501 (France); Sohlenius & Wasilewska 1984: 328 (Sweden); Zullini & Peretti 1986: 403 (Italy); Šály 1989: 48 (Czechoslovakia); Hodda & Wanless 1994: 116 (England); Ruess et al. 1996: 52 (Scotland); Háněl 1996: 15 (Czech Republic: Beskydy Mountains); Háněl 1998: 44 (Czech Republic: South Moravia).

Oriental: Ahmad & Jairajpuri 1982: 54 (India - Uttar Pradesh).

HABITAT

Agroecosystem: Tjepkema et al. 1971: 40 (beet field); Ahmad & Jairajpuri 1982: 54 (around roots of wheat, *Triticum vulgare* L.); Baird & Bernard 1984: 380 (soybean-wheat crops); Šály 1989: 52 (*A. obtusicaudatus* = *A. obscurus* in soil of herbicide-treated vineyards); Al-Banna & Gardner 1996: 974 (*A. obtusicaudatus* = *A. obscurus* in soil from California native grape, *Vitis californica*).

Forest: Johnson et al. 1972: 176 (various types of woodlot sites: with one or more tree species from sugar maple, beech, oak, black locust, white oak, silver maple, cottonwood; natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Johnson et al. 1974: 123; 119, Table 1 (mixed tree woodlot site, grazed by livestock; soil type Brookston silt loam; very poorly drained); Arpin 1975: 494 (oak forest, with *Molinia* sp. and moss layer of *Polytrichum* sp.; acid soil, pH 3); Sohlenius & Wasilewska 1984: 335 (natural, irrigated and/or fertilized Scots pine forest); Ruess et al. 1996: 53 (*A. obtusicaudatus* = *A. obscurus* from natural and acidified soil in Sitka spruce forest); Háněl 1998: 44 (*A. obtusicaudatus* = *A. obscurus* from flood-plain forests: oak-linden and linden-oak and hornbeam-linden; thermophilus oak forest).

Grassland: Hodda & Wanless 1994: 123, Table 1 (*A. obtusicaudatus* = *A. obscurus* from chalk grassland soil; soil pH 7.5); Háněl 1996: 19 (*A. obtusicaudatus* = *A. obscurus* from 5 to 134 year old spruce forests).

Misc.: Tjepkema et al. 1971: 42 (common in soil in wooded, shrubby and grassy areas; beet field); Thorne 1974: 14 (the most common dorylaimoid species in soils of the Northern Great Plains of USA); Arpin 1975: 516 (park, with *Carpinus*, *Mercurialis* and *Hedera* species; calcareous soil, pH 8); Johnson et al. 1974: 123 (one of two dominant, dorylaimid species at the site); Zullini & Peretti 1986: 405 (*A. obtusicaudatus* = *A. obscurus* from mosses on walls in industrial area with high lead pollution of atmospheric origin); Esser & Buckingham 1987: 482 (aquatic: stream); Háněl 1998: 44 (*A. obtusicaudatus* = *A. obscurus* from flood-plain meadows with different associations of vegetation).

MISC. INFORMATION

Morphology: Lippens et al. 1974: 242-256 (ultrastructure of anterior region of *Aporcelaimellus* based on two species, including *A. obscurus*: body wall; feeding apparatus and its musculature; nervous system); Thorne 1974: 14 (comment: variation in body length and egg size of *A. obscurus* may confuse the worker to establish several subspecies, but examination of a large number of specimens will show overlap of various other morphological characters to the extent that it will become difficult to separate them).

ADDITIONAL REFERENCES

Tjepkema et al. 1971: 38-39 (review of the genus *Aporcelaimellus*; differentiation of *Aporcelaimellus* from the genus *Eudorylaimus*).

Aporcelaimellus* sp.*REMARKS**

Thorne (1974: 12) amended the diagnosis of Heyns (1971: 147-149) for the genus *Aporcelaimellus* as follows: vulva a transverse slit, not pore-like; cuticle often without two thick, prominent layers on tail; cardiac disc present, not absent.

DESCRIPTION**British Columbia Material**

Fig. 22, after Ahmad & Jairajpuri (1982: 57). The British Columbia specimens could not be identified to the species level by use of the available keys. They were identified to genus by use of the keys in (Heyns 1971: 141), Bongers (1988: 337) and Jairajpuri & Ahmad (1992: 108). The following information relates mostly to the genus.

Other Descriptions

Misc.: Jairajpuri & Ahmad 1992: 111 (the type species for this genus is *A. obscurus* (Thorne & Swanger, 1936) Heyns, 1965); see *A. obscurus* in this catalogue.

BIOLOGY

Feeding habit: Omnivorous or Predator: Yeates et al. 1993: 319.

c-p rating: 5: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Heyns 1971: 141 (Key to 10 genera, including *Aporcelaimellus* Heyns, 1965, in the subfamily Dorylaiminae of the family Dorylaimidae de Man, 1876); Thorne 1974: 12 (Key to 11 species of *Aporcelaimellus* from the Northern Great Plains, USA); Bongers 1988: 337 (Key to 6 genera in the family Aporcelaimidae Heyns, 1965; 338 (Key to 4 species in the genus *Aporcelaimellus*); Jairajpuri & Ahmad 1992: 108 (Key to 9 genera, including *Aporcelaimellus*, in the subfamily Aporcelaiminae).

Taxonomy: Tjepkema et al. 1971: 38-39 (review of the genus *Aporcelaimellus*; differentiation of *Aporcelaimellus* from the genus *Eudorylaimus*).

Morphology: Geraert et al. 1980: 260; 263, Fig. 6 (structure of female reproductive system); von Bussau 1991: 54-55; 54, Fig. 11 A-D (female anterior end, amphid, spear, and labial and cephalic structures; reproductive system; tail region; whole body in outline); 54, Fig. 11 E-G (male posterior region, spicules and supplements; spicular apparatus; whole body in outline). *Misc.:* Bongers 1988: 338 (diagnostic characters of genus *Aporcelaimellus* Heyns, 1965).

Family Nygolaimidae Thorne, 1935

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 466), Heyns (1971: 195), Maggenti (1982: 892), Bongers (1988: 304), Jairajpuri & Ahmad (1992: 377).

***Nygolaimus aquaticus* Thorne, 1930**

Nygolaimus (*Nygolaimus*) *aquaticus* Thorne, 1930; Thorne 1930: 456

Nygolaimus aquaticus, Thorne 1939: 97

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DESCRIPTION

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Fig. 23, after Thorne (1939: 222). This species was identified by use of the keys in Thorne (1939: 91), Hopper & Cairns (1959: 127) and Bongers (1988: 305-306), and it agreed with the description in Thorne (1939: 222).

Other Descriptions

Female: Thorne 1939: 97; Goodey 1963: 468; Bongers 1988: 306, Fig. 67.3.2 (tail end).

Male: Thorne 1939: 97, 223, Fig. 125 C (posterior region); Goodey 1963: 468; 467, Fig. 263 D (posterior end); Bongers 1988: 306, Fig. 67.3.2 (posterior end, spicule).

Misc.: Thorne 1939: 223, Fig. 125 A-B (anterior part, and head end with stylet partly or fully extruded); Goodey 1963: 467, Fig. 263 A-C (anterior end, mural stylet); Bongers 1988: 306, Fig. 67.3.2 (anterior part).

IDENTIFICATION KEY

Thorne 1939: 91 (Key to 22 species, including *N. aquaticus*, in the genus *Nygolaimus* Cobb, 1913); Hopper & Cairns 1959: 127 (Key to 29 species, including *N. aquaticus*, in the genus *Nygolaimus*); Bongers 1988: 305-306 (Key to 11 species for females, including *N. aquaticus*, and 6 species for males in the genus *Nygolaimus* Thorne, 1930).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 322; Goodey 1963: 469 (feeds on small oligochaetes; their setae seen in intestinal contents); Thorne 1939: 97 (on oligochaetes of the family Naididae).

c-p rating: 5: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Thorne 1939: 97 (Canada - Lake Nipigon, ON; USA - UT, VA).

Palearctic: Bongers 1988: 306 (Netherlands).

HABITAT

Misc.: Thorne 1939: 97 (lakes: at elevations of 4,750 and 8,500 feet); Goodey 1963: 469 (in freshwater and soil; more prevalent in light sandy soils than in heavy ones); Bongers 1988: 306 (a typical freshwater dweller).

ADDITIONAL REFERENCES

Key: Heyns 1971: 195 (Key to 2 families, including Nygolaimidae, and 2 genera, including *Nygolaimus* Cobb, 1913, in the superfamily Nygolaimoidea); Thorne 1974: 75 (Key to 10 species in the genus *Nygolaimus* from the Northern Great Plains, USA); Bongers 1988: 304 (Key to 4 genera, including *Nygolaimus*, in the family Nygolaimidae Thorne, 1935); Jairajpuri & Ahmad 1992: 378 (Key to 7 genera, including *Nygolaimus*, in the subfamily Nygolaiminae).

Morphology: Coomans 1964: 602, Fig. 1 (structure of female gonad of *Nygolaimus* sp.).

Family Longidoridae Thorne, 1935

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 438), Heyns (1971: 165), Maggenti (1982: 888), Bongers (1988: 343), Jairajpuri & Ahmad (1992: 229).

***Xiphinema bakeri* Williams, 1961**

Xiphinema bakeri Williams, 1961; Williams 1961: 407

REMARKS

Stegaresku (1980: 50) placed *X. bakeri* in one of 10 groups based on the degree of reduction of the anterior reproductive tract as compared to the complete posterior tract; the *X. bakeri* group was characterized by *X. setariae*, and the other species placed in this group were *X. basiri*, *X. ifacolum*, *X. meridianum*, *X. sahelense* and *X. vulgare*.

DESCRIPTION

British Columbia Material

Fig. 24, after Williams (1961: 408). This species was identified by use of the key in Loof & Maas (1972: 114), and it agreed with the description in Williams (1961: 408). Identification was facilitated by comparisons with the descriptions and illustrations in several other sources as cited below.

Other Descriptions

Female: Williams 1961: 407 (morphometric data); 408, Fig. 1 A-B, E-F (head and oesophageal region; tail region; whole body anatomy; reproductive system); Sutherland et al. 1970: 771, Table 1 (morphometric data); Figs. 13-15 (tail ends); Hooper & Southey 1978b: 226 (morphometrics).

Male: Williams 1961: 410 (morphometric data); 408, Fig. 1 C-D (tail region; spicules); Sutherland et al. 1970: 771, Table 1 (morphometric data); Fig. 16 (tail end).

Larvae: Williams 1961: 411 (morphometric data); Sutherland et al. 1970: 771, Table 1 (morphometric data for 4 larval or juvenile stages, J1-J4); Figs. 1-12 (posterior regions); Fig. 17 (newly emerged J1 with replacement stylet overlapping the stylet extension); Robbins et al. 1991: 166 (larval or juvenile stage J4 reported in the species description).

Egg: Sutherland 1969: 1964 (size 175 μ x 46 μ).

IDENTIFICATION KEY

Loof & Maas 1972: 114 (Key to 61 species, including *X. bakeri*, in the genus *Xiphinema*).

BIOLOGY

Feeding habit: Plant-parasitic: Yeates et al. 1993: 324; 317 (ectoparasite on plants); Sutherland 1969: 1963-1965, Figs. 1-6 (feeding *in vitro* on roots of seedlings of 5 coniferous species; fed mainly on root tips, preferably those of Douglas-fir and Sitka spruce seedlings; mechanism and behaviour of feeding; all life stages, except first larval stage, were feeding); Webster 1972: 354, 358 (feeds at the root tips of strawberry and raspberry plants causing stunting, swelling and curling of the tips).

c-p rating: 5: Bongers 1990: 15.

Misc.: Sutherland 1969: 1964 (evidence for development of egg in winter months, and egg-laying in spring and early summer; gravid females contain 2-3 eggs; larvae emerge 10-14 days after eggs are laid); Sutherland 1970: 589, Figs. 1-6 (population changes over a year, in all developmental stages including gravid females, of *X. bakeri* in the soil planted with seedling monocultures of several coniferous species); Sutherland & Ross 1971: 277, Table 1 (temperature effects on survival: populations of *X. bakeri* in naturally-infested soils increased in the first month of storage at temperatures of 5° C intervals from 0° C to 30° C, then generally declined over the next several months; concurrently, the populations trended toward a gradual

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decline in numbers of the earlier larval stages, L1-L2, and a gradual increase in numbers of the later stages, L4 and adult females; eggs, larvae, and adults were killed by storage at -18° C for 48 hr or at -34° C for 12 hr; it was concluded that low soil temperatures may be the reason for the restricted distribution of the nematode in the warmer coastal areas of B.C.); Sutherland & Slugget 1973: 299-303 (relationships between density of *X. bakeri* populations in soil and severity of symptoms of corky root disease in Douglas-fir seedlings; higher populations adversely affected epicotyl length, the number of first-order lateral roots, tissue nutrients, and chlorophyll content; corky root soil was less fertile than non-corky root soil); Sutherland & Slugget 1974: 507-513 (survival of *X. bakeri* in fallow soil stored under various combinations of temperature, soil moisture tension and time: survival was best, for the entire 32-week storage period, at 4° C and pF 2.4; survival at 30° C and pF 4.2 was 90% after 4 weeks, but reduced to 10% after 8 weeks; a shift in population composition from early to late developmental stages with increasing storage time, temperature and soil moisture tension followed the pattern noted above; see Sutherland & Ross 1971); Sutherland 1974: 177, Fig. 1 (in all seasons, over 90% *X. bakeri* were found in the upper 20 cm of soil, the only soil zone with roots, in nursery seedbeds of Douglas-fir; the ratio of "L4+total females" to "L1+L2+L3" increased from spring to winter, and most gravid females were found in winter); Maggenti & Viglierchio 1975: 116-119 (infectivity to nursery seedlings: *X. bakeri* maintained itself and reproduced on seedlings of giant sequoia and coast redwood under laboratory conditions); Viglierchio & Maggenti 1975: 327 (susceptibility of conifer seedlings: under greenhouse conditions, seedlings of seven conifer species were susceptible to attack by *X. bakeri*).

DISTRIBUTION

Nearctic: Williams 1961: 407 (Canada - BC: South Fraser River Valley); Sutherland & Dunn 1970: 166 (Canada - BC); Sutherland et al. 1970: 771 (Canada - BC); Johnson et al. 1972: 178 (USA - IN); Maggenti & Viglierchio 1975: 117 (USA - CA); Viglierchio & Maggenti 1975: 326 (USA - CA); Hooper & Southey 1978b: 226 (Canada - BC); SON 1984: 8-9, Fig. 4 (Canada - BC; USA - WA, OR, CA, IA, IL, IN, KY, TN, AR, FL; includes list of host plants and references to literature); Lownsbery & Lownsbery 1985: 13 (USA - CA: Sierra, Inyo and North Coast floristic zones); Robbins & Brown 1991: 401 (Canada - BC; USA - AR, CA, FL, IA, IL, IN, KY, OR, TN, WA).

HABITAT

Agroecosystem: Williams 1961: 412 (soil around roots of raspberry plants); Hooper & Southey 1978b: 226 (in soil around raspberry and strawberry trees).

Forest: Sutherland & Dunn 1970: 166 (around roots of nursery seedlings of Douglas-fir, Sitka spruce and Western hemlock); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Maggenti & Viglierchio 1975: 117 (in soil of nursery seedlings of giant sequoia and coast redwood); Viglierchio & Maggenti 1975: 326 (in soil of conifer seedling nursery); Hooper & Southey 1978b: 226 (in soil around coniferous trees); Lownsbery & Lownsbery 1985: 13 (associated with Ponderosa pine, Fremont cottonwood, Quaking aspen and Coast redwood); Robbins & Brown 1991: 401 (wide host range, but mainly associated with forest trees).

Misc.: Sutherland et al. 1970: 771 (seedbeds of Douglas-fir nurseries); SON 1984: 8 (this species is found only in loam soils).

MISC. INFORMATION

Economic importance: Sutherland 1969: 1965 (root tip feeding by *X. bakeri* causes symptoms typical of corky root disease of Douglas-fir seedlings); Sutherland & Dunn 1970: 165-168 (large populations of *X. bakeri* are consistently associated with corky root disease of Douglas-fir seedlings); Webster 1972: 354 (in Canada, causes disease of strawberry plantations; in greenhouse tests, *X. bakeri* increased four-fold in 12 weeks and destroyed the root system of 50% of test plants); Iwaki & Komuro 1974: 344-353 (reported *X. bakeri* as being capable of acquiring and transmitting *Arabis* mosaic nepovirus in laboratory experiments); Dropkin 1980: 198, Fig. 8.5 (causes strawberry root malformation by galling, irreversible stunting, and typical swelling and "fish-hook" curling of roots).

Misc.: Adams 1955: 477-479 (noticed that with treatment of orchard soil with the nematicide hexachlorobenzene, the population of *Xiphinema* sp. in soil decreased while growth of young peach and apple trees increased; Webster 1972: 324 (chemical control of *X. bakeri* associated with Douglas-fir seedlings in forest nurseries, by soil fumigation using 1,3-dichloropropene-propane mixture - DD, Vidden D).

ADDITIONAL REFERENCES

Key: Thorne 1939: 108 (Key to 10 species in the genus *Xiphinema* Cobb, 1913); Hopper & Cairns 1959: 134 (Key to 20 species in the genus *Xiphinema*; from Lordello 1955: 16-21); 135 (Key to 22 species in the genus *Xiphinema*; after Luc 1958: 57-72); Heyns 1971: 167 (Key to 3 genera, including *Xiphinema*, in the family Longidoridae); Cohn & Sher 1972: 64 (Key to 8 subgenera of *Xiphinema*); Bongers 1988: 350-351 (Keys to females for 5 species and males for 4 species in the genus *Xiphinema*); Loof & Luc 1990: 35-66 (a polytomous key for identifying over 172 *Xiphinema* species, each of which is placed in one of eight groups that facilitate identification but do not demonstrate phylogenetic relationships; the species may be keyed out with the help of character states within a set of descriptive codes); 58-59 (according to the code-character scheme in this key, *X. bakeri* falls into group 7 and may be identified by means of a 10 code-character combination; the key does not include the *X. americana* group).

Taxonomy: Williams 1961: 411 (differential diagnosis of 4 species, including *X. bakeri*, in the genus *Xiphinema*); Cohn & Sher 1972: 36-65 (taxonomy of the genus *Xiphinema*); Stegaresku 1966: 55-58 (diagnostics Table for species in the genus *Xiphinema*, including *X. bakeri*); Cohn & Sher 1972: 39, 50, 52, Fig. 1 (significance of female gonad structure in *Xiphinema* spp.: grouping of species according to the gonad being monodelphic, pseudomonodelphic, didelphic); Heyns 1983: 163-174 (discussion of the confusion regarding the identity of many species of *Xiphinema*, with special reference to the *X. american* group, and particularly in relation to the uniparental or monosexual species of which this group is a good example; the biological species concept as being not applicable to these monosexual species, reliance being placed on morphology to delimit the so-called morphospecies, and the problems of differentiating morphospecies).

Morphology: Coomans 1964: 610, Figs. 7-10 (structure of female gonad in *Xiphinema* spp.); Jatala 1975: 205, Fig. 1 (first report of endotokia matricida or intra-uterine birth of larva in a *Xiphinema* sp.); Dropkin 1980: 130 (brief description of *Xiphinema*); Samsoen & Barbez 1982: 774-778, Figs. 1-4 (comparisons of the usefulness of tail shape, relation between odontostylet length and body length, and development of genital primordia for separating juvenile stages and males and females in *Xiphinema* spp.).

Synonymy: Stegaresku 1977: 45-46 (lists synonymizations within the genus *Xiphinema*).

Order DORYLAIMIDA

Misc.: Ruehle 1967: 102 (distribution by country and by States in the USA of *Xiphinema* species associated with various species of forest trees); Boag 1986: 120, Table 1 (longidorid and trichodoridae nematodes as virus vectors; includes 4 genera, including *Xiphinema*, and 36 species, including *X. bakeri*, of virus vectors in these nematode groups, and lists the viruses carried by them; references cited for each vector-virus combination).

Family Leptonchidae Thorne, 1935

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 472), Heyns (1971: 179), Maggenti (1982: 888), Bongers (1988: 363), Jairajpuri & Ahmad (1992: 325).

***Leptonchus granulosus* N. A. Cobb, 1920**

Leptonchus granulosus N. A. Cobb, 1920; N. A. Cobb 1920: 304

Trichodorus granulosus, Micoletzky, 1922a: 1-650

Leptonchus scintillans Loof, 1964; Loof 1964a: 512; Monteiro 1970: 55-58

REMARKS

Goseco et al. (1974: 1, 7) discussed synonymy on morphological grounds, and designated *L. scintillans* Loof, 1964a as a junior synonym of *L. granulosus* N. A. Cobb, 1920. However, Bongers (1988: 366) has questioned whether these two species are conspecific.

DESCRIPTION

British Columbia Material

Fig. 25, after Goodey (1963: 475) and Goseco et al. (1974: 6). This species was identified by use of the keys in Hopper & Cairns (1959: 161), Yeates (1967: 783) and Goseco et al. (1974: 6), and it closely agreed with the descriptions in Goodey (1963) and Goseco et al. (1974).

Other Descriptions

Female: Thorne 1939: 142, 243, Fig. 189 C (tail end); Goodey 1963: 474; 475, Fig. 267 C (tail); Thorne 1964: 33, Fig. 10 D (tail); Goseco et al. 1974: 6-7; 6, Fig. 1 K, E, M (variation in vaginal region); 6, Fig. 1 C, J (tails); Thorne 1974: 104, Fig. 57 A-C (oesophageal-intestinal junction, anterior end, tail); Jairajpuri & Ahmad 1992: 298, Fig. 110 A-B (whole body; anterior end); 329, Fig. 122 D-E (vaginal region; tail).

Male: Thorne, 1939: 142, 243, Fig. 189 B (posterior region); Goodey 1963: 474; 475, Fig. 267 D (tail region); Thorne 1964: 33, Fig. 10 C (posterior region); Goseco et al. 1974: 6-7; 6, Fig. 1 D (posterior region, spicules); 6, Fig. 1 G (sperms); Maggenti 1982: Plate 77 (head showing striated subcuticle and spear); Jairajpuri & Ahmad 1992: 329, Fig. 122 F (posterior region).

Misc.: Thorne, 1939: 243, Fig. 189, Fig. 189 A (head: longitudinal and lateral views); 243, Fig. 189 D (oesophageal-intestinal region); Chitwood & Chitwood 1950: 74, Fig. 64 J (cephalic region); Goodey 1963: 475, Fig. 267 A-B (head end, oesophageal-intestinal junction); Thorne 1964: 33, Fig. 10 A-B, E (lateral and saggital view of head, oesophageal-intestinal junction); Grassé 1965b: 677, Fig. 492 A-B (anterior end, dorsal and lateral aspects; stylet); Goseco et al. 1974: 6, Fig. 1 A, H (anterior ends); 6, Fig. 1 B, I, L (variation in oesophageal bulb shape and oesophageal-intestinal junction); 6, Fig. 1 F (intestine-prerectum junction); Jairajpuri & Ahmad 1992: 329, Fig. 122 A-B (anterior end); 329, Fig. 122 C (oesophageal-intestinal junction).

IDENTIFICATION KEY

Hopper & Cairns 1959: 161 (Key to 5 species, including *L. granulosus*, in the genus *Leptonchus* Cobb, 1920); Yeates 1967: 783 (Key to 8 species, including *L. granulosus*, in the genus

Leptonchus); Goseco et al. 1974: 6 (Key to 4 species, including *L. granulosus*, in the genus *Leptonchus*).

BIOLOGY

Feeding habit: Fungivore: Yeates et al. 1993: 321.

c-p rating: 4: Bongers 1990: 15.

Misc.: Thorne 1964: 6 (in Puerto Rican rain forest, reproduction of all nematode species appeared to be suspended during October through March).

DISTRIBUTION

Nearctic: Thorne 1939: 142 (USA - VA, CA, UT, ID, NV); Goodey 1963: 475 (USA - CA, NV, UT); Grassé 1965b: 680 (USA); Johnson et al. 1972: 176 (USA - IN); Thorne 1974: 105 (USA - NE, MT, MN, IA, ND, SD); Goseco et al. 1974: 7 (USA: well distributed throughout - IN, MO, FL, AZ, NY, WI; citations therein include CA, ID, NV, UT, KS).

Palearctic: Goseco et al. 1974: 7 (cited therein: Netherlands, Hungary).

Neotropical: Thorne 1964: 1 (Puerto Rico); Goseco et al. 1974: 7 (cited therein: Brazil, Venezuela, Argentina, Puerto Rico).

Ethiopian: Goseco et al. 1974: 7 (cited therein: Sudan).

Australian: Goseco et al. 1974: 7 (cited therein: Australia).

Cosmopolitan: Goseco et al. 1974: 7.

HABITAT

Agroecosystem: Thorne 1939: 142 (date gardens; cultivated fields); Thorne 1974: 105 (a common inhabitant of virgin and cultivated soil); Goseco et al. 1974: 7 (cultivated fields);

Desert: Goseco et al. 1974: 7 (sand dunes).

Forest: Thorne 1939: 142 (about roots of willow trees); Thorne 1964: 5 (El Yunque Tropical Rain Forest); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Goseco et al. 1974: 7 (in wooded areas).

Misc.: Goseco et al. 1974: 7 (in different habitats).

MISC. INFORMATION

Economic importance: Grassé 1965b: 680 (a common pathologic agent of pine nurseries in USA).

ADDITIONAL REFERENCES

Key: Thorne 1964: 32 (Key to 2 subfamilies and 8 genera of the family Leptonchidae Thorne, 1935); Heyns 1971: 181 (Key to 5 subfamilies and 7 genera, including *Leptonchus* Cobb, 1920, in the family Leptonchidae); Goseco et al. 1974: 5 (Key to 5 genera, including *Leptonchus*, in the subfamily Leptonchinae; Key to 4 subfamilies, including Leptonchinae Thorne, 1935, in the family Leptonchidae); 6 (differential diagnosis of 3 *Leptonchus* spp.); Thorne 1974: 104 (Key to 3 species, including *L. granulosus*, in the genus *Leptonchus*, from the Northern Great Plains, USA); Bongers 1988: 363 (Key to 7 genera, including *Leptonchus*, in the family Leptonchidae); Jairajpuri & Ahmad 1992: 328 (Key to 7 genera, including *Leptonchus* in the subfamily Leptonchinae).

***Tylencholaimellus diplodorus* N. A. Cobb, 1915**

Tylencholaimellus diplodorus N. A. Cobb, 1915; N. A. Cobb in M. V. Cobb 1915: 28

DESCRIPTION**British Columbia Material**

Fig. 26, after Goodey (1963: 480) and Goseco et al. (1975: 6). This species was identified by use of the keys in Thorne (1939: 148), Hopper & Cairns (1959: 162) and Goseco et al. (1975: 4). It closely agreed with the descriptions in Goodey (1963: 480) and Goseco et al. (1975: 6). Note: Fig. 26 is based on a close resemblance of this species to *T. affinis* (see Goseco et al. 1975).

Other Descriptions

Female: N. A. Cobb in M. V. Cobb 1915: 28 (n. sp.); Thorne 1939: 148.

Male: N. A. Cobb in M. V. Cobb 1915: 29 (n. sp.); Thorne 1939: 148; Goseco et al. 1975: 5.

IDENTIFICATION KEY

Thorne 1939: 148 (Key to 6 species, including *T. diplodorus*, in the genus *Tylencholaimellus* N. A. Cobb in M. V. Cobb 1915); Hopper & Cairns 1959: 162 (Key to 8 species, including *T. diplodorus*, in the genus *Tylencholaimellus*); Goseco et al. 1975: 4 (Key to 26 species, including *T. diplodorus*, in the genus *Tylencholaimellus*).

BIOLOGY

Feeding habit: Fungivore: Yeates et al. 1993: 324.

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: N. A. Cobb in M. V. Cobb 1915: 24 (USA - MI); Thorne 1939: 149 (USA - MI); Goseco et al. 1975: 5 (USA - MI).

HABITAT

Misc.: N. A. Cobb in Cobb M. V. 1915: 21-22 (river inlet and banks, among sand and mud); Thorne 1939: 149 (river: Maple River, MI).

ADDITIONAL REFERENCES

Key: Heyns 1971: 181 (Key to 5 subfamilies and 7 genera, including *Tylencholaimellus* N. A. Cobb in M. V. Cobb 1915, in the family Leptonchidae); Thorne 1974: 109 (Key to 4 species in the genus *Tylencholaimellus* from the Northern Great Plains, USA); Bongers 1988: 363 (Key to 7 genera, including *Tylencholaimellus*, in the family Leptonchidae Thorne, 1935; 367 (Key to 3 species in the genus *Tylencholaimellus*); Jairajpuri & Ahmad 1992: 350 (Key to 7 genera, including *Tylencholaimellus*, in the subfamily Tylecholaimellinae).

Family Alaimidae Micoletzky, 1922

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 508), Heyns (1971: 211), Southey (1978a: 255), Bongers (1988: 290).

***Alaimus arcuatus* Thorne, 1939**

Alaimus arcuatus Thorne, 1939; Thorne 1939: 165

DESCRIPTION**British Columbia Material**

Fig. 27, after Thorne (1939: 250). This species was identified by use of the keys in Thorne (1939:162) and Hopper & Cairns (1959: 113), and it agreed with the description in Thorne (1939: 250).

Other Descriptions

Female: Thorne 1939: 165; 251, Fig. 219 a (tail).

Misc.: Thorne 1939: 251, Fig. 219 (oesophageal region).

IDENTIFICATION KEY

Thorne 1939:162 (Key to 15 species. including *A. arcuatus*, in the genus *Alaimus*); Hopper & Cairns 1959: 113 (Key to 14 species, including *A. arcuatus*, in the genus *Alaimus*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 319.

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Thorne 1939: 166 (USA - UT); Johnson et al. 1972: 180 (USA - IN).

Neotropical: Thorne 1939: 166 (Brazil).

HABITAT

Agroecosystems: Thorne 1939: 166 (soil of onion field).

Forest: Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam).

Misc.: Thorne 1939: 166 (soil about roots of plants imported from Brazil).

ADDITIONAL REFERENCES

Key: Bongers 1988: 290 (Key to 3 genera, including *Alaimus*, in the family Alaimidae Micoletzky, 1922; 290 (Key to 7 species in the genus *Alaimus* de Man, 1880).

Family Qudsianematidae Jairajpuri, 1965

Definitions, descriptions or diagnostic characteristics of this family: Bongers (1988: 324), Jairajpuri & Ahmad (1992: 124).

***Eudorylaimus carteri* (Bastian, 1865)**

Dorylaimus carteri Bastain, 1865; Bastain 1865: 73-184

Eudorylaimus carteri, Andrassy 1959: 214

Dorylaimus carteri littoralis Hofmänner, 1913; Hofmänner 1913: 589-658; Jairajpuri & Ahmad 1992: 132

Dorylaimus carteri profunda Hofmänner, 1913; Hofmänner 1913: 589-658; Jairajpuri & Ahmad 1992: 132

Dorylaimus carteri apicatus Micoletzky, 1922; Micoletzky 1922a: 1-650; Jairajpuri & Ahmad 1992: 132

Order DORYLAIMIDA

Dorylaimus fasciatus von Linstow, 1879; von Linstow 1879: 165-188; Jairajpuri & Ahmad 1992: 132

REMARKS

Many varieties, forms, subforms and even sub-subforms have been described under this species name (Tarjan & Hooper 1974), suggesting that *carteri* in the literature refers to a species group or complex. We have accepted Jairajpuri & Ahmad's (1992) synonymy of this species, except for *Eudorylaimus varians* Thorne, 1974, which Thorne (1974) described as a new species and distinguished it with good reasons from *Eudorylaimus carteri* (Bastian, 1865).

DESCRIPTION

British Columbia Material

Fig. 28. This species was identified by use of the keys in Thorne (1974: 28) and Bongers (1988: 325), and by comparisons with published descriptions and illustrations of species in the genus *Eudorylaimus* as cited below.

Other Descriptions

Female: Goodey 1963: 402; Tjepkema et al. 1971: 7-8; 8, Table 2 (morphometrics); 9, Fig. 3 D-F (variation in tail shape); Thorne 1974: 36, Fig. 16 M (tail end); Southey 1978a: 260, Fig. 12.13 (tail); Bongers 1988: 329-330; 330, Fig. 72.2.2 (tail end).

Male: Goodey 1963: 402, Fig. 223 (posterior end); Tjepkema et al. 1971: 7-8; 8, Table 2 (morphometrics); Thorne 1974: 36, Fig. 16 J (posterior region); Southey 1978a: 260, Fig. 12.13 (posterior part) Bongers 1988: 329-330; 330, Fig. 72.2.2 (posterior part).

Egg: Thorne 1974: 36 (20 µ x 75 µ).

Misc.: Tjepkema et al. 1971: 8, Table 2 (morphometry and characteristics of males and/or females of 23 species in the "carteri" group of *Eudorylaimus*, from original descriptions or descriptions of lectotypes); 9 (diagnosis of *E. carteri* and its similarity with 5 other species in the "carteri" group; morphological and morphometrical differences between *E. carteri* and these 5 species); Yeates 1972a: 345, Fig. 2 F (oesophageal-intestinal junction); Thorne 1974: 35, Fig. 16 K-L (anterior end, oesophageal-intestinal junction); Southey 1978a: 260, Fig. 12.13 (anterior end); Bongers 1988: 330, Fig. 72.2.2 (anterior part).

IDENTIFICATION KEY

Thorne 1974: 28 (Key to 19 species, including *E. carteri*, in the genus *Eudorylaimus*); Bongers 1988: 325-326 (Key to females and males of several genera and their species, in the family Qudsianematidae Jairajpuri, 1965; includes *E. carteri*).

BIOLOGY

Feeding habit: Omnivore or predator: Yeates et al. 1993: 321; Southey 1978a: 259 (on mite eggs); Small 1987: 192 (on mite eggs).

c-p rating: 4: Bongers 1990: 15.

Misc.: Popovici 1984: 208 (mean individual wet mass of adults: 0.6505 µg).

DISTRIBUTION

Nearctic: Tjepkema et al. 1971: 8 (USA - IN); Johnson et al. 1972: 178 (USA - IN); Thorne 1974: 36 (Canada - MB; USA - SD).

Paleartic: Wasilewska 1970: 436 (Poland); Arpin 1975: 494 (France); Sohlenius & Wasilewska 1984: 327-342 (Sweden); Popovici 1984: 205 (Romania); Bongers 1988: 329 (Netherlands); Hodda & Wanless 1994: 116 (England); Al-Banna & Gardner 1996: 974 (USA - CA); de Goede

1996: 228 (Netherlands); Háněl 1996: 15 (Czech Republic: Beskydy Mountains); Sohlenius & Boström 1999: 699 (northern Sweden).

Ethiopian: Jacobs 1984: 277 (Kenya).

Subantarctic: Maslen 1979: 211, 217 (islands in subantarctic zone: Macquarie Island).

Antarctic: Yeates 1970: 105 (South Orkney Islands).

Cosmopolitan: Bongers 1988: 329.

HABITAT

Agroecosystem: Al-Banna & Gardner 1996: 974 (California native grape, *Vitis californica*).

Forest: Wasilewska 1970: 436 (afforested dunes: found only in the earliest of 6 successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Tjepkema et al. 1971: 8 (woods); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Arpin 1975: 494 (oak forest, with *Molinia* and *Polytrichum* spp.; acid soil, pH 3); Popovici 1984: 205 (beech forest, Western Carpathians; 1300 m); Sohlenius & Wasilewska 1984: 327-342 (pine forest soil); (woods); de Goede 1996: 228 (Scots pine forest); Háněl 1996: 19 (105 and 134 year old spruce forests).

Grassland: Yeates 1970: 105 (maritime turf); Hodda & Wanless 1994: 121 (chalk grasslands).

Tundra: Sohlenius & Boström 1999: 696 (peat from ombrotrophic mire).

Misc.: Thorne 1974: 36 (swamp area; aspen thicket); Maslen 1979: 208 (moss communities); Jacobs 1984: 277 (aquatic - lakes, phreatic water, psammon, marshy, swampy soil and hygropetric zone, among algae and mosses in water or near water in humid places; non-aquatic - associated with mosses, bryoedaphic and lichenizedaphic); Bongers 1988: 330 (common in moss, humus in sandy soil, and freshwater "gemeld").

ADDITIONAL REFERENCES

Key: Heyns 1971: 141 (Key to 10 genera, including *Eudorylaimus* Andrásy, 1959, in the subfamily Dorylaiminae in the family Dorylaimidae); Maslen 1979: 226 (Key to males and females of 7 species of *Eudorylaimus*).

Morphology: Siddiqi 1969: 91, Fig. 4 L (oesophageal-intestinal junction in female of *Eudorylaimus* sp.); Yeates 1972a: 347, Fig. 4 A (transverse section of oesophageal-intestinal valve in *Eudorylaimus* sp.); Geraert et al. 1980: 260; 263, Fig. 6 (structure of female reproductive system).

Taxonomy: Tjepkema et al. 1971: 6, Table 1 (characteristics for dividing the very large genus *Eudorylaimus* into 6 species-groups, including the "carteri" group; the groups were not given any nomenclatural status and were only established to form convenient groups for study; the groups contained about two-thirds of the *Eudorylaimus* species); 7 (review of "carteri group").

ORDER MONONCHIDA

Jairajpuri (1969: 574) proposed the new order Mononchida for the mononchids, which until then, were considered under the order Dorylaimida; he gave a taxonomic history of the mononchids; Hooper 1978: 22 (abbreviated description of this order).

Suborder Mononchina

Hooper 1978: 23 (abbreviated description of this suborder).

Family Mononchidae Chitwood, 1937 (*sensu* Jairajpuri, 1969)

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 487-488), Mulvey & Jensen (1967: 669), Jensen & Mulvey (1968: 2-11, Fig. 1), Heyns (1971: 215), Maggenti (1982: 885), Bongers (1988: 296).

***Clarkus papillatus* (Bastian, 1865)**

Mononchus papillatus Bastian, 1865; Bastian 1865: 73-184; non N. A. Cobb, 1917: 465

Clarkus papillatus, Jairajpuri 1970: 217

Mononchus bastiani de Man, 1876, de Man 1876: 107; de Man 1880: 1-104

Mononchus punctatus N. A. Cobb, 1917; N. A. Cobb 1917: 464; Micoletzky 1922a: 1-650

DESCRIPTION**British Columbia Material**

Fig. 29. This species was identified by use of the key in Jairajpuri (1970: 218), and by comparisons with published descriptions and illustrations of species in the genus *Clarkus*, as cited below.

Other Descriptions

Female: Cobb 1917: 458, Fig. 8 (buccal cavity); Jairajpuri 1970: 217, Fig. 1 D-E (head end, ventral ridge without denticles; tail); Coomans & Khan 1981: 70, Fig. 2 D (tail); Bongers 1988: 298, Fig. 65.2.1 (tail shape); Arpin & Armendáriz 1996: 418, Table 3 (morphometric data based on 11 measurements: body length and width, oesophagus and tail length, vulva position, buccal cavity length and width, position of dorsal tooth apex, and de Man ratios a, b and c).

Male: Bongers 1988: 298, Fig. 65.2.1 (posterior end, spicule).

Misc.: Jairajpuri & Khan 1977: 90, Fig. 1 B (buccal cavity); Coomans & Khan 1981: 70, Fig. 2 A-C (head ends); Bongers 1988: 298, Fig. 65.2.1 (anterior part).

IDENTIFICATION KEY

Jairajpuri 1970: 218 (Key to 13 species, including *C. papillatus*, in the genus *Clarkus*).

BIOLOGY

Life-cycle: Yeates 1979: 222 (main period of reproduction March-May, with probably only a single generation a year).

Feeding habit: Predator: Yeates et al. 1993: 320; Cobb 1917: 458; Coomans and Khan, 1981: 71 (nematophagus; also, evidence for feeding on tardigrades found in gut contents); Small 1987: 183 (nematophagus; lists many nematode species as prey; also cannibalism); Bacterivore: Small 1987: 183; Fungivore: Small 1987: 183.

c-p rating: 4: Bongers 1990: 15.

Misc.: Popovici 1984: 208 (mean individual wet mass of adults: 1.5685 µg); Arpin et al. 1998: 173 (citing Arpin et al. 1988: morphometric variability in *C. papillatus* as an indicator of humus types; body and tail length can be used to distinguish intraspecific variability resulting from pedobiological influences); Arpin & Armendáriz 1996: 415, Table 1 (in beech forests, relative abundance of *C. papillatus* among 5 mononchid species was highest in all 3 phases of forest cycle: 75% in clearings in the forest, 75 % in forest growth zones, and 63% in forest mature zones).

DISTRIBUTION

Nearctic: Baird & Bernard 1984: 382 (USA - TN); Al-Banna & Gardner 1996: 974 (USA - CA).
Paleartic: Arpin 1975: 494 (France); Popovici 1984: 205 (Romania); Zullini & Peretti 1986: 403 (Italy); Sohlenius & Sandor 1987: 22, Table 4 (Sweden); Sohlenius et al. 1987: 132 (Sweden); Bongers 1988: 298 (Netherlands); Boag & Lopez-Llorca 1989: 5, Table II (Scotland); Sohlenius & Sandor 1989: 199 (Sweden); Boag et al. 1990: 401 (Scotland); Hansson et al. 1990: 41-83 (Sweden); Boag et al. 1992: 503-504 (Scotland); Dmowska 1993: 98 (Poland); Hodda & Wanless 1994: 116 (England); Ruess 1995: 107 (Germany); de Goede 1996: 228 (Netherlands); Ruess et al. 1996: 52 (Scotland); Háněl 1996: 15 (Czech Republic: Beskydy Mountains); Arpin & Armendáriz 1996: 414 (France: Fontainebleau forest); Armendáriz et al. 1996: 566 (Spain); Alphei 1998: 10 (Germany); Háněl 1998: 37 (Czech Republic: South Moravia).
Ethiopian: Coomans and Khan 1981: 70 (Kenya: Mount Kenya); Jacobs 1984: 275 (Zaire, Ghana).
Oriental: Jairajpuri 1970: 218 (North India).
Cosmopolitan: Cobb 1917: 458; Bongers 1988: 298.

HABITAT

Agroecosystems: Baird & Bernard 1984: 380 (soybean-wheat crops); Sohlenius & Sandor 1987: 22, Table 4 (barley field); Sohlenius et al. 1987: 138 (barley crops under different cropping systems); Boag & Lopez-Llorca 1989: 5, Table II (cereal fields); Boag et al. 1990: 401 (cereal farms); Hansson et al. 1990: 41-83.

Alpine: Coomans and Khan, 1981: 70 (rhizospheres of various vegetation belts at 3,000-3,240 m, and of the alpine belt at 3,850-4,270 m, on Mount Kenya); Dmowska 1993: 99 (acidified *Lolium*-field); Al-Banna & Gardner 1996: 974 (California native grape, *Vitis californica*); Ruess et al. 1996: 58 (natural and acidified soil in Sitka spruce forest).

Forest: Arpin 1975: 501 (oak forest, with *Molinia* and *Polytrichum* spp.; acid soil, pH 3); Popovici 1984: 205 (beech forest, Western Carpathians; 1300 m); Ruess 1995: 111 (*Picea abies* stands); Arpin & Armendáriz 1996: 414 (beech forest, *Fagus sylvatica* L.; acid mull humus on leached soil); Armendáriz et al. 1996: 561 (*Pinus nigra* soil); Háněl 1998: 43 (oak-linden forest).

Grassland: Sohlenius & Sandor 1987: 22, Table 4 (grass ley); Sohlenius & Sandor 1989: 201 (grass ley); Boag & Lopez-Llorca 1989: 5, Table II (permanent pasture); Boag et al. 1992: 503-504 (woodlands: coniferous and deciduous trees); Hodda & Wanless 1994: 121 (chalk grasslands); de Goede 1996: 228 (Scots pine forest); Háněl 1996: 19 (5 to 134 year old spruce forests); Alphei 1998: 11 (beech forest: mull soils); Háněl 1998: 43 (floodplain meadow).

Misc.: Jairajpuri 1970: 218 (soil around roots of *Calamus* sp.); Arpin 1975: 517 (park, with *Carpinus*, *Mercurialis* and *Hedera* spp.; calcareous soil, pH 8); Coomans and Khan, 1981: 70 (among bryophytes in the giant heath belt at 3,240 m on Mount Kenya); Jacobs 1984: 275 (aquatic - rivers and streams - potamon, marshy, swampy soil and hygropetric zone; non-aquatic - terrestrial); Zullini & Peretti 1986: 405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Bongers 1988: 298 (very common terrestrial nematode; also found in freshwater); Arpin 1991: 137, Table 1 (in dysmoder, moder, acid mull, mull, and calcareous-mull types of humus).

ADDITIONAL REFERENCES

Key: Jairajpuri & Khan 1977: 91 (Key to 5 genera, including *Clarkus* Jairajpuri, 1970, in the family Mononchidae Chitwood, 1937); Mulvey 1978: 1848 (Key to 23 genera, including

Order MONONCHIDA

Clarkus, in the family Mononchidae); Bongers 1988: 296 (Key to 6 genera in the family Mononchidae).

Description: Mulvey 1978: 1849 (brief description of the genus *Clarkus* Jairajpuri, 1970).

Morphology: Mulvey 1978: 1852, Fig. 3 H (buccal cavity of *Clarkus*, with ventral ridge).

***Iotonchus antedontus* Mulvey, 1963**

Iotonchus antedontus Mulvey, 1963; Mulvey 1963a: 82

REMARKS

According to Mulvey (1963a: 84), *I. antedontus* resembles *Mononchus parvus* de Man, 1880 in details and shape of buccal cavity, but is distinguished by the oesophageal-intestinal junction having a tuberculate-type valve. Clark (1960a: 182) considered the latter feature to be a good character for separating *Iotonchus* species from members in the genus *Mononchus*.

DESCRIPTION

British Columbia Material

Fig. 30. This species was identified by use of the keys in Mulvey (1963a: 80), Mulvey & Jensen (1967: 681), Jairajpuri (1969: 569) and Khan & Jairajpuri (1980: 7), and by comparisons with published descriptions and illustrations of species in the genus *Iotonchus*, as cited below.

Other Descriptions

Female: Mulvey 1963a: 82; 83, Figs. 4, 6 (head, tail).

Male: Mulvey 1963a: 84; 83, Figs. 5, 7-8 (head; posterior region showing spicules, supplements, accessory piece).

IDENTIFICATION KEY

Mulvey 1963a: 80 (Keys to males of 10 species and females of 19 species in the genus *Iotonchus*; both Keys include *I. antedontus*); Mulvey & Jensen 1967: 681 (Key to males and females of 28 species of *Iotonchus*, including *I. antedontus*); Jairajpuri 1969: 569 (Key to 38 species of *Iotonchus*, including *I. antedontus*); Khan & Jairajpuri 1980: 7 (Key to males and females of 50 species of *Iotonchus*, including *I. antedontus*).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 321; Small 1987: 184 (on nematodes and protozoa).

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Mulvey 1963a: 84 (USA - CA).

Australasia: Clark 1960d: 260 (New Zealand).

HABITAT

Forest: Mulvey 1963a: 84 (redwood forest floor).

ADDITIONAL REFERENCES

Key: Jensen & Mulvey 1968: 52 (Key to 2 Oregon species of *Iotonchus*); Heyns 1971: 216 (Key to 6 genera, including *Iotonchus*, in the family Mononchidae); Mulvey 1978: 1848 (Key to 23 genera, including *Iotonchus*, in the family Mononchidae).

Description: Clark 1960d: 260 (brief description of the genus *Iotonchus* (Cobb, 1916) Altherr, 1950); Mulvey 1978: 1854 (brief description of the genus *Iotonchus*).

Morphology: Clark 1960a: 178-183 (deduced relationships of 6 genera in the family Mononchidae on the basis of the tuberculate versus the non-tuberculate type of valve of oesophageal-intestinal junction; *lotonchus* exemplifies the former condition); Clark 1962: 252, Fig. 1 (family tree showing the deduced relationship of 11 genera, including *lotonchus*, in the family Mononchidae, on the basis of the tuberculate versus the non-tuberculate condition of the oesophageal-intestinal valve, and reduction or loss of subventral teeth and denticles in the stoma); Mulvey 1978: 1850, Fig. 1 C (buccal cavity in the genus *lotonchus*).

***Miconchus trionchus* (Thorne, 1924)**

Mononchus trionchus Thorne, 1924; Thorne 1924: 157-171
Miconchus trionchus, Andrassy 1958a: 160

DESCRIPTION

British Columbia Material

Fig. 31. This species was identified by use of the keys in Mulvey (1962: 66), Mulvey & Jensen (1967: 700) and Mulvey & Dickerson (1970: 233-234), and by comparisons with published descriptions and illustrations of species in the genus *Miconchus*, as cited below.

Other Descriptions

Female: Mulvey 1962: 73; 81, Figs. 27-29 (whole body; head and tail).

Misc.: Mulvey 1962: 73; 81, Figs. 30-32 (*en face* views showing labia, walls of buccal cavity, and three teeth); Mulvey & Jensen 1967: 670, Fig. 6 (buccal cavity).

IDENTIFICATION KEY

Mulvey 1962: 66 (Keys to females of 12 species and males of 7 species in the genus *Miconchus*; the female Key includes *M. trionchus*); Mulvey & Jensen 1967: 700 (Key to females of 14 species and males of 7 species of *Miconchus*; the female Key includes *M. trionchus*); Mulvey & Dickerson 1970: 233-234 (Keys to females of 19 species and males of 10 species in the genus *Miconchus*; the female Key includes *M. trionchus*).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 322.

c-p rating: 4: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Mulvey 1962: 73 (Canada - ON, AB, BC; USA - UT); Johnson et al. 1972: 180 (USA - IN).

Palearctic: Mulvey 1962: 73 (USSR: Volga District, Kama).

HABITAT

Forest: Mulvey 1962: 73 (forest soil and about pine tree roots); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam).

Misc.: Mulvey 1962: 73 (in mosses).

ADDITIONAL REFERENCES

Key: Jensen & Mulvey 1968: 39 (Key to 3 Oregon species of *Miconchus* Andrassy, 1958); Jairajpuri 1969: 573 (Key to 17 species of *Miconchus*); Mulvey 1978: 1848 (Key to 23 genera, including *Miconchus*, in the family Mononchidae).

Description: Mulvey 1978: 1854 (brief description of the genus *Miconchus* Andrassy, 1958).

Morphology: Clark 1962: 252, Fig. 1 (family tree showing the deduced relationship of 11

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genera, including *Miconchus*, in the family Mononchidae, on the basis of the tubeculate versus the non-tuberculate condition of the oesophageal-intestinal valve, and reduction or loss of subventral teeth and denticles in the stoma); Mulvey 1978: 1850, Fig. 1 A (buccal cavity in the genus *Miconchus*).

***Mononchus* sp.**

REMARKS

Cobb (1917: 431-486) is titled as being a treatise on the mononchs, but is essentially about the genus *Mononchus* Bastian, 1865, with 6 subgenera including *Mononchus* as one of them, and 57 species; all the 6 subgenera are now genera within the order Mononchida.

DESCRIPTION

British Columbia Material

Fig. 32. The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Heyns (1971: 216), Jairajpuri & Khan (1977: 91), Mulvey (1978: 1848) and Bongers (1988: 296), and by comparisons with published descriptions and illustrations of the genus, as cited below. The following information relates mostly to the genus.

Other Descriptions

Misc: Goodey 1963: 489 (the type species for this genus is *M. truncatus* Bastian, 1865); 489 (in place of the type species, *M. papillatus* Bastian, 1865 is described); 489-490, Fig. 277 A-C (description; anterior end, female tail end, and male tail region of *M. papillatus*).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 322.

c-p rating: 4: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 115 (Key to 69 species in the genus *Mononchus* Bastian, 1865); Mulvey 1967a: 916 (Keys to males of 13 species and females of 21 species of *Mononchus*; with notes on taxonomy, descriptions and geographical distribution); Jensen & Mulvey 1968: 44 (Key to 3 Oregon species of *Mononchus*); Heyns 1971: 216 (Key to 6 genera, including *Mononchus*, in the family Mononchidae); Jairajpuri & Khan 1977: 91 (Key to 5 genera, including *Mononchus*, in the family Mononchidae); Mulvey 1978: 1848 (Key to 23 genera, including *Mononchus*, in the family Mononchidae); Bongers 1988: 296 (Key to 6 genera, including *Mononchus*, in the family Mononchidae); 301 (Key to 4 species in the genus *Mononchus*).

Morphology: Clark 1960a: 178-183 (deduced relationships of 6 genera in the family Mononchidae on the basis of the tuberculate versus the non-tuberculate type of valve of oesophageal-intestinal junction; *Mononchus* exemplifies the latter condition); Clark 1962: 252, Fig. 1 (family tree showing the deduced relationship of 11 genera, including *Mononchus*, in the family Mononchidae, on the basis of the tubeculate versus the non-tuberculate condition of the oesophageal-intestinal valve, and reduction or loss of subventral teeth and denticles in the stoma); Mulvey 1978: 1852, Fig. 3 B (buccal cavity in the genus *Mononchus*).

Culture: Grootaert & Maertens 1976: 173-181 (mass culture of a species of *Mononchus*, *M. aquaticus*, on agar using the nematode *Panagrellus redivivus* as prey; in absence of males,

M. aquaticus reproduced parthenogenetically, which makes it suitable for mass culture and potentially suitable for predation on plant-parasitic nematodes; optimum temperature for mass culture was 22 °C, with a generation time of 20 days; at 5 °C, *M. aquaticus* was active and feeding, but eggs did not develop; at 10 °C, both activity and egg formation were slow, and generation time was more than 90 days; observations on feeding behaviour, embryology and moulting in *M. aquaticus*).

Misc.: Goodey 1963: 489 (diagnostic characters of the genus *Mononchus*); Mulvey 1978: 1854 (brief description of the genus *Mononchus*); Bongers 1988: 301 (diagnostic characters of the genus *Mononchus*).

***Mylonchulus* sp.**

DESCRIPTION

British Columbia Material

Fig. 33, after Southey (1978b: 265). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Heyns (1971: 216), Mulvey (1978: 1848) and Bongers (1988: 296), and by comparisons with published descriptions and illustrations of the genus *Mylonchulus*, as cited below. The following information relates mostly to the genus.

Other Descriptions

Misc: Goodey 1963: 495 (the type species for this genus is *M. minor* (Cobb, 1893b) Andrassy, 1958a); 495 (in place of the type species, *M. brachyuris*, *sensu* T. Goodey, 1942, is described); 495-497 (description and illustrations of *M. brachyuris*); 496, Fig. 282 A-C (anterior end, *en face* view, and section of mouth cavity showing dorsal tooth and subventral denticles of *M. brachyuris*); 496, Fig. 283 A-B (anterior part of female gonad, and male tail region of *M. brachyuris*).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 322.

c-p rating: 4: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Mulvey 1961: 669-670 (Keys to males of 13 species and females of 21 species in the genus *Mylonchulus* Cobb, 1916); Jensen & Mulvey 1968: 13 (Key to 11 Oregon species in the genus *Mylonchulus*); Heyns 1971: 216 (Key to 6 genera, including *Mylonchulus*, in the family Mononchidae); Mulvey 1978: 1848 (Key to 23 genera, including *Mylonchulus*, in the family Mononchidae); Bongers 1988: 298-299 (Key to 5 species in the genus *Mylonchulus*); Bongers 1988: 296 (Key to 6 genera, including *Mylonchulus*, in the family Mononchidae).

Description: Mulvey 1961: 666, Table I (amphid aperture positions in 10 male and/or female species of *Mylonchulus* with respect to dorsal tooth apex); 667, Table II (morphometric relationship of amphid aperture, body length and buccal cavity among 17 species of male and/or female *Mylonchulus*).

Morphology: Clark 1960a: 178-183 (deduced relationships of 6 genera in the family Mononchidae on the basis of the tuberculate versus the non-tuberculate type of valve of oesophageal-intestinal junction; *Mylonchulus* exemplifies the latter condition); Clark 1962: 252, Fig. 1 (family tree showing the deduced relationship of 11 genera, including *Mylonchulus*, in the family Mononchidae, on the basis of the tuberculate versus the non-tuberculate condition of

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the oesophageal-intestinal valve, and reduction or loss of subventral teeth and denticles in the stoma); Mulvey 1978: 1851, Fig. 2 B (buccal cavity in the genus *Mylonchulus*).

Misc.: Goodey 1963: 495 (diagnostic characters of the genus *Mylonchulus* (Cobb, 1916)

Pennak, 1953); Mulvey 1978: 1854 (brief description of the genus *Mylonchulus*); Bongers 1988: 301 (diagnostic characters of genus *Mylonchulus*).

***Prionchulus muscorum* (Dujardin, 1845)**

Oncholaimus muscorum Dujardin, 1845; Dujardin 1845: 237

Mononchus muscorum, Bastian 1865: 103

Mononchus (Prionchulus) muscorum, N. A. Cobb 1916: 195

Mononchus (Prionchulus) muscorum macrolaimus N. A. Cobb, 1917: 465; Andrassy 1958a: 157

Mononchus (Prionchulus) muscorum microlaimus in Schuurmans Stekhoven & Teunissen 1938: 229 pp.; Goodey 1963: 491

Prionchulus muscorum, Wu & Hoepli 1929: 35-43

Mononchus bastiani de Man, 1876; de Man 1876: 184; Clark 1960a: 194

Mononchus (Prionchulus) longicollis N. A. Cobb, 1917; N. A. Cobb 1917: 465; Andrassy 1958a: 157

Mononchus papillatus N. A. Cobb, 1917; N. A. Cobb 1917: 458; Andrassy 1958a: 157

REMARKS

Until recently, the separation of *P. muscorum* from closely related species was not clear. We have left *Mononchus papillatus* N. A. Cobb, 1917 in the synonymy because Clark (1960a) and Tarjan & Hopper (1974) concluded that this species of miscellaneous authors probably refers to *Prionchulus muscorum* (Dujardin, 1845). However, we have omitted *Prionchulus punctatus* Andrassy, 1958a from the synonymy. Although Andrassy (1958a: 151-171) considered *P. muscorum* and *P. punctatus* to be conspecific, others (Clark 1960a: 178-183; Mulvey 1967b: 941-953) disagreed. Arpin et al. (1984: 223) provided qualitative and quantitative data for the separation of these two species, and noted that (p. 224) the European populations of *P. muscorum* studied by them showed differences with the populations described from North America, especially those by Mulvey (1967b). Also, Mulvey (1967b: 947) stated that *P. moscorum* of Mulvey (1963) is in fact *Prionchulus longus* Thorne, 1929, and he redescribed *P. longus* from material collected in Canada and the USA.

von Bussau (1991: 37), citing Zell (1985) and Bongers (1987), compared and discussed *P. muscorum* (eggs not spiny) and *P. punctatus* (eggs spiny). Mulvey (1973: 241) found *P. punctatus* from Sable Island, southeast of Nova Scotia, Canada; the females contained eggs with punctate (spiny) shells, and closely resembled those described from elsewhere in Canada (Mulvey, 1967b: 941-953). Apparently both *P. muscorum* and *P. punctatus* occur in Canada. Our British Columbia specimens exhibit no spines on the eggshell and are therefore placed in *P. muscorum*.

DESCRIPTION

British Columbia Material

Fig. 34. This species was identified by use of the keys in Mulvey (1967b: 942) and Jensen & Mulvey (1968: 32), and by comparisons with published descriptions and illustrations of species in the genus *Prionchulus*, as cited below.

Other Descriptions

Female: Clark 1960b: 193, Fig. 3 F-H (vulva, genital organs, tail); Clark 1960c: 213; Goodey 1963: 492; Mulvey 1963b: 794, Figs. 1-4 (head, tail, reproductive organs, spermatheca); Mulvey 1967b: 941, 945, Figs. 1-5 (lateral and dorsoventral views of head; *en face* view at levels of labia and dorsal tooth; tail); Jensen & Mulvey 1968: 32, 33, Fig. 8 D-E (anterior end, tail); Jairajpuri 1970: 220; 215, Fig. 1 J-K (head, tail); Heyns 1971: 220, Fig. 144 C (tail); Jairajpuri & Khan 1977: 90, Fig. 1 A (buccal cavity); Mulvey 1978: 1867; 1865, Fig. 12 A-B (head with dorsal tooth and denticles; tail); 1853, Fig. 4 C (non-tuberculate type of oesophago-intestinal junction in *P. muscorum* female); Coomans & Khan 1981: 71, 72, Fig. 2 G-H (head, tail); Maggenti 1982: Plate 76 (head showing buccal teeth, oesophagus); Arpin et al. 1984: 218, Table 2 (morphometrical and morphological data; comparisons with *P. punctatus*); 220, Fig. 2 (variation in buccal cavity; comparison with *P. punctatus*); 224, Fig. 7 (variation in tail; comparison with *P. punctatus*); Bongers 1988: 297, Fig. 65.1.1 (anterior part); Arpin 1991: 135, Fig. 1 A-C (whole body, buccal cavity, tail of *Prionchulus* sp., near *muscorum*).

Male: Goodey 1963: 492; Mulvey 1967b: 941, 944-945, Figs. 6-7 (head; posterior region with spicule and supplements); Bongers 1988: 297.

Larvae: Clark 1960b: 193, Fig. 3 C-D (lateral and dorsal views of denticulated ridges, showing variation in denticulation); Jairajpuri 1970: 220 (morphometrics).

Egg: Cobb, 1917: 465; Arpin et al. 1984: 218, Table 2 (egg-shell contour); 221, Fig. 3 (intra-uterine eggs, surface and median optical views; comparison with eggs of *P. punctatus*); Samsoen et al. 1984: 410, Figs. 2, 4, Table 1 (egg shell structure; surface and median optical views; variation in egg-shell as seen by SEM).

Misc.: Cobb 1917: 464-465, Figs. 36-38 (buccal cavity; morphological differences from type of the species); Chitwood & Chitwood 1950: 91, Fig. 92 A-M (intestine and oesophageal-intestinal valve in serial sections); Clark 1960a: 179, Fig. 1 A-D, Fig. 3 (oesophageal-intestinal junction with non-tuberculate valve; oesophagus at different levels in transverse sections); Clark 1960b: 193, Fig. 3 A-B, E (head end; *en face* view, at level of dorsal tooth apex; oesophageal-intestinal junction; Goodey 1963: 491 (head end, buccal capsule); Mulvey & Jensen 1967: 672, Fig. 11 (buccal cavity); Heyns 1971: 220, Fig. 144 A (head region); 220, Fig. 144 B (oesophageal-intestinal valve); Jairajpuri & Khan 1975: 409-410 (first description of the entire excretory system in a mononchid species; position of excretory pore in relation to anterior end and nerve ring; anatomical relationship of excretory pore, ampulla, renette cells and excretory ducts); Arpin et al. 1984: 219-223 (differential characteristics of *P. muscorum* and *P. punctatus*); Bongers 1988: 297, Fig. 65.1.1 (buccal capsule).

IDENTIFICATION KEY

Mulvey 1967b: 942 (Key to males of 3 species and females of 5 species of *Prionchulus* Wu & Hoepli, 1929; both Keys include *P. muscorum*); Jensen & Mulvey 1968: 32 (Key to 2 Oregon species of *Prionchulus*, including *P. muscorum*).

BIOLOGY

Feeding habit: Predator: Yeates et al. 1993: 323; Cobb 1917: 465 (on smaller soil animals including other nematodes); Coomans & Khan 1981: 73 (nematophagous); Small 1987: 189 (nematodes in several taxa used as prey; also detrital matter, rotifers; source references cited therein); Bacterivore: Small 1987: 189 (source reference cited therein).

c-p rating: 4: Bongers 1990: 15.

Order MONONCHIDA

Misc.: Yeates 1973: 182 (population make-up: juveniles 73%, females 9%, gravid females 18%, males 0%); 184 (vertical distribution: 78% in litter, 22% below litter, to 6 cm soil depth); Yeates 1988: 771 (average individual measurements: length 2060 µm; width 65 µm; biomass 5.44 µg; biovolume $5120 \times 10^3 \mu\text{m}^3$); Arpin & Armendáriz 1996: 415, Table 1 (in beech forests, relative abundance of *P. muscorum* among 5 mononchid species ranked consistently second in all 3 phases of forest cycle: 18% in clearings in the forest, 25% in forest growth zones, and 33% in mature zones of the forest).

DISTRIBUTION

Nearctic: Cobb 1917: 465 (USA - WI); Mulvey 1963b: 793 (Canada - ON); Mulvey 1967b: 945 (Canada - NWT, BC, ON; USA. - CA, FL); Al-Banna & Gardner 1996: 975 (USA - CA).

Palearctic: Cobb 1917: 465 (Europe); Allgén 1925: 1-40 (Sweden); Mulvey 1963b: 793 (Poland); Yeates 1972b: 179 (Denmark); Yeates 1973: 180 (Denmark); Arpin 1975: 494 (France); Arpin et al. 1984: 216 (France, UK; source references cited therein); Zullini & Peretti 1986: 403 (Italy); Bongers 1988: 297 (Netherlands); Boag et al. 1992: 503-504 (Scotland); Ruess 1995: 107 (Germany); Arpin & Armendáriz 1996: 414 (France: Fontainebleau forest); Armendáriz et al. 1996: 566 (Spain); Alphei 1998: 10 (Germany); Ruess et al. 1999: 516 (Sweden: northern Swedish Lapland).

Ethiopian: Heyns 1971: 222 (South Africa); Coomans & Khan 1981: 73 (on Mount Kenya: among ferns in rain forest at 2,600-3,240 m; among bamboo roots at 3,050 m; among moist bryophytes in the giant heath belt at 3,240 m); Arpin et al. 1984: 216 (Kenya; source reference cited therein).

Oriental: Jairajpuri 1970: 220 (North India); Jairajpuri & Khan 1975: 410 (India - Uttar Pradesh).

Australian: Clark 1960c: 213 (New Zealand).

Cosmopolitan: Cobb 1917: 465; Mulvey 1967b: 942; Bongers 1988: 297.

HABITAT

Agroecosystems: Jairajpuri 1970: 220 (around roots of apple trees); Al-Banna & Gardner 1996: 975 (California native grape, *Vitis californica*).

Forest: Mulvey 1963b: 793 (soil around birch tree); Yeates 1972b: 181 (beech forest, *Fagus sylvatica* L.); Yeates 1973: 180 (beech forest); Arpin 1975: 501 (oak forest, with *Molinia* and *Polytrichum* spp.; acid soil, pH 3); Coomans & Khan 1981: 73 (in mountain rain forest on Mount Kenya; around ferns, bamboo, giant heath belt, and moist bryophytes); Arpin et al. 1984: 216 (forest; source reference cited therein); Boag et al. 1992: 503-504 (woodlands: coniferous and deciduous trees); Ruess 1995: 111 (*Picea abies* stands); Arpin & Armendáriz 1996: 414 (beech forest, *Fagus sylvatica* L.; acid mull humus on leached soil); Armendáriz et al. 1996: 561 (*Pinus nigra* soil); Alphei 1998: 11 (beech forest: mull soils).

Grassland: Jairajpuri 1970: 220; Arpin et al. 1984: 216 (pasture; source reference cited therein).

Tundra: Ruess et al. 1999: 516 (subalpine heath, elevation 450 m, soil type gelic gleysol, well-developed humus layer, vegetation mainly dwarf shrubs; fellfield, 1150 m elevation, soil type gelic regosol, thin humus layer, vegetation mainly of dwarf shrubs, mosses and lichens).

Misc.: Cobb 1917: 465 (swamps, marshes, meadows, moorlands); Grassé 1965b: 668, Fig. 478 A (anterior end); Arpin 1975: 517 (park, with *Carpinus*, *Mercurialis* and *Hedera* spp.; calcareous soil, pH 8); Arpin et al. 1984: 216 (moss; source reference cited therein); Zullini & Peretti 1986: 405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Bongers 1988: 297 (very common in moss; typically found in humus, and in moder

and mull type soils); Arpin 1991: 137, Table 1 (mainly in moder, acid mull, and calcareous-mull types of humus).

MISC. INFORMATION

Culture: Samsoen et al. 1984: 407 (on agar plates with a modified enchytraeid medium, with the nematode *Panagrellus redivivus* as prey).

Morphology: Chitwood & Chitwood 1950: 91, Fig. 92 (oesophagus and oesophageal-intestinal valve in cross-sections); 92, Fig. 94 A-D (cross-sections of cuticular lining in stomatal region, procorpus, and bulbar region at level of dorsal gland orifice); 111, Fig. 105 D-E (ventricular- and mid-region of intestine in cross-sections); Clark 1960a: 178-183 (deduced relationships of 6 genera in the family Mononchidae on the basis of the tuberculate versus the non-tuberculate type of valve of oesophageal-intestinal junction; *P. muscorum* exemplifies the latter condition); Grassé 1965a: 178, Fig. 245 (oesophageal-intestinal junction; sectional morphology through this region).

Physiology: Yeates 1973: 184 (oxygen consumption: 131 ml O₂ m⁻²).

Teratology: Mulvey 1963b: 793, Fig. 3 (an abnormal condition of bivulvarity in females of Canadian specimens of *P. muscorum* from Ontario, with two separate vulvar openings, one for each ovary).

ADDITIONAL REFERENCES

Key: Heyns 1971: 216 (Key to 6 genera, including *Prionchulus* Cobb, 1916, in the family Mononchidae); Jairajpuri & Khan 1977: 91 (Key to 5 genera, including *Prionchulus*, in the family Mononchidae); Mulvey 1978: 1848 (Key to 23 genera, including *Prionchulus*, in the family Mononchidae); Bongers 1988: 296 (Key to 6 genera, including *Prionchulus*, in the family Mononchidae).

Description: Mulvey 1978:1855 (brief description of the genus *Prionchulus*).

Morphology: Clark 1962: 252, Fig. 1 (family tree showing the deduced relationship of 11 genera, including *Prionchulus*, in the family Mononchidae, on the basis of the tuberculate versus the non-tuberculate condition of the oesophageal-intestinal valve, and reduction or loss of subventral teeth and denticles in the stoma); Grassé 1965b: 668, Fig. 478 C (relationships of 11 genera, including *Prionchulus*, in the subfamily Mononchinae, based on reduction and loss of subventral teeth and denticles); Matthews & Croll 1974: 133, Fig. 8 (SEM of anterior end of *Prionchulus* sp., showing six-sided stomatal aperture); Mulvey 1978:1851, Fig. 2 A (buccal cavity of *Prionchulus*); von Bussau 1991: 36, Fig. 3 A-D (anterior end, reproductive system, tail, whole body of female *Prionchulus* sp.).

Class Secernentea

Hooper 1978: 23-40 (abbreviated classification to orders, suborders, superfamilies, families and subfamilies in this class).

ORDER RHABDITIDA

Hooper 1978: 24 (abbreviated description of this order); Siddiqi 1980: 155 (phylogeny: on common ancestry of the the orders Rhabditida and Tylenchida); Geraert 1983: 77-79, Fig. 2 (four main types of female genital systems in this order, representing the rhabditid-type, the panagrolaimid-type, the cephalobid-type and the diplogasterid-type; their morphology is useful in elucidating problems of systematics); 81 (in the family Rhabditidae, the structure of female genital system can help to gain better insight into species and genera).

Suborder Rhabditina

See the section on Links (Section 5) for a useful website on this suborder by Dr. K. B. Nguyen. The site includes morphological characters, classification and an illustrated key for identification to superfamilies, families and genera.

Family Rhabditidae Örley, 1880

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 207), Heyns (1971: 25), Hooper (1978: 24), Maggenti (1982: 905), Bongers (1988: 190).

Dougherty (1955) provided a nomenclatorial analysis of the subfamily Rhabditinae Micoletzky, 1922, including reviews of composition of the family Rhabditidae (p. 136) and structural homologies in the stoma of rhabditoid nematodes (p. 139). De Ley et al. (1995: 168) discussed stomal structure in the family Rhabditidae as revealed by TEM, and made homologies with the stoma in two other rhabditid families, Cephalobidae and Panagrolaimidae (p. 174). Vancoppenolle et al. (1999: 16-17, Table 1) cultured rhabditid nematodes on 3% NGM-agar with *Escherichia coli* as food source and showed their generation times at 18-30° C to range between 3-5 days.

Protorhabditis sp.

DESCRIPTION

British Columbia Material

Fig. 35. The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the key in Bongers (1988: 190-193), and by comparisons with published descriptions and illustrations of this genus from several sources, as cited below. The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 232 (the type species for this genus is *Protorhabditis xylocola* (Korner in Osche 1952) Dougherty, 1953); 232, Fig. 125 A-C (description; oesophageal region, male tail, and female tail of *P. xylocola*); Bongers 1988: 201; 202, Fig. 22.12.1 (*P. filiformis* as representing

morphological features of the genus); 201-202, Fig. 22.12.2 (*P. oxyuroides* as representing morphological features of this genus).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 323.

c-p rating: 1: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Goodey 1963: 232 (Tabular Key to 3 genera, including *Protorhabditis*, in the subfamily Protorhabditinae; the key is based on morphological characteristics relating to oesophageal collar, procorpus, female gonad and tail, and spicules); Bongers 1988: 190-3 (Keys to genera and species, including *Protorhabditis* Osche, 1956, and two species, in the family Rhabditidae Örley, 1880).

Nomenclature: Dougherty 1955: 122-123, 134 (recognized 9 genera, including *Protorhabditis*, in the subfamily Rhabditinae; 134-135 (recognized 9 species under *Protorhabditis*).

Misc.: Goodey 1963: 232 (diagnostic characters of the genus *Protorhabditis* (Osche, 1956)

Dougherty, 1953); Bongers 1988: 201 (diagnostic characters of the genus *Protorhabditis* Osche, 1956); De Ley 2000: 11-13 (citing Baldwin et al. 1997: a culture of the strain PS1010 of a morphologically primitive *Protorhabditis* sp. showed differences in the ultrastructure of the buccal cavity, but similarities in DNA sequence data, between this strain and *Caenorhabditis elegans*; the inference was that such differences or similarities do not necessarily indicate phylogenetic relationships in the Rhabditidae).

Rhabditis sp.

DESCRIPTION

British Columbia Material

Fig. 36, after Heyns (1971: 26). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Hopper & Cairns (1959: 8) and Bongers (1988: 190-193), and by comparisons with published descriptions and illustrations of this genus from other sources, as cited below. The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 208 (the type species for this genus is *Rhabditis* (*Rhabditis*) *terricola* Dujardin, 1845 (Dougherty, 1953); 208 (in place of the type species, *Rhabditis* (*R.*) *insectivora* Korner in Osche, 1952 (Osche, 1952) is described); 208, Fig. 108 A-B (description; head end of female, and tail end of male in *Rhabditis* (*R.*) *insectivora*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 323.

c-p rating: 1: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 8 (Key to 7 genera, including *Rhabditis* Dujardin, 1845, in the subfamily Rhabditinae); Bongers 1988: 190-193 (Keys to genera and species, including *Rhabditis* and 6 species, in the family Rhabditidae Örley, 1880).

Morphology: Geraert et al. 1980: 96-104 (comparison of female genital apparatus in 12 *Rhabditis* species; schematic).

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Nomenclature: Dougherty 1955: 107 (review of the genus *Rhabditis* sensu lato); 122 (recognized 9 genera, including *Rhabditis*, in the subfamily Rhabditinae); 131 (recognized 5 subgenera and 67 species under the genus *Rhabditis*).

Misc.: Goodey 1963: 208 (diagnostic characters of the genus *Rhabditis*); Bongers 1988: 193 (diagnostic characters of the genus *Rhabditis*).

Family Bunonematidae Micoletzky, 1922

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 241), Hooper (1978: 25), Maggenti (1982: 907), Bongers (1988: 204).

***Bunonema* sp.**

DESCRIPTION

British Columbia Material

Fig. 37. The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Bongers (1988: 205), and by comparisons with published descriptions and illustrations of this genus from several other sources, as cited below. The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 244 (the type species for this genus is *B. richtersi* Jägerskiöld, 1905); 243-244, Fig. 132 A (oesophageal region of *B. richtersi*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 320.

c-p rating: 1: Bongers 1990: 15.

Culture: Vancoppenolle et al. 1999: 16-17, Table 1 (on 3% NGM agar with *Escherichia coli* as food source; generation times for the particular strain at 25° C and 30° C were 8 and 6 days, respectively).

ADDITIONAL REFERENCES

Key: Bongers 1988: 205 (Key to 3 genera, including *Bunonema* Jägerskiöld, 1905, in the family Bunonematidae Micoletzky, 1922).

Misc.: Goodey 1963: 242 (diagnostic characters of the genus *Bunonema*); Bongers 1988: 205 (diagnostic characters of the genus *Bunonema*); Yeates 1988: 771 (*Bunonema* sp., as exemplifying extremely small nematodes; average individual measurements for females: length 276 µm; biomass 70 ng, biovolume 67 x 10³ µm³).

Family Panagrolaimidae Thorne, 1937

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 250), Heyns (1971: 31), Hooper (1978: 25), Maggenti (1982: 908), Bongers (1988: 219).

***Panagrolaimus* sp.**

DESCRIPTION

British Columbia Material

Fig. 38, after Heyns (1971: 32), Boström (1988: 146). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by

use of the keys in Hopper & Cairns (1959: 16) and Bongers (1988: 219), and by comparisons with published descriptions and illustrations of this genus from several sources, as cited here and below. The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 251 (the type species for this genus is *P. detritophagus* Fuchs, 1930); 251 (in place of the type species, *P. fuchsi* Rühm, 1956 is described); 253, Fig. 135 A-B (description; anterior end, and male tail region of *P. fuchsi*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 322.

c-p rating: 1: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 16 (Key to 10 genera, including *Panagrolaimus* Fuchs, 1930, in the subfamily Panagrolaiminae; 18 (list 17 species of *Panagrolaimus*); Goodey 1963: 252 (a tabular Key to 9 genera, including *Panagrolaimus*, in the subfamily Panagrolaiminae; the key is based on several morphological characteristics including the lip region, body cuticle, stoma shape, metarhabdions, procorpus, vulva, and post-vulval sac); Bongers 1988: 219 (Keys to males and females for 5 genera, including *Panagrolaimus*, in the family Panagrolaimidae Thorne, 1937; 221 (Keys to females of 6 species and males of 4 species in the genus *Panagrolaimus*).

Morphology: Boström 1988: 144-155 (light microscope and SEM study: morphology of 3 populations of *Panagrolaimus*; intraspecific variability; identification); De Ley et al. 1995: 163 (stomal structure in the family Panagrolaimidae as revealed by TEM; 174 (stomal structure: homologies with rhabditid families Cephalobidae and Rhabditidae).

Survival strategy: Aroian et al. 1993: 500-502 (a *Panagrolaimus* sp. from Armenia survived anhydrobiosis in dry soil for 8.7 years; the soil type was clay loam with 33% sand, 32% silt and 35% clay).

Culture: Vancoppenolle et al. 1999: 16-17, Table 1 (on 3% NGM agar with *Escherichia coli* as food source; generation times for a *Panagrolaimus* species at 18° C, 25° C and 30° C were 14, and 7 and 6 days, respectively).

Misc.: Goodey 1963: 251 (diagnostic characters of the genus *Panagrolaimus*); Bongers 1988: 220 (diagnostic characters of the genus *Panagrolaimus*).

Suborder Cephalobina

See the section on Links (Section 5) for a useful website on this suborder by Dr. K. B. Nguyen. The site includes morphological characters, classification and an illustrated Key for identification to superfamilies, families and genera.

Family Cephalobidae Filipjev, 1934

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 271-272), Heyns (1971: 33), Hooper (1978: 25), Bongers (1988: 208). Rashid et al. 1988: 127, Table 1 (diagnosis based on SEM data of head structures of 12 genera in the family Cephalobidae); 128, Fig. 1 (schematic *en face* view representing nine genera in the subfamily Cephalobinae). A useful website on references to literature on the family Cephalobidae, is at:
<http://cbshome.ucdavis.edu/PEET/cephalobidae.html>

***Acrobeles complexus* Thorne, 1925**

Acrobeles complexus Thorne, 1925; Thorne 1925: 171-210

Acrobeles ciliatus von Linstow, 1877; von Linstow 1877: 1-18; Andrassy 1960: 201-216

DESCRIPTION

British Columbia Material

Fig. 39, after Sasser & Jenkins (1960: 153). This species was identified by use of the keys in Hopper & Cairns (1959: 22) and Bongers (1988: 212), and it agreed with the description in Sasser & Jenkins (1960: 153).

Other Descriptions

Female: Maggenti 1982: Plate 81 (head with probolae; oesophageal region); Bongers 1988: 212; 213, Fig. 26.4.2 (posterior part).

Male: Bongers 1988: 212; 213, Fig. 26.4.2 (tail end).

Misc.: Chitwood & Chitwood 1950: 58, Fig. 54 Y (cephalic region, including *en face* view); Sasser & Jenkins 1960: 153, Fig. 7 A-B (anterior end; *en face* view); Hirschmann 1983: 99, Fig. 2 H (SEM of face view showing structure of head probolae); Bongers 1988: 212; 213, Fig. 26.4.2 (anterior part).

IDENTIFICATION KEY

Hopper & Cairns 1959: 22 (Key to 7 species, including *A. complexus*, in the genus *Acrobeles* Linstow, 1877); Bongers 1988: 212 (Key to 3 species, including *A. complexus*, in the genus *Acrobeles*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 319.

c-p rating: 2: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Smolik 1974: 7 (USA - SD).

Paleartic: Bongers 1988: 212 (Netherlands).

Neotropical: Bongers 1988: 212 (Paraguay).

Ethiopian: Bongers 1988: 212 (South Africa).

HABITAT

Grassland: Smolik 1974: 7.

Misc.: Bongers 1988: 213 (common in soil).

MISC. INFORMATION

Morphology: Sasser & Jenkins 1960: 153, Fig. 7 A-B (lateral head region showing labial and cephalic probolae; *en face* view).

ADDITIONAL REFERENCES

Key: Bongers 1988: 208 (Key to 9 genera, including *Acrobeles* Linstow, 1877, in the family Cephalobidae Filipjev, 1934).

***Acobeloides nanus* (de Man, 1880)**

Cephalobus nanus de Man, 1880; de Man 1880: 1-104

Cephalobus persegnis var. *nanus* de Man, 1880; de Man 1880: 1-104; Schneider 1939: 1-260

Acobeloides nanus, Anderson 1968a: 311

REMARKS

Anderson (1968a: 311) regarded *Cephalobus [Acobeloides] buetschlii* de Man, 1884 as a synonym of *Cephalobus nanus* de Man, 1880 on the basis that the two differed only in the number of lateral incisures, three versus five. However, he also cited Andrassy (1967a) who listed only three incisures for *C. nanus*. Boström & Gydemo (1983: 247) discussed the relationship of *A. buetschlii* and *A. nanus* with reference to earlier literature, and with regard to their Swedish specimens, which they considered as *A. nanus*, and they stated that *A. buetschlii* and *A. nanus* could be synonymus. Bird et al. (1993: 613-614) considered *A. nanus* from Australia to be conspecific with Canadian and Swedish populations described by Anderson (1968a) and Boström & Gydemo (1983).

DESCRIPTION

British Columbia Material

Fig. 40. This species was identified by use of the key in Bongers (1988: 213), and by comparisons with descriptions and illustrations in the references cited below.

Other Descriptions

Female: Anderson 1968a: 319, Fig. 5 (phenotypic variation in development of the reproductive system under different environmental conditions; see further under "Misc." below); Boström & Gydemo 1983: 247-251, Table 1 (morphometry); 248, Fig. 1 (SEM micrographs: head end with labial and cephalic probolae, labial papillae, amphid aperture; excretory pore; vulval and anal openings; lateral field with incisures; tail end with phasmid); 248-252, Figs. 2-5 (whole body; different shapes of labial probolae, reproductive system and tail; relative frequency of the different shapes); Rashid et al. 1984: 282, Fig. 16 (anterior region; head region showing variation in probolae; variations in tail region; reproductive system); Rashid et al. 1988: 133, Fig. 4 C-G (SEM micrographs: head, end-on-view; anterior and posterior regions, lateral field, vulval region); Bongers 1988: 214, Fig. 26.5.2 (tail end); Bird et al. 1993: 608, Table 1 (various morphometrical data); 608, Fig. 1 A-B (reproductive system); 608, Fig. 1 C-D (anterior end in median and surface views); 608, Fig. 1 E-F (tail); 608, Fig. 1 G (oesophageal region); 609, Fig. 2 (SEM: whole body; head end showing labial probolae, the six lips with cephalic probolae, labial and cephalic papillae, and amphidial aperture; tail end showing crescent-shaped anus and phasmids).

Male: Bongers 1988: 214.

Larvae: Bird et al. 1993: 613, Fig. 5 (morphology of freshly-hatched larva or L1); 613, Table 4 (morphometrics of first-stage larva or L1); Ilieva-Makulec 1998: 60, Fig. 1 (larval period: 8 days in both xenic and monoxenic cultures).

Egg: Bird et al. 1993: 611, Table 2 (mean dimensions of eggs: freshly-laid eggs 55 µm x 25 µm, and eggs with late larval stage 57 µm x 31 µm); 610-611, Fig. 3 (egg-laying process); 611, Table 4 (embryogenesis at different temperatures between 15-40° C; most rapid rate of embryogenesis considered to be at 36° C); 612, Fig. 4 A-N (stages of embryogenesis at 37.5° C: multicell, gastrula, tadpole, elongation, and hatch-stage or L1; time lapse photographs for each stage, in minutes and hours for upto 40 hours); Ilieva-Makulec 1998: 60, Fig. 1 (egg development time: 3 days in both xenic and monoxenic cultures).

Misc.: Anderson 1968a: 309-320, Table I-II, Figs. 1-5 (demonstrated phenotypic variation in taxonomic characters in the progeny of *A. nanus* females originating from soil around red pine roots or from greenhouse soil; progeny were obtained by rearing *A. nanus* on bacterial cultures

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or in oven-dried soil; the characters assessed for variability were morphometrics, shapes of labial probolae and tails, positions of nerve ring, excretory pore and deirid in relation to oesophagus, position of phasmid, and configuration of reproductive system and ovarian development - see also under "Female:" above; thus phenotypic variation in taxonomic characters, arising from environmental conditions, could have a significant impact on identification of a taxon); Wasilewska 1971: 660 (average body weight of female 0.165 µg); Bongers 1988: 214, Fig. 26.5.2 (oesophageal region; anterior part).

IDENTIFICATION KEY

Bongers 1988: 213 (Key to 4 species, including *A. nanus*, in the genus *Acrobeloides*).

BIOLOGY

Life-cycle: Anderson 1968a: 310 (2-4 days at 20-24 °C on 1.5% potato-dextrose-agar seeded with a mixture of bacteria isolated from soil); Sohlenius 1973: 207 (generation time for *A. nanus*: 11 days at 21 °C and 21 days at 13 °C); 210 (under experimental starvation for 8 days, adult females were shorter in length by about 7%, and the frequency of gravid females was 10 times lower, than in well-fed populations); Boström & Gydemo 1983: 246 (mean generation time from egg to reproductive adult: 12.5 days at 20 °C on xenic agar culture; reproductive period 10-12 days, ovulation capacity 175-200 eggs; oviposition rate maximum on days 2-5 after onset of reproduction, laying 15-20 eggs per day); Ilieva-Makulec 1998: 62, Table 1 (average total life span: 35 days in xenic culture, 30 days in monoxenic culture; average age of maturity: about 11 days in either culture; average reproductive period: 23 days in xenic culture, 16 days in monoxenic culture; average fecundity per female: 149 eggs in xenic culture, 52 eggs in monoxenic culture; average post-reproductive period: 1.41 days in xenic culture and 2.94 days in monoxenic culture; 60, Fig. 1 (50% of reproductive effort: days 11-25 in xenic culture and days 11-15 in monoxenic culture; egg development time and larval period: see under "Egg:" and "Larvae:" above); 62, Table 2 (net reproductive rate or number of females produced in each generation: 117 and 35 females in xenic and monoxenic cultures, respectively; mean generation time or average age at which females lay their eggs: 18 and 15 days in xenic and monoxenic cultures, respectively).

Feeding habit: Bacterivore: Yeates et al. 1993: 319.

c-p rating: 2: Bongers 1990: 15.

Culture: Anderson 1968a: 310 (on 1.5% potato-dextrose-agar seeded with a mixture of bacteria isolated from a streak plate of a soil suspension); Boström & Gydemo 1983: 246 (in drops of Nigon's (1949: 1-132) peptone-lecithin agar inoculated with *Escherichia coli*); Bird et al. 1993: 607 (on *Pseudomonas corrugata* growing on plates of 4% malt extract agar at 22-23 °C); Ruess & Dighton 1996: 330-346 (reproduced well in cultures with mycorrhizal fungi); Ilieva-Makulec 1998: 59 (on 0.6% bacto agar, with a bacterium, *Sporosarcina* sp., as food organism; in darkness at 20 °C, without nutrients).

Misc.: Popovici 1984: 207 (mean individual wet mass of adults: 0.1395 µg); Walter & Ikonen 1989: 320, Table 2 (mean daily consumption of about 43 nematodes in 9 species by the nematophagous female ascid mite, *Gamasellodes vermicivorax*, included about 6 or 14% *A. nanus*); Martikainen & Huhta 1990: 13-20 (in microcosms simulating the humus+litter layers of a spruce-birch forest in Finland, two taxa of predatory, mesostigmatic mites significantly reduced the numbers of *A. nanus* and an *Aphelenchoïdes* sp.; regulation of the nematode populations by the mites did not affect decomposition rate, leaching of nutrients, or amounts of fungal hyphae).

DISTRIBUTION

Nearctic: Anderson 1968a: 309 (Canada - QC); Johnson et al. 1972: 179 (USA - IN); Al-Banna & Gardner 1996: 974 (USA - CA).

Paleartic: Wasilewska 1970: 435; Wasilewska 1971: 652 (Poland); Sohlenius 1973: 206 (Sweden); Boström & Gydemo 1983: 245 (Sweden); Popovici 1984: 205 (Romania); Sohlenius & Wasilewska 1984: 335 (Sweden); Zullini & Peretti 1986: 403 (Italy); Sohlenius & Sandor 1987: 22, Table 4 (Sweden); Sohlenius et al. 1987: 132 (Sweden); Bongers 1988: 214 (Netherlands); Šály 1989: 48 (Czechoslovakia); Hansson et al. 1990: 41-83 (Sweden); Háněl & Šimek 1993: 110 (Czech Republic); Sohlenius 1993: 263 (Sweden); van de Velde et al. 1994: 543 (original soil samples from Sweden); Hodda & Wanless 1994: 116 (England); Brzeski 1995: 339 (Poland); Háněl 1995: 203 (Czech Republic: South Bohemia); Ruess 1995: 107 (Germany); Armendáriz et al. 1996: 566 (Spain); de Goede 1996: 228 (Netherlands); Háněl 1996: 15 (Czech Republic: Beskydy Mountains); Ruess et al. 1996: 52 (Scotland); Sohlenius 1997: 108 (Sweden); Alphei 1998: 10 (Germany); Háněl 1998: 37 (Czech Republic: South Moravia); Háněl 1999: 92, Table 1 (Czech Republic: Trojmezná hora Reserve); Sohlenius & Boström 1999: 698 (northern Sweden); Háněl 2002: 188 (Czech Republic: Novohradské hory Mountains).

Neotropical: Rashid et al. 1984: 252 (Brazil).

Oriental: Rashid et al. 1988: 34 (Indonesia).

Australian: Bird et al. 1993: 607 (Australia - NSW).

Cosmopolitan: Bongers 1988: 214.

HABITAT

Agroecosystems: Sohlenius & Sandor 1987: 22, Table 4 (barley field); Sohlenius et al. 1987: 138 (barley crops under different cropping systems); Šály 1989: 52 (herbicide-treated vineyards); Hansson et al. 1990: 41-83; Háněl & Šimek 1993: 111 (roots of red clover, *Trifolium pratense* L.); Al-Banna & Gardner 1996: 974 (California native grape, *Vitis californica*);

Forest: Wasilewska 1970: 435 (afforested dunes: in all six successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Wasilewska 1971: 652 (afforested dunes); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Sohlenius 1973: 206 (in raw humus of pine forest; tree layer of *Picea* and *Abies* spp., ground layer of *Vaccinium* sp., mosses and grasses); Boström & Gydemo 1983: 245 (mixed pine forest, mainly *Picea abies* and *Pinus sylvestris*; ground layer vegetation mainly *Vaccinium myrtillus* mixed with grasses, mosses, lichens and heather); Popovici 1984: 205 (beech forest, Western Carpathians; 1300 m); Sohlenius & Wasilewska 1984: 335 (natural, irrigated and/or fertilized Scots pine forest; most dominant among 33 nematode species from all treatments); Sohlenius 1993: 265, 266 (Scots pine forest; from old stand and clearcut area; podzol soil); van de Velde et al. 1994: 543 (in pine forest soil); Brzeski 1995: 341-342 (moss and soil in Scots pine forest); Háněl 1995: 199, 203 (cambisol soil under oak forest); Ruess 1995: 110 (*Picea abies* stands; a eudominant species, i.e. >10%); Armendáriz et al. 1996: 561 (*Pinus nigra* soil); de Goede 1996: 228 (Scots pine forest); Háněl 1996: 18 (5-134 year old spruce forests); Ruess et al. 1996: 57 (natural and acidified soil in Sitka spruce forest); Sohlenius 1997: 104, 108-110 (in humus, litter and mineral layers of soil in a Scots pine forest on glacifluvial sediment); Alphei 1998: 11 (beech forest: mull and moder soils); Háněl 1998: 41 (oak, oak-linden, linden-oak and hornbeam-linden forests); Háněl 1999: 92, Table 1 (spruce woodland); Háněl 2002: 188 (acid climax spruce forest).

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Grassland: Sohlenius & Sandor 1987: 22, Table 4 (grass ley); Hodda & Wanless 1994: 121 (chalk grasslands); Háněl 1998: 41 (floodplain meadows); Háněl 1999: 92, Table 1 (grassy upland).

Tundra: Sohlenius & Boström 1999: 696 (peat from ombrotrophic mire).

Misc.: Rashid et al. 1984: 254, Table 1 (around roots of various plants, especially *Theobroma cacao* L.; grasses); Zullini & Peretti 1986: 405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Bongers 1988: 214 (common in sand dunes); Háněl 1995: 199-200, 203 (cultivated field, fallow, meadow; soil type silt loam cambisol).

MISC. INFORMATION

Morphology: Boström 1985: 213, Fig. 1 (SEM micrograph of anterior end, and associated structures of chemo- and mechano-reception); 213, Figs. 3, 5 (ultrastructure: transverse sections through labial probola and cheilarhabdion; 214, Figs. 7-10 (ultrastructure: sections through anterior end at level of prostom showing various sensory structures); van de Velde et al. 1994: 545, Fig. 1 A, D (ultrastructure of anterior body cuticle, and at level of amphidial aperture; longitudinal sections); 551, Fig. 4 (ultrastructure of the buccal region showing pharyngeal muscles, dorsal pharyngeal gland, and gland duct).

Physiology: Boström & Gydemo 1983: 252 (qualitative differences in isoenzyme patterns in different populations of *A. nanus*).

Misc.: Nicholas & Stewart 1989: 489-491 (long-term anhydrobiosis: *A. nanus* were isolated from soil samples stored for 6.5 years in plastic bags); Walter & Ikonen 1989: 320, Table 2 (faunal interactions in soils: under experimental conditions at 25° C, adult females of the nematophagous mite, *Gamasellodes vermicivorax*, fed on six *A. nanus* in 24 hours).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 21 (Key to 9 species in the genus *Acobeloides* Cobb, 1924); Bongers 1988: 208 (Key to 9 genera, including *Acobeloides*, in the family Cephalobidae).

Morphology: van de Velde et al. 1994: 545, Fig. 1 C (ultrastructure of anterior body cuticle of *Acobeloides* sp. at level of amphidial aperture; longitudinal section); 545, 547, 549, Figs. 1E, 2, 3 (ultrastructure of the anterior part of buccal cavity, or the entire buccal cavity of *Acobeloides* sp. showing the different buccal regions; longitudinal sections); 553, 557, Figs. 5, 6 (ultrastructure of the pharyngeal muscle arrangement in *Acobeloides* sp.; longitudinal sections).

***Cephalobus persegnis* Bastian, 1865**

Cephalobus persegnis Bastian, 1865; Bastian 1865: 73-184; non Bütschli, 1873: 1-144

Cephalobus brevicaudatus Zimmermann, 1898; Zimmermann 1898: 1-64; Andrássy 1967a: 16

Cephalobus persegnis brevicaudatus Zimmermann, 1898; Zimmermann 1898: 1-64; Andrássy 1967a: 16

Chiloplacus trilineatus Steiner, 1940; Steiner 1940: 54-62; Anderson & Hooper 1970: 457

REMARKS

(1) Anderson & Hooper (1970: 457-458) discussed the taxonomic significance of head structures in the cephalobid genera *Cephalobus*, *Acrobeloides* and *Acrobeloides* with reference to the earlier literature, and concluded that the identity of *C. persegnis* and relationships of *Cephalobus* to *Acobeloides* were confused. They concluded (p. 459) that the species they identified as *C. persegnis* from the type locality were topotypes of *C. persegnis* Bastain, 1865.

(2) Although *Cephalobus persegnis* of Bütschli, 1873 is a homonym, Bütschli's species is equal to *Cephalobus buetschlii* de Man, 1884, which is itself a synonym of *Acrobeloides nanus* (de Man, 1880). According to Altherr (1955) the valid name is for Bastain's species (Tarjan and Hooper 1974: 226).

DESCRIPTION

British Columbia Material

Fig. 41, after Goodey (1963: 273). This species was not identified from a particular key, but was determined by comparisons with published descriptions and illustrations of species in the genus *Cephalobus*, including those in Thorne (1961) and Anderson & Hooper (1970). It agreed with the description in Goodey (1963: 273).

Other Descriptions

Female: Chitwood & Chitwood 1950: 142, Fig. 117 B (reproductive system); Goodey 1963: 272; 273, Fig. 147 A, D (whole body; tail end); Grassé 1965c: 787, Fig. 600 A, C; Anderson & Hooper 1970: 460 (neotype, topotypes: morphometrics); 461, Fig. 1 A-C (whole body and reproductive system); 462, Fig. 2 A (anterior and oesophageal regions); 462, Fig. 2 B (*en face* view showing triradiate mouth opening, cheilarhabdions, duplex lips, arrangement of labial papillae and labial probolae); 462, Fig. 1 C-F (cross sections through stoma at: immediately below cheilarhabdions, prorhabdions, metarhabdions, and telorhabdions); 462, Fig. 2 G-J (cross sections through oesophagus at: immediately posterior to telorhabdions, corpus, isthmus, and basal oesophageal flaps); 465, Fig. 5 A-J (variations in tail shape of specimens from soil and cultures); Southey 1978a: 249, Fig. 12.4 A, D (whole body, tail); Geraert et al. 1980: 105, Fig. 10 B (genital system - schematic); Geraert 1983: 78, Fig. 2 (c) (reproductive system of *C. persegnis* as representing the cephalobid-type of reproductive system); Bongers 1988: 208, 26.1.1 (tail end).

Male: Goodey 1963: 272; 273, Fig. 147 B (posterior end); Grassé 1965a: 202, Fig. 273 I (spicule); 787, Fig. 600 B (posterior part); Anderson & Hooper 1970: 460 (topotypes: morphometrics); 461, Fig. 1 D (whole male); 463, Fig. 3 A (tail showing preanal and postanal supplements); 463, Fig. 3 B (serial cross sections of tail from anterior third to tail terminus); 463, Fig. 3 C-D (lateral view of tail showing variation in number and position of postanal supplements); 463, Fig. 3 F-I (structural parts of gubernaculum); 463, Fig. 3 J-K (tail shape variations in culture specimens); Southey 1978a: 249, Fig. 12.4 B (tail and spicules); Bongers 1988: 208, 26.1.1 (tail end).

Misc.: Chitwood & Chitwood 1950: 58, Fig. 54 W (cephalic region); Goodey 1963: 272; 273, Fig. 147 C (anterior end: structure of wall of stoma as distinguished by the sclerotized rhabdions); Anderson & Hooper 1970: 464, Fig. 4 A-L (head views showing variations in labial probolae); Southey 1978a: 249, Fig. 12.4 C (anterior end: structure of stomal wall); Bongers 1988: 208, 26.1.1 (anterior part, head end).

BIOLOGY

Life-cycle: Nielsen 1949: 94, Table 24 (time required to develop from egg to egg at 15-16° C: about 20 days); Ferris et al. 1996: 275, Fig. 1 (stage-specific developmental periods on bacterial cultures averaged 1.5 days for eggs, 1.7 days for juvenile stages J1+J2, 2.8 days for J3, 2.5 days for J4, and 22.0 days as adults, with a total life span of 30 days; see also section on culture method below); 274 (egg production rate at 20° C: 12.5 eggs per day for 21.3 days).

Feeding habit: Bacterivore: Yeates et al. 1993: 320; Nielsen 1949: 88 (found bacteria in the gut in great numbers); Ferris et al. 1996: 272 (on *Escherichia coli*).

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c-p rating: 2: Bongers 1990: 15.

Culture: Nielsen 1949: 88 (easily cultured on *Micrococcus* sp.); Anderson & Hooper 1970: 458 (on peptone-lecithin agar medium of Nigon 1949: 1-132; presoaking the nematodes in 0.1% malachite green substantially decreased fungal contamination of the cultures; males and females present in cultures in about equal numbers); Popovici 1972 (in agar cultures at 21° C, females produced 10-19 eggs per day for 26.5 days, yielding 299 eggs); Ferris et al. 1996: 271, 277 (cultured from a fourth-stage juvenile or J4, on a lawn of *Escherichia coli* in nutrient agar plus cholesterol at 20° C; average life span was 30 days with 21.3 days or 71% duration of oviposition; rate of egg production was 12.5 eggs per day per female; see also section on "Life-cycle" above).

Misc.: Yeates 1973: 183, Fig. 3 (on percentage contribution of juveniles, non-gravid females, gravid females, and males to monthly abundance and biomass in this species); 182 (population make-up: juveniles 65%, females 21%, gravid females 3%, males 11%); 184 (vertical distribution to 6 cm soil depth: 3% in litter, 97% below litter); 184 (mean individual weight 0.116 µg); Yeates & Wardle 1996: 47, Table 1 (provide evidence that populations of the predatory mononchid nematodes in soil may be regulated, in part, by availability of *C. persegnis* as their prey).

DISTRIBUTION

Nearctic: Smolik 1974: 7 (USA - SD).

Paleartic: Anderson & Hooper 1970: 458 (UK); Wasilewska 1970: 435 (Poland); Yeates 1972b: 179 (Denmark); Yeates 1973: 180 (Denmark); Arpin 1975: 494 (France); Arpin & Ponge 1986: 396 (France); Zullini & Peretti 1986: 403 (Italy); Bongers 1988: 208 (Netherlands); Hansson et al. 1990: 41-83 (Sweden); Dmowska 1993: 98 (Poland); Háněl & Šimek 1993: 110 (Czech Republic); Hodda & Wanless 1994: 116 (England); Háněl: 1995: 197 (Czech Republic: South Bohemia); Háněl 1996: 15: (Czech Republic: Beskydy Mountains); Armendáriz et al. 1996: 566 (Spain); Alphei 1998: 10 (Germany); Háněl 1998: 37 (Czech Republic: South Moravia).

Ethiopian: Jacobs 1984: 284 (Zaire).

Cosmopolitan: Bongers 1988: 208.

HABITAT

Agroecosystems: Hansson et al. 1990: 41-83; Háněl & Šimek 1993: 111 (roots of red clover, *Trifolium pratense* L.); Dmowska 1993: 99 (*Lolium*-field).

Forest: Wasilewska 1970: 435 (afforested dunes: found in all six successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Yeates 1972b: 181 (beech forest, *Fagus sylvatica* L.); Yeates 1973: 180 (beech forest); Arpin & Ponge 1986: 396 (oak and pine plantations); Háněl 1995: 203 (oak forest; cambisol soil); Armendáriz et al. 1996: 561 (*Pinus nigra* soil); Háněl 1996: 18 (5 and 105 year old spruce forests); Alphei 1998: 11 (beech forest: mull soils); Háněl 1998: 41 (oak, oak-linden, linden-oak and hornbeam-linden forests).

Grassland: Smolik 1974: 7; Hodda & Wanless 1994: 121 (chalk grasslands); Háněl 1998: 41 (floodplain meadows).

Misc.: Anderson & Hooper 1970: 458 (fallow field with sandy loam soil containing little organic matter); Arpin 1975: 517 (park, with *Carpinus*, *Mercurialis* and *Hedera* spp.; calcareous soil, pH 8); Jacobs 1984: 284 (aquatic - thermal water and hot springs; non-aquatic - terrestrial, bryoedaphic and lichenedaphic); Zullini & Peretti 1986: 405 (mosses on walls in industrial area

with high lead pollution of atmospheric origin); Bongers 1988: 209 (in freshwater; prefers dry, arid conditions); Háněl 1995: 199-200 (field, fallow, meadow; soil type silt loam cambisol).

MISC. INFORMATION

Physiology: Yeates 1973: 184 (oxygen consumption: 34 ml O₂ m⁻²).

ADDITIONAL REFERENCES

Key: Bongers 1988: 208 (Key to 9 genera, including *Cephalobus* Bastian, 1865, in the family Cephalobidae Filipjev, 1934).

Morphology: De Ley et al. 1995: 156 (stoma structure in Cephalobidae as revealed by TEM).

***Chiloplacus* sp.**

DESCRIPTION

British Columbia Material

Fig. 42, after Goodey (1963: 279). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the keys in Hopper & Cairns (1959: 19) and Bongers (1988: 208). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 280 (the type species for the genus is *Chiloplacus symmetricus* (Thorne, 1925) Thorne, 1937); 279, Fig. 151 A-B (anterior end and male tail end of *C. symmetricus*).

BIOLOGY

Feeding habit: Bacterivore: Yeates et al. 1993: 320.

c-p rating: 2: Bongers 1990: 15.

MISC. INFORMATION

Morphology: van de Velde et al. 1994: 545, Fig. 1 B (ultrastructure of anterior body cuticle; longitudinal section); 559, Fig. 7 (ultrastructure of arrangement of pharyngeal muscles, dorsal pharyngeal gland, gland duct, and tri-radiate lumen of pharynx; longitudinal and transverse sections).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 19 (Key to 7 genera, including *Chiloplacus* Thorne, 1937, in the subfamily Acrobelinae Thorne, 1937; 20 (Key to 11 species in the genus *Chiloplacus*); Bongers 1988: 208 (Key to 9 genera, including *Chiloplacus*, in the family Cephalobidae Filipjev, 1934).

Misc.: Goodey 1963: 278 (diagnostic characters of the genus *Chiloplacus*); Bongers 1988: 216 (diagnostic characters of the genus *Chiloplacus*).

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Thorne 1949: 38 (diagnosis and general description of Tylenchida n. ord.); Hooper 1978: 26 (description of this order); Hooper 1978: 40-45 (Key to subfamilies of plant and soil Tylenchida); Anderson & Mulvey 1979: 19-30 (Key to 47 genera of plant-parasitic nematodes in Canada in this order); Dropkin 1980: 75, Table 5.2 (a lattice, based on 9 character states, for the separation of 11 families in this order); Siddiqi 1980: 154 (on the origin and phylogeny of this order); 155 (phylogeny: on common ancestry of the orders Tylenchida and Rhabditida);

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156 (phylogeny of this order in respect to distinct origins and evolutionary lines of four suborders: Tylenchina, Criconematina, Hexatylina and Myenchina); 168 (on ecological, ethological and mostly morphological evidences, the orders Tylenchida and Aphelenchida were deemed to represent different evolutionary lines and neither could have been derived from the other); Siddiqi 1983: 124-126 (on the origin and evolution of plant-parasitism in this order); Geraert 1983: 74-77, Fig. 1 (three main types of female genital systems in this order, represented by the Aphelenchidae-type, the Aphelenchoididae-type and the Tylenchina-type; their morphology is helpful in elucidating problems of classification); 81 (in this order, the morphology of the female genital system is useful in elucidating the systematic position of some genera or families); Diederich et al. 2000: 807, Table 1 (list of morpho-anatomical structures for nematodes in the order Tylenchida, for developing a uniform method for building databases in taxonomy and identification; the structures relate to external morphology, body envelopes, skeleton, and all organ and sub-organ systems).

Suborder Tylenchina

Luc et al. 1987 (a reappraisal of this suborder: phenetics versus cladistic approaches to taxonomy; desirability of applying principles of evolution to taxonomy, by combining morpho-anatomical and biological data, for stabilization and clarification of the status of taxa; reassessment of generic validity; euryomorphic versus oligomorphic genera; evolution and systematics; phylogenetic trends in this suborder in relation to male and female morpho-anatomy, and evolution of plant-parasitic habit and parthenogenesis; definition of a hypothetical "prototylenchid" based on these trends, and the tylenchid genus *Psilenchus* as being the closest form to this prototylenchid); Maggenti et al. 1987: 136 (diagnostic characteristics of this suborder).

Family Tylenchidae Filipjev, 1934

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 88), Heyns (1971: 61), Paramonov (1972: 49), Hooper (1978: 26), Maggenti (1982: 924), Geraert & Raski (1987: 144), Maggenti et al. 1987: 137), Bongers (1988: 67). Raski & Maggenti 1983: 131-142 (a broad perspective, including a brief history and proposal of a model of inferred phylogeny among Tylenchidae); Geraert & Raski 1987: 145-149, Figs. 1-2 (comparative morphology of various genera in the family Tylenchidae: lip area and *en face* views; morphometrics, female reproductive system). There is little agreement on the authority for this family (see Goodey 1963, Heyns 1971, Paramonov 1972, Andrassy 1976, Bongers 1988, Ebsary 1991), and we have chosen to accept Filipjev, 1934, which is the choice of many authors.

***Psilenchus* sp.**

REMARKS

Bongers (1988: 81) placed the genus *Psilenchus* de Man, 1921, in the family Psilenchidae Paramonov, 1967.

DESCRIPTION

British Columbia Material

Fig. 43, after Sasser & Jenkins (1960: 173). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by comparisons with the descriptions, illustrations, diagoseses or keys in Thorne (1949: 60-61),

Sasser & Jenkins (1960: 173), Paramonov (1972: 139), Geraert & Raski (1987: 158) and Siddiqi (1985: 228-230). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 33 (the type species for this genus is *Psilenchus hilarulus* de Man, 1921); 33-34, Fig. 4 A-G (description; *en face* view, head end, whole female, male tail, cuticular pattern near female anus, deirid and excretory pore, variations in tip of female tail of *P. hilarulus*).

BIOLOGY

Feeding habit: Plant-parasitic (plant-feeding): Yeates et al. 1993: 323 (epidermal cell and root hair feeder).

c-p rating: 2: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Thorne 1949: 60-61 (diagnosis of the genus *Psilenchus* de Man, 1921; Key to 6 species in the genus *Psilenchus*); Hopper & Cairns 1959: 66 (Key to 7 species in the genus *Psilenchus*); Paramonov 1972: 139 (Key to 6 species of *Psilenchus*; description of the type species *P. hilarulus* de Man, 1921); Geraert & Raski 1987: 158 (Key to 34 genera, including *Psilenchus*, and 11 species of *Psilenchus*, in the family Tylenchidae Örley, 1880; Bongers 1988: 81 (Key to 3 species in the genus *Psilenchus*); Brzeski 1989: 51 (male and female morphology of the genus *Psilenchus*); 66-67 (Tabular Key to 12 species of *Psilenchus*).

Description: Goodey 1963: 33 (diagnostic characters of the genus *Psilenchus* de Man, 1921); Paramonov 1972: 138 (diagnosis of the subfamily *Psilenchinae*); Siddiqi 1985: 228-230 (on the genus *Psilenchus*).

Distribution: Heyns 1971: 63 (South Africa); Sohlenius & Wasilewska 1984: 327-342 (Sweden).

Habitat: Sohlenius & Wasilewska 1984: 327-342 (pine forest soil).

Misc.: Goodey 1963: 33 (diagnostic characters of the genus *Psilenchus*); Bongers 1988: 81 (diagnostic characters of the genus *Psilenchus*).

***Tylenchus* sp.**

DESCRIPTION

British Columbia Material

Fig. 44, after Heyns (1971: 60). The British Columbia specimens could not be identified to species level by use of the available keys. They were identified to genus by use of the descriptions, illustrations, diagoneses or keys in Filipjev (1934a: 27), Heyns (1971: 60), Paramonov (1972: 58-75), Corbett (1978: 188), Siddiqi (1985: 108-110), Geraert & Raski (1987: 158) and Bongers (1988: 67). The following information relates mostly to the genus.

Other Descriptions

Misc.: Goodey 1963: 27 (the type species for this genus is *Tylenchus (Tylenchus) davainei* Bastian, 1865 (Filipjev, 1934); 27-28, Fig. 2 A-G (description; whole female, anterior end, *en face* view, male tail region, bursal-cloacal region with spicular apparatus, cuticle near female anus, deirid and excretory pore of *T. (Tylenchus) davainei*).

BIOLOGY

Feeding habit: Plant-parasitic (plant-feeding): Yeates et al. 1993: 324 (also feed on algae, and lichen and moss cells by piercing).

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c-p rating: 2: Bongers 1990: 15.

ADDITIONAL REFERENCES

Key: Filipjev 1934a: 27 (simplified Key to genera in the family Tylenchidae; keys out 7 genera, including *Aphelenchus*, *Aphelenchoïdes* and *Tylenchus* of this Monograph); Hopper & Cairns 1959: 61 (Key to 4 subgenera in the genus *Tylenchus* Bastian, 1865); 61 (Key to 19 species in the subgenus *Tylenchus* (Bastian, 1865)); 63 (Key to 15 species in the genus *Tylenchus*); Paramonov 1972: 62 (Key to 11 selected species in the subgenus *Tylenchus* (*Filenchus*) Andrassy, 1954); 69 (Key to 5 selected species in the subgenus *Tylenchus* (*Lelenchus*) Andrassy, 1954); 72 (Key to 3 selected species in the subgenus *Tylenchus* (*Cephalenchus*) J. B. Goodey 1962); Corbett 1978: 188 (Key to the genus *Tylenchus* and 7 closely related genera); Geraert & Raski 1987: 158 (Key to 34 genera, including *Tylenchus*, and 11 species in the family Tylenchidae Örley, 1880; note: we have this genus under the family Tylenchidae with its authority as Filipjev, 1934); Bongers 1988: 67 (Key to 12 genera, including *Tylenchus*, in the family Tylenchidae Filipjev, 1934; 75 (Key to 3 species in the genus *Tylenchus*).

Descriptions: Thorne 1949 (diagnosis of the genus *Tylenchus*); Goodey 1963: 25, 27 (diagnostic characters of the genus *Tylenchus*); Wu, L. Y. 1969: 1005-1010 (described 5 new species of *Tylenchus* from Canadian Arctic); Paramonov 1972: 58-75, Figs. 17-21 (diagnoses and descriptions of the genus *Tylenchus*, and the subgenera *T. (Tylenchus)*, *T. (Filenchus)*, *T. (Lelenchus)* and *T. (Cephalenchus)*, and 21 species thereof); Siddiqi 1985: 108-110 (on the genus *Tylenchus*); Bongers 1988: 75 (diagnostic characters of the genus *Tylenchus*); Brzeski 1996: 387-389 (male and female morphology and morphometrics of the genus *Tylenchus*); 389 (main diagnostic characters of *Tylenchus*); 390, Table 1 (coefficients of variability calculated for 11 morphometric characters for five *Tylenchus* species; 4 of these characters considered to be reliable for differentiation of *Tylenchus* species).

Family Anguinidae Nicoll, 1935

Definitions, descriptions or diagnostic characteristics of this family: Brzeski (1981: 24); Fortuner & Maggenti (1987: 164), Maggenti et al. (1987: 137), Bongers (1988: 169), Brzeski (1991: 10). Brzeski 1981: 23-25 (reviewed this family: redefinition by including 8 genera; general morphology of members of the family). Fortuner & Maggenti 1987: 164 (discussion on synonymy of Anguinidae); 174 (hypothetical considerations in the evolution of the anguinids).

***Ditylenchus myceliophagus* Goodey, 1958**

Ditylenchus myceliophagus Goodey, 1958; Goodey 1958: 91

Tylenchus geraerti Paramonov, 1970; Paramonov 1972: 83 [English translation of Paramonov 1970]

Ditylenchus geraerti, Fortuner 1982: 28

REMARKS

Although Smart & Darling (1963; cited in Hooper 1969: 136) regarded *D. myceliophagus* as a junior synonym of *Ditylenchus destructor* Thorne, 1945, and SON (1984: 31) considered the former to be a physiological race of the latter, we nevertheless designate *D. myceliophagus* as a distinct species. Until Goodey (1958) described *D. myceliophagus*, *Ditylenchus* nematodes in mushroom beds were usually identified as *D. destructor* (Hesling 1972: 452-453; in Webster 1972). Since 1958, most reports of *Ditylenchus* in mushrooms beds have been cited as

D. myceliophagus. Also, Webster & Hooper (1968; cited in Hooper 1969: 137) separated *D. destructor* and *D. myceliophagus* using serological techniques.

DESCRIPTION

British Columbia Material

Fig. 45, after Hooper & Southey (1978a: 88) and Brzeski (1991: 37). This species was identified by use of the keys in Hopper & Cairns (1959: 65), von Hirling (1969: 419), Paramonov (1972: 87) and Bongers (1988: 172). It agreed with the descriptions in these references and in Hooper & Southey (1978a: 88).

Other Descriptions

Female: Paramonov 1972: 104; 105, Fig. 37 A; Hooper & Southey 1978a: 87; 88, Fig. 4.3 B (posterior part, including uteri and vagina); Fortuner 1982: 19, Fig. 1 (graphic representation of correlations between five basic de Man ratios and post-uterine sac length in relation to vulva-anus distance and body diameter); 20, Table 1 (quantitative measurements based on 13 morphometrical criteria of individuals in four populations); 22, Fig. 2 A-M (whole body of large versus small female; anterior ends with abutting oesophageal glands versus dorsal oesophageal gland overlapping intestine; lateral fields with 6 to 8 lateral lines; posterior ends showing variations in tail; ovaries showing post-uterine sac empty or with sperms); 25 (genital apparatus: ovary, spermatheca, columella, post-uterine sac, vulva; comparative review of these characters in species of *Ditylenchus*, including *D. myceliophagus*); Bongers 1988: 173 (morphometrics); 174, Fig. 18.2.5 (tail region); Zeidan & Geraert 1991b: 9 (morphometrics); 8, Fig. 2 I (genital system); 8, Fig. 2 K (lateral field); 8, Fig. 2 L (anterior region up to oesophageal-intestinal junction); 8, Fig. 2 M-N, R (variation in tail shape); 8, Fig. 2 P-Q (variation in oesophageal-intestinal overlap); Brzeski 1991: 16, Table 1 (diagnostic features, including de Man ratios); 36 (morphometrics of Polish and Syrian collections); 37, Fig. 14 A-E (oesophageal region, posterior oesophagus, head, lateral field, tail); 38 (morpho-anatomical description).

Male: Paramonov 1972: 104; 105, Fig. 37 C; 105 (cephalic end); Hooper & Southey 1978a: 87; 88, Fig. 4.3 A (posterior part, spicules); Fortuner 1982: 22, Fig. 2 N-O (posterior ends showing spicular apparatus and bursa); 27, Table 2 (quantitative measurements based on 13 morphometrical criteria of individuals in four populations); 26 (genital characters: spicules, bursa, sperm cells; comparative review of these characters in species of *Ditylenchus*, including *D. myceliophagus*); Bongers 1988: 173 (morphometrics); 174, Fig. 18.2.5 (tail region); Zeidan & Geraert 1991b: 9 (morphometrics); 8, Fig. 2 J (anterior region up to oesophageal-intestinal junction); 8, Fig. 2 O (tail region: bursa, spicule); Brzeski 1991: 16, Table 1 (diagnostic features, including de Man ratios); 36 (morphometrics of Polish and Syrian collections); 37, Fig. 14 (tail region); 38 (morpho-anatomical description).

Misc.: Hesling 1974: 4 pp. (review on variations in size of specimens depending on age, host, nutrition, temperature and other environmental factors; hence care needed in identification); Fortuner 1982: 23-24 (digestive system: stylet, cephalic framework, oesophagus, median bulb, oesophageal glands; comparative review of these characters in species of *Ditylenchus*, including *D. myceliophagus*); 24, Fig. 3 (variability in the disposition of oesophageal glandular lobes during development of *D. myceliophagus* from juvenile to adult stage); Bongers 1988: 174, Fig. 18.2.5 (anterior part).

IDENTIFICATION KEY

Hopper & Cairns 1959: 65 (Key to 19 species, including *D. myceliophagus*, in the genus *Ditylenchus* Filipjev, 1934); von Hirling 1969: 419 (Tabular Key to 6 species, including

Order TYLENCHIDA

D. myceliophagus, in the genus *Ditylenchus*); Paramonov 1972: 87 (Key to 22 species, including *D. myceliophagus*, in the genus *Ditylenchus*); Fortuner 1982: 34, Table 3 (Tabular Key to 37 species of *Ditylenchus*, including *D. myceliophagus*, based on seven most reliable morphometrical characters); Bongers 1988: 172 (Key to 6 species, including *D. myceliophagus*, in the genus *Ditylenchus*).

BIOLOGY

Life-cycle: Hooper 1969: 134 (citing Cayrol & Legay 1967: temperature greatly affected measurements of the various developmental stages); Hesling 1972: 452 (life-cycle completed in 40 days at 13° C, 26 days at 18° C and 11 days at 23° C); Hooper & Southey 1978a: 87 (citing Cayrol 1964: life-cycle influenced by temperature, being about 42 days at 13° C and 18 days at 23° C); Lee & Atkinson 1976: 89 (rate of development suppressed by low oxygen concentration).

Feeding habit: Fungivore: Yeates et al. 1990: 320; Sasser & Jenkins 1960: 361 (feeds mainly on fungi/mushrooms; may also feed on soil algae); Doncaster 1966: 417-427 (detailed description of mechanism and behaviour of feeding); Lee & Atkinson 1976: 42 (a slow feeder, with a 40-minute period of injection of dorsal pharyngeal gland enzymes into fungal cell, followed by a similar period of pharyngeal pumping to withdraw cell contents); 51 (enzyme chitinase present in pharyngeal glands helps to breakdown fungal chitin).

c-p rating: 2: Bongers 1990: 15.

Survival strategy: Sasser & Jenkins 1960: 362 (the later larval stages and young adults are especially capable of anabiosis for long periods; in this state of dormancy, they are considerably more heat resistant, hence more likely to survive in fermenting or heat-treated compost in which the rate of mycelial destruction is high and hence nematode reproduction is low); Perry 1977: 45-70 (at both 0% and 50% relative humidity, all developmental stages dry very rapidly due to a lack of ability to control water loss); Womersley 1978: 401-405 (behavioural responses of body coiling and clumping to drying conditions reduce rate of water loss); Womersley et al. 1998: 271-302 (lack of food, or toxic products, from decaying host results in mass movement or swarming, followed by aggregation and coiling during subsequent dehydration in the absence of a host); Perry 1999: S25 (preliminary preparation for dry conditions by synthesizing trehalose, but this may not indicate survival under severe desiccation).

Culture: Fortuner 1982: 18 (on the fungus *Colletotrichum gloeosporioides* Penz., growing on potato-dextrose agar); SON 1984: 31 (populations increased optimally at 25° C on *Agaricus bisporus*, with more females initially, but males predominating at the end of the experiment).

Misc.: SON 1984: 31 (main means of dissemination in a mushroom house was by dipterous insects).

DISTRIBUTION

Nearctic: SON 1984: 31 (USA - KS); Lownsbery & Lownsbery 1985: 8 (USA - CA: Sierra, Cascade-North Sierra and Central Coast floristic zones).

Paleartic: Wasilewska 1970: 434 (Poland); Bongers 1988: 173 (Netherlands); Brzeski 1991: 38 (Bulgaria, Poland, Syria); Hodda & Wanless 1994: 116 (England); de Goede 1996: 228 (Netherlands).

Ethiopian: Fortuner 1982: 18 (Ivory Coast; Upper Volta); Zeidan & Geraert 1991b: 9, 11 (Sudan).

Cosmopolitan: Hooper & Southey 1978a: 87 (mushroom growing regions throughout the world, particularly in temperate areas).

HABITAT

Agroecosystems: Fortuner 1982: 18 (rice panicles; soil around roots of sugarcane); Zeidan & Geraert 1991b: 5, 11 (rhizosphere of wilting, yellowing and poorly growing cultivated and ornamental plants and fruit trees).

Forest: Wasilewska 1970: 434 (afforested dunes: in the earlier four of six successional stages, characterized by age and number of species of coniferous and hardwood trees, and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Fortuner 1982: 18 (forest soil; Taï forest); Lownsbery & Lownsbery 1985: 8 (associated with Red-fir and Douglas-fir, Incense cedar, and Jeffrey and Ponderosa pines); de Goede 1996: 228 (Scots pine forest).

Grassland: SON 1984: 31 (in a native of Kansas prairie); Hodda & Wanless 1994: 121 (chalk grasslands).

Misc.: Brzeski 1991: 38 (soils in general).

MISC. INFORMATION

Economic importance: Hesling 1972: 435-468 (review on nematode pests of mushrooms, including *D. myceliophagus*, and its economic impact in mushroom industry; *D. myceliophagus* populations increase optimally at mushroom-growing temperatures of 18° C; at 26° C reproduction almost ceases; cites a suggestion for raising mushrooms under cooler conditions of 7-10° C, but this considered economically unacceptable for intensive mushroom production); Hooper & Southey 1978a: 88 (destruction of mushroom mycelia by *D. myceliophagus* results in formation of dense clusters of the nematodes on or beneath the mushroom boxes, from where they can be dispersed by insects); Dropkin 1980: 84 (a pest of the mushroom industry); SON 1984: 31 (common in mushroom spawn houses).

Physiology: Sasser & Jenkins 1960: 361 (*D. myceliophagus* discharges the hydrolytic enzymes chitinase and cellulase which aid in penetrating chitinous cell walls of fungi or the cellulose walls of soil algae during feeding); Giebel 1974: 176, Table 1 (hydrolytic enzymes identified from the nematode: pectinmethyl esterase, cellulase, polygalacturonase; involved in metabolic changes in host plant); Barrett 1976: 43 (lipid content is 33% by dry weight); Croll & de Soyza 1980: 132-135 (calorific value: 20.679 j/mg); Evans & Womersley 1980: 205, Table II (analysis of lipid and carbohydrate changes in the nematode before, during, and after desiccation by slow drying); Barrett 1991: 166 (citing Womersley 1987: a biochemical adaptation of *D. myceliophagus* during desiccation is to accumulate glycerol and ribitol).

Misc.: Cayrol 1970: 409-440 (feeding on eggs of *D. myceliophagus* by the mite *Lasioeius thermophilus* resulted in reduction of the nematode's population); Yeates 1979: 222 (dry-matter content ranges from 20%-32%; calorific equivalent is 5.453 cal/mg dw); Howell 1990: 266 (citing Cayrol et al. 1978: the nematode-trapping fungus, *Arthrobotrys robusta*, in a commercial formulation called Royale 300, was used to control *D. myceliophagus* on commercial mushrooms); Brzeski 1991: 38 (diagnosis, and relationships with four other species of *Ditylenchus*).

ADDITIONAL REFERENCES

Key: Brzeski 1981: 25 (Key to 8 genera, including *Ditylenchus*, in the family Anguinidae Nicoll, 1935); Fortuner & Maggenti 1987: 175 (Tabular Key to 9 genera, including *Ditylenchus*, in the family Anguinidae); Bongers 1988: 169 (Key to 5 genera, including *Ditylenchus*, in the family Anguinidae).

Order TYLENCHIDA

Nomenclature: Fortuner 1982: 18 (used Brzeski's 1981 revised classification of the family Anguinidae as the framework for his study on the genus *Ditylenchus*); 27-33 (emended definition of the genus *Ditylenchus* Filipjev, 1936 under the subfamily Anguininae; list of species of *Ditylenchus*, including valid species, type species, species inquirendae, species incertae sedis and species transferred to other genera; related and synonym genera, etc.).

Economic importance: Goodey 1960: 111-126.

Misc.: Paramonov 1972: 81 (diagnosis of the genus *Ditylenchus* Filipjev, 1936); Dropkin 1980: 84 (description of the genus *Ditylenchus*); Brzeski 1981: 31 (diagnosis of the genus *Ditylenchus*).

Misc.: Ruehle 1967: 21 (distribution by country and by States in the USA of *Ditylenchus* species associated with various species of forest trees).

Suborder Criconematina

Siddiqi 1980: 149 (review of literature on the origin and phylogeny of this suborder).

Family Criconematidae Taylor, 1936

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 93-94), Heyns (1971: 95), Hooper (1978: 34), Dropkin (1980: 121), Maggenti (1982: 926), Maggenti et al. (1987: 138), Raski & Luc (1987: 411-412), Bongers (1988: 139).

***Criconema menzeli* (Stefański, 1924)**

Hofmaenneria menzeli Stefański, 1924; Stefański 1924a: 21-60

Iota menzeli, Micoletzky 1925: 57-310

Criconema menzeli, Taylor 1936: 391-421

Criconema guernei (Certes, 1889) of Menzel in Hofmänner & Menzel, 1914 (in part); Certes 1889: 53 pp.; Hofmänner & Menzel 1914: 88

DESCRIPTION

British Columbia Material

Fig. 46, after Goodey (1963: 102). This species was identified by use of the keys in Hopper & Cairns (1959: 31) and Sasser & Jenkins (1960: 199). It agreed with the description in Goodey (1963: 102).

Other Descriptions

Male: Hopper 1963a: 595, Figs. 1-4 (whole body, head, tail, spicules).

IDENTIFICATION KEY

Hopper & Cairns 1959: 31 (Key to 16 species, including *C. menzeli*, in the genus *Criconema* Hofmänner & Menzel, 1914); Sasser & Jenkins 1960: 199 (Key to 23 species, including *C. menzeli*, in the genus *Criconema*).

BIOLOGY

Feeding habit: Plant-parasite: Yeates et al. 1993: 32 (as ectoparasite on root tissues).

c-p rating: 3: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Anonymous 1957: 288 (Canada - ON, QC); Mai et al. 1960: 9 (USA - MD, NJ, WV); Ruehle 1967: 9 (Canada); Hoffmann & Norton 1976: 33 (USA - NY, VT, NH, ME).

HABITAT

Agroecosystems: Mai et al. 1960: 48 (associated with wild blueberry, *Vaccinium* spp.).

Forest: Anonymous 1957: 288 (soil around *Picea glauca* and *Ulmus* sp.); Ruehle 1967: 9 (associated with *Picea glauca* and *Ulmus* sp.); Hoffmann & Norton 1976: 33 (Hemlock-Hardwood, Boreal Forest, and Alpine Tundra formations).

ADDITIONAL REFERENCES

Key: Bongers 1988: 140 (Key to 7 genera and 33 species in the family Criconematidae Taylor, 1936).

Misc.: Sasser & Jenkins 1960: 196-197 (systematics of the genus *Criconema*); Bongers 1988: 152-155, Figs. 12.7.1-12.7.7 (descriptions of the genus *Criconema* and 7 species of *Criconema*). Loof 1988: 140-143, Table 1 (character states of body sheath, annuli, head structure and vulva for differential identification of 12 genera of female and/or juvenile criconematids, including *Criconema*).

Misc.: Ruehle 1967: 8 (distribution by States in the USA of *Criconema* species associated with various species of forest trees).

ORDER APHELENCHIDA

Siddiqi 1980: 149, 161, 162, 167 (on the origin and phylogeny of this order; on ecological, ethological and mostly morphological evidences, the orders Aphelenchida and Tylenchida were deemed to represent different evolutionary lines and neither could have been derived from the other); 165 (characteristics of Aphelenchida n. ord.); Siddiqi 1983: 127 (on the origin and evolution of plant-parasitism in this order); Baujard (1988) listed ten character states by which the aphelenchid nematodes could be characterized at low magnification, before observation of detailed morphology, i.e. as promorph-aphelenchids. He recognized 29 valid genera in this group (p. 153). He also listed nine "best identification criteria" at the generic and/or specific levels for the aphelenchids (p. 154): stylet length, position of valve in the median bulb, oesophageal gland morphology, vulva position, vulval morphology, presence and length of post-uterine sac, presence and morphology of bursa, presence and morphology of spicules and gubernaculum, and presence or absence of anal aperture in females. For the identification process, he listed eight "primary identification criteria" (p. 154): presence of two versus three adult forms, stylet length more or less than 30 µm, position of vulva at more or less than 80% of body, bursa present or absent, gubernaculum present and V-shaped or absent, spicules fused or not fused, anus present or absent, tail with or without appendage. He then created eight "nests of species" (pp. 154-155) by using all the eight primary criteria for each nest. Each nest contained a varying number of genera, for a total of 31 genera. The concepts of promorph and nest of species, as mentioned above and as they might relate to computer-aided approaches to nematode identification, are based on Fortuner (1988: 39, 41).

Suborder Aphelenchina

This suborder is separated from the suborder Tylenchina, order Tylenchida, on the basis of the dorsal oesophageal gland being in the metacorpus (Hooper 1978: 38).

Family Aphelenchidae Fuchs, 1937

Definitions, descriptions and diagnostic characteristics of this family: Goodey (1963: 132), Heyns (1971: 111), Franklin (1978: 173), Hooper (1978: 38), Maggenti (1982: 928), Bongers (1988: 178).

Aphelenchus avenae Bastian, 1865

Aphelenchus avenae Bastian, 1865; Bastian 1865: 73-184

Aphelenchus avenae form *tricaudata* Krall, 1959; Krall 1959: 49; Ebsary 1991: 86

Aphelenchus avenae form *bicaudata* Adilova, 1973; Adilova 1973: 15-68; Ebsary 1991: 86

Aphelenchus avenae of Bütschli, 1871 = *Aphelenchus agricola* of de Man 1881; Micoletzkey 1922a: 1-650

Aphelenchus agricola de Man, 1881; de Man 1881: 138-143; Goffart 1930: 105 pp.

Aphelenchus agricola of Maupas 1900; Maupas 1900: 571; Ebsary 1991: 86

Isonchus radiciculus N. A. Cobb, 1913; N. A. Cobb 1913: 439; T. Goodey 1951: 390 pp.

Aphelenchoides radiciculus, Steiner 1931: 468-475

Aphelenchus (Isonchus) radiciculus, T. Goodey 1963: 134

Aphelenchus (Paraphelenchus) maupasi Micoletzky, 1922; Micoletzky 1922a: 119; Goffart 1930: 105 pp.

Aphelenchus cylindricaudatus N. A. Cobb, 1926; in Steiner 1926: 360; J. B. Goodey 1960: 112

Tylenchus cylindricaudatus, Steiner 1931: 468-475

Aphelenchoides solani Steiner, 1935; Steiner 1935: 104; T. Goodey 1951: 390 pp.

Aphelenchus solani, T. Goodey, 1951: 390 pp.

Paraphelenchus micoletzkyi Steiner, 1941; Steiner 1941: 31-34; Goodey & Hooper 1965: 64

Metaphelenchus micoletzkyi, Ebsary 1991: 86

Aphelenchus macrobolbus Steiner, 1942; Steiner 1942: 32-38; J. B. Goodey 1960: 111-126

Metaphelenchus rhopalocercus Steiner, 1943; Steiner 1943: 95-116; Goodey & Hooper 1965: 64

Aphelenchus maximus Das, 1960; Das 1960: 553-605; Ebsary 1991: 86

Aphelenchus allahabadi Edward & Misra, 1969; Edward & Misra 1969: 1-6; Ebsary 1991: 86

Metaphelenchus goldeni Chaturvedi & Khera, 1979; Chaturvedi & Khera 1979: 105 pp.; Ebsary 1991: 86

ADDITIONAL COMBINATION/SYNONYMY

Heyns 1971: 113; Ebsary 1991: 86.

REMARKS

(1) The long synonymy list for *A. avenae* may be the result of inadequate detailed descriptions of many species (J. B. Goodey 1960: 112). (2) Heyns (1971: 112, Fig. 75) illustrated anterior part, female tail, and male tail of *A. radiciculus*, and cited T. Goodey (1963:113) as synonymizing both *A. cylindricaudatus* and *A. radiciculus* with *A. avenae*. He was not convinced that these synonymies represented a single species.

DESCRIPTION

British Columbia Material

Fig. 47, after Franklin (1978: 174). This species was not identified from a particular key, but was determined by comparisons with published descriptions and illustrations of species in the genus *Aphelenchus* from several sources, including Thorne (1961) and the references cited below. It agreed with the description in Franklin (1978: 174).

Other Descriptions

Female: Krall 1959: 49 (length; ratios a, b, c, V); 49, Figs. 2-3 (anterior part; tail end); Goodey 1963: 133, Fig. 61; Thorne & Malek 1968: 95, Fig. 48 B (tail end); Mai & Lyon 1975: 40; 41, Plate 11 (mature female; anterior portion showing stylet without basal knobs and large metacorpus); Triantaphyllou & Fisher 1976: 170, Figs. 1-3 (reproductive system: ovary, gonoduct, fertilization chamber, developing oocytes, spermatotheca; 172, Figs. 4-16 (gametogenesis); Fisher & Triantaphyllou 1976: 249, Fig. 1 (development of gonad); Franklin 1978: 172, 174, Fig. 8.1 (description based on Hechler 1962, Goodey & Hooper 1965, Hooper 1974); Anderson & Mulvey 1979: 118, Fig. 77; Siddiqi 1980: 148 (oesophagus); 151, Fig. 5 J-K (vulval region; posterior end); Geraert 1983: 75-76, Fig. 1 (a) (female reproductive system of *A. avenae* as representing the Aphelenchidae-type of reproductive system); Bongers 1988: 178, Fig. 20.1.1 (tail).

Male: Krall 1959: 50 (length, ratios a, b, c; spicule length and morphology; gubernaculum present; tailform); 49, Fig. 2 (tail region, lateral view); Goodey 1963: 133, Fig. 61; Grassé 1965a: 73, Fig. 100 A (bursa, ventral aspect); Grassé 1965c: 856, Fig. 683 (posterior region, spicules); Fisher & Triantaphyllou 1976: 251, Fig. 2 (development of gonad); Triantaphyllou & Fisher 1976: 174, Figs. 17-25 (spermatogenesis); Franklin 1978: 173; 174, Fig. 8.1 (description based on Hechler 1962, Goodey & Hooper 1965, Hooper 1974); Siddiqi 1980: 157, Fig. 7 F (posterior region); Bongers 1988: 178, Fig. 20.1.1 (anterior part; tail end); Zeidan & Geraert 1991a: 435, Table III (morphometric comparison between males of 5 species of *Aphelenchus*, including *A. avenae*, from Sudan, India, UK and USA; source references cited therein).

Larvae: Fisher & Triantaphyllou 1976: 249-251, Figs. 1-3 (development of gonads in male and female larval stages L2-L4); Franklin 1978: 174 (from Hechler 1962, Goodey & Hooper 1965).

Egg: Franklin 1978: 174 (description based on Hechler 1962, Goodey & Hooper 1965, Hooper 1974).

Misc.: Goodey & Hooper 1965: 55-65 (description with designation of a neotype); Grassé 1965c: 856, Fig. 683 (anterior region); Thorne & Malek 1968: 95, Fig. 48 A (anterior end); Wasilewska 1971: 660 (average body weight of female 0.429 µg); Dropkin 1980: 76, Fig. 5.11a (cephalic framework, stylet); Bongers 1988: 178, Fig. 20.1.1 (anterior part).

BIOLOGY

Life-cycle: Krall 1959: 49 (propagation takes place parthenogenetically; as a rule only females are encountered; males are observed rarely); Hechler 1962: 162-167 (life-history and larval development; generation time 6 days at 28° C and about 10 days at 20° C, on the fungus *Pyrenophaeta terristris*; Goodey & Hooper 1965: 55-65 (generation time 11-12 days at 20° C on *Botrytis cinerea*); Zuckerman et al. 1971: 272 (optimum temperature for egg hatching 36° C); 283 (hatching behaviour similar to that of a *Ditylenchus* sp.; see citation therein); 267, 271 (feeding larvae increase in size between each moult); SON 1984: 149 (generally parthenogenetic, few males present, also bisexual).

Feeding Habit: Fungivore: Yeates et al. 1993: 319 (mainly hyphal feeder, also epidermal and root hair feeder); Sasser & Jenkins 1960: 361; 363 (essentially mycophagous, and beneficial in the control of fungus diseases of roots; also seen feeding on its own eggs); Goodey 1963: 134 (feeds on fungi in decaying root tissue, but no conclusive evidence for *A. avenae* being a plant parasite); Ruehle 1972: 315-316: feeds on mycorrhizal fungi; inhibits formation of mycorrhizae on red pine in pure culture); Wood 1973: 596 (in lab trials, fed and reproduced on fungi, seedling roots, callus tissue and moss, but not on bacteria and nematodes); 599 (feeds on a

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range of fungi and on roots of higher plants, and exhibits a similarity of feeding requirements with *A. bicaudatus*); Lee & Atkinson 1976: 42 (feeding behaviour: after penetration of a hyphal cell with its stylet, *A. avenae* completely removes the contents of the cell within a brief period of 15 seconds, thus causing immediate destruction of the cells); Franklin 1978: 176 (on food sources, with references cited therein); Anderson & Mulvey 1979: 118 (mainly on fungi, but also been observed to feed on root hairs and mycorrhizae); SON 1984: 149 (although mainly mycophagous, it also feeds and reproduces on roots of plants such as cotton, onions, tomato and melons); Small 1987: 195 (nematophagus; also feeds on nematode eggs).

c-p rating: 2: Bongers 1990: 15.

Survival strategy: Zuckerman et al. 1971: 312-313 (larval stages L3 and L4, and adults are capable of surviving cryptobiosis); Demeure et al. 1979b: 193 (*A. avenae* as a model system to study the nature of anhydrobiosis in nematodes); 192, Table 1 (anhydrobiotic coiling in *A. avenae* reached over 80% in loamy sand soil and over 96% in sandy loam soil, when moisture contents of these soils were at a low of 2.0-3.5%; these levels of coiling corresponded to 0.5-3.0 and 6.0-9.0 bars of suction in the two soil types); 194, Fig. 4 A, D (SEM photographs of coiled *A. avenae* in soil pore spaces at 9 bars suction); Lee & Atkinson 1976: 58-59 (glycogen content: 8% of dry body weight); Evans & Perry 1976: 393 (congregation or swarming into masses when exposed to desiccation facilitates survival); Bolla 1980: 169 (*A. avenae* can enter a cryptobiotic state after prolonged oxygen stress, thus curtailing energy metabolism); Dropkin 1980, citing Demeure et al. 1979a: 30-32, Fig. 3.2 (under slow drying conditions, *A. avenae* coil up and lapse into a state of low metabolic activity for long periods, but are able to revive when moist conditions return; coiling reduces exposed area, which helps to slow down rate of water loss); 33 (*A. avenae* can survive well in aerobic - 5-21% oxygen, microaerobic - less than 5% oxygen, and anaerobic - no oxygen, conditions; during aerobic starvation, it utilizes stored lipids, but shifts to utilizing glycogen in low oxygen conditions); Evans & Womersley 1980, in Zuckerman 1980: 196 (reproduction was observed in a Canadian population while feeding on tomato plant, so that some populations may be facultative plant parasites); Womersley et al. 1998: 271-302 (lack of food or toxic products from decaying host results in mass movement or swarming, followed by aggregation and coiling during dehydration in the absence of a host); Perry 1999: S25 (preliminary preparation for dry conditions by synthesizing trehalose, although this may not mean survival under severe desiccation).

Culture: Sasser & Jenkins 1960: 363 (on fungi as probably the main and essential part of diet; but they also cite Steiner 1936 as finding *A. avenae* to be a facultative parasite, able to live and reproduce in healthy tissue of higher plants); Hechler 1962: 162-167 (easy to culture on fungal species; hence frequently used as a lab animal, e.g. as food for predaceous nematodes, and for studying nematode feeding behaviour - see Doncaster 1971); Evans & Fisher 1970: 295-304 (on *Rhizoctonia solani* on agar; optimum temperature 30° C); Webster 1972: 476 (in dual cultures of the mycophagous *A. avenae* and a nematode-trapping fungus, on 2% cornmeal agar; there was an initial period of "nematode-trapping" or predation by the fungus, then the nematode populations increased to levels that eventually killed the fungus); de Soyza 1973: 1 (on *Botrytis cinerea* on potato dextrose agar at 26° C); Franklin 1978: 176 (discussion on culture methods; source references cited therein); Viglierchio 1979: 378, Table 2 (on *Fusarium solani* culture); Evans & Womersley 1980, in Zuckerman 1980: 197 (monoxenic, mass culture using soil fungi growing on a sterile, cooked-wheat substrate); Geraert 1990: 194, Fig. 1 (morphometric analysis of *A. avenae* in laboratory cultures in different studies: mean length of

the largest females in one study was more than three times that of the smallest specimens in another study).

Misc.: Norton et al. 1971: 160-161, Fig. 5 A-B (abundance of *A. avenae* in soybean fields with different soil textures, i.e. soils with varying percentages of sand, silt and clay; relative abundance of *A. avenae* in total nematode populations in these same soils); de Soyza 1973: 4 (wet to dry weight ratio of all stages of *A. avenae* approximated to 5:1); Evans & Womersley 1980, in Zuckerman 1980: 199 (*A. avenae* as a convenient test organism in nematicide toxicity studies; source references cited therein); Hechler 1963, in Siddiqi 1980: 162 (mechanism of predaceous feeding on *A. avenae* by nematodes in the genus *Seinura*); Hussey & Roncadori 1981, in Freckman and Casswell 1985: 279 (high densities of *A. avenae* retarded stimulation of shoot and root growth of cotton by endomycorrhizal fungi associated with cotton plants); Esser 1983: 1 (a predacious amoeba, *Theratromyxa weberi*, listed as a predator of *A. avenae*); Esser 1987a: 1 (*A. avenae* listed as a prey for the dorylaim nematodes in the genus *Thornia*); Esser 1987b: 1 (*A. avenae* listed as a prey for the nematode *Seinura tenuicaudata*); Fisher & Davies 1990: 175-182 (relationship between duration of feeding and body size, and their effect on each moult within the moulting cycle; hormonal control of growth and development); Yeates & Wardle 1996: 44 (reference to *A. avenae* as a suitable prey for many mononchid nematodes).

DISTRIBUTION

Nearctic: Mai et al. 1960: 47 (Northeastern USA - CT, WV, NY); Thorne & Malek 1968: 96 (Canada - MB; USA - MN, ND, MT, NE, CO); Sutherland & Dunn 1970: 166 (Canada - BC); Norton et al. 1971: 154 (USA - IA); Johnson et al. 1972: 179 (USA - IN); Smolik 1974: 7 (USA - SD); Anderson & Mulvey 1979: 118 (one of the most common inhabitants of Canadian soils); Baird & Bernard 1984: 380 (USA - TN); SON 1984: 149 (reported from many areas of North America); Freckman & Mankau 1986: 133 (USA - NV); Al-Banna & Gardner 1996: 974 (USA - CA).

Paleartic: Krall 1959: 48 (Estonia); von Bassus 1968: 289 (Germany: GDR); Bonifacio & Marinari 1969: 141-144 (Italy); Wasilewska 1970: 435 (Poland); Wasilewska 1971: 652 (Poland); Yeates 1972b: 179 (Denmark); Arpin 1975: 494 (France); Zullini & Peretti 1986: 403 (Italy); Sohlenius & Sandor 1987: 20 (Sweden); Sohlenius et al. 1987: 132 (Sweden); Bongers 1988: 178 (Netherlands); Boag & Lopez-Llorca 1989: 5 (Scotland); Šály 1989: 48 (Czechoslovakia); Hansson et al. 1990: 41-83 (Sweden); Zeidan & Geraert 1991a: 435, Table III (UK: source cited therein); Dmowska 1993: 98 (Poland); Háněl & Šimek 1993: 110 (Czech Republic); Steinberger & Sarig 1993: 189 (Israel); Hodda & Wanless 1994: 116 (England); Háněl 1995: 199 (Czech Republic: South Bohemia); Moon et al. 1995: 127 (Korea); Alphei 1998: 10 (Germany); Háněl 1998: 37 (Czech Republic: South Moravia).

Ethiopian: Zeidan & Geraert 1991a: 420 (Central and Eastern Sudan).

Oriental: Zeidan & Geraert 1991a: 435, Table III (India: source cited therein).

Cosmopolitan: Krall 1959: 48; Bongers 1988: 178.

HABITAT

Agroecosystems: Mai et al. 1960: 47 (associated with bean, buckwheat, cauliflower, celery, corn, potato, tobacco, weigelia); Thorne & Malek 1968: 8, 96 (unbroken prairie sod, virgin and cultivated soils); Norton et al. 1971: 154, 160 (soybean fields with a range of soil textures); Baird & Bernard 1984: 380 (soybean-wheat crops); Sohlenius & Sandor 1987: 22, Table 4 (barley field); Sohlenius et al. 1987: 138 (barley crops under different cropping systems); Šály 1989: 52 (herbicide-treated vineyards); Boag & Lopez-Llorca 1989: 5, Table II (cereal fields);

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Hansson et al. 1990: 41-83; Háněl & Šimek 1993: 111 (roots of red clover, *Trifolium pratense* L.); Dmowska 1993: 99, 102 (untreated and acidified *Lolium*-field); Háněl 1995: 199-200, 203 (cultivated field, fallow, meadow; soil type silt loam cambisol); Al-Banna & Gardner 1996: 974 (California native grape, *Vitis californica*).

Desert: Freckman & Mankau 1986: 129 (a *Larrea-Ambrosia* shrub association; vegetation characteristic of both Mojave and Great Basin deserts); Steinberger & Sarig 1993: 189 (highlands of northern Negev Desert).

Forest: Mai et al. 1960: 47 (associated with arborvitae, cedar, pine, spruce, maple); von Bassus 1968: 291 (Scots pine forests damaged by industrial SO₂ pollution); Bonifacio & Marinari 1969: 141-144 (associated with Black pine); Sutherland & Dunn 1970: 166 (around roots of nursery seedlings of Douglas-fir, Sitka spruce, White spruce and Western hemlock); Wasilewska 1970: 435 (afforested dunes: in all of six successional stages, characterized by age and number of species of coniferous and hardwood trees and by increasing humus in soil and cover of grass clumps, herbs, shrubs, mosses and lichens); Wasilewska 1971: 652 (afforested dunes); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Yeates 1972b: 181 (beech forest, *Fagus sylvatica* L.); Háněl 1995: 199, 203 (oak forest; cambisol soil); Alphei 1998: 11 (beech forest: mull soils).

Grassland: Smolik 1974: 7; Sohlenius & Sandor 1987: 22, Table 4 (grass ley); Boag & Lopez-Llorca 1989: 5, Table II (permanent pasture); Hodda & Wanless 1994: 121 (chalk grasslands); Háněl 1998: 42 (floodplain meadows).

Misc.: Krall 1959: 48 (in rotting portions of many plants, including above-ground portions, tubers, and soil around roots of potato plant); Arpin 1975: 517 (park, with *Carpinus*, *Mercurialis* and *Hedera* spp.; calcareous soil, pH 8); Zullini & Peretti 1986: 405 (mosses on walls in industrial area with high lead pollution of atmospheric origin); Moon et al. 1995: 129 (soil around roots of saplings of *Hibiscus syriacus* L. and *Zelkova serrata* Makino).

MISC. INFORMATION

Culture: Viglierchio 1979: 384 (*A. avenae* as a single-species inoculum inhibited growth of *Pinus ponderosa* seedlings, but a mixed inoculum of *A. avenae* and *Ditylenchus destructor* did not affect seedling growth; the conclusion was that there appeared to be mutual antagonism between the two nematode species); Evans & Womersley 1980, in Zuckerman 1980: 196 (culture is possible on a wide range of soil fungi, but plant-pathogenic forms are preferred; depending on the particular population of *A. avenae*, feeding on plant-pathogenic fungi may reduce or aggravate plant disease symptoms).

Economic importance: Krall 1959: 48 (causes damage to plants); Rhoades & Linford 1959, in Sasser & Jenkins 1960: 363 (a beneficial mycophagous nematode that may aid in control of fungus diseases of roots, e.g. the root rot fungus *Pythium arrhenomanes*); Bonifacio & Marinari 1969: 141-144 (*A. avenae* and the fungus *Fusarium moniliforme* associated with damping-off disease of Black pine); Webster 1972: 450 (only infrequently a problem in mushroom industry); SON 1984: 149 (a facultative plant pathogen on tomatoes).

Morphology: Chitwood & Chitwood 1950: 59, Fig. 55 K (cephalic region); 79, Figs. 72-75 (cross-sectional morphology of procorpus, metacorpus, bulbar region, and region of glandular appendage); Anderson & Mulvey 1979: 119, Fig. 78 D (lateral field showing incisures); Franklin 1978: 175, Fig. 8.2 (oesophageal region showing variations in overlap of dorsal oesophageal gland).

Physiology: Myers 1966: 579-586 (osmoregulation: *A. avenae* has mechanisms for regulating fluid volume and internal salt solution); Zuckerman et al. 1971: 214 (osmoregulation: incubation of *A. avenae* in Fenwick's physiological saline, containing NaCl, KCl, CaCl₂ and MgCl₂, resulted in an increase in every ion in the nematodes as compared to those incubated in distilled water; the Na content was 3-3.5 times as high as in nematodes incubated in distilled water; the level of K was also high in the nematodes incubated in the salt solution); de Soyza 1973: 1-10 (calorific value: 22.827 j/mg); Giebel 1974: 176, Table 1 (hydrolases identified from the nematode: cellulase, polygalacturonase; involved in metabolic changes in host plants); Barrett 1976: 18, 44 (carbohydrate and lipid utilization in *A. avenae*; references cited therein); Barrett 1976: 38 (ethanol as the main end product of glycolysis under anaerobic conditions); Wright & Newall 1976: 163-210 (osmotic and ionic regulation in *A. avenae*; references cited therein); Bolla 1980: 205 (under anhydrobiotic conditions, *A. avenae* rapidly uses glycogen for the production of glycerol and trehalose); Croll & de Soyza 1980: 132-135 (calorific value: 22.814 j/mg); Evans & Womersley 1980: 205 (on lipid and carbohydrate changes in the nematode analyzed before, during, and after desiccation by slow drying); Pree et al. 1990: 182-186 (exposure of *A. avenae* to the nematicides carbofuran and fenamiphos for 72 hours reduced their numbers by over 75%; the primary mechanism of toxicity of the nematicides was by inhibition of acetylcholinesterases; the antidotes atropine sulphate and 2-PAM were ineffective in counteracting the toxic effects); O'Dell & Crowe 1979, cited in Wharton 1995: 176 (*A. avenae* will survive freezing in liquid nitrogen if its water content is less than 21%; this may correspond to the loss of all free water, the remaining bound or unstructured water being unfreezable).

Misc.: Krall 1959: 48 (mass reproduction seen in a rotting potato tuber); Zuckerman et al. 1971: 312 (cryptobiosis: *A. avenae* can enter a cryptobiotic state in response to environmental stresses; hence, a valuable organism for the study of the physiological, biochemical, and morphological changes occurring during cryptobiosis, and for the study of biological senescence); Crowe & Madin 1975: 323-334 (anhydrobiosis: *A. avenae* could be recovered, when re-cultured on fungi, from laboratory-prepared soil pellets stored in dry air for 18 months). Zuckerman 1976: 222 (a sieving method for separation of L2 and L3 from eggs, and L4 and adults, originating from gravid *A. avenae* females; references cited therein).

ADDITIONAL REFERENCES

Misc.: Franklin 1978: 173, Table 1 (differentiating characteristics of families Aphelenchidae, Paraphelenchidae and Aplelenchoididae in the superfamily Aplelenchoidea, based on disposition of oesophageal glands, stylet, spicules, caudal alae and feeding habit); Zuckerman 1980: 196 (cites useful references on taxonomy, morphology, and life-history of *A. avenae*: Thorne 1961; Mankau & Mankau 1963; Hooper 1974); Geraert 1983: 195, Fig. 1 (discontinuous variation in body length of various tylenchids, including *A. avenae*).

Family Aphelenchoididae Skarbilovich, 1947

Definitions, descriptions or diagnostic characteristics of this family: Goodey (1963: 134), Heyns (1971: 115), Franklin (1978: 173), Hooper (1978: 39), Dropkin (1980: 128), Bongers (1988: 180). Geraert 1983: 75-76, Fig. 1 (b, b') (female reproductive system of *Aphelenchoides ritzemabosi* as representing the Aphelenchoididae-type of reproductive system).

***Aphelenchoides clarus* Thorne & Malek, 1968**

Aphelenchoides clarus Thorne & Malek, 1968; Thorne & Malek 1968: 98

DESCRIPTION**British Columbia Material**

Fig. 48. This species was identified by using the key in Thorne & Malek (1968: 97). Identification was facilitated by comparisons with the descriptions, illustrations and diagnoses in the references cited below.

Other Descriptions

Female: Thorne & Malek 1968: 98, Fig. 49 D-F (anterior, posterior, and vulvar regions).

Male: Thorne & Malek 1968: 99 (males not found, but sperm present in females).

IDENTIFICATION KEY

Thorne & Malek 1968: 97 (Key to 7 species, including *A. clarus*, in the genus *Aphelenchoides*).

BIOLOGY

Feeding habit: Fungivore: Yeates et al. 1993: 319.

c-p rating: 2: Bongers 1990: 15.

DISTRIBUTION

Nearctic: Thorne & Malek 1968: 99 (USA - SD); Johnson et al. 1972: 179 (USA - IN); Lownsbery & Lownsbery 1985: 6 (USA - CA: Inyo and Sierra floristic zone).

HABITAT

Forest: Thorne & Malek 1968: 99 (in soil around roots of *Pinus sylvestris*); Johnson et al. 1972: 176 (woodlots: natural, cut, cut-grazed, grazed or flooded; soil type silt loam to silty clay loam); Lownsbery & Lownsbery 1985: 6 (associated with Bristlecone and Jeffrey pines).

ADDITIONAL REFERENCES

Key: Hopper & Cairns 1959: 71 (Key to 45 species in the genus *Aphelenchoides* Fischer, 1894); Sanwal 1961: 145 (Keys to 33 species for females and 2 species for males in the genus *Aphelenchoides*); Franklin 1978: 173, Table 1 (differentiating characteristics of families Aphelenchidae, Paraphelenchidae and Aplelenchoididae in the superfamily Aphelenchoidea, based on disposition of oesophageal glands, stylet, spicules, caudal alae and feeding habit); Bongers 1988: 180 (Key to 6 genera, including *Aphelenchoides* Fischer, 1894, in the family Aphelenchoididae Skarbilovich, 1947).

Biology: Sasser & Jenkins 1960: 361-371 (several aspects of the biology of *Aphelenchoides* spp.); Croll 1976: 439 pp. (basic biology of and survival strategy in several *Aphelenchoides* spp.); Lee & Atkinson 1976: 215 pp. (*Aphelenchoides* spp. as biological models for studying the basic biology of species in this genus); Franklin 1978: 179-187 (several aspects of the biology of *Aphelenchoides* spp.); Zuckerman 1980: 306 pp. (basic biology of *Aphelenchoides* spp., and their use as model systems for studies in aging).

Morphology: Krall 1959: 52, Fig. 5 (gynandromorphism or intersex in a population of *Aphelenchoides parietinus*).

Culture: Ruess et al. 2000: 223-230 (an *Aphelenchoides* sp., taxonomically closely related to *A. parietinus*, cultured on 17 fungal species belonging to various taxonomic groups; mass cultures obtained with two saprophytic and three mycorrhizal fungal species).

Misc.: Ruehle 1967: 5 (distribution by country and by States in the USA of *Aphelenchoides* species associated with various species of forest trees).

SECTION 3: KEY TO BRITISH COLUMBIA TAXA

KEY TO FOREST SOIL NEMATODE TAXA OF BRITISH COLUMBIA

The following key is based on soil nematodes collected from Coastal Douglas-fir Forests in British Columbia (Panesar et al. 2000, 2001). The key is adapted mainly from Bongers (1988; we mostly used English translations of Bonger's taxonomic Keys by Jan van de Haar, 1989), Freckman & Baldwin (1990) and Jairajpuri & Ahmad (1992). Other sources included Goodey (1963), Heyns (1971), Pennak (1978), Southey (1978b) and Poinar (2001). In addition to the Glossary herein (Section 4), it is essential to refer to these or other similar texts for detailed explanation of morphological character states. Reference information on synonymy, description, identification key, biology, distribution, habitat, and other miscellaneous data for each taxon is given in the text (Section 2) and cited in the References section (Section 6). The photographs in the key are original. The drawings are adapted from various literature sources, after modification, and in some cases after recombining from more than one source. Sources for the drawings are cited in their figure captions. Sources of keys to the various taxa are listed under the individual species treated above (Section 2).

Key to Classes, Orders, Families, Genera and Species

Note: The emphasis is on nematode females, but where deemed useful, male character states are added at the end of specific couplets.

1. Phasmids present; amphid apertures usually small, pore-like or slit-like, located on the lips; oesophagus three-part or four-part; excretory system with H- or U-shaped lateral canals; caudal and hypodermal glands absent; cephalic and somatic setae rare; rectal glands usually present; (male: bursa or caudal alae and rectal glands usually present).
CLASS **Secernentea** (= Phasmida) 2
- Phasmids absent; amphid apertures usually more elaborate in form and post-labial in position; oesophagus one-part or two-part; excretory system usually a single cell with a terminal duct but without lateral canals; caudal and hypodermal glands usually present; cephalic and somatic setae common; rectal glands usually absent; (male: bursa or caudal alae and rectal glands usually absent).
CLASS **Adenophorea** (= Aphasmida) 4
2. Mouth cavity (= buccal cavity, buccal capsule, stoma, vestibule) without a stylet (= spear); stomatal walls lined with rhabdions which may be separate or fused to a greater or lesser extent; oesophagus three-part (corpus, isthmus, basal bulb) or four-part (procorpus, metacorpus, isthmus, basal bulb); valves present in corpus or basal bulb or in both; tail never filiform; body without bristles.
ORDER **RHABDITIDA** 9
- Mouth cavity armed with a protrusible stylet; oesophagus three-part or four-part 3
3. Dorsal oesophageal gland opening (DEGO) in lumen of procorpus, usually near base of stylet (stomatostylet), relatively easy to see; lumen of DEGO with sudden bend close to base of stylet; stylet with basal knobs; oesophagus three-part or four-part; metacarpus moderate in size.
ORDER **TYLENCHIDA** 16

- Dorsal oesophageal gland opening (DEGO) in lumen of metacarpus (= median bulb), difficult to see; lumen of DEGO continues straight from stylet to metacorpus; stylet with or without basal thickenings, rarely with knobs; oesophagus four-part; metacarpus large, three-fourths of body width or more.

ORDER APHELENCHIDA 19

4. Oesophagus one-part cylindrical; some tending towards two-part with large pyramidal oesophageal-intestinal valve 5
- Oesophagus two-part (rarely three-part) without large oesophageal-intestinal valve .. 7
5. Amphid openings typically circular; head region with four or more (6 or 8) cephalic setae on or close to lip region; lips indistinct, continuous with body; mouth cavity generally small and usually unarmed (without stylet or teeth); mouth cavity thin-walled (= lining weakly sclerotized); oesophagus cylindrical; oesophageal-intestinal valve (= cardia, or "gland cells between oesophagus and intestine" of some authors) conspicuous, spheroid to cylindrical; ovary usually outstretched.

ORDER MONHYSTERIDA 20

- Amphid openings indistinct, slit-like or cyathiform; presence of cephalic setae and teeth variable 6
6. Mouth cavity wide, spacious, usually oval in outline, without stylet but with large tooth/teeth (onchium/onchia) and/or denticles; lining of mouth cavity sclerotized; oesophagus one-part; oesophageal lumen interrupted posterior to nerve ring by openings of gland ducts (often difficult to observe); cuticle smooth; body without setae.

ORDER MONONCHIDA 22

- Mouth cavity without stylet, but sometimes with tooth/teeth; lining of mouth cavity variable; oesophagus one-part, cardia prominent; subventral oesophageal glands open into mouth cavity; oesophageal lumen interrupted posterior to nerve ring by openings of gland ducts (often difficult to observe); body usually with setae; caudal glands and spinneret usually present.

ORDER ENOPLIDA 27

7. Mouth cavity armed with stylet, as axial odontostylet or mural tooth; stylet knobs usually absent; oesophagus two-part, narrow anteriorly, broad and usually elongate and cylindrical posteriorly (i.e. bottle-shaped); amphids typically cyathiform, but never spiral; cuticle smooth.

ORDER DORYLAIMIDA 29

- Mouth cavity without stylet, but tooth present; oesophagus narrow anteriorly, bulboid posteriorly; amphid variable but rarely cyathiform 8

8. Mouth cavity mostly unarmed (without teeth); cuticle without punctations; amphid shape as variations of spiral (elongate loop, shepherd's crook, question mark, circular); oesophagus three-part (procorpus, isthmus and usually a terminal bulb); head with four cephalic setae, well back from anterior end (lip region); caudal glands and spinneret present or absent.

ORDER ARAEOLAIMIDA 41

- Mouth cavity usually with a large dorsal tooth and/or smaller teeth; cuticle with strong cuticular ornamentation, generally punctations and/or setae scattered over the body; amphid shape variable, often spiral or single loop (donut-shaped); oesophagus cylindrical
-

Key to Classes, Orders, Families, Genera and Species

or with basal bulb; head with 16 cephalic setae in three or two circlets; caudal glands and spinneret present.

ORDER CHROMADORIDA **46**

ORDER RHABDITIDA

- 9.** Longitudinal ridges present on one side of body, and wartlike structures (cuticular protuberances) present on the other side; head region retractile and with large bristles and lamellae.

Bunonematidae

Genus ***Bunonema*** (Fig. 37) ***Bunonema* sp.**

- Longitudinal ridges and wartlike structures absent, head without bristles **10**

- 10.** Mouth cavity narrow, appearing collapsed for most of its length; rhabdions of mouth cavity jointed but distinctly separate; cheilostom wide, rest of mouth cavity narrower; oesophagus with a more or less cylindrical anterior part, and a basal bulb with plate-like valve; some genera with elaborate labial and/or cephalic probolae without cirri; single ovary, anteriorly directed, then reflexed back past vulva; (male: bursa absent; gubernaculum present).

Cephalobidae **11**

- Mouth cavity mostly broad, tubular or funnel shaped; rhabdions partially fused; probolae, if present, with fine cirri **14**

- 11.** Anterior end with three labial and six cephalic probolae (labial and head appendages or ornaments); labial probolae deeply forked and fringed, projecting well beyond the cephalic ones; cephalic probolae pointed, not forked but fringed; tail of both sexes conoid to elongate-conoid with pointed tip.

Genus ***Acrobeles*** (Fig. 39) ***Acrobeles complexus* Thorne, 1925**

- Labial probolae forked, or absent **12**

- 12.** Labial probolae plate-like, the dorsal two forked, the ventral two pointed, showing a total of six pointed tips; cephalic probolae reduced, forming axial borders for the labial probolae.

Genus ***Chiloplacus*** (Fig. 42) ***Chiloplacus* sp.**

- Labial probolae not forked, or absent **13**

- 13.** Labial probolae short, small, rounded or conical, not forked; head margin truncated; oesophageal corpus swollen posteriorly into a fusiform (spindle-shaped) mesocorpus; tail convex-conoid, more usually bluntly rounded.

Genus ***Acobeloides*** (Fig. 40) ***Acobeloides nanus* (de Man, 1880)**

- Labial probolae absent; head margin not truncated; oesophagus long, cylindrical, narrowing slightly at region of isthmus; corpus cylindrical; tail of both sexes bluntly rounded.

Genus ***Cephalobus*** (Fig. 41) ***Cephalobus persegnis* Bastian, 1865**

- 14.** Mouth cavity cylindrical, formed by fusion of protorhabdions; terminated by a glottid apparatus formed of telorhabdions, and provided with small denticles or tubercles; walls not heavily cuticularized; oesophagus rhabditoid (having a short cylindroid anterior part or procorpus, sometimes with a slightly swollen median bulb without valve plates, i.e. a

pseudo-bulb, followed by a narrow isthmus, and a basal bulb with valve plates); ovaries single or paired; (males with a well-developed bursa).

Rhabditidae 15

- Mouth cavity funnel-shaped (broad anteriorly, tapering posteriorly) or barrel-shaped; walls heavily cuticularized, formed of fused rhabdions; base of mouth cavity surrounded by anterior end of oesophagus; oesophagus panagrolaimoid (having a longer cylindrical procorpus, usually without a median bulb, a narrow isthmus, and basal bulb with valve plates); (males lacking a bursa).

Panagrolaimidae

- Genus **Panagrolaimus** (Fig. 38) **Panagrolaimus** sp.

- 15.** Mouth cavity typically rhabditoid; glottid apparatus present, with tubercles; oesophageal collar always present; tail longer than six anal body widths; body from less than 1 mm to about 3 mm; lip region not offset; (male leptoderan: bursa not reaching tail tip).

- Genus **Rhabditis** (Fig. 36) **Rhabditis** sp.

- Mouth cavity long and narrow; glottid apparatus absent; oesophageal collar present or absent; tail shorter than six anal body widths; small nematodes, body shorter than 1 mm; (male peloderan: bursa reaching tail tip).

- Genus **Protorhabditis** (Fig. 35) **Protorhabditis** sp.

ORDER TYLENCHIDA

- 16.** Vulva position on lower third of body, at most two body diameters before anus. 18

- Vulva position more than two body diameters before anus; oesophagus (oesophageal gland) not overlapping intestine; procorpus distinct and narrow before reaching the expanded metacorpus; cuticle not strongly annulated; stylet may or may not be well-developed.

- Tylenchidae** 17

- 17.** Metacorpus in posterior half of oesophagus, with valves; tail attenuated, terminus not pointed but clavate or knobbed.

- Genus **Psilenchus** (Fig. 43) **Psilenchus** sp.

- Metacorpus in anterior half of oesophagus, without valves; tail attenuated, terminus pointed.

- Genus **Tylenchus** (Fig. 44) **Tylenchus** sp.

- 18.** Procorpus and metacorpus grade (fuse) into each other; metacorpus large, oval; isthmus and basal bulb reduced, together forming a short cylinder rounded at its posterior end; cuticle conspicuously annulated, annules with posteriorly-directed spines or scale-like extensions; stylet well-developed, greatly elongated.

Criconematidae

- Genus **Criconema** (Fig. 46) **Criconema menzeli** (Stefaniński, 1924)

- Procorpus clearly separated from metacorpus by a constriction; oesophagus (oesophageal gland) overlapping intestine; basal bulb claviform; stylet usually small and weak; (male: bursa leptoderan, enveloping 1/4 to 3/4 of male tail).

Anguinidae

- Genus **Ditylenchus** (Fig. 45) **Ditylenchus myceliophagus** Goodey, 1958
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Key to Classes, Orders, Families, Genera and Species

ORDER APHELENCHIDA

19. Stylet knobs absent, tail short, cylindrical, with a broadly rounded terminus without a mucro; (male with a peloderan, ribbed bursa, and gubernaculum).

Aphelenchidae

Genus ***Aphelenchus*** (Fig. 47) ***Aphelenchus avenae*** Bastian, 1865

— Stylet knobs present; tail conoid, tapering, with one or more mucro; (male without a bursa).

Aphelenchoididae

Genus ***Aphelenchoides*** (Fig. 48) ***Aphelenchoides clarus*** Thorne & Malek, 1968

ORDER MONHYSTERIDA

20. Cuticle with fine annulations; single, outstretched gonad at left side of intestine; oesophagus undifferentiated throughout; tail tip without terminal setae.

Xyalidae

Genus ***Theristus*** (Fig. 9) ***Theristus* sp.**

— Cuticle smooth; single, outstretched gonad at right side of intestine.

Monhysteridae **21**

21. Mouth cavity small and shallow anteriorly, without teeth; body cuticle with fine bristles or setae, usually irregularly distributed; oesophagus cylindrical, but may broaden posteriorly, without valve; gonad long, vulva positioned posteriorly; tail length shorter than vulva-anus distance, about 7 times width at anus, tapered and with caudal glands and terminal duct.

Genus ***Monhystera*** (Fig. 7) ***Monhystera dispar*** Bastian, 1865

— Mouth cavity elongate, usually armed with three small teeth; oesophagus forms a small basal bulb-like swelling; gonad short, vulva equatorial; tail length longer than vulva-anus distance.

Genus ***Monhystrella*** (Fig. 8) ***Monhystrella* sp.**

ORDER MONONCHIDA

Note: All the species listed under this order belong in the family Mononchidae which has the characteristics of this order (see above).

22. Base of mouth cavity flat; three identical teeth, one dorsal and two subventral, all pointing forward, present at the same level in posterior part of mouth cavity.

Genus ***Miconchus*** (Fig. 31) ***Miconchus trionchus*** (Thorne, 1924)

— Base of mouth cavity funnel-shaped; subventral teeth, when present, never identical to dorsal tooth **23**

23. Mouth cavity with dorsal tooth only **24**

— Mouth cavity with dorsal tooth and additional fine teeth (= denticles) **26**

24. Dorsal tooth opposed by a smooth, non-denticulate ridge.

Genus ***Clarkus*** (Fig. 29) ***Clarkus papillatus*** (Bastian, 1865)

— Dorsal tooth not opposed by a ridge **25**

- 25.** Oesophageal-intestinal junction with non-tuberculate valve; dorsal tooth in anterior part of mouth cavity.
 Genus ***Mononchus*** (Fig. 32) ***Mononchus* sp.**
- Oesophageal-intestinal junction with tuberculate valve; dorsal tooth in posterior part of mouth cavity.
 Genus ***Iotonchus*** (Fig. 30) ***Iotonchus antedontus*** Mulvey, 1963
- 26.** Mouth cavity with denticles arranged in 4-6 regular, transverse rows opposite dorsal tooth.
 Genus ***Mylonchulus*** (Fig. 33) ***Mylonchulus* sp.**
- Mouth cavity with denticles in two longitudinal rows on two ridges opposite dorsal tooth.
 Genus ***Prionchulus*** (Fig. 34) ***Prionchulus muscorum*** (Dujardin, 1845)

ORDER ENOPLIDA

- 27.** Mouth cavity spacious, barrel-shaped, with strongly sclerotized walls, without conspicuous teeth; head setae prominent; no somatic setae; tail long, thread-like, about 20 times body width at anus.
Prismatolaimidae
 Genus ***Prismatolaimus*** (Fig. 15) ***Prismatolaimus intermedius*** (Bütschli, 1873)
- Mouth cavity collapsed, with weakly sclerotized walls, head setae very short and blunt; tail never long and thread-like **28**
- 28.** Cuticle annulated; mouth cavity long, narrow, closed when resting; one small dorsal tooth recognizable in mouth cavity.
Tripylidae
 Genus ***Tripyla*** (Fig. 13) ***Tripyla affinis*** de Man, 1880
- Cuticle smooth; mouth cavity tubular, long and sclerotized, with two movable teeth at its base.
Ironidae
 Genus ***Cryptonchus*** (Fig. 14) ***Cryptonchus tristis*** (Ditlevsen, 1911)

ORDER DORYLAIMIDA

- 29.** Body and head region slender; amphids minute, slit- or pore-like, at several body widths from anterior end; mouth cavity vestigial, unarmed (without stylet or tooth); oesophagus expanded basally into a small elongate portion, not a basal bulb; anterior gonad reduced; tail long; (male: testis single; gubernaculum and adanal supplements absent).
Alaimidae
 Genus ***Alaimus*** (Fig. 27) ***Alaimus arcuatus*** Thorne, 1939
- Mouth cavity with stylet; basal bulb present; gonads double **30**
- 30.** Long (>2 mm and up to 10 mm) slender nematodes; stylet (odontostylet) slender, straight, axial and long; guiding ring 'single', located deep in mouth cavity near base of stylet; stylet extension rod-like, with conspicuous basal flanges; amphids usually stirrup-shaped with slit-like apertures; oesophagus with its basal third expanded; gonads usually didelphic-amphidelphic; tail shape variable, usually short, conoid, but similar in sexes.
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Key to Classes, Orders, Families, Genera and Species

Longidoridae

Genus **Xiphinema** (Fig. 24) **Xiphinema bakeri** Williams, 1961

- Stylet short, or when long, then body length shorter than 2 mm 31

31. Small to medium-sized nematodes; mouth cavity armed with a sharp, protrusible tooth-like stylet (mural stylet), originating from left wall of mouth cavity; stylet symmetrically pointed at tip, and not axial in position; oesophagus with a slender anterior part about one-half oesophageal length, and an expanded posterior part surrounded by a muscle sheath; three round or ovoid cardiac glands present at base of oesophagus; tail similar in sexes.

Nygolaimidae

Genus **Nygolaimus** (Fig. 23) **Nygolaimus aquaticus** Thorne, 1930

- Relatively larger nematodes; stylet (odontostylet) axial and with wide aperture, near one-half stylet length, and surrounded by a membranous guiding tube 32

32. Medium- to large-sized (about 1-4 mm) nematodes with robust body; ratio $a = 20-30$; lip region set off by a constriction; cuticle thick, particularly at extremities, and sometimes having a pattern of criss-cross lines; separate cuticular layers visible on tail; stylet short, stout, with aperture usually larger than half stylet length; tail of sexes similar, short, bluntly rounded, conoid or digitate (finger-like); oesophageal-intestinal disc absent, except in some genera; vulva near mid-body; usually two or more eggs seen in uterus; (male: gubernaculum absent).

Aporcelaimidae 33

- Stylet aperture not larger than half stylet length; guiding tube not membranous (i.e. sclerotized); no separate cuticular layers visible on tail 34

33. Large-sized (3-4 mm) nematodes; ratio a near 30; ratio $b < 5$; ratio c near 50; vulva near mid-body, with sclerotized labial pieces; odontostylet wide, its aperture more than one-half stylet length; a cardiac disc present; three cuticular layers visible on tail; tail short, bluntly rounded, similar in sexes; usually two or more eggs in uterus (male: ventral supplements present, noncontiguous) ... (Fig. 21) **Aporcelaimellus obscurus** (Thorne & Swanger, 1936)

- Medium-sized (1-3 mm) nematodes; stylet aperture about one-half stylet length; a thin cardiac disc may be present (Fig. 22) **Aporcelaimellus** sp.

34. Sub-cuticle coarsely striated, with abundant radial striae; expanded part of oesophagus usually as a small basal bulb 35

- Sub-cuticle not striated, radial striae few, if present; oesophagus a slender tube ending in an expanded, pyriform basal part; stylet (odontostylet) slender, needle-like, curved posteriorly; stylet extension (= odontophore) plain, without flanges, but with knob-like outgrowths; amphids slit-like or obscure; (male: two testes, gubernaculum absent, but lateral guiding pieces present; a pair of adanal supplements present).

Leptonchidae 36

35. Stylet (odontostylet) well-developed, as long as width of lip region, not curved posteriorly; stylet extension with basal knobs or flanges; expanded part of oesophagus about one-half oesophageal length; tail rounded.

Tylencholaimidae

Genus **Tylencholaimus** (Fig. 20) **Tylencholaimus** sp.

- Stylet slender and needle-like, expanded part of oesophagus pyriform 37

36. Stylet (odontostylet) with distinct knobs or flanges, with dorsal accessory, stiffening piece; Genus ***Tylencholaimellus*** (Fig. 26) ***Tylencholaimellus diplodorus*** N. A. Cobb, 1915

— Stylet (odontostylet) slender, without distinct knobs, very rarely flanged; gonads paired; vulva usually mid-body.

Genus ***Leptonchus*** (Fig. 25) ***Leptonchus granulosus*** N. A. Cobb, 1920

37. Stylet (odontostylet) slender, rather long, usually much longer than width of lip region; stylet extension elongate, rod-like, not flanged; four sclerotized pieces present around mouth opening.

Nordiidae

Genus ***Pungentus*** (Fig. 19) ***Pungentus sp.***

— Stylet not attenuated and usually about as long as width of lip region **38**

38. Large and stout nematodes (>2 mm); tail dissimilar in sexes, usually long, filiform in females (male tail short or bluntly rounded); cuticle with fine transverse striae and longitudinal ridges; mouth cavity armed with a prominent, protrusible, axially-positioned stylet (odontostylet), asymmetrically pointed at tip (sloped on one side), and with a rod-like extension, rarely with basal knobs or flanges; amphids stirrup-shaped.

Dorylaimidae

Genus ***Dorylaimus*** (Fig. 17) ***Dorylaimus helveticus*** Steiner, 1919

— Medium-sized nematodes, with short conoid or hemispheroid (rounded) tail, similar in sexes **39**

39. Lip region conspicuously discoid to form an expanded lip disc, and provided with cuticularized plates; anterior oesophagus forming a single or double swelling; well-developed hypodermal glands present; stylet long and narrow, and sometimes may be slightly non-axial.

Discolaimidae

Genus ***Discolaimus*** (Fig. 16) ***Discolaimus sp.***

— Lip region set off, lips usually separated; dorsal oesophageal gland nucleus near beginning of oesophageal enlargement; tail not cylindrical; stylet extension not flanged.

Qudsianematidae **40**

40. Stylet large, with wide lumen and aperture; guiding ring sclerotized, 'double'; stylet extension rod-like; lip region without deeply sunken oral fields; inner liplets not well separated; anterior portion of oesophagus nearly as wide as posterior portion; tail rounded, similar in sexes, with numerous caudal papillae; body usually >2 mm in length; (male: ventral supplements numerous, contiguous).

Genus ***Labronema*** (Fig. 18) ***Labronema thornei*** Ferris, 1968

— Stylet small, 1 to 1½ times as long as width at lip region; guiding ring 'single'; anterior portion of oesophagus much narrower than posterior portion; usually up to 2 mm in length; tail short, conoid, ventrally curved, similar in sexes; (male: precloacal space present between adanal pair and ventral row of supplements; ventral row spaced, not contiguous).

Genus ***Eudorylaimus*** (Fig. 28) ***Eudorylaimus carteri*** (Bastian, 1865)

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ORDER ARAEOLAIMIDA

- 41.** Oesophagus with a basal bulb containing conspicuous valvular apparatus; head setae present or absent **42**
- Oesophagus without bulb, or when present, without valvular apparatus; usually four head setae present **45**
- 42.** Head with six well-separated, pointed, flap-like incurved lips forming a crown; lip edges strongly sclerotized; head setae usually absent; amphids pore-like, inconspicuous; mouth cavity funnel-shaped with well separated rhabdions; caudal glands and spinneret absent.
Teratocephalidae
 Genus ***Teratocephalus*** (Fig. 6) ***Teratocephalus subvexus*** Anderson, 1969
- Head without distinct lips or crown; head setae usually present, longer than width of head; amphids circular or slit-like, located half-way along mouth cavity; basal bulb with or without valvular apparatus; caudal glands and spinneret present **43**
- 43.** Amphids stirrup-shaped; basal bulb without valvular apparatus; a conspicuous, tongue-like extension of basal bulb connects with the intestine; female with one gonad.
Leptolaimidae
 Genus ***Chronogaster*** (Fig. 3) ***Chronogaster longicollis*** (von Daday, 1899)
- Amphids circular; basal bulb with valvular apparatus; oesophagus without a post-bulbar extension; female generally with two gonads.
Plectidae **44**
- 44.** Wing-like, bulbiform, membranous extensions surround the neck region; head end bearing 6 cirri projecting from outer edges of dorsal and ventral lips; amphids kidney-shaped; female with one gonad.
 Genus ***Wilsonema*** (Fig. 5) ***Wilsonema* sp.**
- Wing-like extensions and cirri in neck region absent; amphids small, circular or elliptical; female with two gonads.
 Genus ***Plectus*** (Fig. 4) ***Plectus parietinus*** Bastian, 1865
- 45.** Amphids conspicuous, circular, somewhat smaller than one half the corresponding body diameter; mouth cavity tubular with sclerotized walls; ratio $c' < 6$.
Diplopeltidae
 Genus ***Cylindrolaimus*** (Fig. 1) ***Cylindrolaimus melancholicus*** de Man, 1880
- Amphids circular or uni-spiral shape; mouth cavity inconspicuous; basal bulb lacking; body conspicuously annulated; very slender nematodes, ratio $a > 40$.
Bastianiidae
 Genus ***Bastiania*** (Fig. 2) ***Bastiania* sp.**

ORDER CHROMADORIDA

46. Amphids slit-like, inconspicuous; mouth cavity with one dorsal tooth and some sub-ventral teeth; cuticular punctations of two sizes, being coarser on the lateral fields; oesophagus distally symmetrical; oesophageal-intestinal junction small, not tri-radiate.

Chromadoridae

Genus **Punctodora** (Fig. 10) **Punctodora sp.**

— Amphids uni- or multi-spiraled, conspicuous; mouth cavity with one or more small teeth; cuticular punctations of uniform size; ratio $b < 10$; tail long, ratio c at most 15 **47**

47. Amphids spiral-shaped, conspicuous, at level of base of mouth cavity; anterior part of oesophagus, which surrounds mouth cavity, strongly offset by a constriction; three equal teeth may be present in anterior mouth cavity, but single large dorsal tooth lacking; (male: supplements present, numerous).

Ethmolaimidae

Genus **Ethmolaimus** (Fig. 12) **Ethmolaimus pratensis** de Man, 1880

— Amphids spiral-shaped, conspicuous, just behind base of mouth cavity; one or two small subventral teeth present in mouth cavity; basal bulb small, less than twice the diameter of procorpus; (male: supplements absent).

Achromadoridae

Genus **Achromadora** (Fig. 11) **Achromadora ruricola** (de Man, 1880)

SECTION 4: GLOSSARY

The following glossary contains two categories of terms: those relating more specifically to nematode taxonomy as used in the dichotomous key and elsewhere in the Monograph, and those relating more generally to the general biology and systematics of nematodes, habitats, and soil types. Only brief and very basic definitions or explanations of all the terms are given.

Accessory piece: same as Gubernaculum.

Adanal: Located adjacent to the anal or cloacal orifice, e.g. adanal supplements; see also Supplements.

Alae: Lateral, longitudinal, wing-like expansions of the cuticle, e.g. caudal alae or male bursa; also see Bursa.

Amphid: One of a pair of lateral, innervated sense organs that open to the exterior on or near the lip region.

Amphidelphic: Having two gonads (ovaries), of which one extends anterior and the other posterior to the vulva.

Ampulla (of excretory system): An internal membranous sac or vestibule that connects to the excretory pore at the external cuticle by means of the excretory duct.

Anabiosis: A state of facultative quiescence induced by desiccation and revived upon re-hydration.

Anhydrobiosis: A state of facultative quiescence in nematodes initiated by loss of body water.

Annulation: The arrangement or pattern of conspicuous, transverse cuticular rings, occurring close together and at regular intervals, on the nematode body.

Annule: One of transverse rings or striations forming the nematode cuticle.

Apomorphic (character): A relatively advanced, derived or "modern" character state in an organism, as opposed to a plesiomorphic or primitive character state.

Apophysis: A process or a prominence, e.g. as might be found on the Gubernaculum.

Attenuated: Thin, slender, and drawn-out; thin and long.

Bar (in relation to soil suction): The bar is a standard unit for the expression of soil suction; it is a unit of pressure equal to 10^6 dyne/cm², which is the equivalent of 0.987 atmospheres.

Basal bulb: See Metacarpus and Oesophageal bulb.

Basal knobs: The basal or posterior knobs of the stylet.

Biogeoclimatic zone: A geographical area in which the mosaic of soils and vegetation broadly reflects the regional macroclimate; the geographical limits of the zone are defined by the climax vegetation on mesic sites with zonal soils; in this context, climax is the final seral stage, mesic site is one in which the regional climate determines the moisture experiences of the vegetation, and zonal soil is the type of soil that will develop under a particular combination of climate and vegetation.

Biome: A major terrestrial ecological community that extends over a large geographical area, and is characterized by climatic climax vegetation; in general a major biotic zone; examples of a biome are tundra, northern coniferous forest, grassland, desert, etc.

Brunisol (soil type): A soil that occurs in temperate regions mostly under forest cover, with a brownish B horizon (Bm).

Buccal capsule: See Mouth cavity.

Buccal cavity: See Mouth cavity.

Bursa: Lateral, longitudinal, flap-like or wing-like cuticular expansions, or alae, at the tail end of males of certain nematode species; the bursa is wrapped around the female during copulation.

Calcareous (soil): Soil made alkaline by free CaCO₃ or other carbonates.

Cambisol (soil type): A soil of semiarid or dry regions with uniform texture except where there is stratification in the parent material.

Cardia: A muscular structure, located between the oesophagus and intestine, and opening into the intestine; it acts as a valve to prevent intestinal contents from moving back into the oesophagus.

Cardiac disc: The oesophageal-intestinal disc; a disc-shaped structure present between oesophagus and intestine.

Cardiac glands: Three glandular bodies located at the base of the oesophagus.

Cardiac region: The oesophageal-intestinal junction.

Caudal alae: Flap-like, lateral expansions of the cuticle on male tails of certain nematode species, forming the bursa.

Caudal glands: Elongate unicellular glands, usually three, in or near the tail, discharging by separate ducts into a common sac (ampulla), and then opening through a common duct at the tail-tip or spinneret.

Cephalic setae: Tactile bristle-like organs located on the anterior end, around the mouth opening.

Character (character state): Any attribute or feature of an organism that is capable of being described or measured and used for classification or taxonomic purposes; each character has a distinctive and descriptive quality, condition, form, structure or state; shared similarities or differences in homologous characters are called character states which are used to classify organisms and place them in particular taxonomic groups.

Cheilarhabdions: Scleritized pieces forming wall of anterior part of the mouth cavity or stoma (the cheilstom); the cuticularized walls of the cheilstom; see Rhabdions.

Cheilstom, cheilstome: The most anterior part, or lip cavity, of the mouth cavity or stoma, lying between the oral opening and protostom; see Cheilarhabdions, Rhabdions.

Cirri: Elaborate cephalic appendages in front of the cephalic setae, such as those found in *Wilsonema* spp.

Cladism, cladistic: A taxonomic approach in which organisms are ordered and ranked on the basis of "recency of common descent", or the most recent branching point of inferred phylogeny; in this approach, a limited number of morpho-anatomical characters are selected, their ancestral (plesiomorphic) or derived (apomorphic) polarities are defined and hierarchized, and the construction of cladograms or dichotomous phyletic trees is based on sequences of those character states.

Class: See Classification.

Glossary

Classification: The systematic ordering and ranking of organisms into groups or categories (taxa) based on natural relationships; the main categories or taxa, in diminishing rank, are phylum, class, order, family, genus and species.

Clavate, claviform: Club-shaped.

Columella: Region of specialized gland cells between the oviduct and uterus that secrete egg membrane; these glands are variously named crustaformeria, tricolumella and quadricolumella.

Conoid: Shaped like a cone.

Conspecific: Individuals or populations of the same species.

Corpus: The most anterior part of the oesophagus, usually of an elongate cylindrical shape, but sometimes the corpus may be swollen basally to form a bulb. In the latter condition, the elongate anterior part is termed the Procorpus and the bulb is termed the Metacorpus.

c-p rating: This concept classifies nematodes on a colonizers-to-persisters continuum, the colonizers being *r*-strategists with lower c-p ratings, and the persisters being *K*-strategists with higher c-p ratings; see also under Introduction (Section 1) and the references therein.

Cryptobiosis: A facultative state of quiescence (hypobiosis, ametabolism, lowered metabolism) in nematodes initiated by dehydration and low temperature.

Cuticle: The non-cellular external covering of nematodes; the cuticle is secreted by the underlying hypodermis, and lines the natural orifices of the nematode body, such as the mouth cavity, anus, vulva, vagina, oesophageal lumen, rectum, etc.

Cyathiform: Cup-shaped, concave.

Deirid: One of the paired lateral cervical papillae located near the nerve ring and believed to function as tactoreceptors.

de Man Formula (= de Man indices/ratios/values): A series of measurements and ratios thereof that are used for the descriptions and identification of nematodes; the basic measurements are a nematode's body length, width, oesophageal length, tail length, etc.; these measurements are then used to express certain ratios such as the relative lengths of the oesophagus and tail, the position of the vulva, etc.; see also Morphometry, Ratio *a*, Ratio *b*, Ratio *c*, Ratio *c'*.

Denticle: A small tooth or projection in the mouth cavity (stoma) of some nematodes; in ventral, dorsal or variations of these positions in the mouth cavity.

Diagnosis, differential diagnosis: A scrutiny and formal statement of those characters that differentiate the species, or a taxon at another level, from its closest relatives.

Dichotomy, dichotomous (Key): A dichotomous Key is an identification key in which a branch-point has only two descendant branches (= couplets); see also Polychotomy.

Didelphic (species): Having two gonads (ovaries).

Dysmoder (soil type): A humus form, intermediate between a mull and a mor, low in nutrient status.

Edaphic: Relating, belonging or pertaining to the soil; growing on soil.

Epicotyl: The stem portion of the plumule in seedlings.

Esophagus, esophageal: See Oesophagus, oesophageal.

Euryomorphic (genus): A large genus in which one or more characters can vary progressively from one species to the other (morphoclinal) within the genus; in such a genus, species are easily separated from each other, but the limits of the genus itself are more difficult to assess; see also Oligomorphic (genus).

Eutrophic: Habitats, particularly soils and water that are rich or adequate in nutrients.

Excretory system: The structures (other than the intestine) concerned with voiding waste products from the nematode body; the system consists of ducts or canals by which excretory products are voided through the ventral excretory pore on the cuticle. Secernentean nematodes generally have the H-shaped or the U-shaped lateral canal systems and the excretory sinus, a common cavity of the canals opening to the exterior by the excretory pore.

Family: See Classification.

Fecundity: Egg-laying or egg production capacity of female nematodes.

Flange (in reference to stylet extension): A rim or expansion of stylet extension (= Odontophore) developed to give structural strength to the latter; see Stylet extension.

Gametogenesis: The development or formation of reproductive cells.

Gastrula: A stage in embryogenesis; the early embryo with an open-mouthed saclike body with a wall of two layers of cells; the opening is called the blastopore and the central cavity the archenteron; gastrulation results in the formation of a cylindrical embryo.

Gelic gleysol (soil type): A frozen soil developed under conditions of periodic or prolonged water-logged conditions, and hence an anaerobic environment.

Gelic regosol (soil type): A frozen soil that is weakly developed, but sometimes may have a dark coloured surface horizon (Ah), or a buried horizon (Ahb).

Generation time: The length of time required to complete a life-cycle from egg to reproductive adult; time from the first oviposition by a female to the first oviposition by the progeny of that female.

Genus, genera: See Classification.

Glottid apparatus: The metastom (posterior part of protostom; see Mouth cavity, Protorhabdions) of some nematodes, e.g. rhabditids, in which the dorsal and two subventral metarhabdions (see Rhabdions) are highly modified into denticle-like structures.

Gonopore: The exterior opening of gonads; the vulva in females and the cloacal opening in males.

Gravid: Female bearing one or more eggs.

Gubernaculum: In males, a grooved, cuticularized structure that guides the spicule(s) toward the female gonopore (vulva); may be paired.

Guiding ring: See Stylet guiding ring.

Guiding tube: A sheath around the stylet extending from stylet guiding ring to stylet base.

Gynandromorphism: An intersex; an individual in which both the male and the female secondary characters are present; it functions as one or the other or neither sex, but not as both.

Glossary

H-shaped lateral canals: See Excretory system.

Humus: A general term for the more or less decomposed residues of plants and animals in soil, litter thus being excluded.

Hygroscopic: Pertaining to an aquatic habitat over the surface of which a minimal film of water flows, such as the surface of a vertical rock.

Hypodermal glands: Unicellular glands found in the sub-cuticular, cellular layer of the body wall of adenophorean nematodes; they do not include the glands associated with sensory organs, such as amphids and phasmids.

Incisure: See Lateral lines.

Isthmus: The portion of the oesophagus between the Metacarpus (= Median bulb) and the Basal bulb.

Juvenile (juvenile stage): Each of four nematode juvenile (= larval) stages J1-J4 before reaching adulthood; see also Larva and L1-L4.

J1-J4: The four immature, developmental stages (= juvenile stages J1-J4 or larval stages L1-L4) of nematodes before reaching the adult stage.

Larva (larval stage): Each of four nematode larval (= juvenile) stages L1-L4 before reaching adulthood; see also Juvenile and J1-J4.

L1-L4: The four immature, developmental stages (= larval stages L1-L4 or juvenile stages J1-J4) of nematodes before reaching the adult stage.

Labia; labial: Plural of labium or lips; pertaining to or located on the lip(s).

Labium, labia, labial: Lip; plural of labium or lips; pertaining to or located on the lip(s).

Lateral fields: Distinct longitudinal cuticular areas overlying the lateral hypodermal cords on either lateral side; the lateral fields may be demarcated or divided by longitudinal lateral lines, usually two or four in number, occurring as longitudinal cuticular clefts, incisures or involutions.

Lateral lines: Incisures; involutions; longitudinal cuticular clefts that divide the lateral fields.

Leptoderan: Type of bursa in which the caudal alae do not reach the tail tip.

Ley: Land temporarily under grass.

Loam: A loose term for any non-sandy, non-sticky, friable soil; a soil intermediate in texture and properties between fine-textured and coarse-textured soils; a textural class defined to specific ranges of sand, silt and clay content.

Longitudinal ridge(s): Longitudinal lateral thickening(s) of the external cuticle extending the whole body.

Mesocorpus: Posterior enlargement or swelling of the procorpus in some nematodes; see Procorpus.

Metacorpus: Also known as median bulb; the posterior bulb-like subdivision of the oesophageal corpus (see Basal bulb); usually ovate in shape and preceded by a cylindrical anterior part, and frequently containing a valvular structure used as a pump for ingesting fluids.

Microcosm: A laboratory experimental system that closely simulates the ecological and climatic conditions in the field.

Moder: A loose term for a morphological form of mor, in which the organic material forms a well-defined superficial layer, as in mor, but is granular and loose, resembling a mull in structure, and consists mainly of fecal pellets of very small invertebrates.

Monoxenic culture: In nematology, a laboratory culture in which only one other species (e.g. a bacterium or a fungus) is associated with the primary species under culture (i.e. a nematode species).

Mor: A humus form characterized by a clear separation of organic layers above the mineral horizons, and is generally acid and supports abundant fungal growth and small invertebrates.

Morphometrics, morphometry: Measurements of morphological features that are important in nematode taxonomy, in particular for differentiating species within genera; such measurements include the de Man ratios; see also de Man Formula, Ratio *a*, Ratio *b*, Ratio *c*, Ratio *c̄*.

Morphospecies: A typological species recognized merely on the basis of morphological difference.

Mouth cavity: Buccal cavity, Buccal capsule, Stoma, Vestibule; the part of the digestive tract between the oral opening and the anterior end of the oesophagus; in the broad sense, the stoma; in the narrow sense, the cheilostom or cheilostome. Three main sections are distinguished in mouth cavity, namely Cheilostom, Protostom and Telostom; protostom is further subdivided into prostom, mesostom and metastom; see also Rhabdions.

Mucro: A small pointed process or projection, as occurring at the tail tip of certain nematodes.

Mull: Soils whose upper mineral layer has become intimately mixed (mainly through the activities of earthworms) with amorphous organic material, often to a depth of 4-5 feet; has a granular and lumpy appearance, and is loose and friable.

Mural stylet: A tooth-like stylet derived from the wall of the mouth cavity (stoma).

Mural tooth/stylet: A tooth/stylet derived from and attached to the wall of the mouth cavity (stoma).

Mycorrhiza: The symbiotic, non-parasitic association between the root or rhizome of a green plant and a fungus.

Neotype: A specimen from the original type locality designated as a new holotype; holotype is the single specimen designated as the Type by the original author at the time of publication of the original description.

Nomenclature: A system of names or naming as, for example, in the classification of organisms into taxa; see also Classification.

Odontophore: See Stylet extension.

Odontostylet: A stylet with a dorsally oblique aperture, derived from the wall of the oesophagus and then moving into position in the mouth cavity (stoma); found in dorylaimid nematodes.

Oesophageal bulb(s): The one or more muscular, swollen regions of the oesophagus or pharynx; see also Basal bulb and Metacorpus.

Oesophageal glands: Elongated glands located in the oesophageal region; one gland is dorsal and two are in subventral positions; their secretions have an enzymatic function.

Glossary

Oesophageal-intestinal junction: Same as Cardiac region.

Oesophageal-intestinal valve: Same as Cardia.

Oesophagus: The muscular portion of the digestive tract between the mouth cavity (stoma) and the intestine; in nematology, the terms oesophagus and pharynx have been used interchangeably.

Oligomorphic (genus): A genus in which all the species closely resemble each other; such a genus is easily defined, but its species are more difficult to separate from each other; see also Euryomorphic (genus).

Oligotrophic: Habitats, particularly soils and water that are low in basic nutrients.

Ombratrophic mire: A boggy soil of poor nutrient status and dissociated from underground water.

Onchiostylet: A stylet having a dorsally oblique aperture, as in the odontostylet, but is derived from an onchium.

Onchium: Sclerotized, tooth-like outgrowth formed in the wall of the mouth cavity (stoma); also called a mural tooth.

Oocyte: A female gamete prior to maturation.

Opisthodelphic (species): Having a single ovary located posterior to the vulva.

Order: See Classification.

Osmoregulation: The ability of an organism, such as a nematode, to regulate ionic content of body fluids under conditions of osmotic stress, i.e. under conditions that become hypotonic or hypertonic to the nematode's natural environment.

Papilla, papillae: Minute projections or elevations of the nematode cuticle; they are generally sensory in function.

Parthenogenesis, parthenogenetic: Reproduction from unfertilized ova without the participation of male gametes.

Peloderan: Type of bursa in which the caudal alae meet posterior to the tail end, i.e. the alae envelops the entire tail to its tip.

Pharynx: See Oesophagus, Esophagus.

Phasmid: One of a pair of post-anal, lateral caudal papillae; the phasmids are connected with the lateral caudal glands and believed to be chemoreceptive sensory organs.

Phenetics (numerical taxonomy): A taxonomic approach in which organisms are ordered and ranked on the basis of similarity as determined by phenetic characters or characters responsible for overall appearance; in this approach, a large number of characters are identified without regard to the organisms' evolutionary history; then their relationships are analyzed statistically, for example by the use of multivariate analysis for making distinctions at the species levels.

Phenotype, phenotypic: The totality of visible characters (appearance) of an organism resulting from the interaction of its genotypic characters and the environment.

Phreatic water: Ground water, independent of precipitation.

Phylogenetics (phylogeny): The study of evolutionary relationships within and between groups of organisms, resulting in phylogenetic trees of evolutionary patterns or lineages; such lineages form the basis for the cladistic approaches to classification and taxonomy.

Plesiomorphic (character): A relatively primitive, ancestral or non-derived character state in an organism, as opposed to an apomorphic or derived, advanced or 'modern' character state.

Podzol: A loan word derived from a Russian folk term for ash-grey soils; podzol is characterized by a superficial layer of raw humus above a generally grey horizon of mineral soil depleted by leaching of Fe and Al sesquioxides and colloids, and overlaying a horizon wherein Fe sesquioxides and/or organic matter have accumulated; podzols are the commonest soils in conifer areas in temperate regions.

Polarity (of character states): The evolutionary ordering of character states; the polarity of a character is used to specify which of its character states is to be regarded as as primitive or ancestral (plesiomorphic) and which as derived or advanced (apomorphic).

Polychotomy, polychotomous, polytomous (Key): A polytymous Key is an identification key in which a branch-point has more than two descendant branches, as opposed to a dichotomous Key in which it has only two branches; polytymous branching may result from uncertainty or insufficiency of data to resolve branching dichotomously; a polytymous key is particularly suited for a genus with a large number of species (multiple species); it is often constructed as a lattice containing numerical codes for the characteristics of interest; a specimen under examination for its specific identification is then verified for presence or absence of the distinguishing characteristics against the species listed in the lattice; the specimen is then declared as a known or a new species.

Probolae: Conspicuous, often elaborate, cuticular extensions encircling the oral aperture in ceratin nematodes, and situated in labial and cephalic positions.

Procorpus: Anterior cylindrical subdivision of corpus of oesophagus located between base of mouth cavity (stoma) and posterior subdivision of the corpus or mesocorpus.

Prodelphic (species): Having a single ovary located anterior to the vulva.

Protorhabdions: Sclerized pieces forming wall of middle, cylindrical part of mouth cavity or stoma (the protostom); see Rhabdions.

Punctations: Small dot-like markings, in the form of pits or depressions, on the cuticle surface; usually round but their shape may vary.

Ratio a: A ratio expressing relative thickness or thinness of a nematode (body length ÷ greatest body width, usually at the vulva or mid-body); see also de Man Formula.

Ratio b: A ratio expressing relative length of oesophagus (body length ÷ distance from anterior end to junction of oesophagus and intestine); see also de Man Formula.

Ratio c: A ratio expressing relative tail length (body length ÷ tail length); see also de Man Formula.

Ratio c̄: A ratio of tail length ÷ body width at anus or cloaca; see also de Man Formula.

Rectal glands: Large unicellular glands in the rectal region, usually three in females and six in males.

Glossary

Renette: An internal, ventral “gland cell” at the end of excretory duct; ultrastructural and histochemical evidence has indicated a secretory rather than an excretory function for this cell.

Rhabdions: Sclerotized pieces or sections forming the wall of the mouth cavity (stoma); from front to back, the sections may be distinguished as cheilorhabdions forming the lip cavity of stoma or cheilostom, protorhabdions (prorhabdions, mesorhabdions, metarhabdions) forming the cylindrical part of stoma or protostom, and telorhabdions, forming the end-cavity of the stoma or the telostom.

Rhabditoid (*oesophagus*): A four-part oesophagus consisting of an anterior, cylindrical part (the procorpus), followed by a pseudobulb (the metacarpus or median bulb), a slender part (the isthmus), and terminating in an ovoid basal bulb.

Rhizosphere: The microenvironment of roots of plants.

Seta, setae: Bristle-like projection(s) from the nematode cuticle, which function as tactile sensory organs.

Silt: A finer soil fraction of mineral particles, 0.002 to 0.05 mm in diameter; particle size of silt is between that of clay and sand; a soil containing a high proportion of such particles; more generally, a fine water-borne sediment.

Somatic setae: Setae in general, distributed on nematode body cuticle.

Spear: See Stylet.

Species: See Classification.

Spermatheca, spermatotheca: An enlarged portion of female gonad between the oviduct and uterus; its function is to store sperm received from the male.

Spicule: Cuticularized male copulatory organ for the transfer of sperm to female; often paired; the spicule is extruded through the cloacal opening during copulation.

Spinneret: The terminal pore or outlet of the caudal cement glands.

Stoma: See Mouth cavity.

Stomatal: Pertaining to the stoma; see Mouth cavity.

Stomatostylet: A stylet derived from the wall of mouth cavity (stoma), and formed through evolutionary development from rhabdions; found in tylenchid nematodes.

Striated, striation: Arranged with striae or transverse cuticular annules or annulations.

Stylet: A long, slender, heavily sclerotized, hollow feeding structure, usually located axially in the mouth cavity (stoma) of many nematodes; used to pierce plant and fungal cells, or bodies of small animals preyed on; after piercing, the cell or body contents are sucked up; see also odontostylet, onchiostylet, stomatostylet, mural stylet/tooth.

Stylet extension: A sclerotized section of oesophageal lumen from the base of the stylet to the beginning of the oesophagus in most dorylaimid nematodes; stylet extensions may be simple rod-like, or they may bear knobs or flanges; also called odontophore.

Stylet guiding ring ('single' vs. 'double'): Scleritized or muscular ring at anterior end of guiding sheath surrounding the stylet in some nematodes; it may appear 'single' (when the stylet is completely retracted) or 'double' (when the stylet is protruded); or the guiding ring may be seen as plicated (bearing folds) at the anterior end of the guiding sheath.

Stylet sheath or tube: A sheath surrounding the stylet from the stylet-guiding ring to stylet base.

Suborder: A taxon that is less inclusive than an order but more than a family; see Classification.

Supplements: In some male nematodes, papilla-like organs of secretion and attachment, located anterior to the cloacal orifice in a ventromedian position; they may be regularly or irregularly spaced, or contiguous, or arranged in several contiguous groups; frequently, there is a pair of supplements close to the cloacal orifice and separate from the ventromedian series, called the adanal pair; supplements are functional during copulation.

Synonym: A systematic name replaced due to priority of another name, reclassification, etc.; in nomenclature, each of two or more names for the same taxon.

Synonymy: A chronological list of the scientific names that have been used for a given taxon, including the authors' names and dates of publication of those scientific names.

Systematics: The basic and systematic study of the diversity of organisms and their phylogenetic relationships.

Taxon: A collective term for any taxonomic category; see Classification.

Taxonomy: The systematic grouping of organisms according to their natural relationships; the practice of describing and classifying organisms.

Telorhabdions: Sclerotized pieces forming wall of posterior part of the mouth cavity (stoma); the telostom; see also Rhabdions

Teratology: A conspicuous malformation or an abnormal condition in an organism.

Thiobiosis: Ability to survive in thiobiotic or sulphide-rich environments.

Type specimen: A specimen taken from the locality of the original type.

Trinomen: With three names, e.g. genus, species and subspecies.

Tubercle: A small, knob-like projection of the cuticle; more generally, a smooth rounded outgrowth or protuberance.

Type: The zoological specimen that serves as the basis for the name of a taxon.

Type species: The zoological specimen from which a species is described or upon which a taxon is founded.

U-shaped lateral canals: See Excretory system.

Vestibule: See Mouth cavity.

Vulva: External opening (= gonopore) of the female genital system.

Xenic culture: In nematology, a laboratory culture in which the number of the other species of organisms associated with the primary species under culture (a nematode species) is unknown.

SECTION 5: LINKS

Interactive Diagnostic Key to Plant Parasitic, Freeliving and Predaceous Nematodes

By University of Nebraska, Lincoln (UNL) Nematology Lab. Adapted from: An Illustrated Key to Nematodes Found in Fresh Water. Armen C. Tarjan (University of Florida, Lake Alfred), Robert P. Esser (Florida Department of Agriculture, Gainesville) and Shih L. Chang (Environmental Protection Agency, Cincinnati, Ohio).

Nematode Species List

By University of Nebraska, Lincoln: Nematodes listed alphabetically by Genera.

Plant and Insect Parasitic Nematodes

By University of Nebraska, Lincoln. Nematology: Miscellaneous Topics.

<http://www.ifas.ufl.edu/~kbn/rhabdi/rhabmain.htm>

By Dr. Khuong B. Nguyen, University of Florida: a useful website on the suborder Rhabditina, including morphological characters, classification and an illustrated key for identification to superfamilies, families and genera.

<http://gnv.ifas.ufl.edu/~kbn/cephalob/cephmain.htm>

By Dr. Khuong B. Nguyen, University of Florida: a useful website on the suborder Cephalobina, including morphological characters, classification and an illustrated key for identification to superfamilies, families and genera.

SECTION 6: REFERENCES

This bibliography contains all works that have been cited in the Monograph. Some earlier papers dealing with descriptions were not available to us. For these references, the appropriate bibliographic entry is preceded by an asterisk (*). Full titles for Journals are given.

- Adams, R. E. (1955) Evidence of injury to deciduous trees by an ectoparasitic nematode (*Xiphinema* sp.) and a promising control measure. *Phytopathology* 45: 477-479.
- Adamson, M. L. (1987) Phylogenetic analysis of the higher classification of the Nematoda. *Canadian Journal of Zoology* 65: 1478-1482.
- *Adilova, N. B. (1973) The nematode fauna on maize and its rhizosphere; its dynamics in the Tashkent area. In: The question of phytонематodes in the Uzbekistan, Book 3. Isdatel'stvo "Fan", Tashkent, 15-68.
- Ahmad, W., Jairajpuri, M. S. (1982) Some new and known species of Dorylaimoidea. *Nematologica* 28: 39-61.
- Al-Banna, L., Gardner, S. L. (1996) Nematode diversity of native species of *Vitis* in California. *Canadian Journal of Zoology* 7: 971-982.
- Allgén, C. (1925) Beiträge zur Kenntnis der freilebenden Nematoden Schwedens. *Arkiv för Zoologi* 18A (5): 1-40.
- *Allgén, C. (1933) Über einige freilebende Nematoden aus dem Niederkongo. *Zoologischer Anzeiger*, Leipzig 103 (11-12): 312-320.
- Alphei, J. (1998) Differences in soil nematode community structure of beech forests: comparison between a mull and a moder soil. *Applied Soil Ecology* 9: 9-15.
- *Altherr, E. (1955) Les nématodes du Parc national suisse (Nématodes libres du sol). 3^e partie. Ergebnisse der Wissenschaftlichen Untersuchung des Schweizerischen Nationalparks 3, n. F. (32): 319-328.
- Anderson, R. C. (2000) Nematode Parasites of Vertebrates. Their Development and Transmission. 2nd. Edn. CAB International, Wallingford, UK. 650 pp.
- Anderson, R. V. (1966) An emendation of the diagnosis of both the subfamily and two genera of Wilsonematiniae and a new genus, *Ereptonema* n.g. (Plectidae: Nematoda). *Canadian Journal of Zoology* 44: 923-935.
- Anderson, R. V. (1968a) Variation in taxonomic characters of a species of *Acrobeloides* (Cobb, 1924) Steiner and Buhrer, 1933. *Canadian Journal of Zoology* 46: 309-320.
- Anderson, R. V. (1968b) Emendation of the generic diagnosis of *Cryptonchus* Cobb, 1913 (Nematoda: Ironidae), redescription of *C. tristris* (Ditlevsen, 1911) Filipjev, 1934, and description of the male. *Canadian Journal of Zoology* 46: 935-942.
- Anderson, R. V. (1969) Comparative morphology and descriptions of three new species of *Teratocephalus* from Canada. *Canadian Journal of Zoology* 47: 829-840.
- Anderson, R. V., Hooper, D. J. (1970) A neotype for *Cephalobus persegnis* Bastian, 1865, redescription of the species, and observations on variability in taxonomic characters. *Canadian Journal of Zoology* 48: 457-469.
- Anderson, R. V., Mulvey, R.H. (1979) Plant-parasitic nematodes in Canada. Part 1: An illustrated guide to the genera. Monograph No. 20. Agriculture Canada. 152 pp.

- *Andrássy, I. (1957) Über die Gattung *Chronogaster* Cobb, 1913 (Nematoda, Plectidae). *Annales Universitatis Scientiarum Budapestiensis Rolando Eötvös, Sectio Biologica* 1: 3-12.
- *Andrássy, I. (1958a) Über das System der Mononchiden (Mononchidae Chitwood, 1937; Nematoda). *Annales Historico-Naturales Musei Nationalis Hungarici* 50: 151-171.
- *Andrássy, I. (1958b) Noch einmal über die Gattung *Chronogaster* Cobb, 1913. *Opuscula Zoologica Instituti Zoosystematici Universitatis Budapestinensis* 2 (4): 7-11.
- *Andrássy, I. (1958c) Szabadonélő fonálférgek (Nematoda libera). In: *Magyarország Állatvilága*, Budapest 3 (1): 1-362.
- *Andrássy, I. (1959) Taxonomische Übersicht der Dorylaimen (Nematoda), I. *Acta Zoologica Hungarica* 5: 191-240.
- *Andrássy, I. (1960) Beiträge zur Kenntnis der freilebenden Nematoden Chinas. *Annales Historico-Naturales Musei Nationalis Hungarici* n. s. 52: 201-216.
- *Andrássy, I. (1967a) Die unterfamilie Cephalobinae (Nematoda: Cephalobidae) und ihre Arten. *Acta Zoologica Academiae Scientiarum Hungaricae* 13: 1-37.
- Andrassy, I. (1967b) The determination of volume and weight of nematodes. In: Zuckerman, B. M., Brzeski, M. W., Deubert, K. H. (eds) English Translation of Selected East European Papers in Nematology. University of Massachusetts, Cranberry Experiment Station, East Wareham, MA. Pp. 73-84.
- Andrássy, I. (1976) Evolution as a Basis for the Systematization of Nematodes. London: Pitman Publishing. 288 pp.
- *Andrássy, I. (1981) Revision of the order Monhysterida (Nematoda) inhabiting soil and inland waters. *Opuscula Zoologica* (Budapest) 17-18: 13-47.
- Anonymous (1957) Occurrence of plant-parasitic and predaceous nematodes in soil and tree root samples from Ontario and Quebec. *Canadian Insect Pest Review* 35: 287-290.
- Armendáriz, I., Hernández, M. A., Jordana, R. (1996) Temporal evolution of soil nematode communities in *Pinus nigra* forests of Navarra, Spain. *Fundamentals of Applied Nematology* 19 (6): 561-577.
- Aroian, R. V., Carta, L., Kaloshian, I., Sternberg, P. W. (1993) A free-living *Panagrolaimus* sp. from Armenia can survive in anhydrobiosis for 8.7 years. *Journal of Nematology* 25 (3): 500-502.
- Arpin, P. (1975) Étude systématique et dynamique de deux nématocénoses en climat tempéré. *Revue d'Écolgie et de Biologie du Sol* 12 (2): 493-521.
- Arpin, P. (1991) Mise au point sur la caractérisation biologique des humus forestiers par l'étude des Nematodes Mononchida. *Revue d'Écolgie et de Biologie du Sol* 28 (2): 133-144.
- Arpin, P., Armendáriz, I. (1996) Nematodes and their relationship to forest dynamics: II. Abundance and morphometric variability of Mononchida related to changes in humus forms. *Biology and Fertility of Soils* 23: 414-419.
- Arpin, P., Jagers op Akkerhuis, G., Ponge, J.-F. (1988) Morphometric variability in *Clarkus papillatus* (Bastian, 1865) Jairajpuri 1970 in relation to humus types and season. *Revue de Nématologie* 11: 149-158.

References

- Arpin, P., Ponge, J.-F. (1986) Influence d'une implantation récente de pin sylvestre sur le comportement de la nématofaune du sol, par comparaison avec un peuplement feuillu pur et un peuplement mélangé. *Pedobiologia* 29: 391-404.
- Arpin, P., Ponge, J.-F., Faille, A., Blandin, P. (1998) Diversity and dynamics of eco-units in the biological reserves of the Fontainebleau forest (France): contribution of soil biology to a functional approach. *European Journal of Soil Biology* 34 (4): 167-177.
- Arpin, P., Samsoen, L., Ponge, J.-F., Khan, S. H. (1984) Ecology and systematics of the Mononchid nematodes from wood and grassland areas in wet temperate climate. II. The genus *Prionchulus* Cobb, 1916. *Revue de Nématologie* 7(3): 215-225.
- Baird, S. M., Bernard, E. C. (1984) Nematode population and community dynamics in soybean-wheat cropping and tillage regimes. *Journal of Nematology* 16 (4): 379-386.
- Baldwin, J. G., Frisse, L. M., Vida, J. T., Eddleman, C. D., Thomas W. K. (1997) An evolutionary framework for the study of developmental evolution in a set of nematodes related to *Caenorhabditis elegans*. *Molecular Phylogenetics and Evolution* 8: 249-259.
- Barker, K. R., Hussey, R. S., Krusberg, L. R., Bird, G. W., Dunn, R. A., Ferris H., Ferris, V. R., Freckman, D. W., Gabriel, C. J., Grewal, P. S., MacGuidwin, A. E., Riddle, D. L., Roberts, P. A., Schmitt, D. P. (1994) Plant and soil nematodes: societal impact and focus for the future. *Journal of Nematology* 26 (2): 127-137.
- Barrett, J. (1976) Energy metabolism in nematodes. In: Croll, N. A. (ed) *The Organization of Nematodes*. London: Academic Press. Pp. 11-70.
- Barrett, J. (1991) Anhydrobiotic nematodes. In: Evans, K. (ed) *Agricultural Zoology Reviews*, Volume 4, Intercept Ltd., Andover, Hampshire, UK. Pp. 161-176.
- *Bastian, H. C. (1865) Monograph of the Anguillulidae, or free nematoids, marine, land and freshwater; with descriptions of 100 new species. *Transactions of the Linnean Society of London, Zoology* 25 (2): 73-184.
- Baujard, P. (1988) Identification of aphelenchids. In: Fortuner, R. (ed). *Nematode identification and expert system technology*. New York: Plenum Press. Pp. 153-156.
- Beaver, P. C., Jung, R. C., Cupp, E. W. (1984) *Clinical Parasitology*. 9th. Edn. Philadelphia: Lea & Febiger, 825 pp.
- Bird, A. F., De Ley, P., Bird, J. (1993) Morphology, oviposition and embryogenesis in an Australian population of *Acrobeloides nanus*. *Journal of Nematology* 25 (4): 607-615.
- Blakely, J. K., Neher, D. A., Spongberg, A. L. (2002) Soil invertebrate and microbial communities, and decomposition as indicators of polycyclic aromatic hydrocarbon contamination. *Applied Soil Ecology* 21: 71-88.
- Boag, B. (1986) Detection, survival and dispersal of soil vectors. In: McLean, G. D., Garrett, R. G., Ruesink, W. G. (eds) *Plant Virus Epidemics: Monitoring, Modeling and Predicting Outbreaks*. Sydney: Academic Press. Pp. 119-145.
- Boag, B., Bowen, S., Spaull, A. M., Wright, G., Smith, B. F. L. (1990) Migratory plant-parasitic nematodes associated with cereals in Scotland. *Annals of Applied Biology* 117: 399-406.
- Boag, B., Lopez-Llorca, L. V. (1989) Nematodes and nematophagous fungi associated with cereal fields and permanent pasture in eastern Scotland. *Crop Research (Horticultural Research)* 29 (1): 1-10.

- Boag, B., Small, R. W., Neilson, R., Gauld, J. H., Robertson, L. (1992) The Mononchida of Great Britain: observations on the distribution and ecology of *Anatonchus tridentatus*, *Truxonchus dolichurus* and *Miconchooides studeri* (Nematoda). *Nematologica* 38: 502-513.
- Bolla, R. (1980) Nematode energy metabolism. In: Zuckerman, B. M. (ed) *Nematodes as Biological Models: Aging and other model systems*, Vol. 2, New York: Academic Press. Pp. 165-192.
- Bongers, T. (1987) De Nematoden van Nederland. Utrecht: Koninklijke Nederlandse Natuurhistorische Vereniging - III. - (Natuurhistorische Bibliotheek, ISSN 0169-5355: nr. 46) 1987.
- Bongers, T. (1988) De Nematoden van Nederland. In: van Bohemen, H. D., Buizer, D. A. G., Littel, A. (eds) *Natuurhistorische Bibliotheek*. KNNV. 408 pp. [in Dutch].
- Bongers, T. (1990) The maturity index: an ecological measure of environmental disturbance based on nematode species composition. *Oecologia* 83: 14-19.
- Bongers, T., Bongers, M. (1998) Functional diversity of nematodes. *Applied Soil Ecology* 10: 239-251.
- *Bonifacio, A., Marinari, A. (1969) Osservazioni a proposito del damping-off dei semenzali. Deuxième Congrès Union Phytopathologique Méditerranéenne, Avignon-Antibes, France, 21-27 settembre 1969. *Annales de Phytopathologie* 1: 141-144.
- Boström, S. (1985) Aspects on the ultrastructure of the cephalic region in two species of Acrobelinae (Nematoda, Cephalobidae). *Acta Zoologica* (Stockholm) 66 (4): 211-216.
- Boström, S. (1988) Description and morphological variability of three populations of *Panagrolaimus* Fuchs, 1930 (Nematoda: Panagrolaimidae). *Nematologica* 34: 144-155.
- Boström, S. (1989) The taxonomic position of some teratocephalid nematodes - a scanning electron microscope study. *Revue de Nématologie* 12 (2): 181-190.
- Boström, S., Gydemo, R. (1983) Intraspecific variability in *Acobeloides nanus* (de Man) Anderson (Nematoda: Cephalbidae) and a note on external morphology. *Zoologica Scripta* 12 (4): 245-255.
- Brown, D. J. F., Fortuner, R., Creamer, L. R. (eds) (1989) English Translations of Selected Taxonomic Papers in Nematology. California Department of Food and Agriculture, Sacramento, CA, Vol. 5, 75 pp.
- *Brzeski, M. W. (1963) Further studies on nematodes (Nematoda) of the *Sphagnaceae* of the Tatra Mountains. *Fragmenta Faunistica*, Warszawa 10 (21): 309-315. (in Polish).
- *Brzeski, M. W. (1964) Revision der Gattungen *Tripyla* Bastian und *Paratripyla* gen. n. (Nematoda, Tripylidiae). *Annales Zoologici*, Warszawa. 22: 157-178.
- Brzeski, M. W. (1981) The genera of Anguinidae (Nematoda, Tylenchida). *Revue de Nématologie* 4: 23-34.
- Brzeski, M. W. (1989) Notes on the genus *Psilenchus* de Man, 1921, with description of *P. klingleri* sp. n. (Nematoda: Tylenchidae). *Annales Zoologici*, Warszawa, 43 (3): 51-69.
- Brzeski, M. W. (1991) Review of the genus *Ditylenchus* Filipjev, 1936 (Nematoda: Anguinidae) *Revue de Nématologie* 14 (1): 9-51.
- Brzeski, M. W. (1995) Changes of the nematode fauna in the successive age classes of a Scots pine forest. *Fragmenta Faunistica*, Warszawa, 38 (15): 339-345.

References

- Brzeski, M. W. (1996) Comments on some known species of the genus *Tylenchus* and description of *Tylenchus stachys* sp. n. (Nematoda: Tylenchidae). *Nematologica* 4: 387-407.
- Brzeski, M. W., Winiszewska-Ślipińska, G. (1993) Taxonomy of Tripylidae (Nematoda: Enoplia). *Neamatologica* 39: 12-52.
- *Bütschli, O. (1873) Beiträge zur Keinntnis der freilebenden Nematoden. *Nova Acta Leopoldina* 36 (5): 1-144.
- Cayrol, J. C. (1964) Études préliminaires sur le cycle évolutif de *Ditylenchus myceliophagus* Goodey. *Nematologica* 10: 361-368.
- Cayrol, J. C. (1970) Action des autres composants de la bioéénose du champignon de couche sur le nématode mycophage, *Ditylenchus myceliophagus* J. B. Goodey 1958, et étude de son anabiose: forme de survie en conditions défavorables. II^e partie. *Revue d'Écolgie et de Biologie du Sol* 7: 409-440.
- Cayrol, J. C., Frankowski, J. P., Laniece, A., d'Hordemare, Talon, J. P. (1978) Contre les nematodes en champignonniere. Mise au point d'une méthode de lutte biologique à l'aide d'un hypomycete prédateur *Arthrobotrys robustus* souche antipolis (Royale 300). *Revue Horticole* 184: 23-30.
- Cayrol, J. C., Legay, J. M. (1967) Étude statistique de l'influence de la température et du stade de développement sur les mensurations du nématode mycophage *Ditylenchus myceliophagus* J. B. Goodey, 1958. *Annales des Epiphyties*, Paris, 18: 193-211.
- *Certes, A. (1889) Protozoaires. Mission Scientifique du Cap Horn. (1882-83), Vol. 6, pt. 3: Zoologie, Paris: Gauthier-Villar. 53 pp.
- Chaturvedi, Y., Khera, S. (1979) Studies on taxonomy, biology and ecology of nematodes associated with jute crop. Technical Monograph, Zoological Survey of India No. 2, 105 pp.
- Chitwood, B. G., Chitwood, M. B. (1950) Introduction to Nematology. Baltimore: University Park Press. 334 pp.
- Clark, W. C. (1960a) The oesophago-intestinal junction in the Mononchidae (Enoplida: Nematoda). *Nematologica* 5: 178-183.
- Clark, W. C. (1960b) Redescription of *Mononchus truncatus* Bastian, *M. papillatus* Bastian and *Prionchulus muscorum* (Dujardin) (Enoplida, Nematoda). *Nematologica* 5: 184-198.
- Clark, W. C. (1960c) New Zealand Mononchidae (Enoplida, Nematoda). I. The genera *Mononchus* Bastian and *Prionchulus* Cobb. *Nematologica* 5: 199-214.
- Clark, W. C. (1960d) The Mononchidae (Enoplida, Nematoda) of New Zealand. II. The genus *Iotonchus* (Cobb, 1916) Alther, 1950. *Nematologica* 5: 260-274.
- Clark, W. C. (1961) A revised classification of the order Enoplida (Nematoda). *New Zealand Journal of Science* 4: 123-150.
- Clark, W. C. (1962) Evolution within the family Mononchidae (Enoplida: Nematoda). *Nematologica* 7: 252-255.
- Cobb, M. V. (1915) Some fresh-water nematodes of the Douglas Lake region of Michigan, U.S.A. *Transactions of the American Microscopical Society* 34: 21-47.

- *Cobb, N. A. (1893a) Nematodes, mostly Australian and Fijian. Macleay Memorial Volume, Linnean Society of New South Wales: 252-308.
- *Cobb, N. A. (1893b) Plant Diseases and their Remedies. Diseases of the sugar cane. III. Nematode worms found attacking sugar cane. Agricultural Gazette of New South Wales 4 (10): 808-833.
- *Cobb, N. A. (1898) Australian free-living marine nematodes. Proceedings of the Linnean Society of New South Wales (91) 23 (3): 383-407.
- *Cobb, N. A. (1906) Free living nematodes inhabiting the soil about the roots of cane, and their relation to root diseases. In: Fungus maladies of the sugar cane, with notes on associated insects and nematodes. Bulletin (5), Hawaiian Sugar Planters' Association, Experiment Station, Division Pathology and Physiology: 163-195.
- Cobb, N. A. (1913) New nematode genera found inhabiting fresh water and non-brackish soils. Journal of the Washington Academy of Sciences 3 (16): 432-444.
- Cobb, N. A. (1914) The North American free-living freshwater nematodes. Contributions to a science of nematology, 2. Transactions of the American Microscopical Society 33 (2): 69-134.
- *Cobb, N. A. (1916) Subdivisions of *Mononchus*. Journal of Parasitology 2 (4): 195-196.
- Cobb, N. A. (1917) The Mononchs (*Mononchus* Bastian, 1865). A genus of free-living predatory nematodes. Soil Science 3: 431-486.
- *Cobb, N. A. (1918) Filter-bed nemas: Nematodes of the slow sand filter beds of American cities. (Including new genera and species.) With notes on hermaphroditism and parthenogenesis. Contrib. Sci. Nematol. (7): 189-212.
- Cobb, N. A. (1920) One hundred new nemas. (Type species of 100 new genera.) Contributions to a Science of Nematology, IX. Nematology, Baltimore: Waverley Press. Pp. 217-343.
- *Cobb, N. A. (1927) Nemas and recent progress in nematology research. Yearbook, USDA 1926. Pp. 540-543.
- Cohn, E., Sher, S. A. (1972) A contribution to the taxonomy of the genus *Xiphinema* Cobb, 1913. Journal of Nematology 4: 36-65.
- Coleman, D. C., Crossley Jr., D. A. (1996) Fundamentals of Soil Ecology. San Diego, CA: Academic Press. 205 pp.
- Coomans, A. (1964) Structure of the female gonads in members of the Dorylaimina. Nematologica 10: 601-622.
- Coomans, A. (2000) Nematode systematics: past, present and future. Nematology 2 (1): 3-7.
- Coomans, A., van der Heiden, A. (1978) The systematic position of the family Ironidae and its relation to the Dorylaimida. Annales de la Societe Royale Zoologique de Belgique 108 (1-2): 5-11.
- Coomans, A., Khan, S. H. (1981) Mononchida from Mount Kenya. Biologisch Jaarboek Dodonea 49: 64-75.
- Corbett, D. C. M. (1978) Migratory soil Tylenchida. In: Southey, J. F. (ed) Plant Nematology, 3rd. Edn., London: Her Majesty's Stationery Office. Pp. 188-206.
- Croll, N. A. 1976 (ed) The Organization of Nematodes. London: Academic Press. 439 pp.

References

- Croll, N. A., de Soyza, K. (1980) Comparative calorie values of nematodes. *Journal of Nematology* 12 (2): 132-135.
- Crowe, J. H., Madin, A. C. (1975) Anhydrobiosis in nematodes: Evaporative water loss and survival. *Journal of Experimental Zoology* 193: 323-334.
- Das, V. M. (1960) Studies on the nematode parasites of plants in Hyderabad (Andhra Pradesh, India). *Zeitschrift für Parasitenkunde* 9: 553-605.
- DeAngelis, D. L. (1992) Dynamics of Nutrient Cycling and Food Webs. London: Chapman & Hill. 270 pp.
- *de Coninck, L. A. P., Schuurmans Stekhoven Jr., J. H. (1933) The freeliving marine nemas of the Belgian coast. II. With general remarks on the structure and the system of nemas. *Mémoires du Museum d'Histoire National Belgique* (58), 163 pp.
- Decraemer, W., Coomans, A. (1978) Scientific Report on the Belgian Expedition to the Great Barrier Reef in 1967. Nematodes XIII. A description of four new species and a redescription of four known species from in and around mangroves on Lizard Island. *Australian Journal of Marine and Freshwater Research* 29: 509-541.
- de Goede, R. G. M. (1996) Effects of sod-cutting on the nematode community of a secondary forest of *Pinus sylvestris* L. *Biology and Fertility of Soils* 22: 227-236.
- De Ley, P. (2000) Lost in worm space: phylogeny and morphology as road maps to nematode diversity. *Nematology* 2 (1): 9-16.
- De Ley, P., van de Velde, M. C., Mounport, D., Baujard, P., Coomans A. (1995) Ultrastructure of the stoma in Cephalobidae, Panagrolaimidae and Rhabditidae, with a proposal for a revised stoma terminology in Rhabditida (Nematoda). *Nematologica* 41: 153-182.
- *de Man, H. (1876) Onderzoeken over vrij in de aarde levende Nematoden. *Tijdschrift der Nederlandsche Dierkundige Vereeniging* 2: 78-196.
- *de Man, J. G. (1880) Die einheimischen, frei in der reinen Erde und im süßen Wasser lebende Nematoden. Vorläufiger Bericht und descriptivsystematischer Theil. *Tijdschrift der Nederlandsche Dierkundige Vereeniging* 5: 1-104.
- *de Man, J. G. (1881) Ueber einige neue oder noch unvollständig bekannte Arten von frei in der reinen Erde lebenden Nematoden. (1. Supplement zu der aufsatz auf S. 1 dieses Bandes.) *Tijdschrift der Nederlandsche Dierkundige Vereeniging* 5: 138-143.
- *de Man, J. G. (1884) Die frei in der reinen Erde und im süßen Wasser lebenden Nematoden der Niederländischen Fauna. Eine systematische-faunistische Monographie. Leiden: Brill. 206 pp.
- *de Man, J. G. (1904a) Ein neuer freilebender Rundworm aus Patagonien, *Plectus (Plectoides) patagonicus* n. sp. Bericht Senckenbergischen Naturforschenden Gesellschaft in Frankfurt a. M., 2 Teil: 41-45.
- *de Man, J. G. (1904b) Nématodes libres. Expédition Antarctique Belge. In: Résultats du voyage du S. Y. Belgica en 1897-1898-1899 sous le commandement de A. de Gerlach de Gomery, ed. Zoologie. 55 pp., pls. 1-11, figs. 1-9 w. Anvers.
- Demeure, Y., Freckman, D. W., van Gundy, S. D. (1979a) *In vitro* response of four species of nematodes to desiccation and discussion of this and related phenomena. *Revue de Nématologie* 2 (2): 203-210.

- Demeure, Y., Freckman, D. W., van Gundy, S. D. (1979b) Anhydrobiotic coiling of nematodes in soil. *Journal of Nematology* 11 (2): 189-195.
- de Soya, K. (1973) Energetics of *Aphelenchus avenae* in monoxenic culture. *Proceedings of the Helminthological Society of Washington* 40 (1): 1-10.
- Diederich, J., Fortuner, R., Milton, J. (2000) A uniform representation for the plan of organization of nematodes of the order Tylenchida. *Nematology* 2(8): 805-822.
- *Ditlevson, H. (1911) Danish free-living nematodes. *Videnskabelige Meddelelser Dansk Naturhistorisk Forening, Kobenhavn*. 63: 213-256.
- Dmowska, E. (1993) Effects of long-term artificial acid rain on species range and diversity of soil nematodes. *European Journal of Soil Biology* 29 (3-4): 97-107.
- Doncaster, C. C. (1966) Nematode feeding mechanisms. 2. Observations on *Ditylenchus destructor* and *D. myceliophagus* feeding on *Botrytis cinerea*. *Nematologica* 12: 417-427.
- Doncaster, C. C. (1971) Feeding in plant parasitic nematodes: mechanisms and behaviour. In: Zuckerman, B. M., Mai, W. F., Rohde, R. A. (eds), *Plant parasitic nematodes. II*. New York & London: Academic Press. Pp.137-157.
- Dougherty, E. (1955) The Genera and Species of the Subfamily Rhabditinae Micoletzky, 1922 (Nematoda): a Nomenclatorial Analysis – including an Addendum on the Composition of the Family Rhabditidae Örley, 1880. *Journal of Helminthology* 29 (3): 105-152.
- Dropkin, V. H. (1980) *Introduction to Plant Nematology*. New York: John Wiley & Sons. 293 pp.
- *Dujardin, F. (1845) *Histoire naturelle des helminthes ou vers intestinaux*. Paris, 654 pp. + 12 pls.
- Ebsary, B. A. (1985) Two new species of *Plectus* with a redescription of *Plectus cancellatus* Zullini, 1978 (Nematoda: Plectidae) from Canada. *Canadian Journal of Zoology* 63: 2395-2400.
- Ebsary, B. A. (1991) Catalog of the Order Tylenchida (Nematoda). Publication 1869/B. Agriculture Canada. 196 pp.
- Edward, J. C., Misra, S. L. (1969) Occurrence of some new species of Aphelenchoidea in the rhizosphere of certain field crops of Uttar Pradesh, India, with a note on an intersex. *Allahabad Farmer* 43 (1): 1-6.
- Ekschmitt, K., Bakonyi, G., Bongers, M., Bongers, T., Boström, S., Dogan, H., Harrison, A., Kallimanis, A., Nagy, P., O'Donnell, A. G., Sohlenius, B., Stamou, G. P., Wolters, V. (1999) Effects of the nematofauna on microbial energy and matter transformation rates in European grassland soils. *Plant and Soil* 212 (1): 45-61.
- Esser, R. P. (1983) Amoebic predation upon nematodes. *Nematology Circular No. 8*, Florida Department of Agriculture and Consumer Services, Division of Plant Industry. Contribution No. 264, Bureau of Nematology. 2 pp.
- Esser, R. P. (1987a) Biological control of nematodes by nematodes. I. *Dorylaims* (Nematoda: Dorylaimina). *Nematology Circular No. 144*, Florida Department of Agriculture and Consumer Services, Division of Plant Industry. Contribution No. 329, Bureau of Nematology. 4 pp.
- Esser, R. P. (1987b) Biological control of nematodes by nematodes. II. *Seinura* (Nematoda: Aphelenchoididae). *Nematology Circular No. 147*, Florida Department of Agriculture and Consumer Services, Division of Plant Industry. Contribution No. 330, Bureau of Nematology. 3 pp.

References

- Esser, R. P., Buckingham, G. R. (1987) Genera and species of free-living nematodes occupying fresh-water habitats in North America. In: Veech J. A., Dickson, D. W. (eds) *Vistas on Nematology: A Commemoration of the Twenty-fifth Anniversary of the Society of Nematologists*. Society of Nematologists, Inc., Hyattsville, MD. Pp. 477-487.
- Ettema, C. H., Lowrance, R., Coleman, D. C. (1999) Riparian soil response to surface nitrogen input: the indicator potential of free-living soil nematode populations. *Soil Biology and Biochemistry* 31: 1625-1638.
- Evans, A. A. F., Fisher, J. M. (1970) Some factors affecting the number and size of nematodes in populations of *Aphelenchus avenae*. *Nematologica* 16: 295-304.
- Evans, A. A. F., Perry, R. N. (1976) Survival strategies in nematodes. In: Croll, N. A. (ed) *The Organization of Nematodes*. London: Academic Press. Pp. 383-424.
- Evans, A. A. F., Womersley, C. (1980) Longevity and survival in nematodes: models and mechanisms. In: Zuckerman, B. M. (ed) *Nematodes as Biological Agents: Aging and other model systems*, Vol. 2, New York: Academic Press. Pp. 193-211.
- Ferris, V. R. (1968) Biometric analyses in the genus *Labronema* (Nematoda: Dorylaimida) with a description of *L. thornei* n. sp. *Nematologica* 14 (2): 276-284.
- Ferris, V. R., Ferris, J. M. (1989) Why ecologists need systematists: importance of systematics to ecological research. *Journal of Nematology* 21 (3): 308-314.
- Ferris, H., Eyre, M., Venette, R. C., Lau, S. S. (1996) Population energetics of bacterial-feeding nematodes: stage-specific development and fecundity rates. *Soil Biology and Biochemistry* 28: 271-280.
- *Filipjev, I. N. (1930) Les nématodes libres de la baie de la Neva et de l'extrême orientale du golfe de Finlande. Deuxième partie. *Archiv fuer Hydrobiologie (Plankt.)* 21: 1-64
- Filipjev, I. N. (1934a) [Nematodes harmful and useful in rural economy]. In: Fortuner, R. (ed) (1986) *English Translations of Selected Taxonomic Papers in Nematology*. California Department of Food and Agriculture, Sacramento, CA, Vol. 3: 27-31.
- Filipjev, I. N. (1934b) The classification of the freelifing nematodes and their relation to the parasitic nematodes (Publication 3216). *Smithsonian Miscellaneous Collections* 89 (6): 1-63 + 8 Plates.
- *Filipjev, I. N., Schuurmans Stekhoven, Jr., J. H. (1941) *A Manual of Agricultural Helminthology*. Leiden: Brill. 878 pp.
- Fisher, J. M., Davies K. A. (1990) On size and moulting of *Aphelenchus avenae* (Nematoda: Aphelenchida). *International Journal for Parasitology* 20 (2): 175-182.
- Fisher J. M., Triantaphyllou, A. C. (1976) Observations on development of the gonad and on reproduction in *Aphelenchus avenae*. *Journal of Nematology* 8 (3): 248-254.
- Fisher, K. D. (1968) Population patterns of nematodes in Lake Champlain. *Nematologica* 14: 7 (Abstr.)
- Fortuner, R. (1982) On the genus *Ditylenchus* Filipjev, 1936 (Nematoda: Tylenchida) *Revue de Nématologie* 5 (1): 17-38.
- Fortuner, R. (1988) A new description of the process of identification of plant-parasitic nematode genera. In: Fortuner, R. (ed). *Nematode identification and expert system technology*. New York: Plenum Press. Pp. 35-44.

- Fortuner, R., Maggenti, A. R. (1987) A reappraisal of Tylenchina (Nemata). 4. The family Anguinidae Nicoll, 1935 (1926). *Revue de Nématologie* 10 (2): 163-176.
- Franklin, M. T. (1978) *Aphelenchoïdes* and related genera. In: Southey, J. F. (ed) *Plant Nematology*, 3rd. Edn., London: Her Majesty's Stationery Office. Pp. 172-187.
- Freckman, D. W., Baldwin, J. G. (1990) Nematoda. In: Dindal, D. L. (ed) *Soil Biology Guide*. New York: John Wiley & Sons. Pp. 155-200.
- Freckman, D. W., Caswell, E. P. (1985) The ecology of nematodes in agroecosystems. *Annual Review of Phytopathology* 23: 275-296.
- Freckman, D. W., Mankau, R. (1986) Abundance, distribution, biomass and energetics of soil nematodes in a Northern Mojave Desert Ecosystem. *Pedobiologia* 29: 129-142.
- *Fuchs, A. G. (1930) Neue an Borken-und Rüsselkäfer gebundene Nematoden, halbparasitische und Wohnungseinmieter. Freilebende Nematoden aus Moss und Walderde in Borken-und Rüsselkäfergegangen. *Zoologische Jahrbücher*, Jena, Abteilungen für Systematik 59 (5-6): 505-646.
- *Gadea, E. (1955) Nematodos dulceacuícolas de Galicia. *Publicaciones del Instituto de Biología Aplicada*, Barcelona 20: 77-104.
- Geraert, É. (1983) The use of the female reproductive system in nematode systematics. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) *Concepts in Nematode Systematics*. London: Academic Press. Pp. 73-84.
- Geraert, É. (1990) Discontinuous variation in Tylenchoidea (Nemata). *Nematologica* 36: 194-198.
- Geraert, É., Raski, D. J. (1987) A reappraisal of Tylenchina (Nemata). 3. The family Tylenchidae Örley, 1880. *Revue de Nématologie*. 10 (2): 143-161.
- Geraert, É., Grootaert, P., Decraemer, W. (1980) Structure of the female reproductive system in some Dorylaimida and Enoplida (Nematoda). *Nematologica* 26: 255-271.
- Geraert, É., Reuse, Ch., van Brussel, D., Vranken, G. (1981) The female reproductive system in Monhystera (Nematoda: Monhysterida). *Biologisch Jaarboek Dodonaea* 49: 148-154.
- Geraert, É., Sudhaus, W., Grootaert, P. (1980) The structure of the female genital apparatus in the order Rhabditida (Nematoda). *Annales de la Societe Royale Zoologique de Belgique* 109: 91-108.
- Gerlach, S. A., Riemann, F. (1973) The Bremerhaven checklist of aquatic nematodes. A catalogue of Nematoda Adenophorea excluding the Dorylaimida. 1. Veröffentlichungen des Instituts für Meeresforschung in Bremerhaven, Supplement 4, 404 pp.
- Giebel, J. (1974) Biochemical mechanisms of plant resistance to nematodes: a review. *Journal of Nematology* 6 (4): 175-184.
- *Goffart, H. (1930) Die Aphelenchen der Kulturpflanzen. Berlin [Monographien zum Pflanzenschutz, hrsg. von H. Morstatt. (4)]. 105 pp.
- Goodey, J. B. (1958) *Ditylenchus myceliophagus* n. sp. (Nematoda: Tylenchidae) *Nematologica* 3: 91-96.
- Goodey, J. B. (1960) The classification of the Aphelenchoidea Fuchs, 1937. *Nematologica* 5: 111-126.

References

- *Goodey, J. B. (1961) The nature of the spear guiding apparatus in Dorylaimidae. *Journal of Helminthology* (R.T. Leiper Supplement): 101-106.
- Goodey, J. B. (1963) Soil and Freshwater Nematodes. 2nd. Edn., London, UK: Methuen & Co. Ltd., 544 pp. [see also Goodey, T. (1963)].
- Goodey, J. B., Hooper, D. J. (1965) A neotype of *Aphelenchus avenae* Bastian, 1865 and the rejection of *Metaphelenchus* Steiner, 1943. *Nematologica* 11: 55-65.
- *Goodey, T. (1951) Soil and freshwater nematodes - a monograph. London, UK: Methuen & Co. Ltd., 390 pp.
- Goodey, T. (1963) Soil and Freshwater Nematodes. 2nd. Edn., revised and rewritten by J. B. Goodey. London, UK: Methuen & Co. Ltd., 544 pp. [see also Goodey, J. B. (1963)].
- Goseco, G. C., Ferris, V. R., Ferris, J. M. (1974) Revisions in Leptonchoidea (Nematoda: Dorylaimida). *Leptonchus*, *Proleptonchus*, *Funaria*, and *Meylis* n. gen. in Leptonchidae, Leptonchinae. Purdue University Agricultural Experiment Station, West Lafayette, IN. Research Bulletin No. 911, 32 pp.
- Goseco, G. C., Ferris, V. R., Ferris, J. M. (1975) Revisions in Leptonchoidea (Nematoda: Dorylaimida). *Tylencholaimellus*, *Doryllium*, *Gerthus* n. gen. and *Agmodorus* in Tylencholaimellidae; and *Aulolaimoides* and *Adenolaimus* in Aulolaimoididae. Purdue University Agricultural Experiment Station, West Lafayette, IN. Research Bulletin No. 928, 40 pp.
- Grassé, P-P. (ed) (1965a) *Traité de zoologie. Anatomie, systématique, biologie*. 4 (2): 3-432. Paris, Masson et Cie.
- Grassé, P-P. (ed) (1965b) *Traité de zoologie. Anatomie, systématique, biologie*. 4 (2): 601-1497. Paris, Masson et Cie.
- Grassé, P-P. (ed) (1965c) *Traité de zoologie. Anatomie, systématique, biologie*. 4 (3): 803-1161. Paris, Masson et Cie.
- Grootaert, P., Maertens, D. (1976) Cultivation and life cycle of *Mononchus aquaticus*. *Nematologica* 22: 173-181.
- Háněl, L. (1995) Secondary successional stages of soil nematodes in cambisols of South Bohemia. *Nematologica* 41: 197-218.
- Háněl, L. (1996) Soil nematodes in five spruce forests of the Beskydy mountains, Czech Republic. *Fundamentals of Applied Nematology* 19 (1): 15-24.
- Háněl, L. (1998) Soil nematodes (Nematoda) in meadow and forest ecosystems of the Pálava Biosphere Reserve, Czech Republic. In: Pižl, V., Tajovský, K. (eds) *Soil Zoological Problems in Central Europe*. Institute of Soil Biology, Academy of Sciences of the Czech Republic, České Budějovice. Pp. 37-44.
- Háněl, L. (1999) Fauna of soil nematodes (Nematoda) in Trojmezná hora Reserve. *Silva Gabreta* 3: 89-99.
- Háněl, L. (2002) Comparison of soil nematode communities in spruce forests of the Žofín woodland area (Novohradské hory Mts.) and the upper Vydra river basin (Šumava Mts.), Czech Republic. In: Papáček M. (ed) *Biodiverzita a přírodní podmínky Novohradských hor*. Jihočeská univerzita a Entomologický ústav AV ČR, 10.-11.1.2002, 285 s.
- Háněl, L., Šimek, M. (1993) Soil nematodes and nitrogenase activity (symbiotic N₂-fixation) in red clover (*Trifolium pratense* L.) European Journal of Soil Biology 29 (3-4): 109-116.

- Hansson, A.-C., Andrén, O., Boström, S., Boström, U., Clarholm, M., Lagerlöf, J., Lindberg, T., Paustian, K., Pettersson, R., Sohlenius, B. (1990) 4. Structure of the agroecosystem. Ecological Bulletins (Copenhagen) 40: 41-83.
- Hechler, H. C. (1962) The development of *Aphelenchus avenae* Bastian, 1865 in fungus culture. Proceedings of the Helminthological Society of Washington 29: 162-167.
- *Hechler, H. C. (1963) Description, developmental biology and feeding habits of *Seinura tenuicaudata* (de Man) J. B. Goodey, 1960 (Nematoda: Aphelenchoididae), a nematode predator. Proceedings of the Helminthological Society of Washington 30: 182-195.
- Heip, C., Vincx, M., Smol, N., Vranken, G. (1982) The systematics and ecology of free-living marine nematodes. Helminthological Abstracts, Series B, Plant Nematology. Vol. 51 (1): 1-31.
- Hesling, J. J. (1972) Nematode pests of mushrooms. In: Webster, J. M. (ed) Economic Nematology. London & New York: Academic Press. Pp. 435-468.
- Hesling, J. J. (1974) *Ditylenchus myceliophagus*. CIH Descriptions of Plant-parasitic Nematodes Set 3, No. 36, 4 pp.
- *Heyns, J. (1966) On the morphology and taxonomy of the Aporcelaimidae, a new family of Dorylaimoid nematodes. Entomology Memoirs, South Africa 10 (1965): 1-51.
- *Heyns, J. (1968) A monographic study of the nematode families Nygolaimidae and Nygolaimellidae. Entomology Memoirs, South Africa 19: 1-144.
- Heyns, J. (1971) A Guide to the Plant and Soil Nematodes of South Africa. Cape Town: A. A. Balkema. 233 pp.
- Heyns, J. (1983) Problems of species delimitation in the genus *Xiphinema*, with special reference to monosexual species. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) Concepts in Nematode Systematics. London: Academic Press. Pp. 163-174.
- Heyns, J., Coomans, A. (1980) Freshwater nematodes from South Africa. 5. *Chronogaster* Cobb, 1913. Nematologica 26: 187-208.
- Heyns, J., Coomans, A. (1983) New and known species of *Chronogaster* Cobb, 1913 (Nematoda: Leptolaimidae). Nematologica 29: 245-265.
- Heyns, J., Coomans, A. (1989) A new freshwater species of *Theristus* from South West Africa/Namibia (Nematoda: Xyalidae). South African Journal of Zoology 24 (1): 95-98.
- *Hirschmann, H. (1952) Die nematoden der Wassergrenze mittelfränkischer Gewässer. Zoologische Jahrbücher, Jena, Abteilungen für Systematik 81 (4): 313- 436.
- Hirschmann, H. (1983) Scanning electron microscopy as a tool in nematode taxonomy. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) Concepts in Nematode Systematics. London: Academic Press. Pp. 95-111.
- Hodda, M., Wanless, F. R. (1994) Nematodes from an English chalk grassland: species distributions. Nematologica 40: 116-132.
- Hoeksema, J. D., Lussenhop, J., Teeri, J. A. (2000) Soil nematodes indicate food web responses to elevated atmospheric CO₂. Pedobiologia 44: 725-735.
- *Hoepli, R. J. C., Chu, H. J. (1932) Free-living nematodes from hot springs in China and Formosa. Hongkong Nat. Suppl. (1): 15-28.

References

- Hoffmann J. K., Norton, D. C. (1976) Distribution patterns of some Criconematinae in different forest associations. *Journal of Nematology* 8 (1): 32-35.
- *Hofmänner, B. (1913) Contribution à l'étude des nématodes libres du Lac Léman. *Revue Suisse Zoologie* 21 (16): 589-658.
- *Hofmänner, B., Menzel, R. (1914) Neue Arten freilebender Nematoden aus der Schweiz. *Zoologischer Anzeiger*, Leipzig 44: 80-91.
- Hooper, D. J. (1969) Some problems in the systematics of soil nematodes. In: Sheals, J. G. (ed) *The Soil Ecosystem. Systematic aspects of the environment, organisms and communities*. The Systematics Association, London, Publication No. 8: 131-142.
- Hooper, D. J. (1974) *Aphelenchus avenae*. CIH Descriptions of Plant-parasitic Nematodes. Set 4, No. 50. Commonwealth Institute of Helminthology, St. Albans, UK. 4 pp.
- Hooper, D. J. (1978) Structure and classification of nematodes. In: Southey, J. F. (ed) *Plant Nematology*, 3rd. Edn., London: Her Majesty's Stationery Office. Pp. 3-45.
- Hooper, D. J. (1986) Handling, fixing, staining and mounting nematodes. In: Southey, J. F. (ed) *Laboratory methods for work with plant and soil nematodes. Reference Book 402*. Ministry of Agriculture, Fisheries and Food. Her Majesty's Stationery Office, London. Pp. 59-80.
- Hooper, D. J., Southey J. F. (1978a) *Ditylenchus, Anguina* and related genera. In: Southey, J. F. (ed) *Plant Nematology*, 3rd. Edn., London: Her Majesty's Stationery Office. Pp. 78-97.
- Hooper, D. J., Southey J. F. (1978b) Plant-parasitic Dorylaimida: morphology and identification. In: Southey, J. F. (ed) *Plant Nematology*, 3rd. Edn., London: Her Majesty's Stationery Office. Pp. 207-231.
- Hopper, B. E. (1963a) The males of *Criconema menzeli* (Stefański, 1924) Taylor, 1936 and *C. octangulare* (Cobb, 1914) Taylor, 1936 (Criconematidae: Tylenchida). *Canadian Journal of Zoology* 41: 595-597.
- Hopper, B. E. (1963b) *Punctodora exochopora* n. sp. (Chromadoridae: Nematoda) from the Canadian shore of Lake Ontario. *Canadian Journal of Zoology* 41: 1121-1126.
- Hopper, B. E. (1968) Marine nematodes of Canada. I. Prince Edward Island. *Canadian Journal of Zoology* 46: 1103-1111.
- Hopper, B. E., Cairns, E. J. (1959) Taxonomic keys to plant, soil and aquatic nematodes. Southern Regional Nematode Project S-19. Alabama Polytechnic Institute, Auburn, Alabama. 176 pp.
- Howell, C. R. (1990) Fungi as biological control agents. In: Nakas, J. P., Hagedorn, C. (eds) *Biotechnology of Plant-Microbe Interactions*. New York: McGraw-Hill Publishing Company. Pp. 257-286.
- Hussey, R. S., Roncadori, R. W. (1981) Influence of *Aphelenchus avenae* on vesicular-arbuscular endomycorrhizal growth response in cotton. *Journal of Nematology* 13: 48-52.
- ICZN (International Commission on Zoological Nomenclature) (1999) International Code of Zoological Nomenclature. 4th. Edn. London, UK: International Trust for Zoological Nomenclature, xxix + 306 pp.
- Ilieva-Makulec, K. (1998) Life-history and population parameters of two bacterial-feeding nematodes. In: Pižl, V., Tajovský, K. (eds) *Soil Zoological Problems in Central Europe*. České Budějovice. Pp. 59-63.

- Inglis, W. G. (1983) An outline classification of the phylum Nematoda. *Australian Journal of Zoology* 31: 243-255.
- Iwaki, M., Komuro, Y. (1974) Viruses isolated from *Narcissus* (*Narcissus* spp.) in Japan. V. *Arabis* mosaic virus. *Annals of the Phytopathological Society of Japan* 40: 344-353.
- Jacobs, L. J. (1984) The free-living inland aquatic nematodes of Africa – a review. *Hydrobiologia* 113: 259-291.
- Jacobs, L. J., Heyns, J. (1990) An ecological strategy in the genus *Monhystera* – an hypothesis. *Revue de Nématologie* 13 (1): 109-111.
- *Jägerskiöld, L. A. K. E. (1905) *Bunonema richtersi* n.g. n.sp. Ein eigentümlicher neue Landnematode aus dem Schwarzwald, von Kerguelen und Possession-Island (Crozet-Inseln). *Zoologischer Anzeiger*, Leipzig 28: 557-561.
- Jairajpuri, M. S. (1969) Studies on Mononchida of India. I. The genera *Hadronchus*, *Iotonchus* and *Miconchus* and a revised classification of Mononchida, new order. *Nematologica* 15: 557-581.
- Jairajpuri, M. S. (1970) Studies on Mononchida of India. II. The genera *Mononchus*, *Clarkus* n. gen. and *Prionchulus* (Family Mononchidae Chitwood, 1937). *Nematologica* 16: 213-221.
- Jairajpuri, M. S., Ahmad, W. (1992) Dorylaimida. Free-living, Predaceous and Plant-parasitic Nematodes. Leiden: E. J. Brill. 458 pp.
- Jairajpuri, M. S., Khan, W. U. (1975) Studies on Mononchida of India. VII. Excretory system of *Prionchulus muscorum*. *Nematologica* 21: 409-410.
- Jairajpuri, M. S., Khan, W. U. (1977) Studies on Mononchida of India. IX. Further division of the genus *Clarkus* Jairajpuri, 1970 with proposal of *Coomansus* n. gen. (Family Mononchidae Chitwood, 1937) and descriptions of two new genera. *Nematologica* 23: 89-96.
- Jatala, P. (1975) Endotokia matricida in a *Xiphinema* sp. *Journal of Nematology* 7 (2): 205-6.
- Jensen, H. J., Mulvey, R. H. (1968) Predaceous nematodes (Mononchidae) of Oregon. Oregon State University Press, Corvallis, OR. 57 pp.
- Jensen, P. (1994) Revision of Ethmolaiminae Filipjev & Stekhoven, 1941 (Nematoda, Chromadorida), with descriptions of one new genus and three new species. *Hydrobiologia* 286: 1-15.
- Johnson, S. R., Ferris, V. R., Ferris, J. M. (1972) Nematode community structure of forest woodlots. I. Relationships based on similarity coefficients of nematode species. *Journal of Nematology* 4 (3): 175-183.
- Johnson, S. R., Ferris, J. M., Ferris, V. R. (1974) Nematode community structure of forest woodlots. III. Ordinations of taxonomic groups and biomass. *Journal of Nematology* 6 (3): 118-126.
- Khan, W. U., Jairajpuri, M. S. (1980) Studies on Mononchida of India. XIII. Genus *Iotonchus* (Cobb, 1916) Altherr, 1950 with a key to the species. *Nematologica* 26: 1-9.
- Klinka, K., Pojar, J., Meidinger, D. V. (1991) Revision of biogeoclimatic units of coastal British Columbia. *Northwest Science* 65: 32-47.
- Korthals, G. W., de Goede, R. G. M., Kammenga, J. E., Bongers, T. (1996) The maturity index as an instrument for risk assessment of soil pollution. In: van Straalen, N. M., Krivolutsky,

References

- D. A. (eds) Bioindicator Systems for Soil Pollution. Kluwer Academic Publishers, Netherlands. Pp. 85-93.
- Krall, E. L. (1959) [New and little known Tylenchids (Nematoda, Tylenchida) together with description of a case of gynandromorphism in the genus *Aphelenchoïdes*.] In: Fortuner, R. (ed) (1983) English Translations of Selected Taxonomic Papers in Nematology. California Department of Food and Agriculture, Sacramento, CA, Vol. 2: 47-56.
- Lee, D. C. (1970) The Rhodacaridae (Acari: Mesostigmata); classification, external morphology and distribution of genera. Records of the South Australian Museum 16 (3): 1-219.
- Lee, D. L., Atkinson, H. J. (1976) Physiology of Nematodes, 2nd. Edn. London: The MacMillan Press Ltd., 215 pp.
- Lippens, P. L., Coomans, A., de Grisse A. T., Lagasse, A. (1974) Ultrastructure of the anterior body region in *Aporcelaimellus obtusicaudatus* and *A. obscurus*. *Nematologica* 20: 242-256.
- Litvaitis, M. K., Bates, J. W., Hope, W. D., Moens, T. (2000) Inferring a classification of the Adenophorea (Nematoda) from nucleotide sequences of the D3 expansion segment (26/28S rDNA). *Canadian Journal of Zoology* 78: 911-922.
- Loof, P. A. A. (1964a) A review of the nematode genus *Leptonchus* (Enoplia). *Nematologica* 9 (4) [1963]: 507-520.
- Loof, P. A. A. (1964b) Free-living and plant-parasitic nematodes from Venezuela. *Nematologica* 10: 201-300.
- Loof, P. A. A. (1988) Identification of criconematids. In: Fortuner, R. (ed). *Nematode identification and expert system technology*. New York: Plenum Press. Pp. 139-152.
- Loof, P. A. A., Luc, M. (1990) A revised polytomous key for the identification of species of the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) with the exclusion of the *X. american-group*. *Systematic Parasitology* 16: 35-66.
- Loof, P. A. A., Maas, P. W. Th. (1972) The genus *Xiphinema* (Dorylaimida) in Surinam. *Nematologica* 18: 92-119.
- Lordello, L. G. E. (1955) *Xiphinema krugi* n. sp. (Nematoda, Dorylaimidae) from Brazil with a key to the species of *Xiphinema*. *Proceedings of the Helminthological Society of Washington* 22 (1): 16-21.
- Lorenzen, S. (1981) Entwurf eines phylogenetischen Systems der freilebenden Nematoden. *Veröffentlichungen des Instituts für Meeresforschung in Bremerhaven*, Supplement 7, 472 pp.
- Lorenzen, S. (1983) Phylogenetic systematics: problems, achievements and its application to the Nematoda. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) *Concepts in Nematode Systematics*. London & New York: Academic Press. Pp. 11-23.
- Lownsbery, J. W., Lownsbery, B. F. (1985) Plant-parasitic nematodes associated with forest trees in California. *Hilgardia* 53 (5): 1-16.
- Luc, M. (1958) *Xiphinema* de l'Ouest Africain: Description de cinq nouvelles espèces (Nematoda: Dorylaimidae). *Nematologica* 3 (1): 57-72.
- Luc, M., Maggenti, A. R., Fortuner, R., Raski, D. J., Geraert, E. (1987) A reappraisal of Tylenchina (Nemata). 1. For a new approach to the taxonomy of Tylenchina. *Revue de Nématologie* 10 (2): 127-134.

- Maggenti, A. R. (1961a) Morphology and biology of the genus *Plectus* (Nematoda: Plectidae). Proceedings of the Helminthological Society of Washington 28 (2): 118-130.
- Maggenti, A. R. (1961b) Revision of the genus *Plectus* (Nematoda: Plectidae). Proceedings of the Helminthological Society of Washington 28 (2): 139-166.
- Maggenti, A. R. (1982). Nemata. In: Parker, S. P. (ed) Synopsis and Classification of Living Organisms. New York: McGraw-Hill. Vol. 1. Pp. 879-923.
- Maggenti, A. R. (1983) Nematode higher classification as influenced by species and family concepts. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) Concepts in Nematode Systematics. London & New York: Academic Press. Pp. 25-40.
- Maggenti, A. R., Luc, M., Raski, D. J., Fortuner, R., Geraert, E. (1987) A reappraisal of Tylenchina (Nemata). 2. Classification of the suborder Tylenchina (Nemata: Diplogasteria). Revue de Nématologie 10 (2): 135-142.
- Maggenti, A. R., Viglierchio, D. R. (1975) *Sequoia sempervirens* and *Sequoia giganteum*: hosts of common plant-parasitic nematodes of California. Plant Disease Reporter 59 (2): 116-119.
- Mai, W. F., Crittenden, H. W., Jenkins W. R. (1960) Distribution of stylet-bearing nematodes in the Northeastern United States. New Jersey Agricultural Experiment Station, Bulletin 795, 62 pp.
- Mai, W. F., Lyon, H. H. (1975) Pictorial key to genera of plant-parasitic nematodes. 4th. Edn. Ithaca, NY: Cornell University Press. 219 pp.
- Mankau, R., Mankau, S. K. (1963) The role of mycophagous nematodes in the soil. I. The relationship of *Aphelenchus avenae* to phytopathogenic fungi. In: Doeksen, J., van der Drift, J. (eds) Soil Organisms. Amsterdam: North-Netherlands Publishers. Pp. 271-280.
- Martikainen, E., Huhta, V. (1990) Interactions between nematodes and predatory mites in raw humus soil: a microcosm experiment. Revue d'Écologie et de Biologie du Sol 27 (1): 13-20.
- Maslen, N. R. (1979) Additions to the nematode fauna of the Antarctic region with keys to taxa. British Antarctic Survey Bulletin, No. 49: 207-230.
- Maslen, N. R. (1981) The Signy Island terrestrial reference sites: XII. Population ecology of nematodes with additions to the fauna. British Antarctic Survey Bulletin, No. 53: 57-75.
- Matthews, B. E., Croll, N. A. (1974) Comparative stereoscan electron micrographs of nematode heads. Journal of Nematology 6 (3): 131-134.
- *Maupas, E. F. (1900) Modes et formes de reproduction des nématodes. Archives de Zoologie Expérimentale et Générale 3. s. 8: 463-624.
- *Micoletzky, H. (1913) Die freilebenden Süßwassernematoden der Ost-Alpen. 1. Teil der vorläufige Mitteilung: Die frilebenden Süßwassernematoden des Lunzer Seengebietes. Sitzungsberichte der K. Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche-Klasse, Abt. 1, 122 (1): 111-122.
- *Micoletzky, H. (1914) Freilebende Süßwasser-Nematoden der Ost-Alpen mit besonderer Berücksichtigung des Lunzer Seengebietes. Zoologische Jahrbücher, Jena, Abteilungen für Systematik 36 (4-5): 331-546.
- *Micoletzky, H. (1922a) Die freilebenden Erd-Nematoden, mit besonderer Berücksichtigung der Steiermark und der Bukowina, zugleich mit einer Revision sämtlicher nicht mariner,

References

- freilebender Nematoden in Form von Genus - Beschreibungen und Bestimmungsschlüsse. Archiv für Naturgeschichte, Abt. A, 87 (8, 9): 1-650.
- *Micoletzky, H. (1922b) Freie Nematoden aus dem grundschlamm norddeutscher Seen (Madü-und Plönersee). Archiv für Hydrobiologie 13: 532-560.
- *Micoletzky, H. (1925) Die freilebenden Süßwasser-und Moornematoden Dänemarks. Nebst Anhang: Über Amöbosporidien und andere Parasiten bei freilebenden Nematoden. Kongelige Danske Videnskabernes Selskabs Skrifer, Naturv. Math. Afd., ser. 8, 10 (2): 57-310.
- *Monteiro, A. R. (1970) Dorylaimoidea de cafezais paulistas (Nemata, Dorylaimida). Thesis, Escola Superior de Agricultura "Luiz de Querioz", São Paulo, 137 pp.
- Moon, Y. S., Lee, S. M., Lee, W. K. (1995) Distribution of nematodes associated with saplings in Korea. Forest Research Institute, Journal of Forest Science (Seoul). 51: 127-142.
- Mulk, M. M., Coomans, A. (1978a) Freeliving nematodes from Mount Kenya. II. Scientific Report of the Belgian Mt. Kenya Bio-Expedition. Revue de Zoologie Africaine 92 (3): 593-608.
- Mulk, M. M., Coomans, A. (1978b) Freeliving nematodes from Mount Kenya. III. Scientific Report of the Belgian Mt. Kenya Bio-Expedition, n° 15. Biologisch Jaarboek Dodonea 46: 145-157.
- Mulvey, R. H. (1961) The Mononchidae: A family of predaceous nematodes. I. Genus *Mylonchulus* (Enoplida: Mononchidae). Canadian Journal of Zoology 39: 665-696.
- Mulvey, R. H. (1962) The Mononchidae: a family of predaceous nematodes. III. Genus *Miconchus* (Enoplida: Mononchidae). Canadian Journal of Zoology 40: 65-81.
- Mulvey, R. H. (1963a) The Mononchidae: a family of predaceous nematodes. IV. Genus *Iotonchus* (Enoplida: Mononchidae). Canadian Journal of Zoology 41: 79-98.
- Mulvey, R. H. (1963b) Abnormalities in the reproductive organs of a predaceous nematode, *Prionchulus muscorum*. Canadian Journal of Zoology 41: 793-795.
- Mulvey, R. H. (1967a) The Mononchidae: A family of predaceous nematodes. VI. Genus *Mononchus* (Nematoda: Mononchidae). Canadian Journal of Zoology 45: 915-940.
- Mulvey, R. H. (1967b) The Mononchidae: A family of predaceous nematodes. VII. Genus *Prionchulus* (Nematoda: Mononchidae). Canadian Journal of Zoology 45: 941-953.
- Mulvey, R. H. (1969) Soil-inhabiting nematodes of the orders Araeolaimida, Chromadorida, Enoplida, and Monhysterida from the Canadian high Arctic. Canadian Journal of Zoology 47: 365-382.
- Mulvey, R. H. (1973) Nematodes of the family Mononchidae (Dorylaimida: Mononchoidea) from Sable Island, Canada. Canadian Journal of Zoology 51: 237-242.
- Mulvey, R. H. (1978) Predaceous nematodes of the family Mononchidae from the Mackenzie and Porcupine river systems and Somerset Island, N. W. T., Canada. Canadian Journal of Zoology 56: 1847-1868.
- Mulvey, R. H., Dickerson, O. J. (1970) *Miconchus kansasensis* n. sp. (Mononchidae: Nematoda) from Kansas, United States. Canadian Journal of Zoology 48: 231-234.
- Mulvey, R. H., Jensen, H. J. (1967) The Mononchidae of Nigeria. Canadian Journal of Zoology 45: 667-727.

- Myers, R. F. (1966) Osmoregulation in *Panagrellus redivivus* and *Aphelenchus avenae*. *Nematologica* 12: 579-586.
- Neher, D. A. (2001) Role of nematodes in soil health and their use as indicators. *Journal of Nematology* 33: 161-168.
- Neher, D. A., Olson, R. K. (1999) Nematode communities in soils of four farm cropping management systems. *Pedobiologia* 43: 430-438.
- Nicholas, W. L., Stewart, A. C. (1989) Experiments on anhydrobiosis in *Acrobeloides nanus*. *Nematologica* 35: 489-491.
- Nielsen, C. O. (1949) Studies on the soil microfauna. II. The soil inhabiting nematodes. *Natura Jutlandica* 2: 1-132.
- Nigon, V. (1949) Les modalités de la reproduction et la déterminisme du sexe chez quelque nématodes libres. *Annales des Sciences Naturelles* (bII) 11: 1-132.
- Norton, D. C., Frederick, L. R., Ponchillia, P. E., Nyhan, J. W. (1971) Correlations of nematodes and soil properties in soybean fields. *Journal of Nematology* 3 (2): 154-163.
- *O'Dell, S. J., Crowe, J. H. (1979) Freezing in nematodes: the effects of variable water contents. *Cryobiology* 16: 534-541.
- *Örley, L. (1880) Monographie der Anguilluliden. [Monograph of the Anguillulids.] Természettudományi. Füzetek 4, Budapest, 165 pp.
- Panesar, T. S., Marshall, V. G., Barclay, H. J. (2000) The impact of clearcutting and partial harvesting systems on population dynamics of soil nematodes in coastal Douglas-fir forests. *Pedobiologia* 44: 641-665.
- Panesar, T. S., Marshall, V. G., Barclay, H. J. (2001) Abundance and diversity of soil nematodes in chronosequences of coastal Douglas-fir forests on Vancouver Island, British Columbia. *Pedobiologia* 45: 193-212.
- Paramonov, A. A. (1972) Plant-parasitic nematodes. Vol. III, Systematics of Nematodes. Superfamily Tylenchoidea. Translated from the 1970 Russian text by K. I. Skrjabin (ed), Israel Program for Scientific Translations, Jerusalem. 199 pp.
- *Pennak, R. W. (1953) Fresh-water Invertebrates of the United States. New York: Ronald Press Co. 769 pp.
- Pennak, R. W. (1978) Fresh-water Invertebrates of the United States. 2nd. Edn., New York: John Wiley & Sons. Pp. 211-230 (Chapter 9: Nematoda (Roundworms)).
- Perry, R. N. (1977) The water dynamics of stages of *Ditylenchus dipsaci* and *D. myceliophagus* during desiccation and rehydration. *Parasitology* 75: 45-70
- Perry, R. N. (1999) Desiccation survival of parasitic nematodes. *Parasitology* 119: S19-S30.
- Poinar Jr., G. O. (1983) The Natural History of Nematodes. Englewood Cliffs, NJ: Prentice-Hall Inc. 323 pp.
- Poinar Jr., G. O. (1984) Fossil evidence of nematode parasitism. *Revue de Nématologie* 17 (2): 201-203.
- Poinar Jr., G. O. (2001) Nematoda and Nematomorpha. In: Thorp, J. H., Covich, A. P. (eds) Ecology and Classification of North American Freshwater Invertebrates. 2nd. Edn. San Diego: Academic Press. Pp. 255-296.

References

- Popovici, I. (1972) Studies on the biology and population development of *Cephalobus persegnis* (Nematoda, Cephalobidae) in agar cultures. *Pedobiologia* 12: 123-127.
- Popovici, I. (1984) Nematode abundance, biomass and production in a beech forest ecosystem. *Pedobiologia* 26: 205-219.
- Pree, D. J., Townshend, J. L., Cole, K. J. (1990) Inhibition of acetylcholinesterases from *Aphelenchus avenae* by carbofuran and fenamiphos. *Journal of Nematology* 22 (2): 182-186.
- Rashid, F., Geraert, E., Coomans, A., Suatmadji, W. (1988) Cephalobidae from the Krakatau Region (Nematoda: Rhabditida). *Nematologica* 34: 125-143.
- Rashid, F., Geraert, E., Sharma, R. D. (1984) Morphology, taxonomy and morphometry of some Cephalobidae (Nematoda: Rhabditida) from Brazil, with descriptions of two new genera and four new species. *Nematologica* 30: 251-299.
- Raski, D. J., Luc, M. (1987) A reappraisal of Tylenchina (Nemata). 10. The superfamily Criconematoidea Taylor, 1936. *Revue de Nématologie* 10 (4): 409-444.
- Raski, D. J., Maggenti, A. R. (1983) Tylenchidae: morphological diversity in a natural, evolutionary group. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) Concepts in Nematode Systematics. London: Academic Press. Pp. 131-142.
- Raski, D. J., Maggenti, A. R. (1984) Four new species of *Chronogaster* Cobb, 1913 (Nemata: Plectidae) with a key to species of the genus. *Nematologica* 30: 117-130.
- Rhoades, H. L., Linford, M. B. (1959) Control of *Pythium* root rot by the nematode *Aphelenchus avenae*. *Plant Disease Reporter* 43: 323-328.
- Robbins, R. T., Brown, D. J. F. (1991) Comments on the taxonomy, occurrence and distribution of Longidoridae (Nematoda) in North America. *Nematologica* 37: 395-419.
- Robbins, R. T., Brown, D. J. F., Halbrendt, J. M., Vrain, T. C. (1991) Compendium of juvenile stages of *Xiphinema* species (Nematoda: Longidoridae). *Russian Journal of Nematology* 4 (2): 163-171.
- Ruehle, J. L. (1967) Distribution of plant-parasitic nematodes associated with forest trees of the world. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, NC. 156 pp.
- Ruehle, J. L. (1972) Nematodes of forest trees. In: Webster, J. M. (ed) Economic Nematology. London & New York: Academic Press. Pp. 312-334.
- Ruess, L. (1995) Nematode fauna in spruce forest soils: a qualitative/quantitative comparison. *Nematologica* 41: 106-124.
- Ruess, L., Dighton, J. (1996) Cultural studies on soil nematodes and their fungal hosts. *Nematologica* 42: 330-346
- Ruess, L., Funke, W. (1992) Effects of experimental acidification on nematode populations in soil cultures. *Pedobiologia* 36: 231-239.
- Ruess, L., Michelsen, A., Jonasson, S. (1999) Simulated climate change in subarctic soils: responses in nematode species composition and dominance structure. *Nematology* 1 (5): 513-526.
- Ruess, L., Garcia Zapata, E. J., Dighton, J. (2000) Food preferences of a fungal-feeding *Aphelenchoïdes* species. *Nematology* 2 (2): 23-230.

- Ruess, L., Sandbach, P., Cudlín, P., Dighton, J., Crossley, A. (1996) Acid deposition in a spruce forest soil: effects on nematodes, mycorrhizas and fungal biomass. *Pedobiologia* 40: 51-66.
- Rühm, W. (1956) Die Nematoden der Ipiden. Parasitologische Schriftenreihe Heft 6. Veb Gustav Fischer Verlag, Jena. 437 pp.
- Šály, A. (1989) Evaluation of herbicide influence on the edaphon in vineyards by means of free-living nematodes. *Polish Ecological Studies* 15 (1-2): 47-54.
- Samsoen, L., Barbez, D. (1982) The development of the genital system in *Xiphinema* and the use of genital primordia for separating juvenile stages. *Mededelingen van de Faculteit Landbouwwetenschappen Rijksuniversiteit Gent* 47 (2): 771-780.
- Samsoen, L., Arpin, P., Khan, S. H., Coomans, A. (1984) Differentiation of *Prionchulus muscorum* (Dujardin, 1845) Wu & Hoepli, 1929 and *P. punctatus* (Cobb, 1917) Andrassy, 1958 by egg-shell structure. *Revue de Nématologie* 7(4): 407-415.
- Santiago, R. P., Coomans, A. (1994a) Revision of the genus *Tylencholaimus* de Man, 1876. Didelphic species. *Nematologica* 40: 32-68.
- Santiago, R. P., Coomans, A. (1994b) Revision of the genus *Tylencholaimus* de Man, 1876. Prodelphic species: Part I. *Nematologica* 40: 157-185.
- Santiago, R. P., Coomans, A. (1994c) Revision of the genus *Tylencholaimus* de Man, 1876. Prodelphic species: Part II. *Nematologica* 40: 186-213.
- Santiago, R. P., Coomans, A. (1994d) Revision of the genus *Tylencholaimus* de Man, 1876. Prodelphic species: Part III. *Nematologica* 40: 348-368.
- Santiago, R. P., Coomans, A. (1996a) Revision of the genus *Tylencholaimus* de Man, 1876. Remaining species. *Nematologica* 42: 417-439.
- Santiago, R. P., Coomans, A. (1996b) Revision of the genus *Tylencholaimus* de Man, 1876. General discussion and key to the species. *Nematologica* 42: 440-454.
- Sanwal, K. C. (1961) A key to the species of the nematode genus *Aphelenchoides* Fischer, 1894. *Canadian Journal of Zoology* 39: 143-148.
- Sanwal, K. C. (1969) Subfamily Plectinae (Nematoda) in classifications of Goodey (1963) and de Coninck (1965); emendation of diagnosis of Plectoidea and Plectidae. *Nematologica* 15: 101-106.
- Sasser, J. N. (1989) Plant-Parasitic Nematodes: the Farmer's Hidden Enemy. Department of Plant Pathology, North Carolina State University, Raleigh, NC. 115 pp.
- Sasser, J. N., Freckman, D. W. (1987) A world perspective on Nematology: the role of the society. In: Veech, J. A., Dickson, D. W. (eds), *Vistas on Nematology: a commemoration of the twenty-fifth anniversary of the Society of Nematologists*. Society of Nematologists, Inc. Hyattsville, MD. Pp. 7-14.
- Sasser, J. N., Jenkins, W. R. (1960) *Nematology. Fundamentals and Recent Advances with Emphasis on Plant Parasitic and Soil Forms*. University of North Carolina Press, Chapel Hill, NC. 480 pp.
- *Schneider, G. (1906) Süßwassernematoden aus Estland. *Zoologischer Anzeiger*, Leipzig 29: 679-683.

References

- *Schneider, W. (1939) Würmer oder Vermes. II. Fadenwürmer oder Nematoden. In: Dahl, F., Dahl, M., Bischoff, H. (eds). Die Tierwelt Deutschlands und der angrenzenden Meeresteile. Jena, Germany: Gustav Fischer. Pp. 1-260.
- *Schuurmans Stekhoven Jr., J. H. (1951) Nématodes saprozoaires et libres du Congo Belge. Mémoires de l'Institut Royal des Sciences Naturelles de Belgique. 2. s. 39: 1-79.
- *Schuurmans Stekhoven Jr., J. H., de Coninck, L. A. (1933) Morphologische Fragen zur Systematik der freilebenden Nematoden. Verhandlungen der Deutschen Zoologischen Gesellschaft, pp. 138-143.
- *Schuurmans Stekhoven Jr., J. H., Teunissen, R. J. H. (1938) Nématodes libres terrestres. Fasc. (22) Mission (de Witte) (1933-35) Explor. Parc Nat. Albert., Brussels. 229 pp.
- Seinhorst, J.W. (1959) A rapid method for the transfer of nematodes from fixative to anhydrous glycerine. *Nematologica* 4: 67-69.
- Scudder, G. G. E. (1996) Terrestrial and freshwater invertebrates of British Columbia: priorities for inventory and descriptive research. British Columbia Ministry of Forests, Research Branch, Victoria, BC. 206 pp.
- Siddiqi, M. R. (1969) *Crateronema* n. gen. (Crateronematidae n. fam.), *Poronemella* n. gen. (Lordellonematinae n. sub-fam.) and *Chrysonemoides* n. gen. (Chrysonematidae n. fam.), with a revised classification of Dorylaimoidea (Nematoda). *Nematologica* 15: 81-100.
- Siddiqi, M. R. (1980) The origin and phylogeny of the nematode orders Tylenchida Thorne, 1949 and Aphelenchida N. Ord. *Helminthological Abstracts, Series B, Plant Nematology*, 49 (4): 143-170.
- Siddiqi, M. R. (1983) Evolution of plant parasitism in nematodes. In: Stone, A. R., Platt, H. M., Khalil, L. F. (eds) *Concepts in Nematode Systematics*. London: Academic Press. Pp. 113-129.
- Siddiqi, M. R. (1985) Tylenchida. Parasites of plants and insects. Commonwealth Institute of Parasitology, Commonwealth Agricultural Bureau, Slough, UK. 645 pp.
- Small, R. W. (1987) A review of the prey of predatory soil nematodes. *Pedobiologia* 30: 179-206.
- Smart, G. C., Darling, H. M. (1963) Pathogenic variation and nutritional requirements of *Ditylenchus destructor*. *Phytopathology* 53: 249-372.
- Smolik, J. D. (1974) Nematode studies at the Cottonwood site. Grassland Biome, Ecosystem Analysis Studies, US International Biological Program. Colorado State University, Fort Collins, CO. Technical Report No. 251, 80 pp.
- Sohlenius, B. (1973) Influence of food supply on population structure and length distribution in *Acrobeloides nanus* (Nematoda: Ceplalobidae). *Pedobiologia* 13: 205-213.
- Sohlenius, B. (1977) Numbers, biomass, and respiration of Nematoda, Rotatoria and Tardigrada in a 120-year-old Scots pine forest at Ivantjdrnsheden, Central Sweden. Technical Report 9, Swedish Coniferous Forest Project, Uppsala.
- Sohlenius, B. (1979) A carbon budget for nematodes, rotifers and tardigrades in a Swedish coniferous forest soil. *Holarctic Ecology* 2: 30-40.
- Sohlenius, B. (1993) Chaotic or deterministic development of nematode populations in pine forest humus incubated in the laboratory. *Biology and Fertility of Soils* 16: 263-268.

- Sohlenius, B. (1997) Fluctuations of nematode populations in pine forest soil. Influence by clear-cutting. *Fundamentals of Applied Nematology* 20: 103-114.
- Sohlenius, B., Boström, S. (1999) Effects of global warming on nematode diversity in a Swedish tundra soil - a soil transplantation experiment. *Nematology* 1 (7-8): 695-709.
- Sohlenius, B., Boström, S., Sandor, A. (1987) Long-term dynamics of nematode communities in arable soil under four cropping systems. *Journal of Applied Ecology* 24: 131-144.
- Sohlenius, B., Sandor, A. (1987) Vertical distribution of nematodes in arable soil under grass (*Festuca pratensis*) and barley (*Hordeum distichum*). *Biology and Fertility of Soils* 3: 19-25.
- Sohlenius, B., Sandor, A. (1989) Ploughing of a perennial grass ley - effect on the nematode fauna. *Pedobiologia* 33: 199-210.
- Sohlenius, B., Wasilewska, L. (1984) Influence of irrigation and fertilization on the nematode community in a Swedish pine forest soil. *Journal of Applied Ecology* 21: 327-342.
- SON (Society of Nematologists) (1984) Distribution of plant-parasitic nematode species in North America. Society of Nematologists. 205 pp.
- Southey, J. F. (1978a) Some free-living nematodes found in plant material and soil samples. In: Southey, J. F. (ed) *Plant Nematology*, 3rd. Edn., London: Her Majesty's Stationery Office. Pp. 244-266.
- Southey, J. F. (1978b) *Plant Nematology*, 3rd. Edn., London: Her Majesty's Stationery Office. 440 pp.
- Spaull, V. W. (1973a) Qualitative and quantitative distribution of soil nematodes of Signy Island, South Orkney Islands. *British Antarctic Survey Bulletin*, Nos. 33-34: 177-184.
- Spaull, V. W. (1973b) The Signy Island terrestrial reference sites: IV. The nematode fauna. *British Antarctic Survey Bulletin*, No. 37: 94-96.
- Spaull, V. W. (1973c) Distribution of nematode feeding groups at Signy Island, South Orkney Islands, with an estimate of their biomass and oxygen consumption. *British Antarctic Survey Bulletin*, No. 37: 21-32.
- *Stefanśki, W. (1924a) Nicenie zamieszkujące mchy, z okolic Zakopanego. (Etude sur les nématodes muscicoles des environs de Zakopane (Massif du Tatra polonais). *Bulletin International de l'Académie Polonaise des Sciences et de Lettres, Cracovie, Classe de Sciences Mathématiques et Naturelles*, s. B: Sciences Naturelles (1-10): 21-60.
- *Stefanśki, W. (1924b) Nowy przyczynek do fauny nicieni mcholubnych okolic Zakopanego. - Nouvelle contribution à la connaissance de la faune des nématodes libres des environs de Zakopane (Massif du Tatra polonais) [French Text]. *Bulletin International de l'Académie Polonaise des Sciences et de Lettres, Cracovie, Classe de Sciences Mathématiques et Naturelles*, s. B: Sciences Naturelles (7-8) 539-553.
- Stegaresku, O. P. (1966) [The application of the polytomous principles to the identification of nematodes of the genus *Xiphinema Cobb*]. In: Brown, D. J. F., Fortuner, R., Creamer, L. R. (eds) (1989) English Translations of Selected Taxonomic Papers in Nematology. California Department of Food and Agriculture, Sacramento, CA, Vol. 5: 53-58.
- Stegaresku, O. P. (1977) [On synonymizations within the genus *Xiphinema Cobb*, 1913 (Nematoda: Dorylaimida)]. In: Brown, D. J. F., Fortuner, R., Creamer, L. R. (eds) (1989) English Translations of Selected Taxonomic Papers in Nematology. California Department of Food and Agriculture, Sacramento, CA, Vol. 5: 45-46.

References

- Stegaresku, O.P. (1980) [On systematics of the nematode family Longidoridae Thorne, 1935 (Nematoda: Dorylaimoidea)]. In: Brown, D. J. F., Fortuner, R., Creamer, L. R. (eds) (1989) English Translations of Selected Taxonomic Papers in Nematology. California Department of Food and Agriculture, Sacramento, CA, Vol. 5: 47-51.
- Steinberger, Y., Sarig, S. (1993) Response by soil nematode populations and the soil microbial biomass to a rain episode in the hot, dry Negev Desert. *Biology and Fertility of Soils* 16: 188-192.
- *Steiner, G. (1916) Freilebende Nematoden von Nowaja-Semlja. *Zoologischer Anzeiger*, Leipzig 47: 50-74.
- *Steiner, G. (1919) Die von A. Monard gesammelten Nematoden der Tiefenfauna des Neuenburgersees. *Bulletin de la Societe Neuchâteloise des Sciences Naturelles* (1917-18) 43: 142-240.
- *Steiner, G. (1920) Freilebende Süßwassernematoden aus peruanischen Hochgebirgsseen (Huaron 5140 m. ü. M. und Naticocha 5140 m. ü. M.) *Revue Suisse de Zoologie* 28 (2): 11-44.
- *Steiner, G. (1926) Parasitic nemas on peanuts in South Africa. *Zentralblatt für Bakteriologie*, 2. Abteilungen 67: 351-365.
- *Steiner, G. (1931) On the status of the nemic genera *Aphelenchus* Bastian, *Pathoaphelenchus* Cobb, *Paraphelenchus* Micoletzky, *Parasitaphelenchus* Fuchs, *Isonchus* Cobb and *Seinura* Fuchs. *Journal of the Washington Academy of Sciences*. 21 (18): 468-475.
- *Steiner, G. (1935) Opuscula miscellanea nematologica II. Proceedings of the Helminthological Society of Washington 2: 104-110.
- *Steiner, G. (1936) The status of the nematode *Aphelenchus avenae* Bastian, 1865, as a plant disease. *Phytopathology* 26: 294-295.
- *Steiner, G. (1940) Opuscula miscellanea nematologica VIII. Proceedings of the Helminthological Society of Washington 7 (1): 54-62.
- *Steiner, G. (1941) Nematodes parasitic on and associated with roots of marigolds. (*Tagetes* hybrids). Proceedings of the Biological Society of Washington 54: 31-34.
- *Steiner, G. (1942) Opuscula miscellanea nematologica II. Proceedings of the Helminthological Society of Washington 9 (1): 32-38.
- *Steiner, G. (1943) New nematodes associated with a disease of the papaya in Chile. *Boletín del Departamento de Sanidad vegetal*, Santiago 3 (2): 95-116.
- Sutherland, J. R. (1969) Feeding of *Xiphinema bakeri*. *Phytopathology* 59: 1963-1965.
- Sutherland, J. R. (1970) Some forest nursery seedling hosts of the nematode *Xiphinema bakeri*. *Canadian Journal of Plant Science* 50: 588-590.
- Sutherland, J. R. (1974) Vertical distribution of *Xiphinema bakeri* nematodes in soil in a Douglas-fir nursery. *Canadian Journal of Forest Research* 4: 175-178.
- Sutherland, J. R., Dunn, T. G. (1970) Nematodes in coastal British Columbia forest nurseries and the association of *Xiphinema bakeri* with a root disease of Douglas-fir seedlings. *Plant Disease Reporter* 54 (2): 165-168.

- Sutherland, J. R., Dunn, T. G., Cousens, N. B. F. (1970) Morphometric and morphological characteristics for identifying the life stages of *Xiphinema bakeri* Williams, 1961 (Nematoda: Longidorinae). Canadian Journal of Zoology 48: 771-773.
- Sutherland, J. R., Ross, D. A. (1971) Temperature effects on survival of *Xiphinema bakeri* in fallow soil. Journal of Nematology 3 (3): 276-279.
- Sutherland, J. R., Slugget, L. J. (1973) Corky root disease of Douglast-fir: relation of *Xiphinema bakeri* nematodes to symptom severity, and observations on seedling tissue and soil nutrients. Canadian Journal of Forest Research 3: 299-303.
- Sutherland, J. R., Slugget, L. J. (1974) Time, temperature, and soil moisture effects on *Xiphinema bakeri* nematode survival in fallow soil. Phytopathology 64 (4): 507-513.
- Tarjan, A. C., Hopper, B. E. (1974) Nomenclatorial Compilation of Plant and Soil Nematodes. Society of Nematologists Inc., E. O. Painter Printing Co., DeLeon Springs, FL. 419 pp.
- Taylor, A. L. (1936) The genera and species of the Criconematinae, a sub-family of the Anguillulinidae (Nematoda). Transactions of the American Microscopical Society 55 (4): 391-421.
- *Thorne, G. (1924) Utah nematodes of the genus *Mononchus*. Transactions of the American Microscopical Society 43: 157-171.
- *Thorne, G. (1925) The genus *Acrobeles* von Linstow, 1887. Transactions of the American Microscopical Society 44 (4): 171-210.
- *Thorne, G. (1927) Life history, habits and economic importance of some mononchs. Journal of Agricultural Research, Washington. 34 (3): 265-286.
- Thorne, G. (1930) Predacious nemas of the genus *Nygolaimus* and a new genus, *Sectonema*. Journal of Agricultural Research, Washington. 41 (6): 445-466.
- *Thorne, G. (1937) A revision of the nematode family Cephalobidae Chitwood & Chitwood. Proceedings of the Helminthological Society of Washington 4: 1-16.
- Thorne, G. (1939) A monograph of the nematodes of the superfamily Dorylaimoidea. Capita Zoologica 8 (5): 1-261.
- Thorne, G. (1945) *Ditylenchus destructor*, n. sp., the potato rot nematode, and *Ditylenchus dipsaci* (Kühn, 1857) Filipjev, 1936, the teasel nematode (Nematoda: Tylenchidae). Proceedings of the Helminthological Society of Washington 12 (2): 27-34.
- Thorne, G. (1949) On the classification of the Tylenchida, new order (Nemata, Phasmida). Proceedings of the Helminthological Society of Washington 16 (2): 37-73.
- Thorne, G. (1960) The superfamily Dorylaimoidea. In: Sasser, J. N., Jenkins, W. R. (1960) Nematology. Fundamentals and Recent Advances with Emphasis on Plant Parasitic and Soil Forms. University of North Carolina Press, Chapel Hill, NC. Pp. 225-226.
- Thorne, G. (1961) Principles of Nematology. New York: McGraw Hill. 553 pp.
- Thorne, G. (1964) Nematodes of Puerto Rico: Belondiroidea new superfamily, Leptonchidae, Thorne, 1935, and Belonenchidae new family (Nemata, Adenophorea, Dorylaimida). University of Puerto Rico, Agricultural Experiment Station, Río Piedras, Puerto Rico, Technical Paper 39, 51 pp.

References

- Thorne, G. (1974) Nematodes of the Northern Great Plains. Part II. Dorylaimoidea in part (Nemata: Adenophorea). Agricultural Experiment Station, South Dakota State University, Brookings, SD, Technical Bulletin 41, 120 pp.
- Thorne, G., Malek, R. B. (1968) Nematodes of the Northern Great Plains. Part I. Tylenchida (Nemata: Secernentea). Agricultural Experiment Station, South Dakota State University, Brookings, SD, Technical Bulletin 31, 111 pp.
- Thorne, G., Swanger, H. H. (1936) A monograph of the nematode genera *Dorylaimus* Dujardin, *Aporcelaimus* n. g., *Dorylaimoides* n. g. and *Pungentus* n. g. *Capita Zoologica* 6 (4): 1-223.
- *Timm, R. W. (1957) Some soil nematodes of East Pakistan. *Pakistan Journal of Biological and Agricultural Science* 1 (1): 4-10.
- Tjepkema, J. P. (1969) Parasitism of aporcelaimid nematodes by mermithid nematodes. *Journal of Nematology* 1: 29.
- Tjepkema, J. P., Ferris V. R., Ferris, J. M. (1971) Review of the genus *Aporcelaimellus* Heyns, 1965 and six species groups of the genus *Eudorylaimus* Andrassy, 1959 (Nematoda: Dorylaimida). *Purdue University Agricultural Experiment Station, Lafayette, IN. Research Bulletin No. 882*, 52 pp.
- Triantaphyllou, A. C., Fisher, J. M. (1976) Gametogenesis in amphimictic and parthenogenetic populations of *Aphelenchus avenae*. *Journal of Nematology* 8 (2): 168-177.
- Vancoppenolle, B., Borgonie, G., Coomans, A. (1999) Generation times of some free-living nematodes cultured at three temperatures. *Nematology* 1 (1): 15-18.
- van de Velde, M. C., De Lay, P., Mounport, D., Baujard, P., Coomans, A. (1994) Ultrastructure of the buccal cavity and the cuticle of three Cephalobidae (Nematoda: Rhabditida). *Nematologica* 40: 541-563.
- Viglierchio, D. R. (1979) Response of *Pinus ponderosa* seedlings to stylet-bearing nematodes. *Journal of Nematology* 11 (4): 377-387.
- Viglierchio, D. R. (1991) The World of Nematodes. University of California, Davis, CA. 266 pp.
- Viglierchio, D. R., Maggenti, A. R. (1975) Susceptibility of western forest conifers to common agricultural plant-parasitic nematodes. *Plant Disease Reporter* 59 (4): 326-328.
- Volz, P. (1951) Untersuchungen über die Mikrofauna des Waldbodens. *Zoologische Jahrbücher, Abteilungen für Systematik* 79: 514-566.
- von Bassus, W. (1968) Über Wirkungen von Industrieexhalaten auf den Nematodenbesatz im Boden von Kiefernwäldern. *Pedobiologia* 8: 289-295.
- von Bussau, C. (1990a) Freilebende Nematoden aus Küstendünen und angrenzenden Biotopen der deutschen und dänischen Küsten. I. Gesamtüberblick und Chromadorida (Nematoda). [Free-living Nematodes from the Coastal Dunes and Adjoining Biotopes of the German and Danish Coasts. I. General Part and Redescription of some Chromadorida (Nematoda).] *Zoologischer Anzeiger*, Leipzig 225: 161-188.
- von Bussau, C. (1990b) Freilebende Nematoden aus Küstendünen und angrenzenden Biotopen der deutschen und dänischen Küsten. II. Monhysterida, Enoplida und Trefusiida (Nematoda). [Free-living Nematodes from the Coastal Dunes and Adjoining Biotopes of the German and Danish Coasts. II. Monhysterida, Enoplida and Trefusiida (Nematoda).] *Zoologischer Anzeiger*, Leipzig 225: 189-209.

- von Bussau, C. (1991) Freilebende Nematoden aus Küstendünen und angrenzenden Biotopen der deutschen und dänischen Küsten. III. Dorylaimida. [Freeliving Nematodes from the Coastal Dunes and Adjoining Biotopes of German and Danish Coasts. III. Dorylaimida.] *Zoologischer Anzeiger*, Leipzig 226: 33-63.
- *von Daday, E. (1896) A magyar fauna édesvízi fonálférgei. *Mathematikai és természettudományi Értesítő*. Kiadja a Magyar Tudományos Akadémia, Budapest 14 (5): 402-415.
- *von Daday, E. (1899) Uj-guineai szabadon élő nematodok. *Mathematikai és természettudományi Értesítő*. Kiadja a Magyar Tudományos Akadémia Budapest 17 (5): 557-572.
- von Hirling, W. (1969) Übersichtliche Tabellen zum Bestimmen von pflanzenschädlichen Nematoden. In: Rademacher, H. C. (ed) *Zeitschrift für Pflanzenkrankheiten (Pflanzenpathologie) und Pflanzenschutz* 76 (7): 412-423. Stuttgart: Verlag Eugen Ulmer.
- *von Linstow, O. F. B. (1877) *Helminthologica*. Archiv für Naturgeschichte, Berlin, 43, J., 1 (1): 1-18, pl.1, figs. 1-26.
- *von Linstow, O. F. B. (1879) *Helminthologische Studien*. Archiv für Naturgeschichte, Berlin, 45. J., 1 (2): 165-188, pls.11-12, figs. 1-39.
- Walter, D. E., Ikonen, E. K. (1989) Species, guilds, and functional groups: taxonomy and behaviour in nematophagous arthropods. *Journal of Nematology* 21 (3): 315-327.
- Wasilewska, L. (1970) Nematodes of the sand dunes in the Kampinos Forest. I. Species structure. *Ekologia Polska* 18 (20): 430-442.
- Wasilewska, L. (1971) Nematodes of the dunes in the Kampinos Forest. II. Community structure based on numbers of individuals, state of biomass and respiratory metabolism. *Ekologia Polska* 19 (38): 651-688.
- Wasilewska, L. (1997) Soil invertebrates as bioindicators, with special reference to soil-inhabiting nematodes. *Russian Journal of Nematology* 5: 113-126.
- Webster, J. M. (ed) (1972) *Economic Nematology*. London & New York: Academic Press. 563 pp.
- Webster, J. M., Hooper, D. J. (1968) Serological and morphological studies on inter- and intra-specific differences of the plant parasitic nematodes *Heterodera* and *Ditylenchus*. *Parasitology* 58: 879-891.
- Wharton, D. A. (1995) Cold tolerance strategies in nematodes. *Biological Reviews* 70: 161-185.
- Williams, T. D. (1961) *Xiphinema bakeri* n. sp. (Nematoda: Longidoridae) from the Fraser River Valley, British Columbia, Canada. *Canadian Journal of Zoology* 39: 407-412.
- Womersley, C. (1978) A comparison of the rate of drying of four nematode species using a liquid paraffin technique. *Annals of Applied Biology* 90: 401-505.
- Womersley, C. (1987) A reevaluation of strategies employed by nematode anhydrobiotes in relation to their natural environment. In: Veech, J. A., Dickson, D. W. (eds) *Vistas on Nematology: A Commemoration of the Twenty-fifth Anniversary of the Society of Nematologists*. Society of Nematologists Inc., Hyattsville, MD. Pp. 165-173.
- Womersley, C. Z., Wharton, D. A., Higa, L. M. (1998) Survival Biology. In: Perry, R. N., Wright, D. J. (eds) *The Physiology and Biochemistry of Free-living and Plant-parasitic Nematodes*. Wallingford, UK: CAB International. Pp. 271-302.

References

- Wood, F. H. (1973) Nematode feeding relationships. Feeding relationships of soil-dwelling nematodes. *Soil Biology and Biochemistry* 5: 593-601.
- Wright, D. J., Newall, D. R. (1976) Nitrogen excretion, osmotic and ionic regulation in nematodes. In: Croll, N. A. (ed) *The Organization of Nematodes*. London: Academic Press. Pp. 163-210.
- *Wu, H. W., Hoepli, R. J. C. (1929) Free-living nematodes from Fookien and Chekiang. Teil III. *Helminthologische Beiträge aus Fookien und Chekiang. Archiv für Schiffs- und Tropen-Hygiene, Pathologie und Therapie exotischer Krankheiten*. Bd. 33, Nr. 1: 35-43.
- Wu, L. Y. (1969) Five new species of *Tylenchus* Bastian, 1865 (Nematoda: Tylenchidae) from the Canadian high Arctic. *Canadian Journal of Zoology* 47: 1005-1010.
- Yeates, G. W. (1967) Studies on nematodes from dune sands. 6. *Dorylaimoidea*. *New Zealand Journal of Science* 10: 752-784.
- Yeates, G. W. (1970) The diversity of soil nematode faunas. *Pedobiologia* 10: 104-107.
- Yeates, G. W. (1972a) The oesophageal-intestinal junction in the *Dorylaimoidea* (Nematoda). *Journal of Natural History* 6: 343-355.
- Yeates, G. W. (1972b) Nematoda of a Danish beech forest. I. Methods and general analysis. *Oikos* 23: 178-189.
- Yeates, G. W. (1973) Nematoda of a Danish beech forest. II. Production estimates. *Oikos* 24: 179-185.
- Yeates, G. W. (1979) Soil nematodes in terrestrial ecosystems. *Journal of Nematology* 11 (3): 213-229.
- Yeates, G. W. (1988) Contribution of size classes to biovolume, with special reference to nematodes. *Soil Biology and Biochemistry* 20 (5): 771-773.
- Yeates, G. W., Bongers, T., de Goede, R. G. M., Freckman, D. W., Georgieva, S. S. (1993). Feeding habits in soil nematode families and genera - an outline for soil ecologists. *Journal of Nematology* 25: 315-331.
- Yeates, G. W., Wardle, D. A. (1996) Nematodes as predators and prey: relationships to biological control and soil processes. *Pedobiologia* 40: 43-50.
- Zeidan, A. B., Geraert, E. (1990) Free-living nematodes from Sudan. *Nematologica* 35: 277-304.
- Zeidan, A. B., Geraert, E. (1991a) *Aphelenchoïdes*, *Aphelenchus*, and *Paraphelenchus* from Sudan with a description of two new species. *Nematologica* 37: 420-438.
- Zeidan, A. B., Geraert, E. (1991b) The Genus *Ditylenchus* Filipjev, 1936 in Sudan (Nematoda: Tylenchida). *Afro-Asian Journal of Nematology* 1 (1): 5-14.
- *Zell, H. (1985) Nematoden eines Buchenwaldbodens 3. *Prionchulus muscorum* (Nematoda, Mononchida). *Carolinea* 42: 57-74.
- *Zimmermann, A. W. P. (1898) De nematoden der Koffierwortels. Deel I. Mededeelingen uit's Lands Plantentuin (Buitenzorg) 27: 1-64, figs 1-17, pl. 1-2.
- Zuckerman, B. M. (1976) Nematodes as models for aging studies. In: Croll, N. A. (ed) *The Organization of Nematodes*. London: Academic Press. Pp. 211-241.

- Zuckerman, B. M. (1980) (ed) *Nematodes as Biological Models: Aging and other model systems*, Vol. 2. New York: Academic Press. 306 pp.
- Zuckerman, B. M., Mai, W. F., Rohde, R. A. (eds) (1971) *Plant Parasitic Nematodes. Cytogenetics, Host-parasite Interactions and Physiology*, Vol. II. New York: Academic Press. 237 pp.
- Zullini, A., Peretti, E. (1986) Lead pollution and moss-inhabiting nematodes of an industrial area. *Water, Air, and Soil Pollution* 27: 403-410.

SECTION 7: INDEX

All nematode taxonomic names, including orders, suborders, families, genera, and species, are listed, with the species name or lowest unit of the infraspecific category given first and followed by the generic name and other names in the epithet. Orthographic variations in spelling (e.g. *alpina* versus *alpinus*) are given as separate entries and taxa without specific names (e.g. *Aporcelaimellus* sp.) are listed under "sp." within the entries under "S". Page numbers for synonymous names are given in italics; other entries are in Roman type.

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Section 8: Figures

This section contains photographs and line drawings of nematodes from the Douglas-fir ecosystems. The photographs are originals made from mounted specimens and the drawings are adopted from the literature and modified for this Monograph. The figures show some of the salient taxonomic or diagnostic features as mentioned in the text for the individual species (Section 2), and as also used in the identification Key for the nematode taxa (Section 3). The literature sources for the drawings are given in their figure captions and are cited in the references (Section 6).

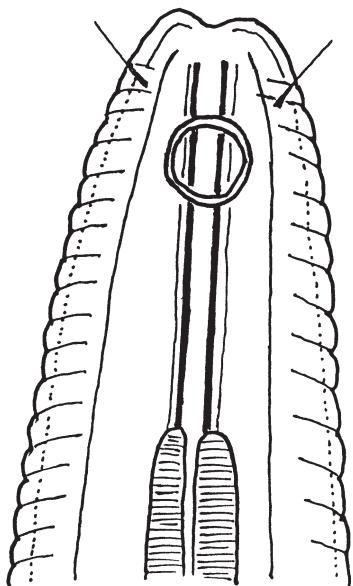


Fig.1. ***Cylindrolaimus melancholicus***: anterior end, lateral view; amphid circular. After Goodey (1963: p. 320).

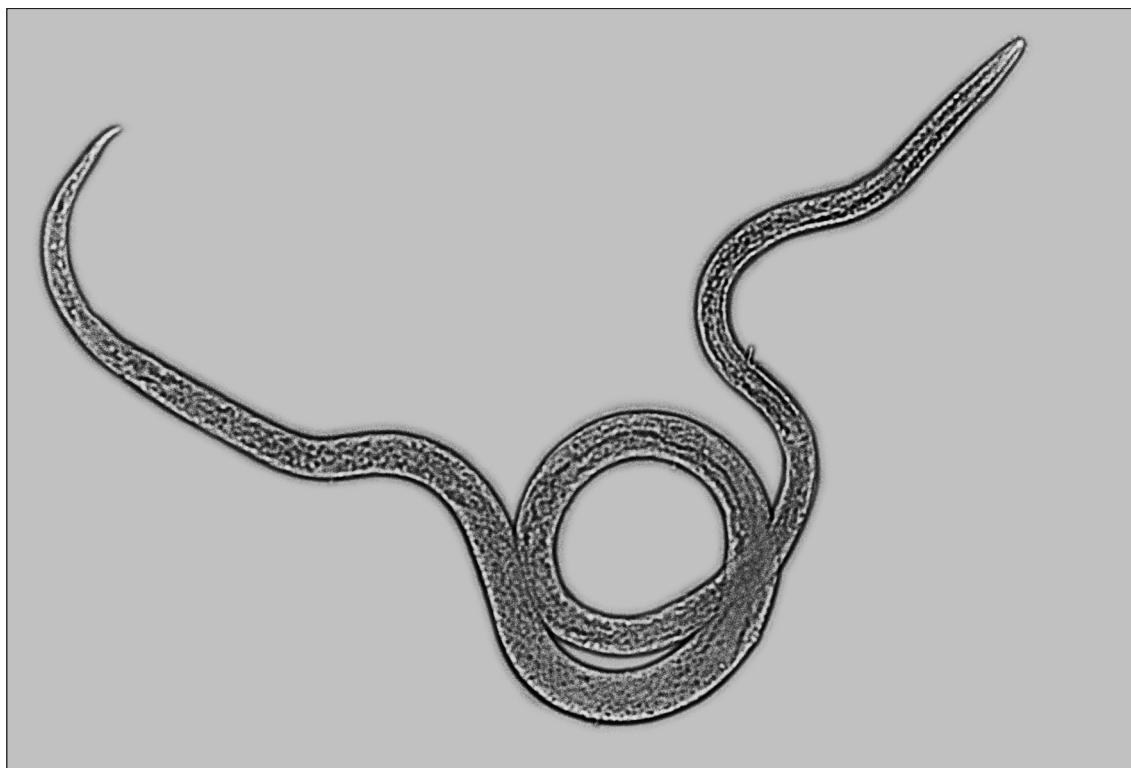


Fig. 2. **Bastiania sp.**: female whole body; a long, slender, pliant nematode (x400).

Figures

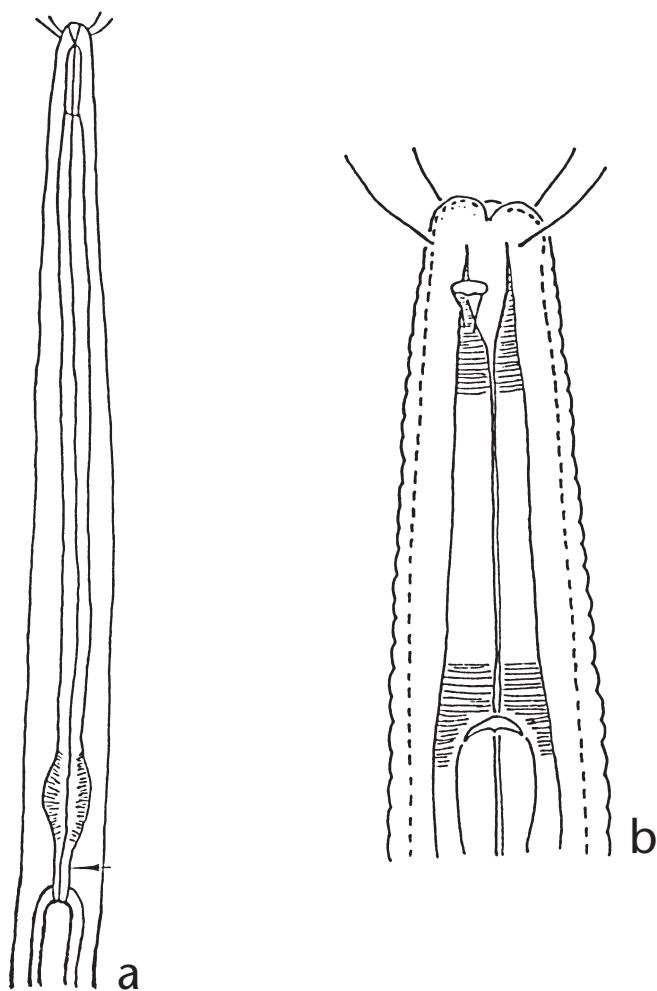


Fig. 3. ***Chronogaster longicollis***: (a) oesophageal region, schematic: a tongue-like basal bulb extension (arrow) connects with intestine; (b) anterior end: amphid stirrup-shaped. After Raski & Maggenti (1984: p. 119).

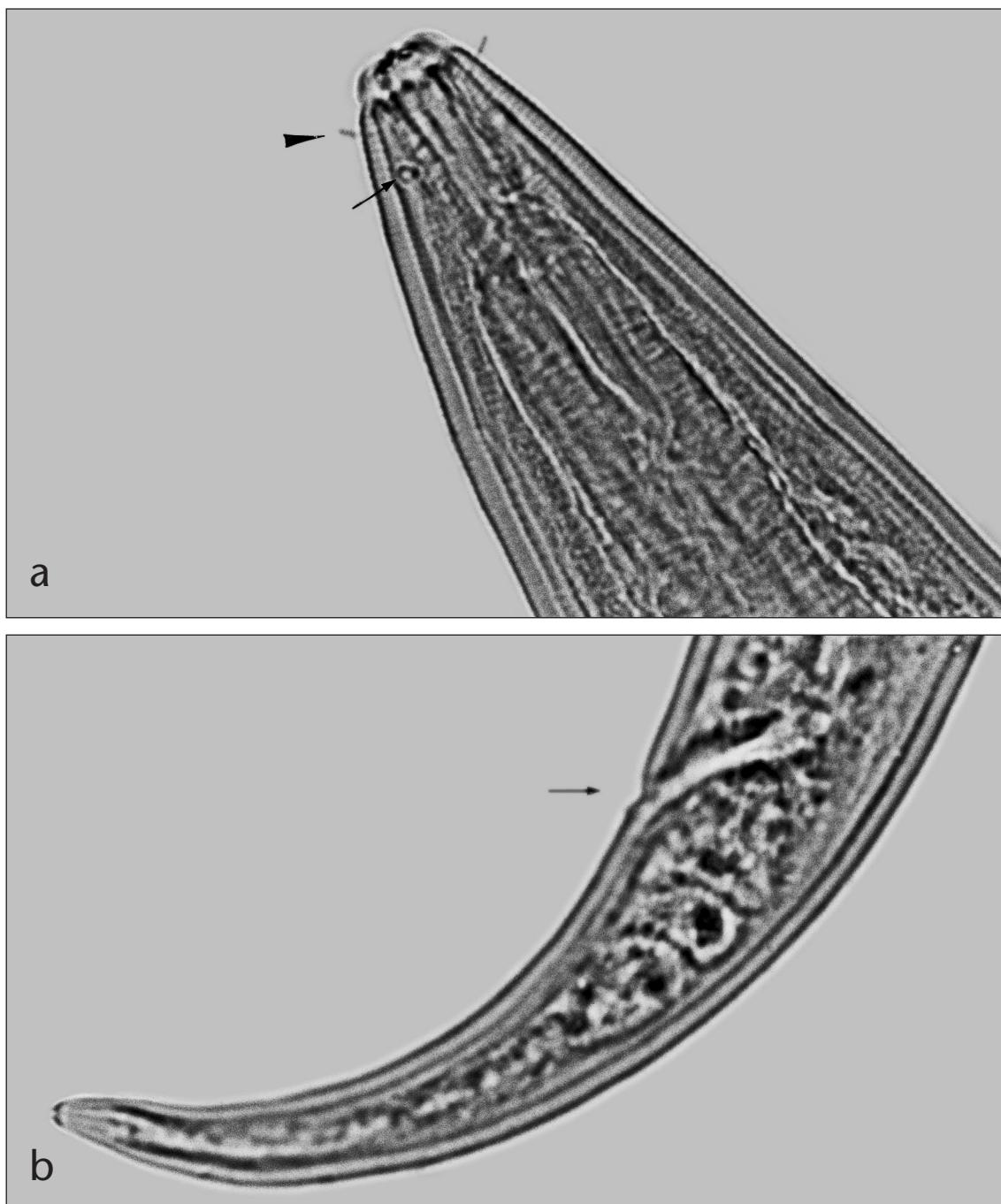


Fig. 4. *Plectus parietinus*: (a) female anterior region showing tubular mouth cavity or stoma, cephalic setae (arrowhead) and amphid (arrow); (b) tail region showing anal opening (arrow) and three caudal glands which open at tail tip by a single duct (x1600).

Figures



Fig. 5. ***Wilsonema* sp.**: anterior region showing bulbiform, membranous expansions with smooth rims, surrounding neck region (x1600).

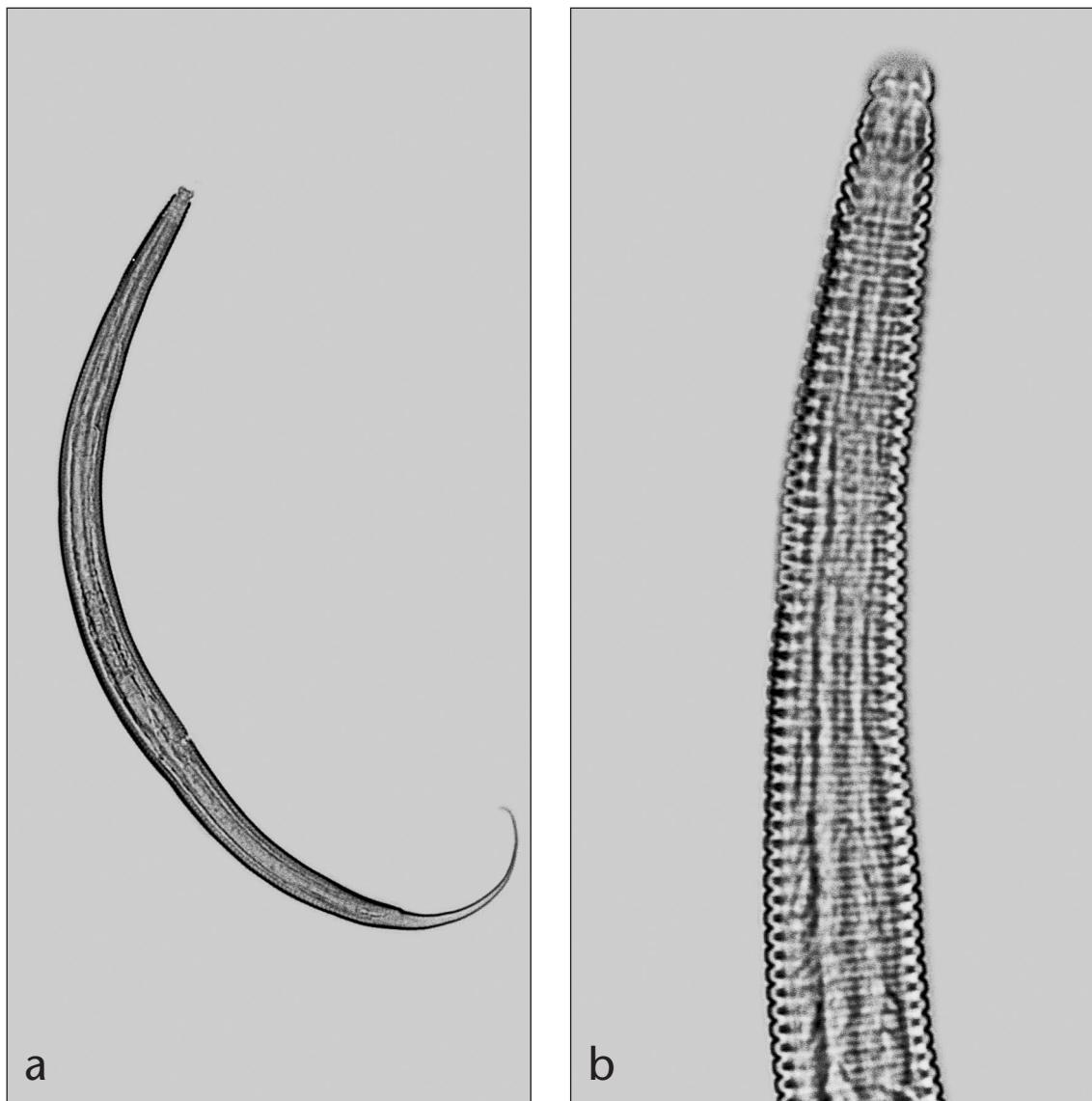


Fig. 6. *Teratocephalus subvexus*: (a) female whole body (x400); (b) anterior region showing lips in shape of a crown, and strongly annulated cuticle (x1600).

Figures

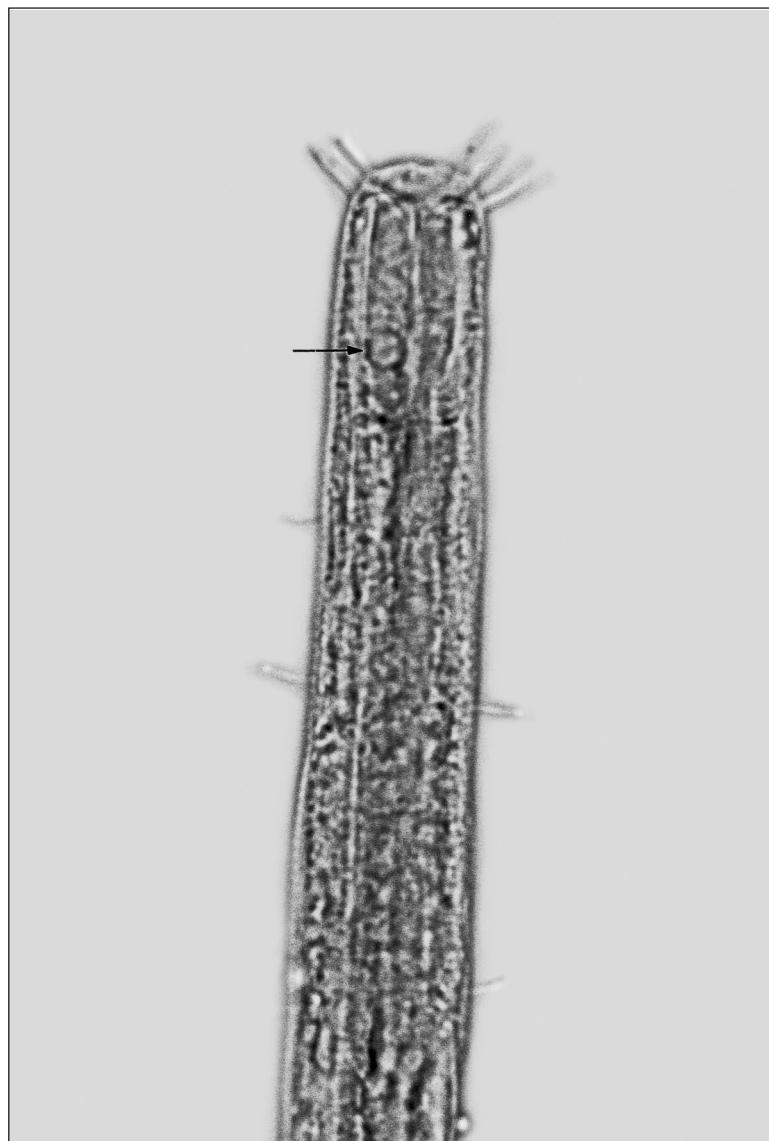


Fig. 7. **Monhystera dispar:** anterior region showing bristle-like cephalic or head setae and some somatic or body setae; arrow indicates an amphid (x1600).

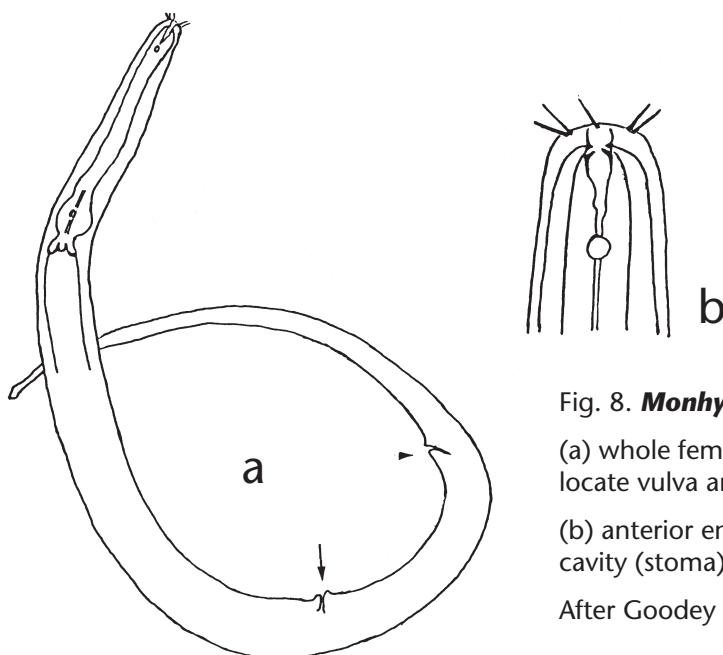


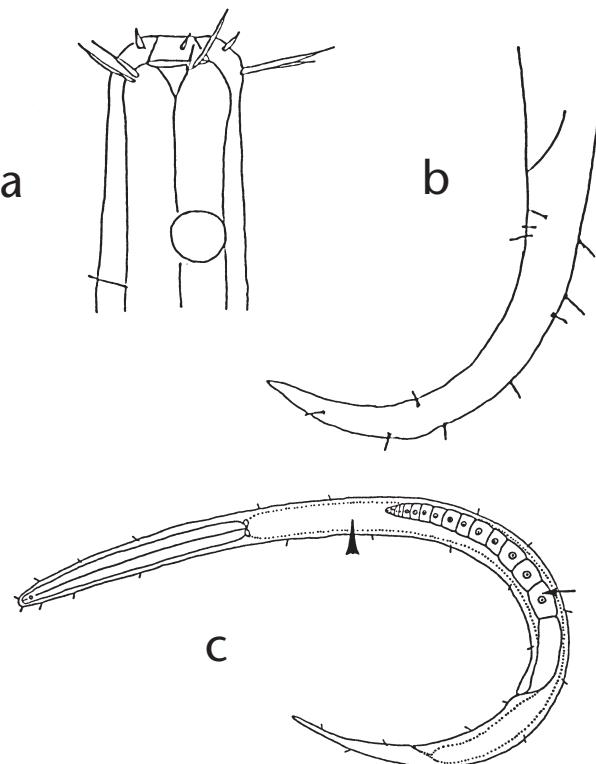
Fig. 8. *Monhystrella* sp.:

- (a) whole female: arrow and arrowhead locate vulva and anus, respectively;
- (b) anterior end showing teeth in mouth cavity (stoma).

After Goodey (1963: p. 335).

Fig. 9. *Theristus* sp.:

- (a) anterior end showing head setae and circular amphid;
- (b) tail region showing somatic setae;
- (c) illustrates the condition of gonad (arrow) being at left side of intestine (arrowhead).
- (a) and (b) after Bongers (1988: p. 246), (c) after Andrassy (1976: p. 98).



Figures

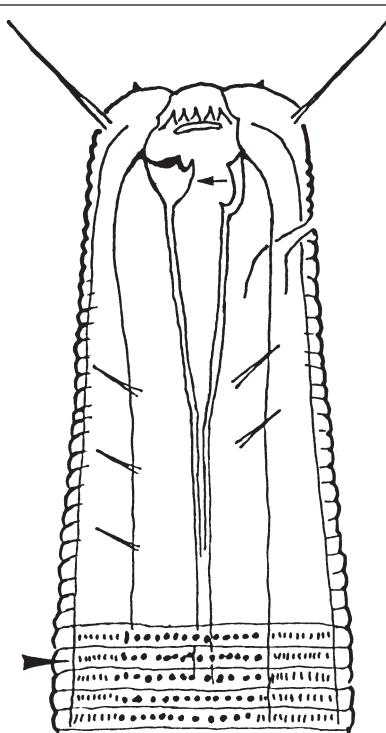


Fig. 10.
Punctodora sp.:
anterior end,
lateral view;
large dorsal tooth
(small arrow)
in mouth cavity or
stoma; a row of
cuticular punctu-
ations is indicated
(arrowhead).
After Goodey
(1963: p. 353).

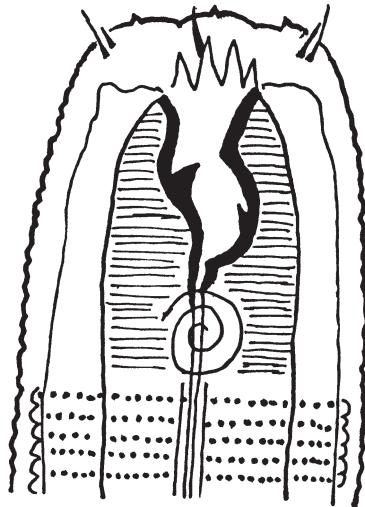


Fig. 11. **Achromadora ruricola:**
anterior end, lateral view.
After Goodey (1963: p. 359).

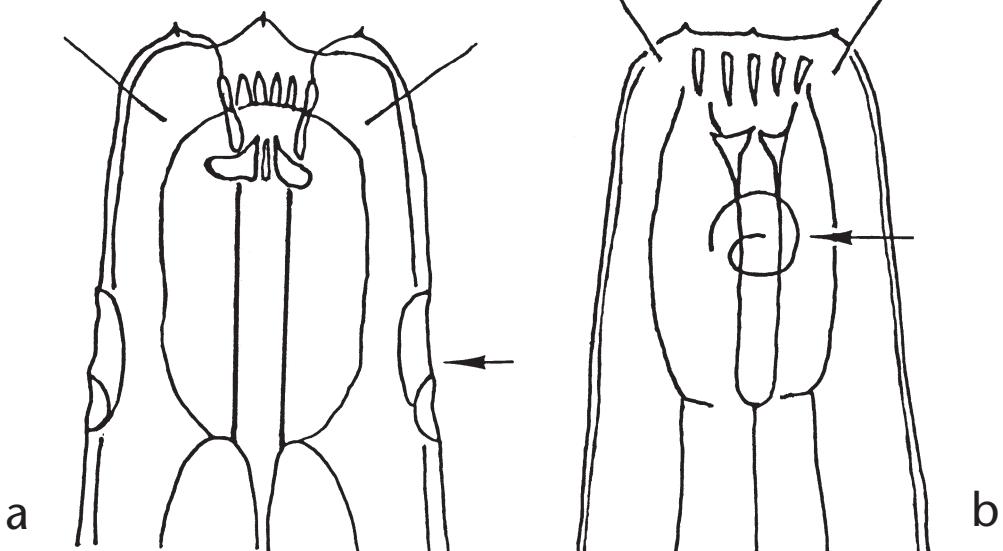


Fig. 12. **Ethmolaimus pratensis:** anterior end: (a) ventral aspect; (b) lateral aspect; spiral
amphids (arrows); mouth cavity or stoma with longitudinal, rib-like structures near its
opening, and three ribs further down with tooth-like ends. (a) after Goodey (1963: p. 361),
(b) after Bongers (1988: p. 272).

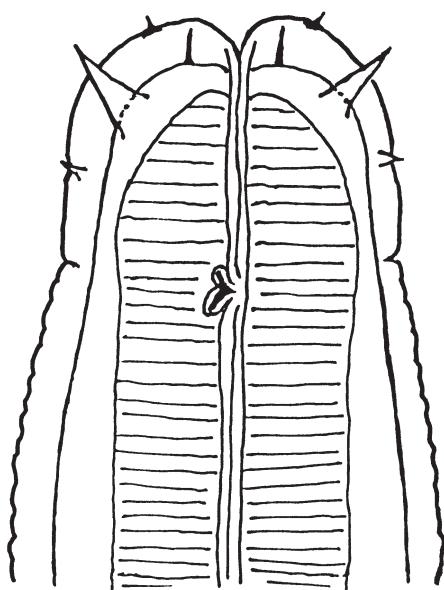


Fig. 13. *Tripyla affinis*:
anterior end; mouth cavity
(stoma) long and narrow,
with a small tooth in dorsal wall.
After Goodey (1963: p. 384).

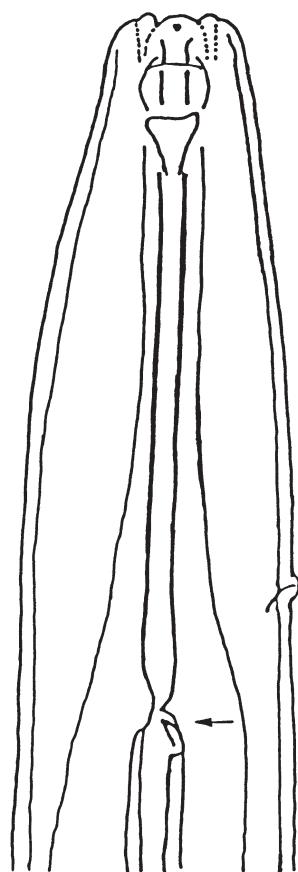


Fig. 14. *Cryptonchus tristis*: anterior end;
two teeth (arrow) at base of long, tubular
mouth cavity or stoma. After Anderson
(1968: 938).

Figures



Fig. 15. *Pristimolaimus intermedius*:

(a) whole female (x160);

(b) anterior region showing spacious mouth cavity (stoma); head end with circlets of longer and shorter setae (x400).

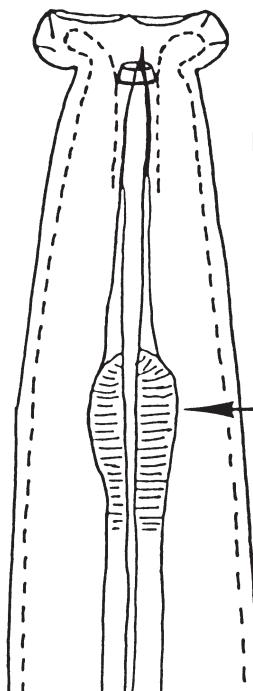


Fig. 16.
***Discolaimus* sp.:**
anterior region;
anterior oesophagus
forming a muscular
swelling (arrow).
Combined after
Heyns (1971:
p. 152) and
Jairajpuri & Ahmad
(1992: p. 158).

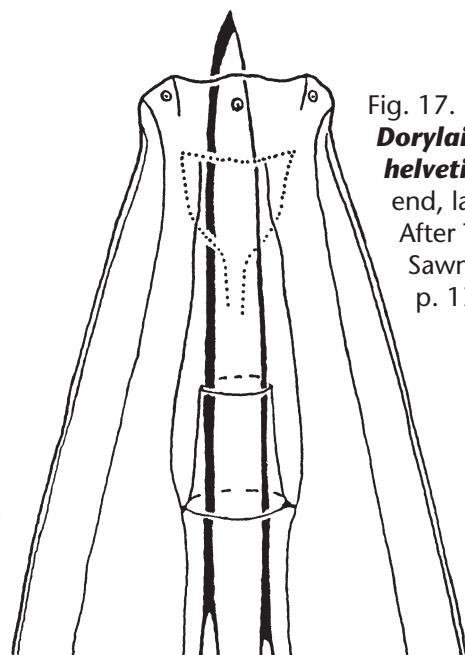


Fig. 17.
Dorylaimus
helveticus: anterior
end, lateral view.
After Thorne &
Sawnger (1936:
p. 171).

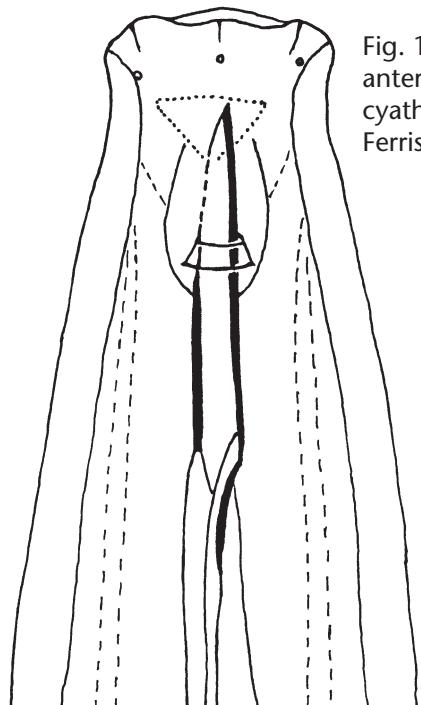


Fig. 18. ***Labronema thornei***:
anterior end; amphid
cyathiform (dotted). After
Ferris (1968: p. 282).

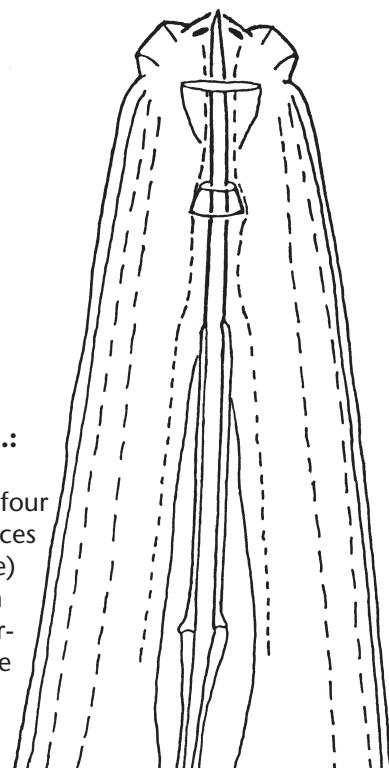


Fig. 19.
***Pungentus* sp.:**
anterior end,
lateral aspect; four
sclerotized pieces
(two seen here)
around mouth
orifice are char-
acteristic of the
genus. After
Heyns (1971:
p. 148).

Figures

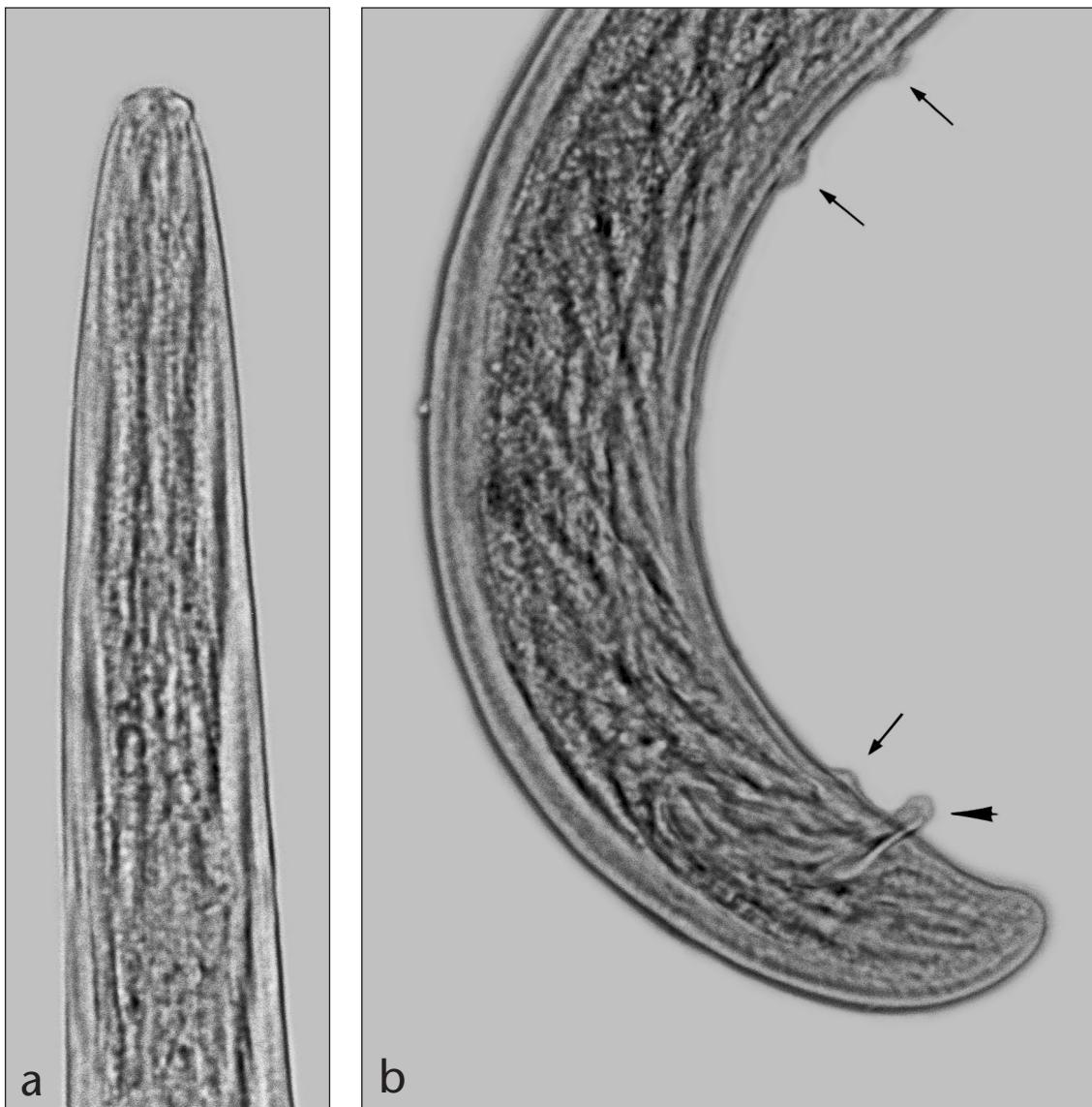


Fig. 20. *Tylencholaimus* sp.:

(a) anterior region ($\times 1600$);

(b) rounded posterior region of male showing extruded spicule (arrowhead) and supplements (arrows) ($\times 1600$).

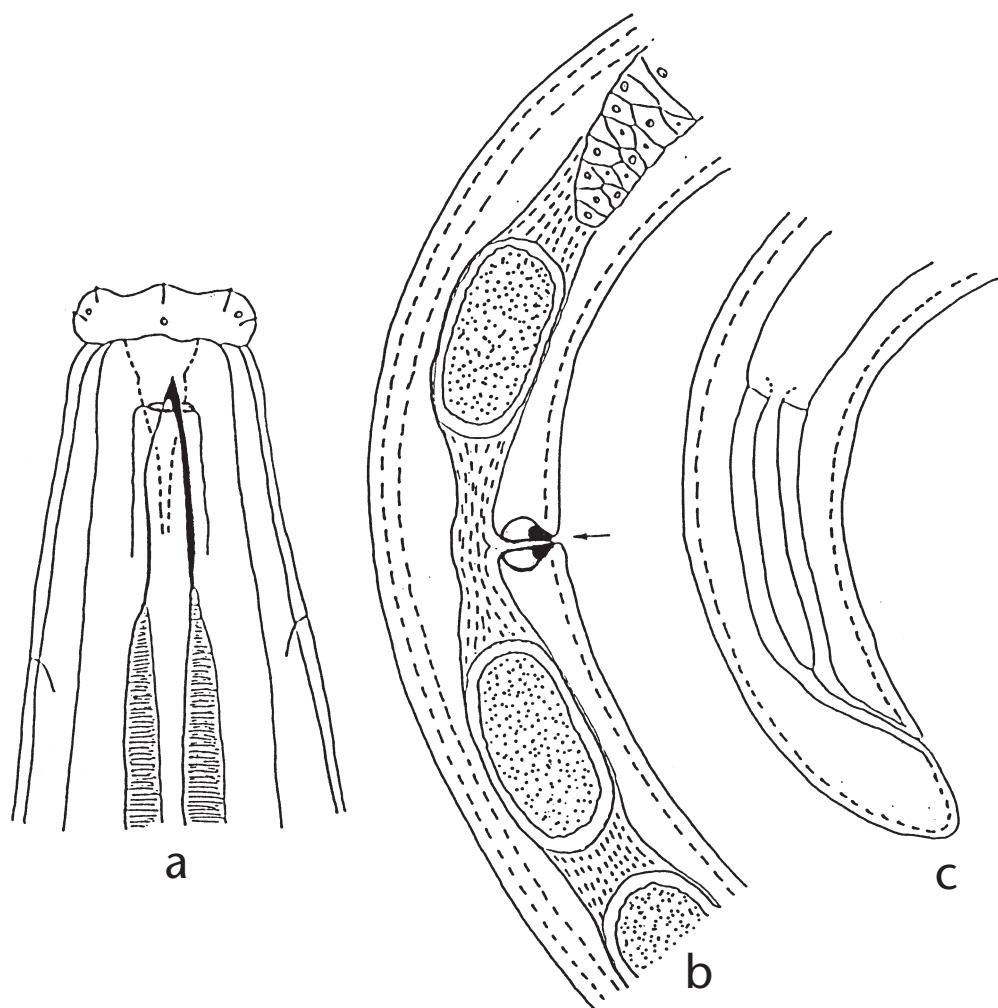


Fig. 21. *Aporcelaimellus obscurus*:

- (a) anterior end: stylet aperture equal to or larger than half of stylet length;
- (b) vulval region: vulva (arrow) with sclerotized labia; eggs seen in opposed uteri;
- (c) female tail.

After Southey (1978b: p. 261).

Figures

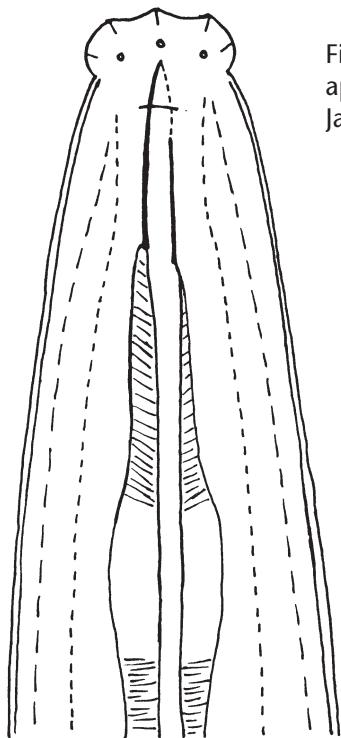


Fig. 22. *Aporcelaimellus* sp.: anterior end; illustration of stylet aperture being smaller than half of stylet length. After Ahmad & Jairajpuri (1982: p. 57).



Fig. 23.
Nygolaimus aquaticus:
anterior end; amphid
cyathiform. After Thorne
(1939: p. 222).

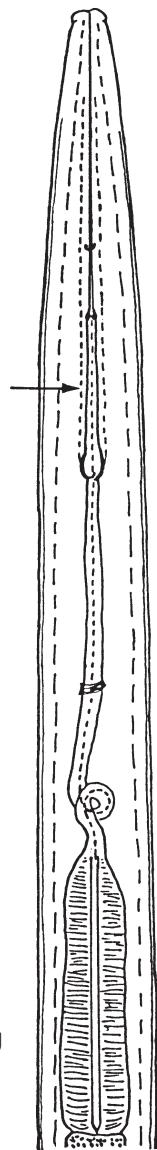


Fig. 24. *Xiphinema bakeri*:
oesophageal region; stylet long
and straight; stylet extension
(arrow) with basal flanges.
After Williams (1961: p. 408).

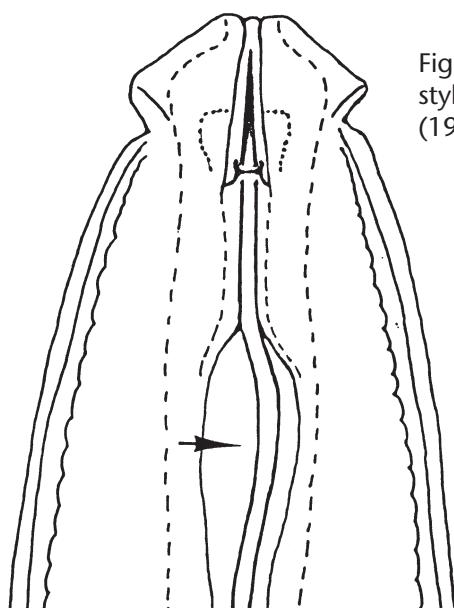


Fig. 25. *Leptonchus granulosus*: anterior end, lateral view; stylet extensions arcuate (arrow). Combined after Goodey (1963: p. 475) and Goseco et al. (1974: p. 6).

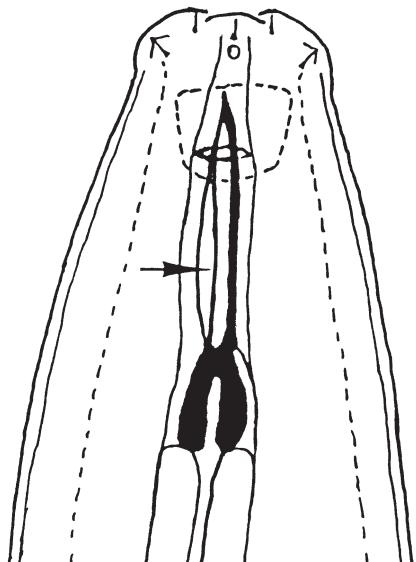


Fig. 26. *Tylencholaimellus diplodorus*: anterior end, lateral view; stylet with conspicuous basal knobs and a dorsal, accessory stiffening piece (arrow). The diagram is based on a close resemblance of this species to *T. affinis* (Goseco et al. 1975: p. 6). After Goodey (1963: p. 480).

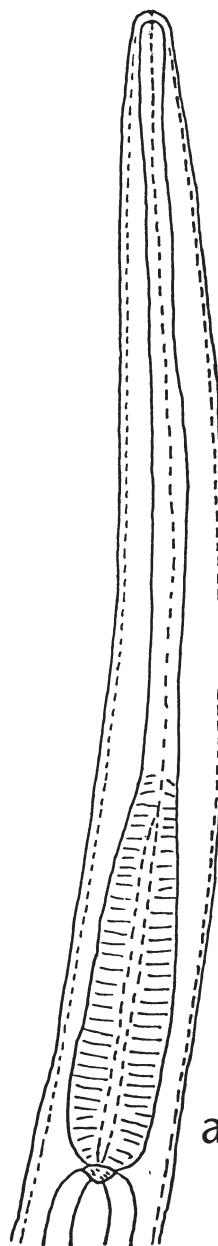


Fig. 27.
Alaimus arcuatus:
(a) oesophageal region;
(b) female tail.
After Thorne (1939:
p. 250).

Figures

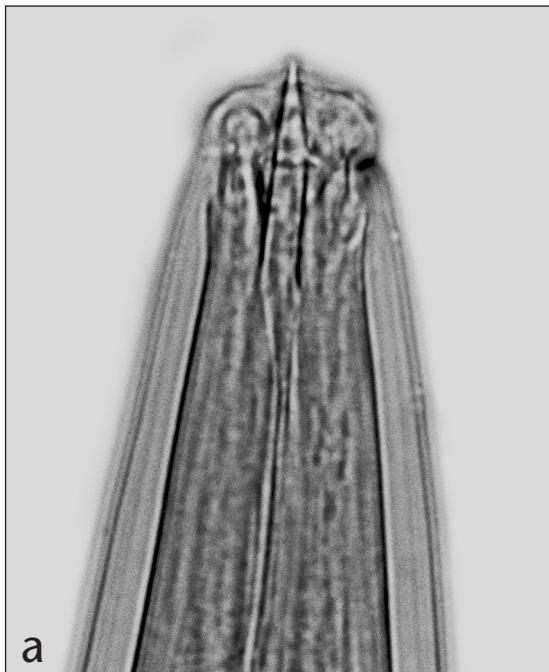
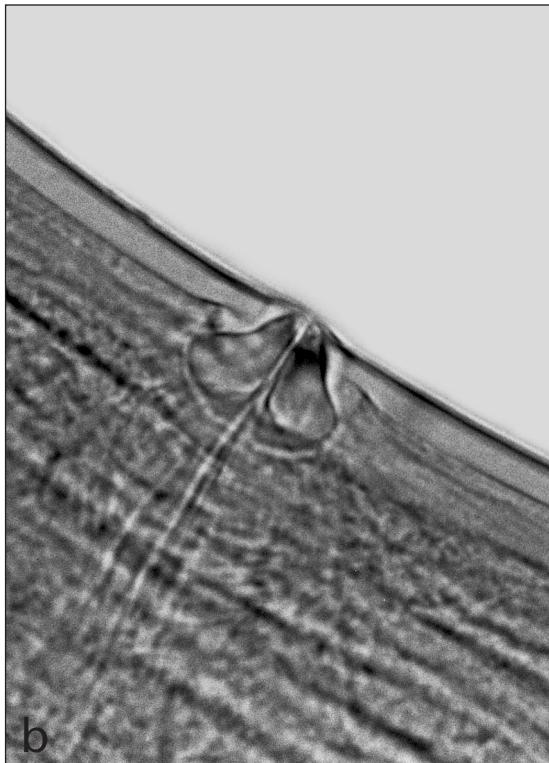
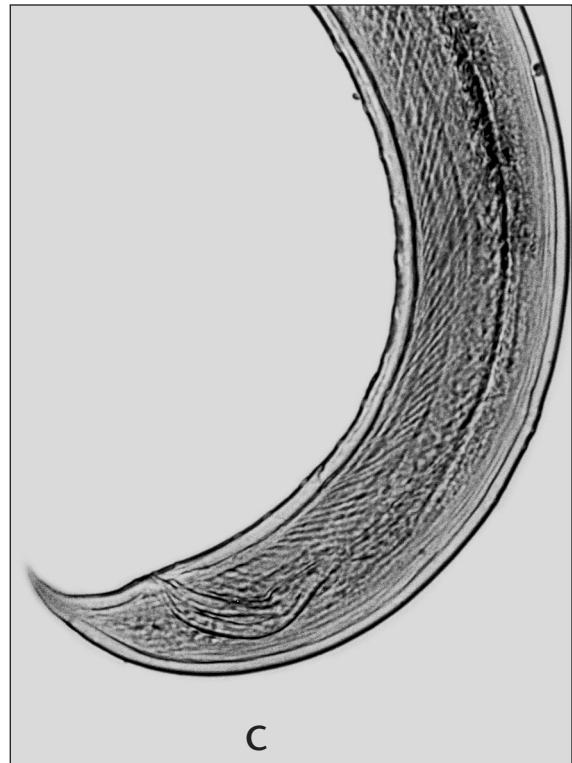
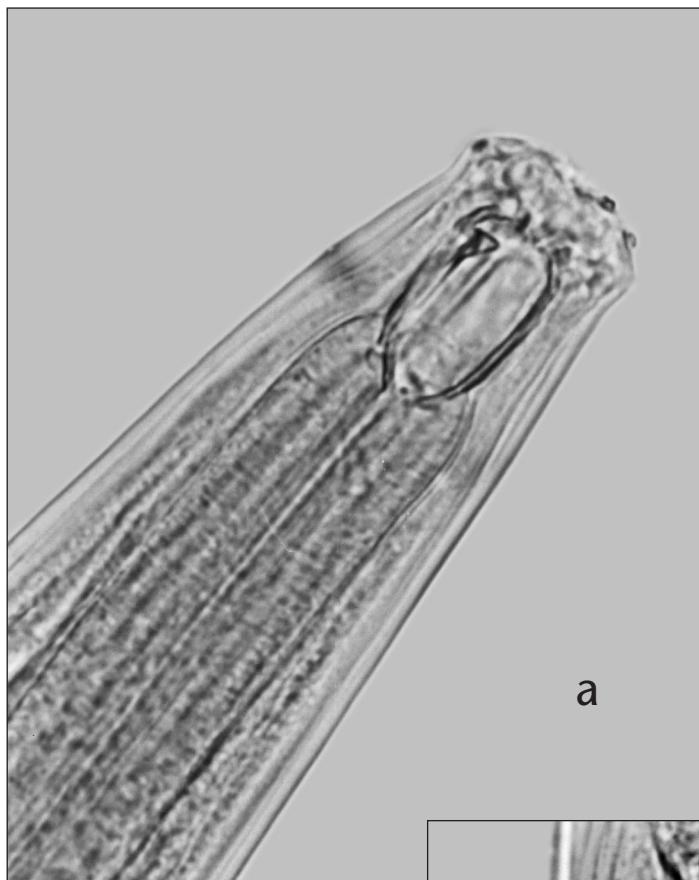
**a****b****c**

Fig. 28. ***Eudorylaimus carteri***:

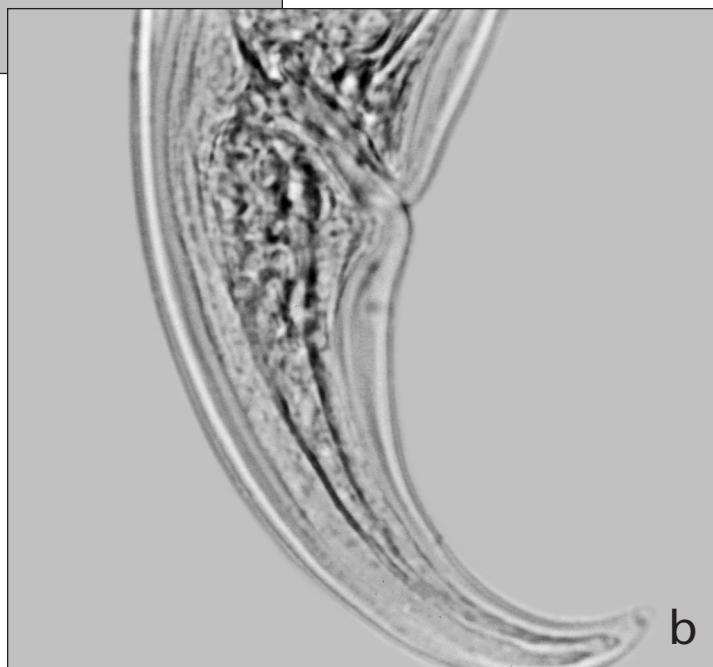
(a) anterior region showing well-developed stylet (x1600);

(b) vulval region: vulval labia with triangular, sclerotized pieces (x1600);

(c) male posterior region showing spicular apparatus (x400).



a



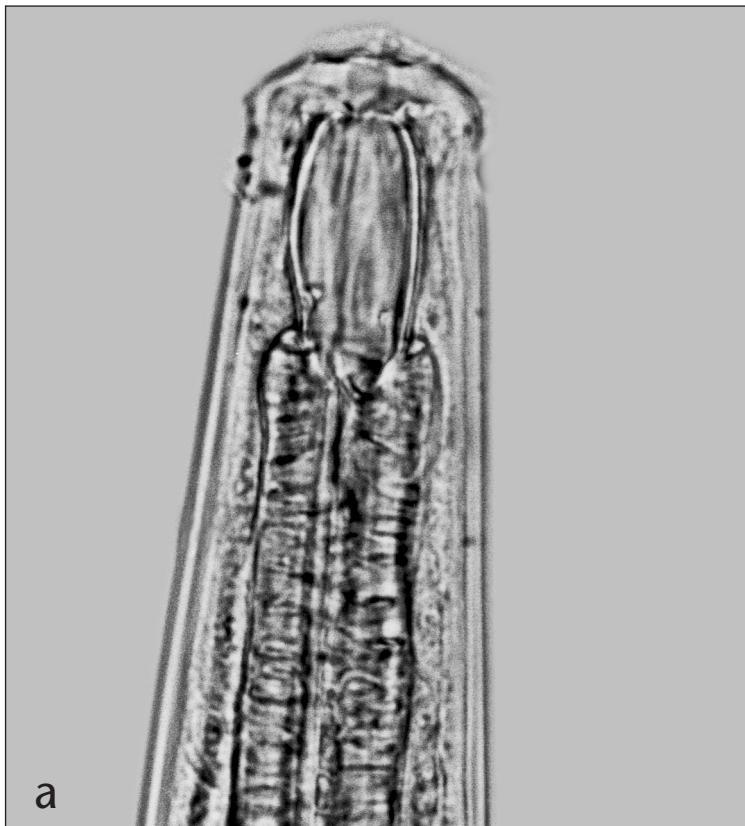
b

Fig. 29. *Clarkus papillatus*:

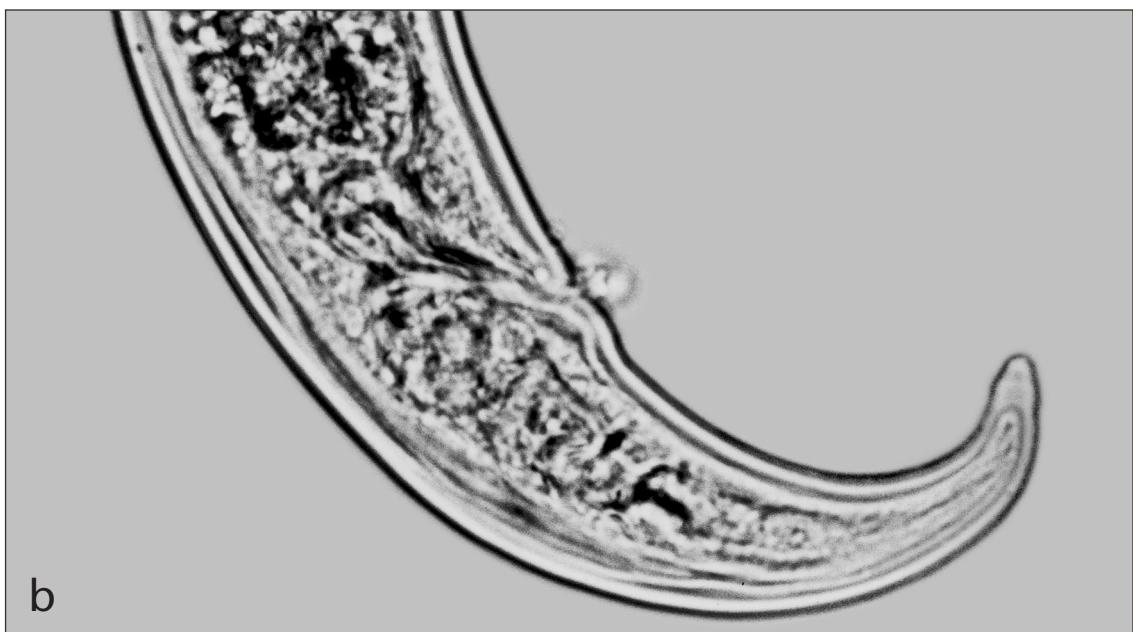
(a) anterior region showing mouth cavity (stoma) with prominent dorsal tooth (x400);

(b) tail and anal region of female (x400).

Figures



a



b

Fig. 30.

Itonchus antedontus:

(a) anterior region showing mouth cavity (stoma) with small dorsal tooth in posterior part of mouth cavity (x1600);

(b) tail and anal region of female (x1600).

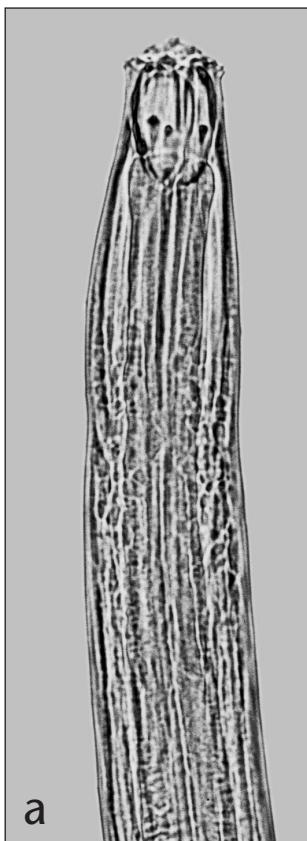
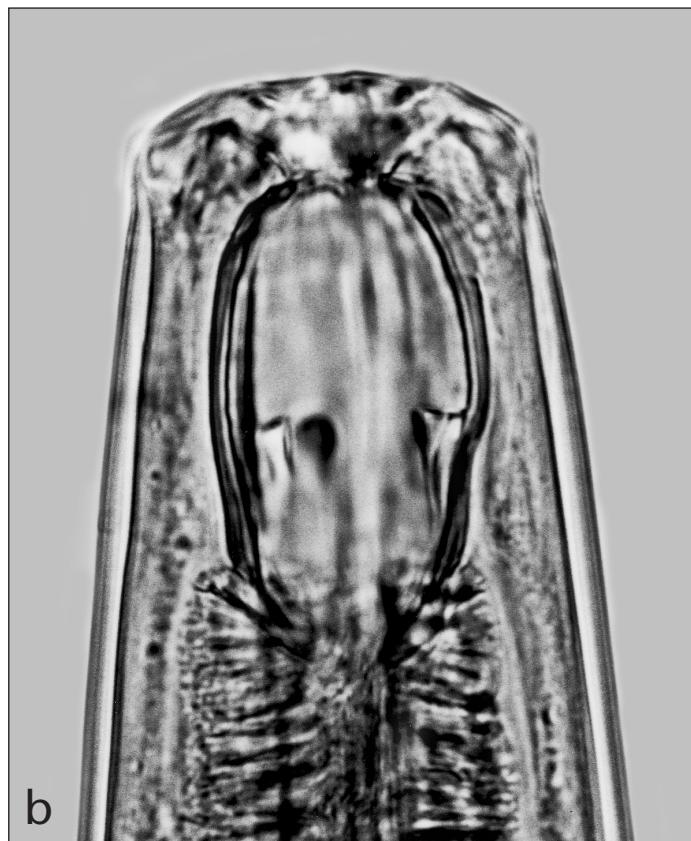
**a****b**

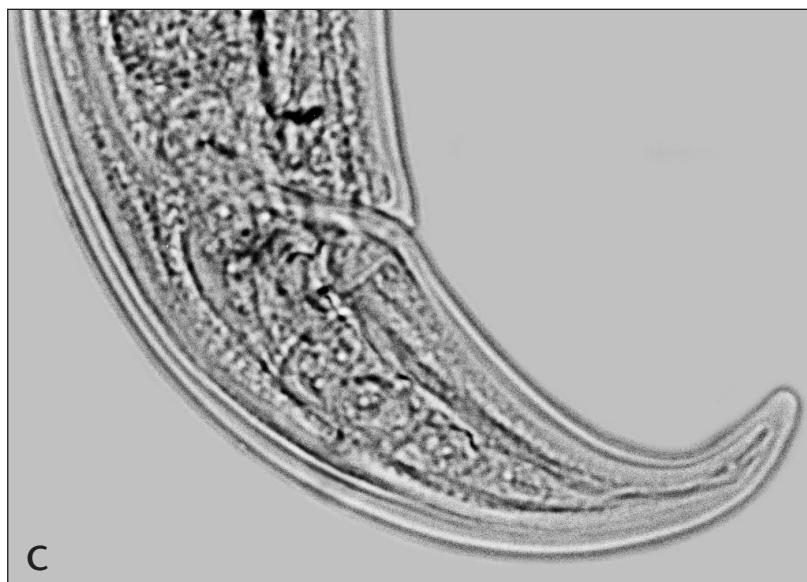
Fig. 31.

Miconchus trionchus:

(a) anterior region showing mouth cavity (stoma) with three nearly equal-sized, forward-pointing teeth situated about middle of thick-walled mouth cavity (x360);

(b) enlarged view of mouth cavity and teeth (x1440);

(c) tail and anal region of female (x1440).

**c**

Figures

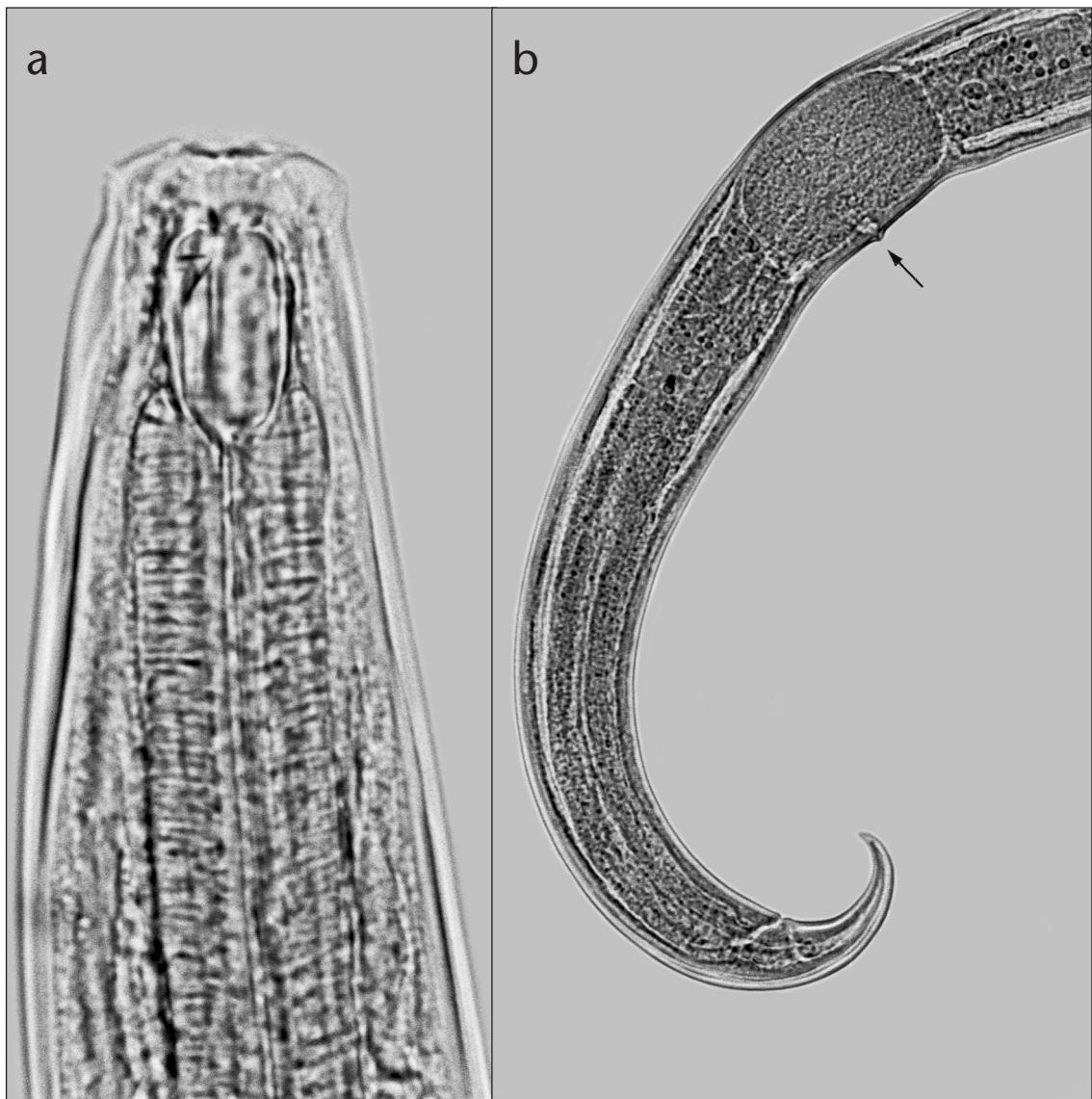


Fig. 32. *Mononchus sp.*: (a) anterior region showing mouth cavity (stoma) and dorsal tooth in anterior mouth cavity ($\times 1600$); (b) tail and genital regions of female: a developing egg is seen in the uterus; arrow locates vaginal opening ($\times 400$).

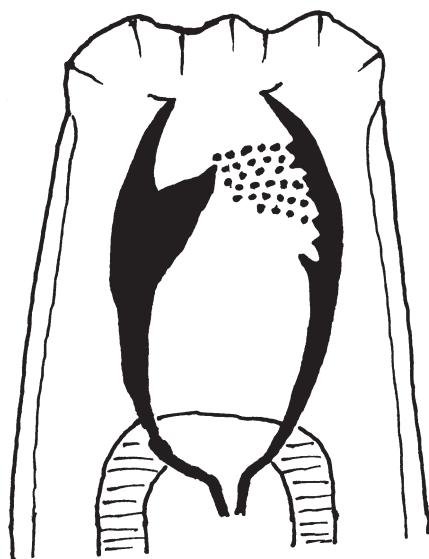


Fig. 33. *Mylonchulus* sp.: mouth cavity (stoma). After Southey (1978b: p. 265).

Figures

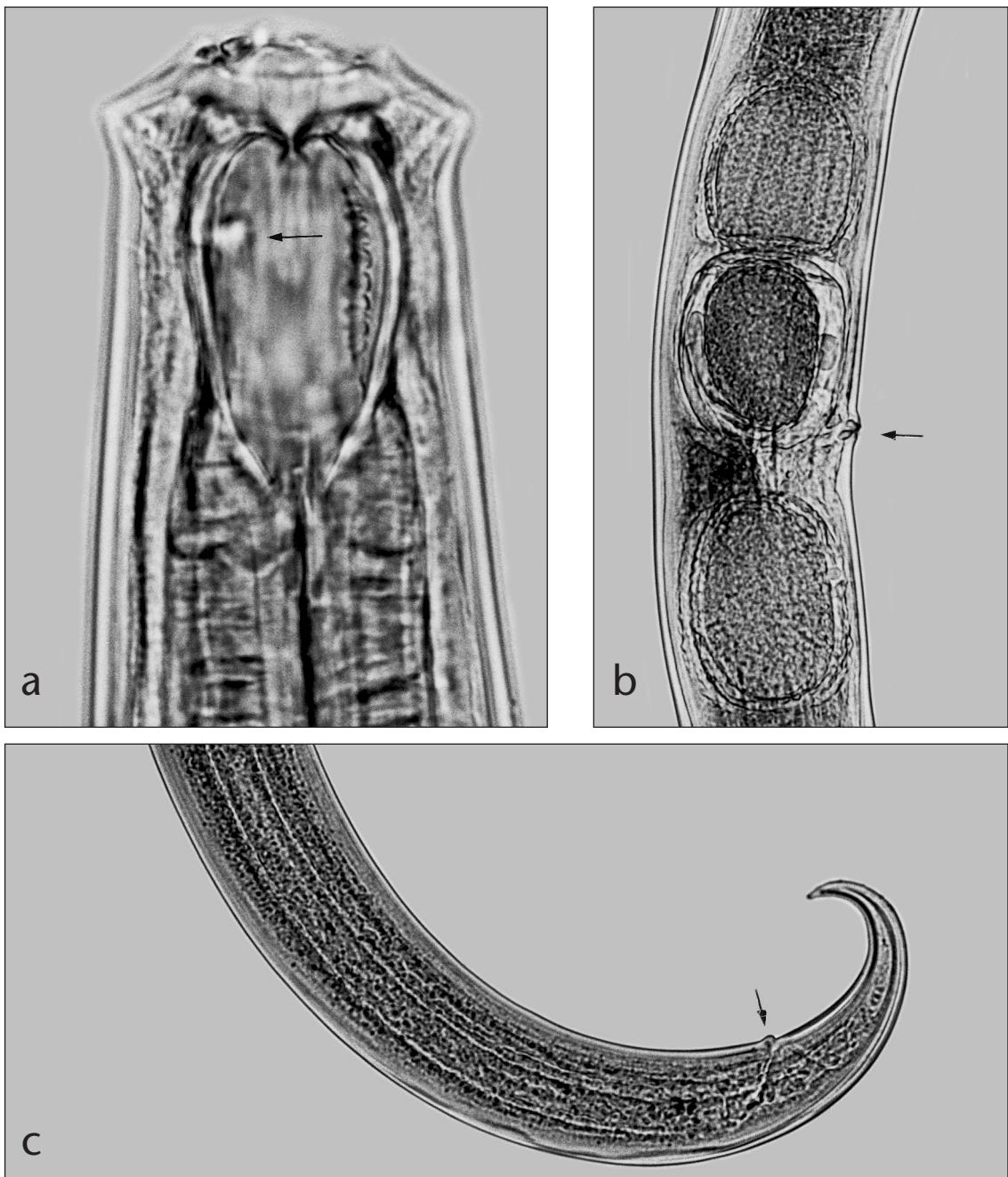


Fig. 34. ***Prionchulus muscorum***: (a) anterior part with dorsal tooth (arrow) in mouth cavity (stoma), and rows of denticles in ventral wall of mouth cavity ($\times 1600$); (b) female with three developing eggs in uterus; arrow locates vaginal orifice ($\times 400$); (c) posterior part of female; anal opening indicated by arrow ($\times 400$).

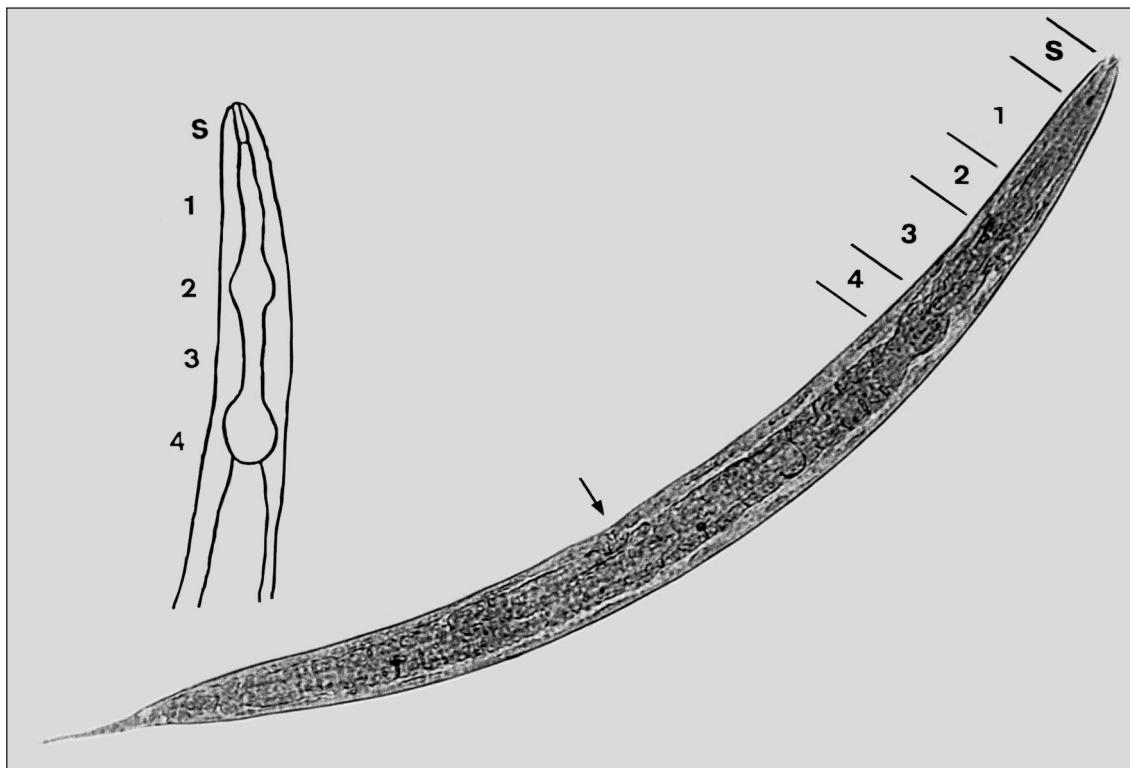


Fig. 35. **Protorhabditis sp.**: female with four-part (1-4), rhabditoid oesophagus behind mouth cavity or stoma (s); vulva near mid body (arrow) (x160).

Figures

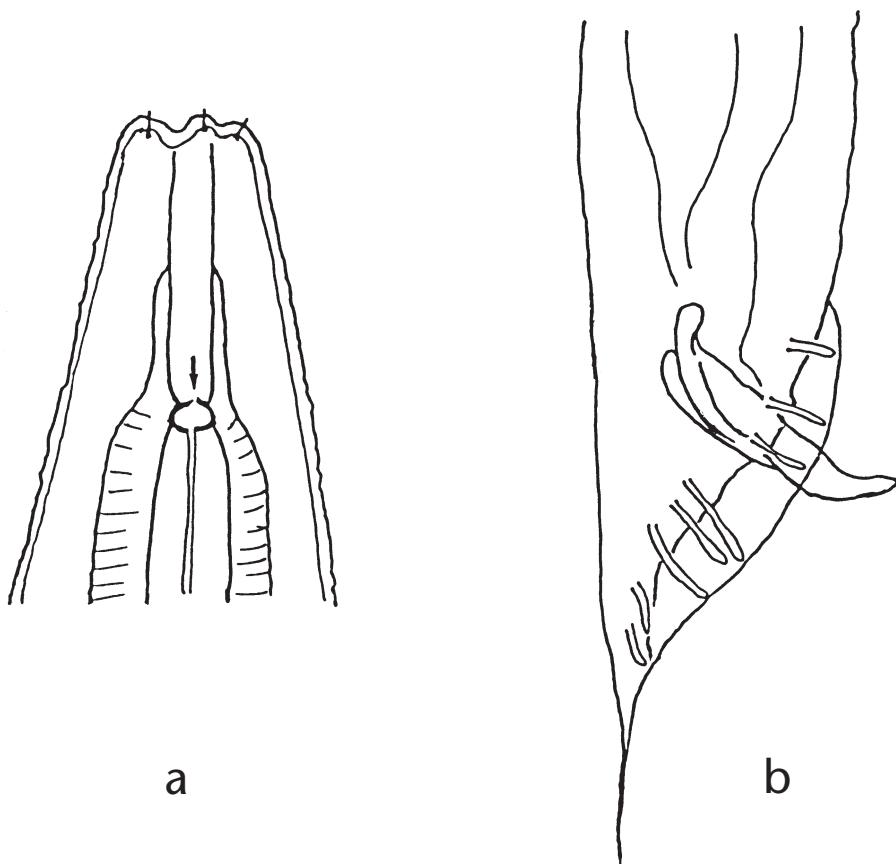


Fig. 36. *Rhabditis* sp.:

(a) anterior end with glottid apparatus (arrow) at base of mouth cavity (stoma);

(b) male tail with rhabditoid, leptoderan-type bursa.

After Heyns (1971: p. 26).

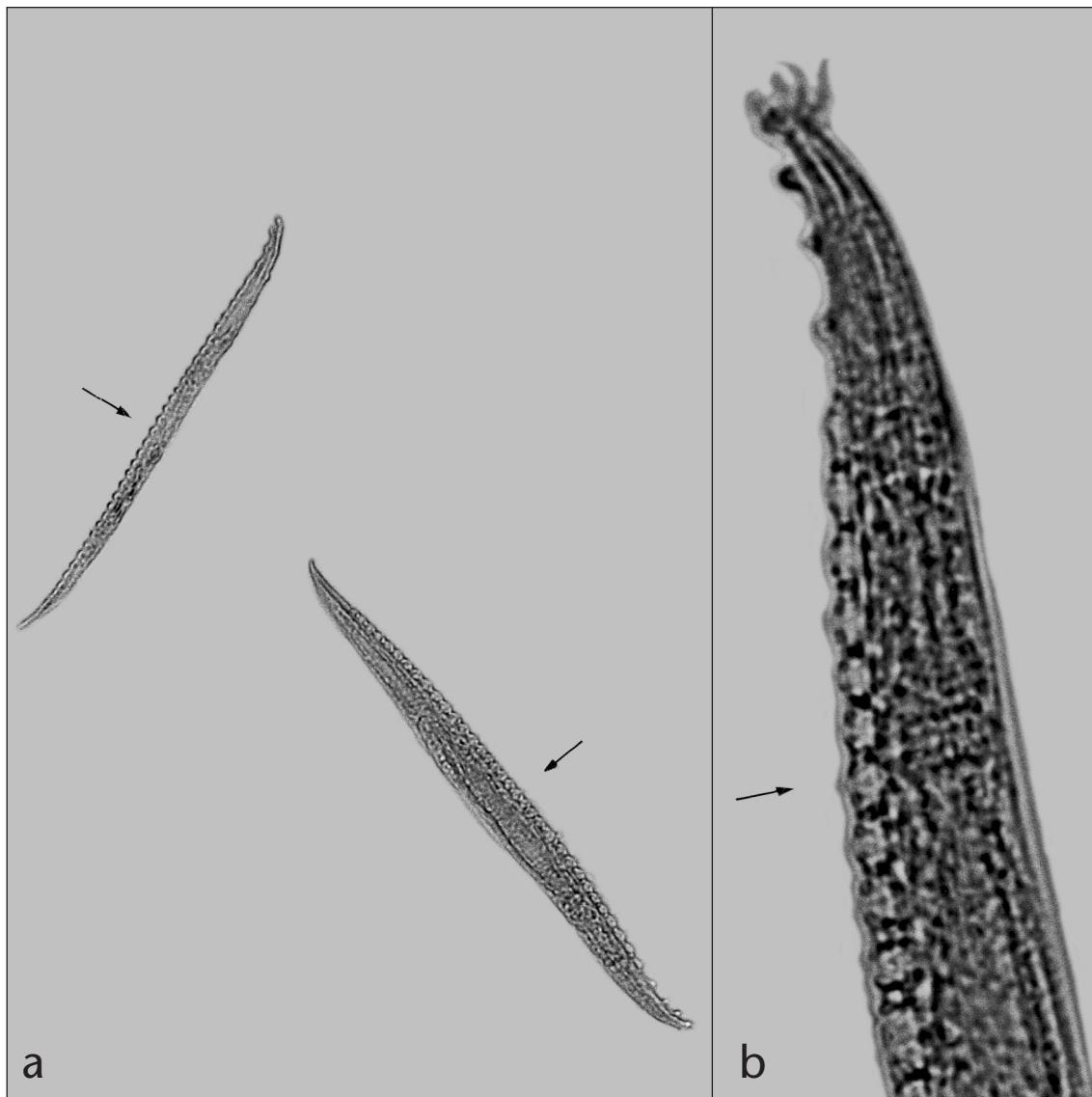


Fig. 37. *Bunonema* sp.:

(a) two females, with wart-like ornamentations on one side (arrows) (x400);

(b) anterior region of female with large bristles on head and wart-like ornamentations on one side (arrow) (x1600).

Figures

Fig. 38. *Panagrolaimus* sp.:

(a) anterior end: walls of mouth cavity (stoma) formed of fused rhabdions (heavy dark shading);

(b) oesophageal region showing the panagrolaimoid type of oesophagus.

(a) after Heyns (1971: p. 32),

(b) after Boström (1988: p. 146).

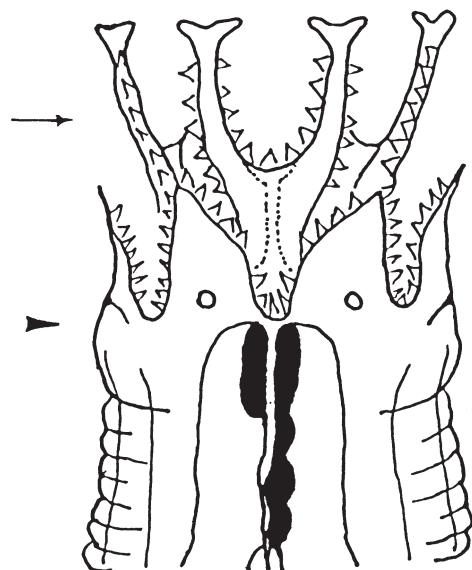
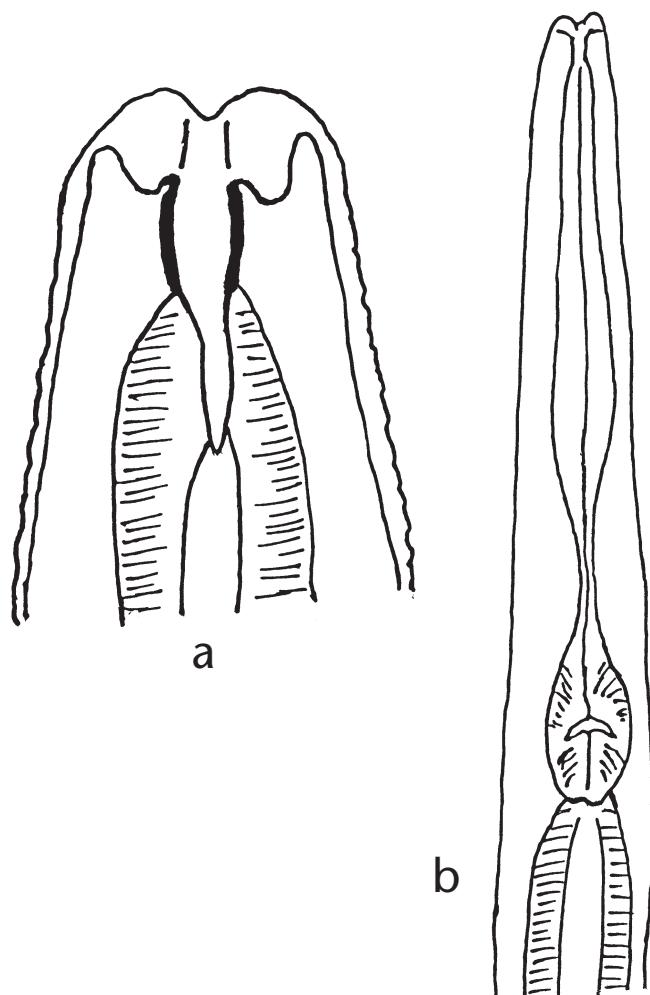


Fig. 39. *Acrobeles complexus*: lateral aspect of head region showing inner circlet of labial (arrow) and outer circlet of cephalic (arrowhead) probolae; rhabdions of wall of mouth cavity (stoma) are shown by heavy dark shading. After Sasser & Jenkins (1960: p.153).



Fig. 40. *Acrobeloides manus*: female with egg in uterus (x160).

Figures

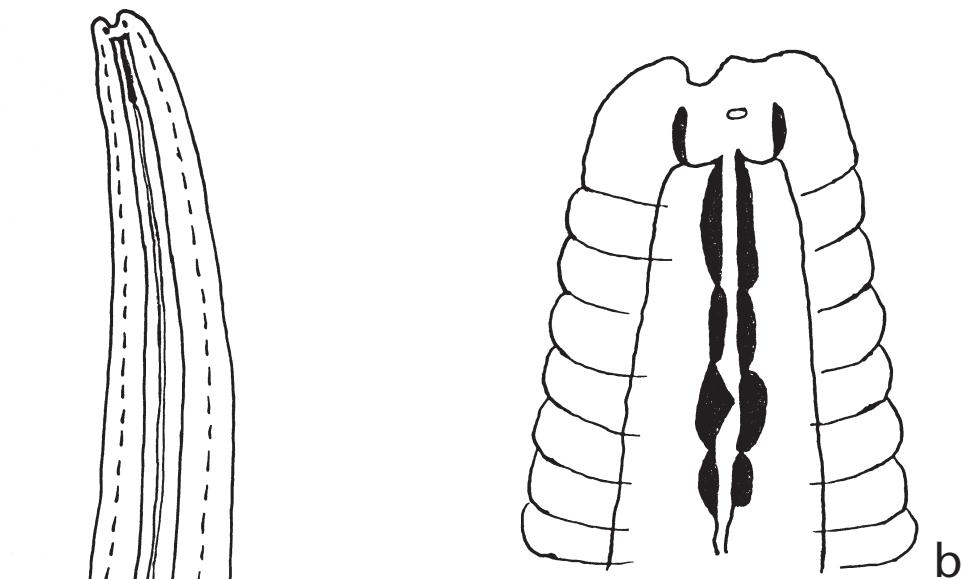


Fig. 41. *Cephalobus persegnis*:

(a) oesophageal region;

(b) head end: rhabdions of wall of mouth cavity (stoma) are shown by heavy dark shading.

After Goodey (1963: p. 273).

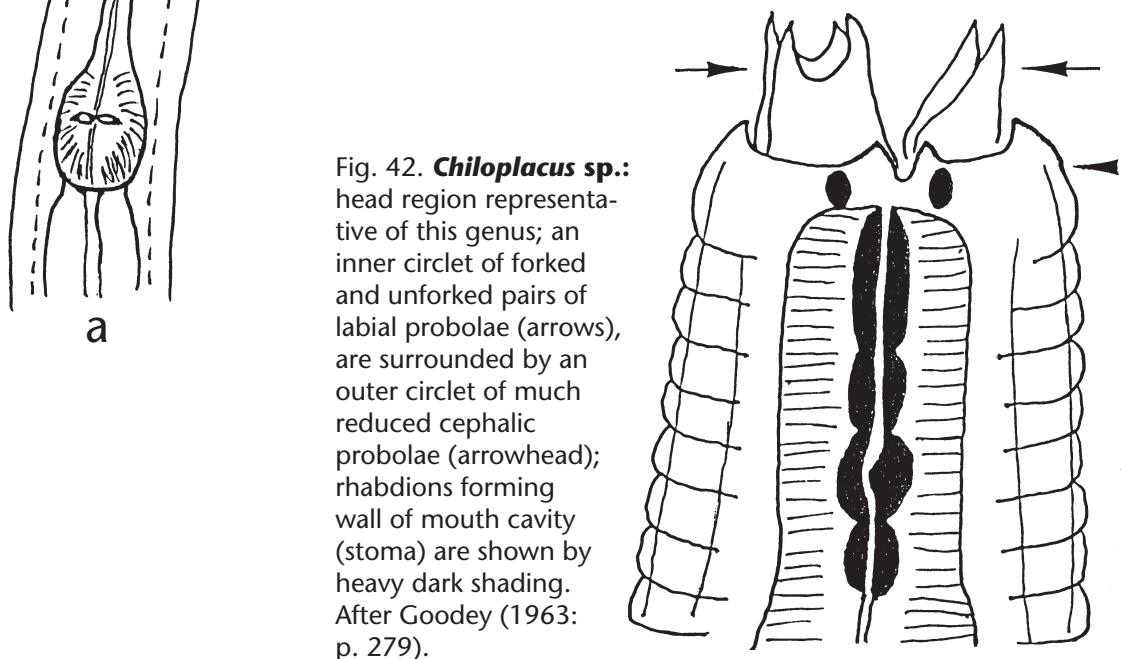


Fig. 42. *Chiloplacus* sp.:

head region representative of this genus; an inner circlet of forked and unforked pairs of labial probolae (arrows), are surrounded by an outer circlet of much reduced cephalic probolae (arrowhead); rhabdions forming wall of mouth cavity (stoma) are shown by heavy dark shading.
After Goodey (1963: p. 279).

Fig. 43. *Psilenchus* sp.:

(a) oesophageal region; (b) tail region: tail tip clavate. After Sasser & Jenkins (1960: p.173).

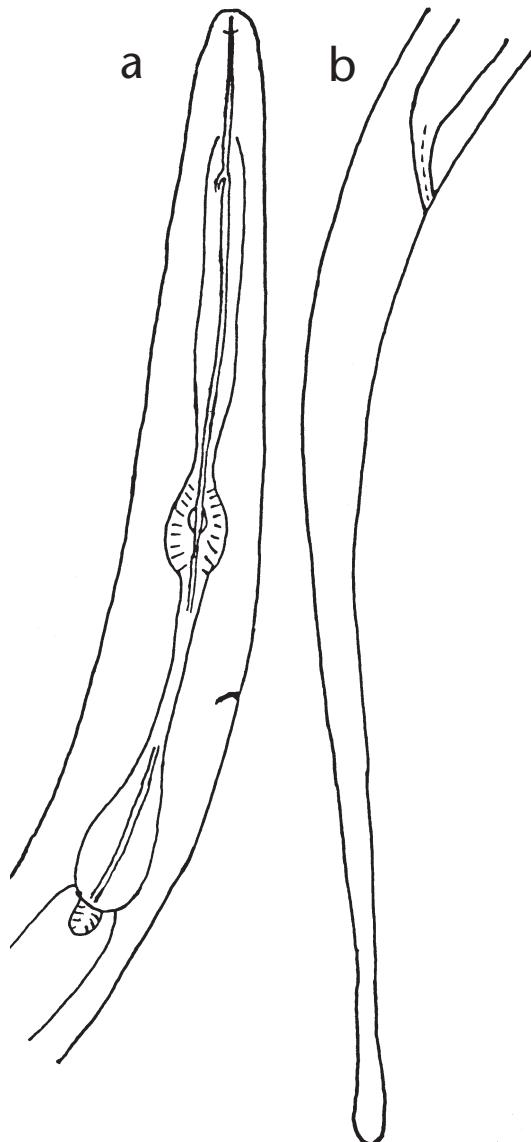
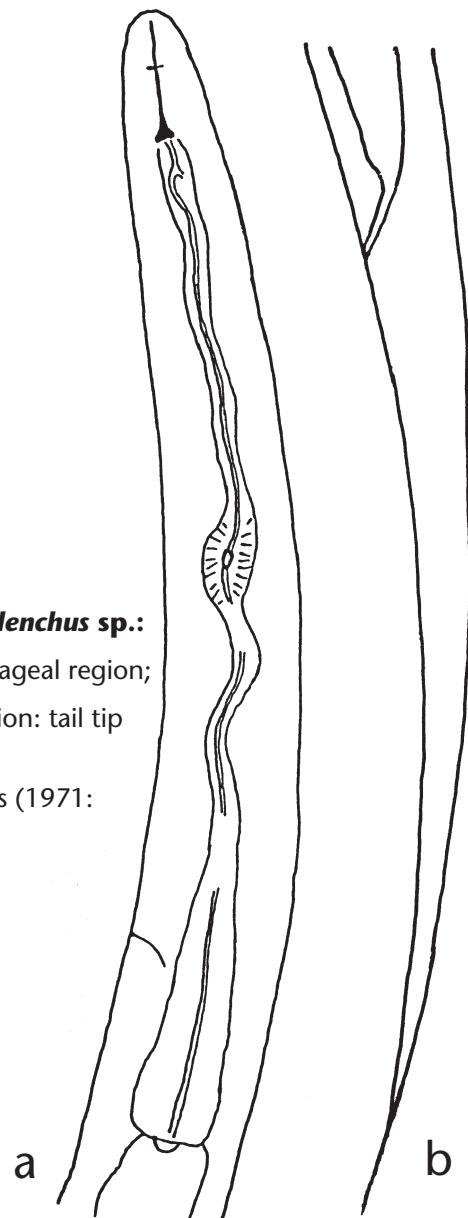


Fig. 44. *Tylenchus* sp.:

(a) oesophageal region;
(b) tail region: tail tip pointed.

After Heyns (1971:
p. 60).



Figures

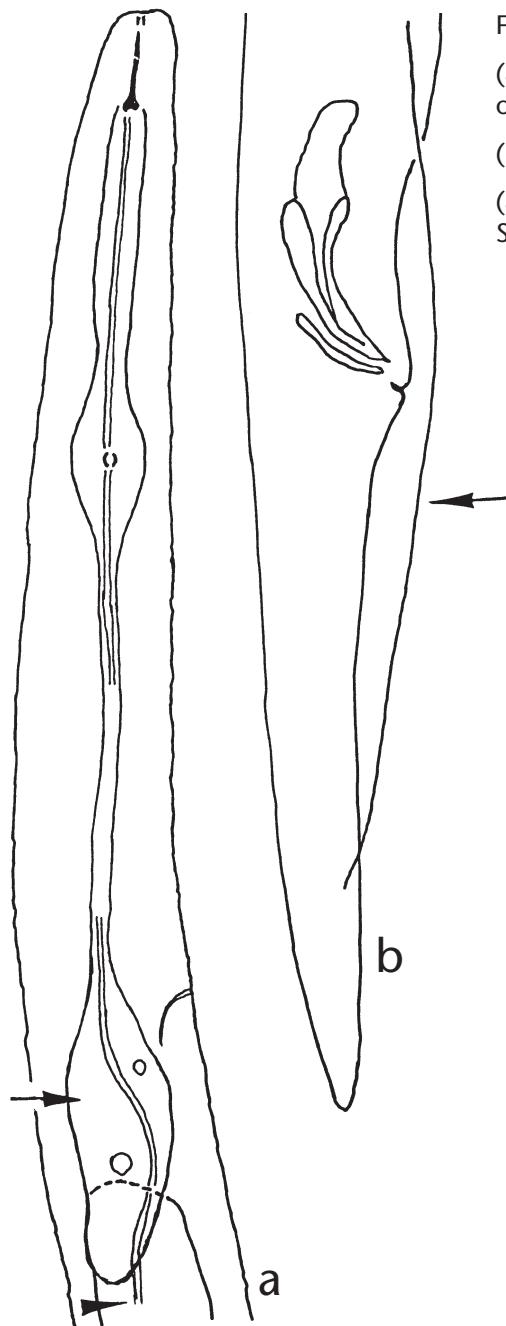


Fig. 45. *Ditylenchus myceliophagus*:

- (a) anterior region: oesophageal gland (arrow) overlaps intestine (arrowhead);
- (b) male tail end, with leptoderan-type bursa (arrow).
- (a) after Brzeski (1991: p. 37), (b) after Hooper & Southey (1978: p. 88).

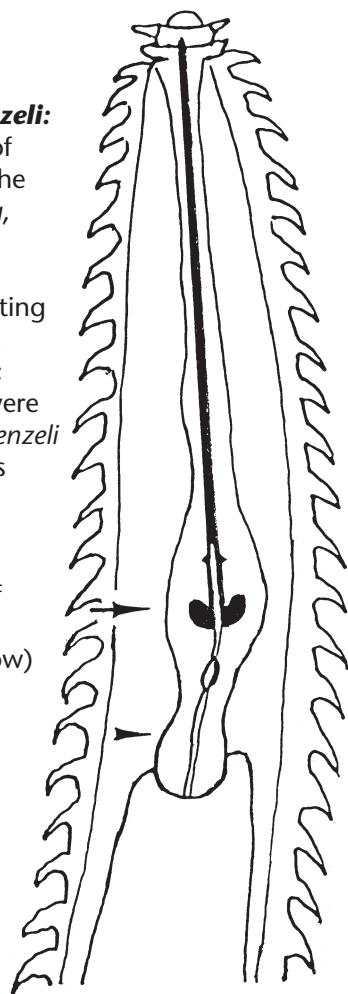


Fig. 46.

***Criconema menzeli*:**

in this diagram of anterior end of the genus *Criconema*, coarse cuticular annules bearing backwardly pointing extensions and a stylet are shown; our specimens were considered *C. menzeli* since a stylet was not observed; oesophagus is degenerate by amalgamation of procorpus and metacarpus (arrow) and reduction of isthmus and basal bulb together to form a short cylinder (arrowhead). After Goodey (1963: p. 102).

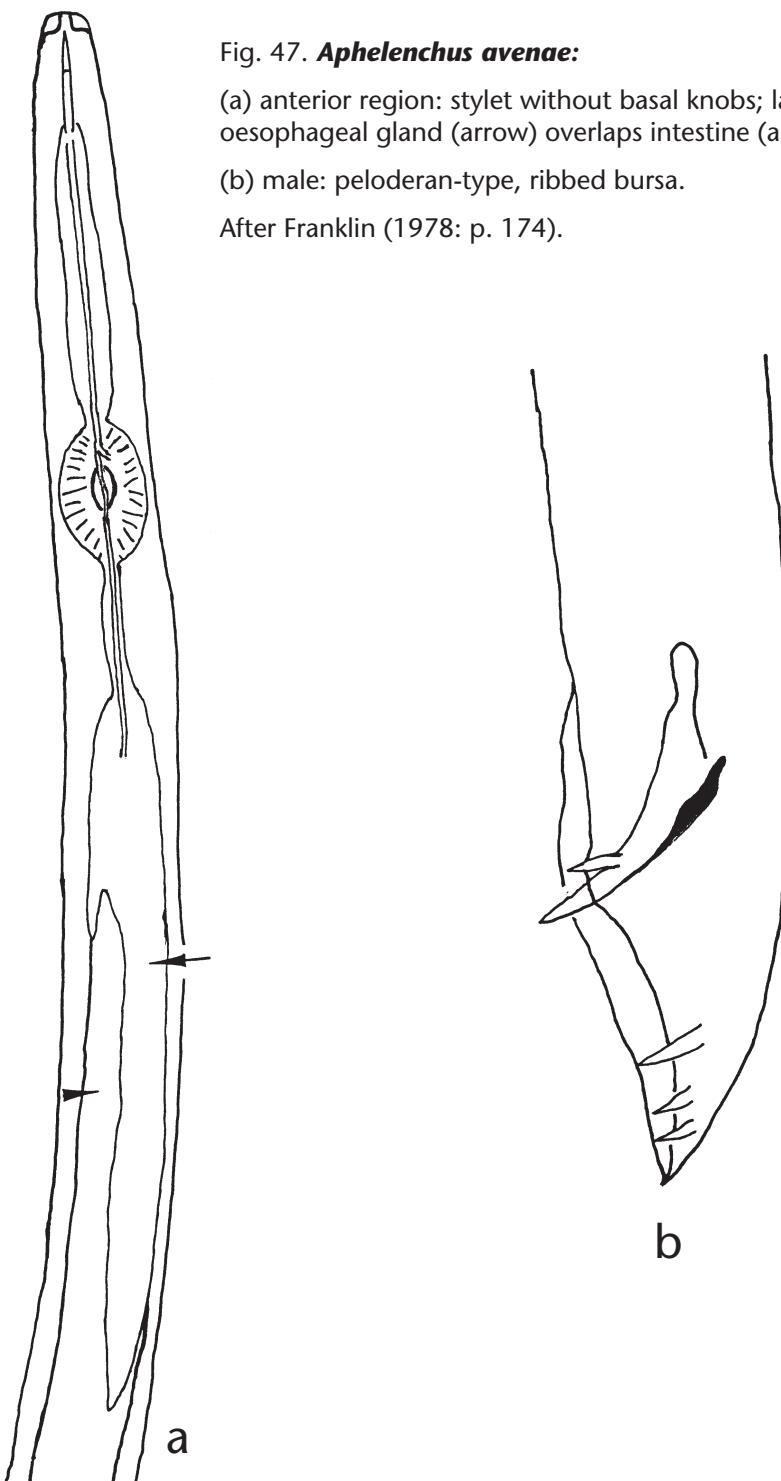


Fig. 47. *Aphelenchus avenae*:

- (a) anterior region: stylet without basal knobs; large oesophageal gland (arrow) overlaps intestine (arrowhead);
- (b) male: peloderan-type, ribbed bursa.

After Franklin (1978: p. 174).

Figures

