Biology and Taxonomy of Nematode Parasites and Associates of Bark Beetles in the United States

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by

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SUMMARY

Bark beetles are the most important insect pests of forest trees in the United States. Nematodes are one of many biotic factors affecting bark beetle populations.

Research into methods for controlling bark beetle populations is mostly centered on manipulation of beetle environment through silvicultural or biological control. Nematodes are one of the major biotic factors affecting bark beetle populations. For the most part, life histories of the parasites are synchronized with their host. Adult parasites are usually produced in adult beetles. Many of the parasites sterilize their host. It may be possible to sterilize one or both sexes of a given beetle population by the planned introduction of infested beetles, or by altering the life history of a parasite so that mature nematodes are produced in immature beetles. In the laboratory, *Contortylenchus reversus*, parasitizing host larvae growing under stress, develop to maturity within the larvae and cause its death.

Egg galleries of beetles infected with nematodes may be used in biological evaluations of beetle infestations. *Scolytus ventralis* infestations can be evaluated simply by the presence or absence of short galleries produced by infected beetles.

This publication includes descriptions and drawings of 32 parasites and 112 associates, many of which are new to science. It also summarizes available information on the biology and ecology of nematode parasites, and includes a historical review of parasite study, a discussion of research problems, a list of parasites according to beetle species, and an index to the genera.

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BIOLOGY AND TAXONOMY OF NEMATODE PARASITES AND ASSOCIATES OF BARK BEETLES IN THE UNITED STATES

by

Calvin L. Massey [1]

INTRODUCTION

Bark beetles are the most important insect pests of forest trees in the United States. Mortality caused by beetles exceeds that of all other natural agents combined, including fire.

Many of our most important bark beetle species are cyclical in nature in that the pests remain endemic until a combination of factors favorable to their development occurs; then populations expand rapidly. Millions of board feet of valuable timber are destroyed in a relatively short period. *Dendroctonus rufipennis* (Kby.), a pest of Engelmann spruce; *Dendroctonus ponderosae* Hopk., a pest of ponderosa and lodgepole pine; *Dendroctonus frontalis* Zimm., a pest of southern pines; and *Dendroctonus adjunctus* Bland., a pest of ponderosa pine in the Southwest, are prime examples of such species.

Research into methods by which bark beetle populations can be held in check is for the most part pointed toward the manipulation of beetle environment, either through the host tree, i.e. silvicultural control; through factors which are concerned primarily with the insect, i.e. biological control; or both.

Although little is known of factors responsible for the rise and decline of bark beetle populations, nematodes are thought to be one of the major biotic factors. Of considerable importance are nematodes belonging to the superfamily Neotylenchoidea, including the genera *Parasitylenchus, Contortylenchus, Sphaerularia,* and *Allantonema.*

The purpose of this volume is to bring together the information available on the biology, ecology, life history, and taxonomy of nematode parasites. In addition, a discussion of research methods and possibilities is presented, and an index to the genera is provided.

The line drawings in the text are designed to provide diagnostic characteristics of the respective nematode species. Scales to illustrate size of most of the drawings were determined by the author. Study material was not available for a few species and the reader is encouraged to determine the size from the text description. The information presented here should provide a basis for extensive research on all factors affecting the ecology of the beetles.

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HISTORICAL REVIEW

The study of nematode parasites of bark beetles originated in Europe. One of the earliest papers on this group of animals and their relationship to bark beetles was published in 1890 by von Linstow. He identified *Contortylenchus diplogaster* (Linstow, 1890) Rühm, 1956, the type species of *Contortylenchus,* as *Allantonema diplogaster* Linstow, 1890; the host was *Tomicus typographus=Ips typographus* L. In his paper, he appears to have misidentified a diplogasterid as the free-living sexual forms of the parasite. Roux (1906) recovered *Anguillonema xylebori* (Roux, 1906), Rühm, 1955 (*Tylenchus xylebori* Roux, 1906) from the tunnels of *Xyleborus saxesensi* Ratz.

Probably the most comprehensive work in the field of bark beetle nematode relationships was initiated by Fuchs (1915) who studied the nematode parasites of *Ips typographus* and *Hylobius abietis* L. Two internal parasites and eight associates, some of which were phoretics, were described. His publications, many of which are landmarks in the field, continued through 1938. Some major taxonomic designations in both the superfamilies Aphelenchoidea and Tylenchoidea were directly affected by his investigations. His studies indicated that nematodes (1) killed or weakened bark beetles, (2) reduced egg-laying in beetles by 40 percent, and (3) prevented multiple generations in a given year.

J. N. Oldham (1930), a British scientist, published on a nematode parasite of *Scolytus multistriatus* (Marsh) and *Scolytus scolytus* F. He observed that approximately 60 percent of the beetle population was infested with a species of *Parasitylenchus* of which 40 percent were sterilized.

Yatsenkowsky (1924), in Russia, noted that bark beetles infected with small numbers of nematodes were castrated; those with larger numbers were killed. More recently, Rühm (1956) made a comprehensive study of the nematode parasites and associates of bark beetles in Germany. He discussed the effect of environment on nematodes' life histories and effect on their hosts. In the study, he described 10 new internal parasites and 50 new associates.

Of considerable interest is the work of Prosper Bovien (1937), a Belgian studying nematode parasites of a large group of coleopterous insects, Psychodids and Diptera. He hypothesized that nematodes infesting the gut of wood-eating insects were in a transitional stage between phoresis and true parasitism.

Two Russian nematologists, S. L. Lazarevskaya (1965) and A. Slankis (1967), have published papers of note during the past decade. The first published on associated insects, Slankis on internal nematode parasites belonging to the genera *Contortylenchus* and *Parasitylenchus.*

The study of nematodes and their relation to bark beetles is of rather recent origin in North America. Thorne (1935) published on the nematode parasites and associates of the mountain pine beetle, *Dendroctonus ponderosae* Hopk., and Nickle (1963) has published on the taxonomy and life history of several species of *Contortylenchus.* Reid (1958) noted several nematode associates of the mountain pine beetle and determined that an internal nematode parasite, *Sphaerularia hastata* Khan 1957, drastically affected the egg production of infested females.

Other studies of considerable importance, while not directly related to parasites and associates of bark beetles, are noteworthy in that they concern groups of nematodes that are parasitic in or associated with the insects. Wülker (1923) made an extensive study of the development of *Allantonema.* Wachek (1955) reviewed nematode genera of the superfamily Tylenchoidea known to be parasitic in insects, many of these genera being parasitic in bark beetles.

MATERIALS AND METHODS

To determine the nematode parasites and associates of a given bark beetle species, beetles were collected nationwide. Beetles collected in distant areas were shipped by airmail, special delivery, to the Forest Insect Laboratory at Albuquerque and stored at 40°F until they could be examined. All stages of beetles were dissected in physiological saline solution and examined for internal nematode parasites. The saline solution prevents bursting of the parasites when removed from the body cavity of the host. The bark from which they were collected was soaked in water for 24 hours, the residues screened, and the free-living forms of the parasites and associated nematodes were retrieved by the Baermann funnel technique developed by Christie and Perry (1951).

Nematodes were processed for species determination by the following method: fixation in FAA for 24 hours. The FAA is composed of: distilled water—120 cc, ethyl alcohol (95 percent)—60 cc, formaldehyde solution (36.6 percent) 18 cc, glacial acetic acid—3 cc, and glycerin--2 cc. Specimens were then processed to pure glycerin by placing them in a solution of 20 percent ethyl alcohol, 1 percent glycerin contained separately in a saturated atmosphere of 95 percent ethyl alcohol for 24 hours. The nematodes were then removed from the resulting solution and placed in 95 percent ethyl alcohol and 5 percent glycerin and allowed to remain until the solution had evaporated to pure glycerin. Glycerin mounts were then made and the nematodes were established in a permanent collection at the Rocky Mountain Forest and Range Experiment Station.

Life history studies were for the most part conducted in the laboratory. To determine life history and effect of the parasite on the host, pairs of beetles were usually introduced into their plant host material (wood bolts or slabs) which were enclosed in individual containers. These were opened at periodic intervals, and numbers of progeny produced by infested female beetles were compared to those produced by noninfested beetles. Free-living stages of the nematode parasites were obtained by washing the nematodes from egg and larval galleries made by the infested females. Life histories of the parasites were determined by examining the immature stages of the beetles at intervals from the time of egg deposition to adulthood. This was accomplished by examining progeny from pairs of beetles in series. Habits of the nematodes were also determined by placing individual infested larvae in vials containing fresh phloem and following the development of host and parasite daily. Percentage of infested beetles in a given population was determined by direct examination following dissection.

Nematode measurements preceding each description were derived in the following manner:

a = Total length divided by greatest width
b = Total length divided by neck length
c = Total length divided by tail length
v = Position of vulva in relation to total body length.

Measurements include ranges for the most part, only when variations were distinctly observable.

BIOLOGY OF PARASITES

Life History

Most nematode parasites of bark beetles are obligate parasites, and, with few exceptions, all are true parasites and do not kill their host. None except *Parasitorhabditis* and the occasionally parasitic *Ektaphelenchus* are capable of completing an individual generation in a free-living state.

In general, the life histories of nematodes belonging to the superfamily Neotylenchoidea infecting bark beetles are the same. The life history of parasites belonging to the genus *Parasitylenchus* is the same as that of the genus *Contortylenchus,* with the exception that members of the genus *Parasitylenchus* are ovoviviparous, and *Contortylenchus* oviparous.

Immature forms of the nematode parasites are deposited in egg galleries by infested beetles. Males develop to maturity in egg galleries and impregnate immature free-living females. Impregnated females immediately penetrate through the cuticle into the body cavity of the host, usually a first or second stage host larva, although older larvae may also become infected. Infection of late stage larvae seems to be dependent on the time of nematode deposition by infected host adults.

The development of the parasite is in general synchronized with its host, parasitic females reaching sexual maturity when the host beetle has attained the same stage of development (fig. 1). Eggs or larvae are then deposited in the body cavity of the host, the young larvae penetrate the gut and are deposited in the egg gallery of the host with the fecal material to complete the generation. The number of generations produced per year by the parasite under normal conditions is the same as for the host. *Contortylenchus elongatus* (Massey, 1960) Nickle, 1963 has three and a partial generation when infecting *Ips confusus* (Lec.) under field conditions. The same nematode will produce as many as 12 generations per year when reared in the insect under controlled laboratory conditions. *Contortylenchus reversus* (Thorne, 1935) Rühm, 1956 may take as long as 2 years to complete its development in the spruce beetle, *Dendroctonus rufipennis,* a bark beetle which in general requires 2 years to complete a generation.

The life history of *Contortylenchus* can be altered under certain conditions of stress. Life history studies conducted in the laboratory reveal that, when host larvae are reared under abnormal nutritional conditions, development of the parasite may be changed. Twenty-five larvae of *D. rufipennis* infested with *C. reversus* were reared on partially dried phloem. Ten of the larvae were killed by accelerated development of the nematode, which produced young in the body cavity of its host. Under these conditions, individual host larvae may be reinfected by infective-stage females which they have deposited.

Studies indicate that free-living forms persist for only a short time in the gallery of the host, and that a greater proportion of the host may be infected when the immature forms of the parasite are deposited in the gallery while host eggs are hatching. Infective-stage females are nonselective. As many as 75 developing parasitic females of *Contortylenchus reversus* have been found in one half-grown larva (fig. 2) while other individuals of the same brood were not yet infected. Multiple infections are common. The average number of parasitic females in a study involving 20 adult *D. rufipennis* infested with *C. reversus* ranged between 1 and 20 and averaged 5.5. The deposition of masses of infective-stage females and developing males in the egg galleries is probably the determining factor.

An individual bark beetle may be infected with more than one genus or species of parasitic females. Individual *Scolytus ventralis* Lec. are commonly infected with *Parasitylenchus elongatus* Massey, 1958 and *Parasitylenchus scrutillus* Massey, 1964. Massey (1956) found that 2 percent of the adult *D. rufipennis* ex-

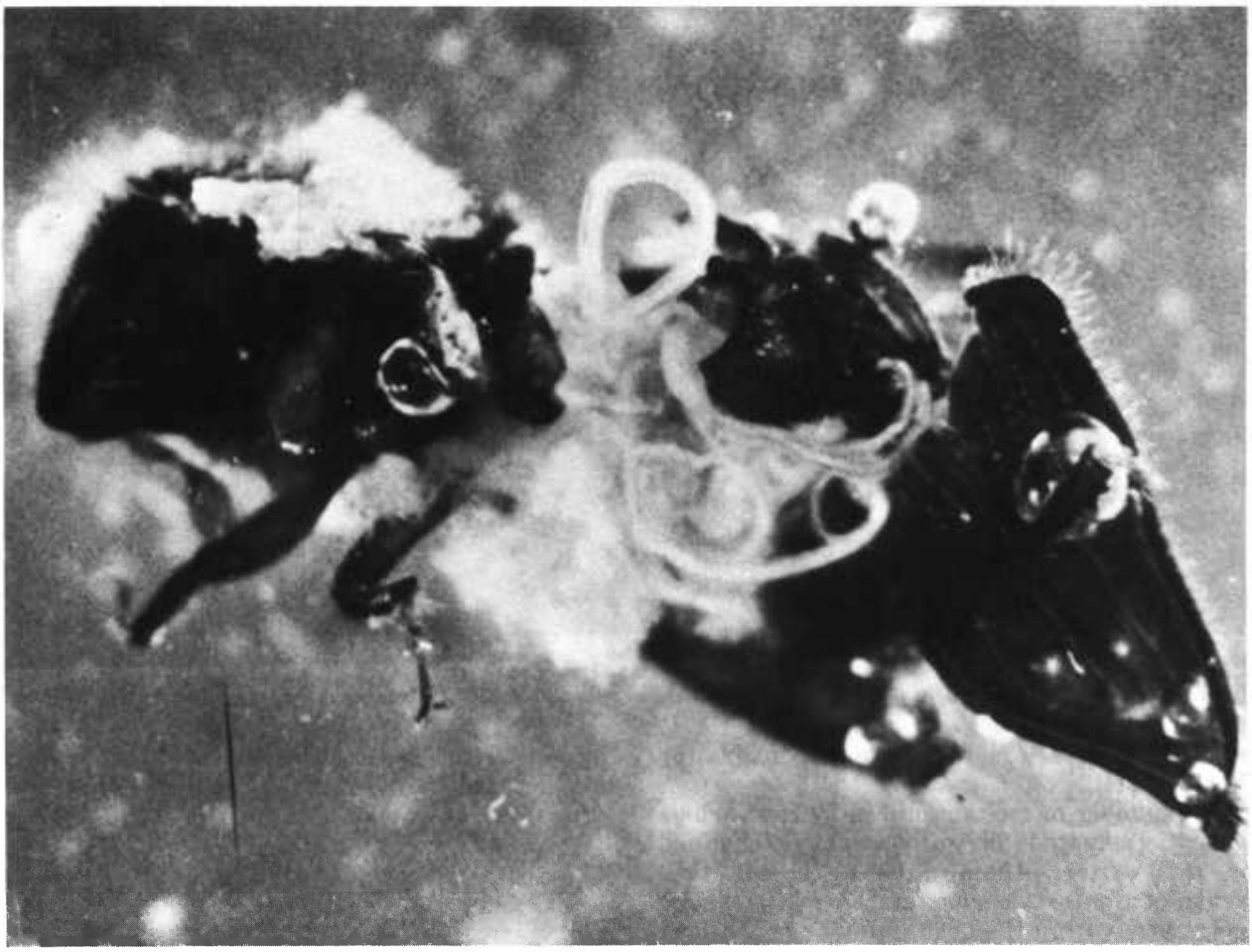

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Figure 1.—*Ips confusus* infected with adults of *Contortylenchus elongatus*.

amined were infected with both *C. reversus* and *Sphaerularia dendroctoni* Massey, 1956 (fig. 3). The same two nematodes have been recovered from individuals of *D. pseudotsugae* Furniss (1967).

Although the life history of *Sphaerularia dendroctoni* is little known, examination of parasitic larvae from the body cavity of adult beetles suggests that it may vary from the typical life cycle of *Parasitylenchus* and *Contortylenchus*. Males attain sexual maturity within the body cavity of the host. The significance of this is not known. Members of the genus *Polymorphotylenchus* also produce sexually mature males in the body cavity of their host and the life cycle proceeds in the same manner as members of the genus *Parasitylenchus*. Whether this will prove to be the case with *S. dendroctoni* remains to be determined.

The life cycle of *Allantonema*, the other important bark beetle parasite, was not studied. It appears to be relatively rare in the United States. Two species have been collected, one from *Orthotomicus ornatus* Sw., the other from *Hylastes* sp., both in New Mexico. Rühm (1956) states that *Allantonema morosum* (Fuchs, 1929) Filipjev, 1934, a parasite of *Hylastes ater* Payk, has a life cycle similar to *Parasitylenchus* and *Contortylenchus*, with the exception that larvae and eggs are produced in the immature stages of the host and are subsequently deposited in the galleries. Rühm also notes that *A. morosum* is the only member of this genus in which such a habit has been reported. His studies were cursory, and it is

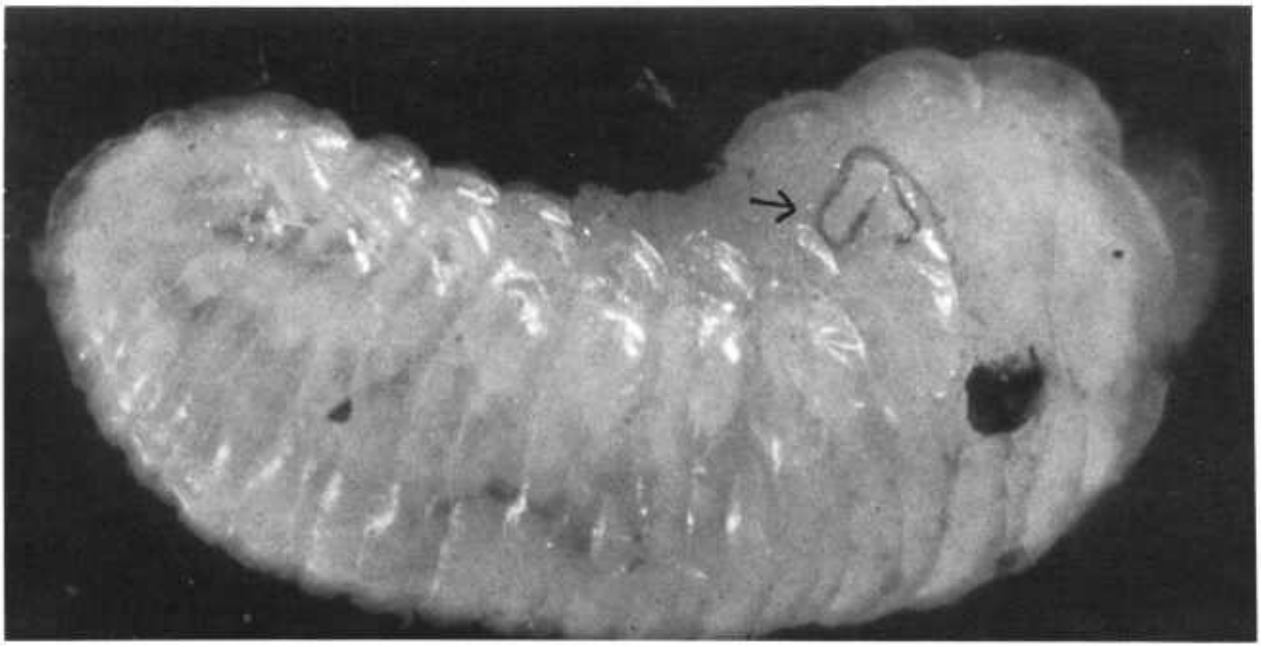

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Figure 2.—Larva of *Ips confusus* with juvenile female of *Contortylenchus elongatus* immediately beneath cuticle.

possible that other factors were responsible for the deviation.

The number of molts required by the various parasitic nematode larvae was not determined by the writer. Rühm (1956) reports that larvae of *Contortylenchus* and *Parasitylenchus* molt twice within the host and once in the host gallery.

The life history of three nematode parasites occurring in the United States—*Parasitylenchus elongatus,* a parasite of *Scolytus ventralis; Contortylenchus elongatus,* a parasite of *Ips confusus* and *Ips lecontei* Sw.; and *Parasitaphelenchus dendroctoni* Massey 1966, a parasite of *Dendroctonus adjunctus* Bland.—are herein presented as typical examples of the development of nematode parasites of bark beetles.

Parasitylenchus elongatus: Infective-stage larvae, approximately 1.0 mm in length, are impregnated by sexually mature males in egg galleries of the host. These impregnated females penetrate the cuticle or the oral or anal opening, and enter the body cavities of larvae which are approximately one-third grown. They also have been recovered from nearly mature larvae indicating that infective-stage females are deposited over a considerable period of time or that infective-stage females migrate from newly formed egg galleries to infect larvae from adjacent larval galleries. Development in general proceeds with the growth of the host:

Host development	Nematody body length (mm)	
	Range	Mean
Larvae		
⅓ grown	1.0–3.4	1.6
½ grown	1.0–4.4	2.5
¾ grown	1.0–5.9	4.1
Pupae	3.4–6.9	4.6
Mature adults	4.3–7.6	6.2

After the nematodes enter their host, the lip region degenerates rapidly and the stylet becomes nonfunctional and displaced, and food apparently is absorbed through the body wall of the parasite.

Although the parasite approaches its mature length in the host pupal stage, young are produced only in the adult beetle. Eggs are hatched in the uterus and the parasite gives birth to living young. Mature nemas are little more than egg sacs. Ovary walls are not discernible and the body cavity is filled with eggs and first-instar larvae.

Host infections are generally multiple. Up to eight individual parasites have been recovered from the body cavity of an infected host larva.

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Figure 3.—Adults, eggs, and larvae of *Contortylenchus reversus* and *Sphaerularia dendroctoni* from the body cavity of adult *Dendroctonus rufipennis*.

The body cavity of an infected adult beetle can be packed with living larvae, approximately 2,500 having been counted from one individual. The nema larvae penetrate the gut of the host and are deposited with the feces in the egg galleries within 10 days after beetle attack.

Infective-stage larvae travel considerable distances to infect host larvae produced by nematode-free beetles. In the laboratory they were collected up to 3 inches from the place of original deposition; evidence indicates that they are capable of traveling twice that distance.

Male parasites occur only in the egg gallery of the host where they fertilize the infective-stage females. The life cycle in the laboratory is completed in approximately 2 months at a temperature of 24°C and a relative humidity of 70 percent. Under field conditions, there is one generation annually.

Contortylenchus elongatus: Infective-stage females are approximately 0.7 mm in length and are impregnated by sexually mature males in the egg galleries of the host. The impregnated females are thought to penetrate the cuticle or oral or anal opening, and enter the body cavity of the host. They usually enter second- or third-instar larvae, although all immature stages may be infected. Development progresses with the development of the insect. Eggs are deposited only in the abdominal cavity of the host. Upon hatching, the nema larvae penetrate the gut and are passed into the egg gallery with the fecal material throughout the egg-laying period of the adult beetle beginning as early as 4 days after beetle attack and as late as 12 days. The nematodes apparently molt twice in the galleries before the sexual characters of the male are observed.

According to Nickle (1963), the nematode larva molts once in the egg and hatches in the

body of the insect as a second-stage larva. It is deposited as a fourth-stage larva in the egg gallery, then molts once more.

Development within the host is rapid:

Host development	Nematode body length (mm)	
	Range	Mean
Larvae		
⅓–½ grown	0.7–0.9	0.8
¾ grown	.9–3.0	2.4
Pupae	.9–3.8	2.4
Mature adults	2.1–6.3	4.3

Head characteristics change immediately after the nema larva has entered the body cavity of the host and the body broadens and elongates.

Young females are often found in the body cavity of insect pupae, with fully developed eggs in the uterus. Under normal conditions, however, no eggs have been found in pupae. Nematode eggs are found immediately after the host has attained adulthood and these eggs hatch immediately after deposition. As with *Parasitylenchus elongatus,* the body cavity of infected beetles is filled with adults and larvae of the parasite; the maximum number of larvae and eggs observed in an individual beetle was 5,775, the maximum number per parasite was 1,375. Because the parasites deposit eggs continuously, the exact number of individuals produced is not known.

The life cycle of *C. elongatus* may vary from 4 weeks to 8 months depending upon the generation of beetles infested. During the summer months, development is complete in approximately 4 weeks while in the overwintering generation, development is not completed for 8 months. Under laboratory conditions, the parasites developed from egg to adult in 23 days.

Internal parasitism of bark beetles by members of the superfamily Aphelenchoidea is confined exclusively to two genera, *Parasitaphelenchus* and *Ektaphelenchus.* Internal parasitism by the latter appears to be accidental and occurs rarely. Members of this genus are typically phoretics, and are carried in small cocoons beneath the wing covers of adult beetles.

Members of the genus *Parasitaphelenchus* are obligate parasites of bark beetles. Little is known of their life history. Of the species occurring in the United States, the biology of *Parasitaphelenchus dendroctoni* Massey 1966, a parasite of *Dendroctonus adjunctus,* is best documented. The nematode has a single generation each year. It is a dimorphic species, the free-living form bearing little resemblance to the parasitic form. Free-living forms may be found in egg galleries of *D. adjunctus* in October and in May of the following year. Since the free-living form is comparatively short-lived, individuals found in the egg galleries in May probably overwintered as parasites within the host.

Free-living females deposit eggs in the host egg gallery where the larvae hatch, enter the beetle, and develop as the beetle develops. Infections are multiple; as many of 25 nematodes have been found in one beetle. Effects on the host are not known but observations indicate that infection may not be detrimental unless a large number of parasites enter a single individual. Young nematodes are not produced within the body cavity of the insect. Sex of parasitic, immature forms could not be determined. Parasitic larvae reenter the gut and are deposited in the egg gallery where they become sexually mature.

Rühm (1956), in discussing the life history of members of the genus *Parasitaphelenchus,* notes that after entering a host larva, the nematode molts only once. It molts again in the egg gallery before sexual maturity is attained. The second molt is accompanied by considerable stretching of the entire body. Rühm notes that sexual development is more advanced in males than in females and that the number of females exceeds the number of males. Nematode larvae produced from eggs within the gallery molt twice before entering their host.

In the superfamily Rhabditoidea, one genus, *Parasitorhabditis,* is an internal parasite of bark beetles. The immature nematodes are usually found parasitic in the gut of various species of scolytids in the United States. Adults are abundantly associated in the galleries with most bark beetle species.

A *Parasitorhabditis* sp. associated with *D. rufipennis* has been easily reared on malt agar. Rühm (1956) records *Parasitorhabditis piniperda* (Fuchs, 1937) Rühm 1954 as a parasite in the body cavity of *Myelophilus piniperda* L., where its mode of infection and parasitic characteristics appear to be similar to that of *Parasitaphelenchus.* The nematode larvae, however, infest only the cavity of immature stages of the beetle. Hunt and Poinar (1971) have success-

fully reared several generations of an undescribed *Parasitorhabditis* from *Dendroctonus valens* Lec. on sporulating cultures of *Ceratocystis minor* (Hedg.) Hunt. Their research indicates that at least some species of the genus can reproduce satisfactorily without passing through an insect host.

Percentage of Various Bark Beetle Species Infected by Internal Nematode Parasites

The percentage of individual bark beetles of a species infected by internal nematode parasites are quite variable. Only two scolytids which have been examined in large numbers have been without them. They are *Dryocoetes confusus* and *Ips integer*. The percentages of infected beetles of a given species in given populations may vary from 0 to 90 percent and may fluctuate drastically from year to year. For example, 15 percent of the roundheaded pine beetle, *D. adjunctus*, examined in 1952 were infected with *Parasitaphelenchus dendroctoni;* in 1963, 80 percent of the beetles from the same area were infected. In 1957, 41 percent of *Ips confusus* adults from 17 trees were infected with *C. elongatus*. In 1958, 29 percent of the beetles from the same area were examined and were infected. The number varied considerably from generation to generation. In 1958, 34 percent of generation I was infected compared to 17 percent of generation IV.

Reasons for the variation are not known. Environmental factors, of which moisture probably is the most important, evidently play a large role in determining nematode abundance. Nematode populations are extremely high and varied as to species in bark beetle infested spruce and fir, and are correspondingly low and less varied in ponderosa pine (*Pinus ponderosa* Laws.) and pinyon (*Pinus edulis* Engelm.) where moisture required for survival of the tree is much lower. *Dendroctonus ponderosae* and *Dendroctonus brevicomis* Lec., pests of ponderosa pine, are generally less heavily parasitized by internal nematode parasites than *Dendroctonus rufipennis* and *Scolytus ventralis*, pests of Engelmann spruce (*Picea engelmanni* Parry) and white fir (*Abies concolor* (Gord. and Glend.) Lindl.), respectively.

During studies on various bark beetle species, the numbers infected were recorded when collections were large enough to be meaningful. Table 1 shows the variation in numbers infected within a given bark beetle species, and among the various host genera and species.

Table 1.—*Percentages of various bark beetle species infected with internal nematode parasites*

Bark beetle species	Nematode species	Beetles			Locality	Date
		Examined	Infected			
		Number	*Number*	*Percent*		
Conopthorus coniperda		57	0	0	Hamden, Conn.	1968
Dendroctonus adjunctus	*Parasitylenchus stipatus*	212	123	58	Lincoln NF, N.M.	1962
Dendroctonus adjunctus	*Parasitylenchus stipatus*	212	25	12	Lincoln NF, N.M.	1963
Dendroctonus adjunctus	*Parasitylenchus stipatus*	104	13	12	Lincoln NF, N.M.	1969
Dendroctonus adjunctus	*Parasitylenchus stipatus*	35	23	66	Lincoln NF, N.M.	1970
Dendroctonus adjunctus	*Parasitaphelenchus dendroctoni*	212	32	15	Lincoln NF, N.M.	1962
Dendroctonus adjunctus	*Parasitaphelenchus dendroctoni*	212	170	80	Lincoln NF, N.M.	1963
Dendroctonus adjunctus	*Parasitaphelenchus dendroctoni*	104	72	70	Lincoln NF, N.M.	1969

Table 1. ***Percentages of various bark beetle species infected with internal nematode parasites*— (Continued)**

Bark beetle species	Nematode species	Beetles			Locality	Date
		Examined	Infected			
		Number	*Number*	*Percent*		
Dendroctonus brevicomis	*Contortylenchus brevicomi*	346	10	3	Bandelier Natl. M., N.M.	1958
Dendroctonus frontalis	*Contortylenchus brevicomi*	611	112	18	Talladega NF, Ala.	1954
Dendroctonus frontalis	*Contortylenchus brevicomi*	192	34	18	Jonesville, La.	1969
Dendroctonus frontalis	*Contortylenchus brevicomi*	116	3	2.5	Beaumont, Texas	1969
Dendroctonus frontalis	———	236	0	0	Keysville, Va.	1968
Dendroctonus parellelicollis	———	42	0	0	Santa Fe, N.M.	1957
Dendroctonus ponderosae	*Contortylenchus reversus*	50	1	2.0	Roosevelt NF, Colo.	1971
Dendroctonus pseudotsugae	*Contortylenchus reversus*	296	106	36	Santa Fe NF, N.M.	1959
Dendroctonus pseudotsugae	*Contortylenchus reversus*	541	175	32	Santa Fe NF, N.M.	1960
Dendroctonus pseudotsugae	*Contortylenchus reversus*	323	173	54	Santa Fe NF, N.M.	1961
Dendroctonus pseudotsugae	*Contortylenchus reversus*	136	56	41	Santa Fe NF, N.M.	1962
Dendroctonus pseudotsugae	*Parasitaphelenchus beccus*	301	227	75	Santa Fe NF, N.M.	1959
Dendroctonus pseudotsugae	*Parasitaphelenchus beccus*	542	407	75	Santa Fe NF, N.M.	1960
Dendroctonus pseudotsugae	*Parasitaphelenchus beccus*	323	276	85	Santa Fe NF, N.M.	1961
Dendroctonus pseudotsugae	*Parasitaphelenchus beccus*	174	152	87	Santa Fe NF, N.M.	1962
Dendroctonus rufipennis	*Sphaerularia dendroctoni*	625	66	11	White River NF, Colo.	1952
Dendroctonus rufipennis	*Sphaerularia dendroctoni*	625	221	35	White River NF, Colo.	1953
Dendroctonus rufipennis	*Sphaerularia dendroctoni*	625	6	1.0	Routt NF, Colo.	1952
Dendroctonus rufipennis	*Sphaerularia dendroctoni*	625	35	6.0	Routt NF, Colo.	1953
Dendroctonus rufipennis	*Sphaerularia dendroctoni*	50	1	2.0	Mt. Taylor, N.M.	1965

Table 1. ***Percentages of various bark beetle species infected with internal nematode parasites—*** **(Continued)**

Bark beetle species	Nematode species	Beetles			Locality	Date
		Examined	Infected			
		Number	*Number*	*Percent*		
Dendroctonus rufipennis	*Contortylenchus reversus*	625	53	8.0	White River NF, Colo.	1952
Dendroctonus rufipennis	*Contortylenchus reversus*	625	115	18.4	White River NF, Colo.	1953
Dendroctonus rufipennis	*Contortylenchus reversus*	625	115	18.4	Routt NF, Colo.	1952
Dendroctonus rufipennis	*Contortylenchus reversus*	625	147	23.6	Routt NF, Colo.	1953
Dendroctonus rufipennis	*Contortylenchus reversus*	174	68	39.0	Mt. Taylor, N.M.	1965
Dendroctonus terebrans	———	96	0	0	Oakdale, La.	1970
Dendroctonus terebrans	*Contortylenchus terebranus*	48	4	8	Spurger, Texas	1970
Dendroctonus terebrans	*Contortylenchus terebranus*	38	1	2.6	Nacogdoches, Texas	1970
Dendroctonus valens	*Contortylenchus* sp.	18	7	39.0	Prescott NF, Ariz.	1966
Ips avulsus	*Parasitylenchus avulsi*	83	18	22.0	Talladega NF, Ala.	1954
Ips avulsus	*Parasitylenchus avulsi*	25	5	20.0	Henderson, N.C.	1968
Ips avulsus	*Parasitylenchus avulsi*	66	15	22.7	Oakdale, La.	1969
Ips calligraphus	*Contortylenchus grandicolli*	108	7	6.5	Weed, N.M.	1969
Ips confusus	*Contortylenchus elongatus*	615	254	41.3	Bandelier Nat'l. M., N.M.	1957
Ips confusus	*Contortylenchus elongatus*	568	163	28.7	Bandelier Natl. M., N.M.	1958
Ips cribicollis	*Contortylenchus cribicolli*	50	9	18	Ruidoso, N.M.	1968
Ips grandicollis	*Contortylenchus grandicolli*	36	6	16.7	Beaumont, Texas	1969
Ips grandicollis	*Contortylenchus grandicolli*	83	11	13.3	Oakdale, La.	1969
Ips integer	———	212	0	0	Prescott, Ariz.	1966
Ips knausi	———	50	0	0	Weed, N.M.	1969

Table 1. ***Percentages of various bark beetle species infected with internal nematode parasites*** **(Continued)**

Bark beetle species	Nematode species	Beetles			Locality	Date
		Examined	Infected			
		Number	*Number*	*Percent*		
Ips pilifrons	*Contortylenchus spirus*	78	14	18.0	Red Feather Lakes, Colo.	1966
Ips pini	*Parasitylenchus ipinius*	50	24	48.0	Gorham, Maine	1968
Ips pini	*Parasitylenchus ovarius*	48	2	4.1	Neola, W. Va.	1968
Ips pini	*Contortylenchus spirus*	48	1	2.0	Neola, W. Va.	1968
Ips pini	*Contortylenchus spirus*	50	7	14.0	Gorham, Maine	1968
Hylurgops pinifex	*Parasitylenchus coronatus*	25	15	60.0	Gorham, Maine	1968
Hylurgops pinifex	*Contortylenchus* sp.	25	1	4.0	Gorham, Maine	1968
Hylurgops pinifex	*Parasitylenchus coronatus*	35	8	22.8	Caroline Co., N.Y.	1968
Leperisinus aculeatus	*Parasitylenchus lepersini*	105	3	2.8	Chillicothe, Ohio	1970
Leperisinus aculeatus	———	21	0	0	Bottineau, N.D.	1969
Leperisinus californicus	———	120	0	0	Bottineau, N.D. & Rugby, N.D.	1970
Leperisinus criddlei	———	386	0	0	Rugby, N.D.	1971
Orthotomicus caelatus	*Parasitylenchus oriundus*	92	3	3.2	Freeport, Maine	1968
Phloeosinus dentatus	———	25	0	0	Keysville, Va.	1968
Pityokteines elegans	———	225	0	0	Sandia Mtns., N.M.	1968
Pityogenes carinulatus	———	78	0	0	Sandia Mtns., N.M.	1968
Pityophthorus sp.	*Contortylenchus pityophthori*	53	15	28.3	Neola, W. Va.	1968
Pityophthorus sp.	*Parasitaphelenchus* sp.	35	5	14.3	Hamden, Conn.	1968
Pityophthorus sp.	*Parasitaphelenchus* sp.	100	2	2.0	Coconino NF, Ariz.	1969
Pityophthorus sp.	*Parasitylenchus* sp.	100	1	1.0	Coconino NF, Ariz.	1969
Polygraphus hoppingi	*Parasitylenchus parasitus*	225	7	3.1	Flagstaff, Ariz.	1968

Table 1. ***Percentages of various bark beetle species infected with internal nematode parasites*— (Continued)**

Bark beetle species	Nematode species	Beetles			Locality	Date
		Examined	Infected			
		Number	*Number*	*Percent*		
Pseudohylesinus grandis		167	0	0	Grand Canyon, Ariz.	1968
Pseudopityophthorus pruinosus		50	0	0	Zaleski SF, Ohio	1970
Scolytus muticus		100	0	0	Delaware, Ohio	1970
Scolytus multistriatus		58	0	0	Chillicothe, Ohio	1970
Scolytus multistriatus	*Parasitaphelenchus* sp.	100	17	17	Albuquerque, N.M.	1963
Scolytus ventralis	*Parasitylenchus elongatus*	215	56	26.0	Sandia Mtns., N.M.	1961
Scolytus ventralis	*Parasitylenchus elongatus*	191	46	24.0	Sandia Mtns., N.M.	1962

Effect on Host

In the United States, extensive nematode studies have been made on only a few scolytid species to determine their effect on the beetles they infect. The author's studies have been confined to the effect of *Contortylenchus reversus* and *Sphaerularia dendroctoni* on *Dendroctonus rufipennis; Parasitylenchus elongatus* on *Scolytus ventralis; C. reversus on D. pseudotsugae, C. reversus* and *Parasitylenchus* sp. on *Ips pilifrons;* and *Contortylenchus elongatus* on *Ips confusus* and *I. lecontei.* In addition to these studies, Ashraf (1969) and Ashraf and Berryman (1970) determined the effect of *P. elongatus* on *S. ventralis* and in Canada, Reid (1958) studied the effect of *Sphaerularia hastata* on *D. ponderosae.* While the effect of parasitism has been determined on only a few beetles, it is logical to assume that similar parasites have a similar effect on the various bark beetles from which they have been collected.

The most pronounced effect of internal nematode parasites of bark beetles is in limiting egg production. Massey (1956) showed that female spruce beetles (*D. rufipennis*) infected with *S. dendroctoni* laid an average of 28.8 eggs per female while noninfected females laid an average of 76.5. Male insects did not appear to be adversely affected, although they did carry nematodes and aided in their dissemination. In the same study, it was determined that females infected with *C. reversus* laid about 35 eggs per female while noninfected females laid an average of 65. In this study, it was also determined that 22 percent of the beetle larvae from parents infected with *C. reversus* were also infected.

Massey (1964), reporting on the effect of *P. elongatus* on the fir engraver, noted that unlike other tylenchs parasitizing bark beetles, *P. elongatus* killed its host. Infected females constructed very short galleries, seldom over an inch in length (fig. 4). The beetles died within a short time after larval nematodes were deposited in the galleries. The study showed that no eggs were produced in short galleries made by 39 infected females, and that 29 noninfected females constructed 66 inches of gallery and deposited 21 eggs per inch.

Studies in New Mexico indicate that *P. elongatus* was responsible for the decline of an infestation of the beetle at Ruidoso. A biological evaluation of the infestation shortly before its termination revealed trees in which the majority of the galleries were very short and eggs had not been deposited. Duplicate conditions were produced in the laboratory by inoculating green logs with beetles infected with the parasite. Ashraf (1969) studied the effect of *P. elongatus* in the fir engraver beetle. He

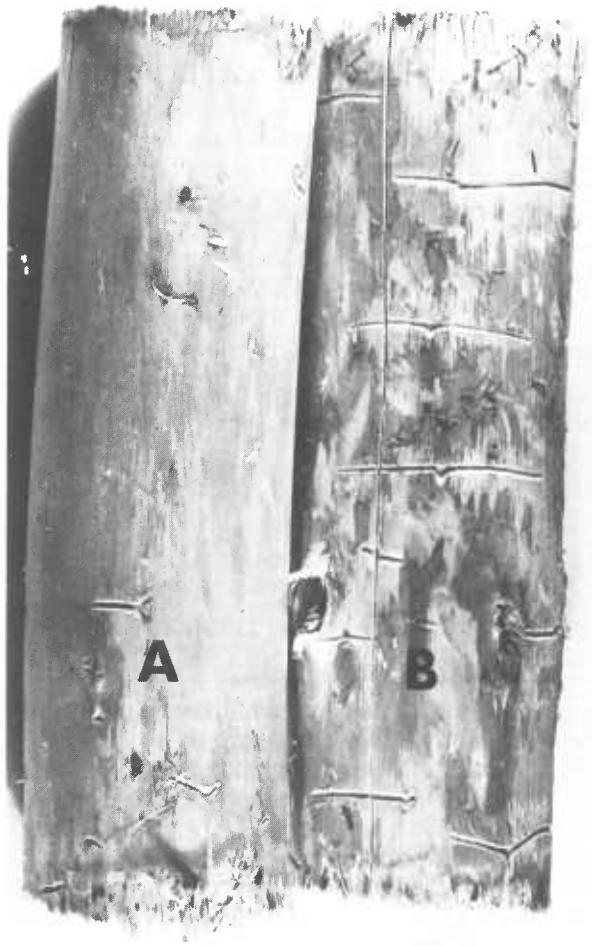

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Figure 4.—*A.* Galleries produced by females of *Scolytus ventralis* infected by *Parasitylenchus elongatus*; *B.* galleries produced by noninfected females.

determined that the nematode caused up to 9 percent egg mortality in *Scolytus ventralis*. Larval parasitism increased over the course of the study and resulted in 1-4 percent larval mortality. Adults were parasitized 63 and 76 percent in 1967 and 1968. Emergence of parasitized adults was delayed. Flight potential of nematode-infected adults was seriously impaired, particularly when parasitism was heavy. Heavy nematode infection sterilized *S. ventralis* females. Ovaries of infected females were rudimentary, while testes of infected males were normal in all except heavily infected individuals.

A study to determine the effect of *C. reversus* on the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk., involved 24 pairs of beetles isolated in green Douglas-fir slabs. Five noninfected females laid an average of 72.2 eggs per gallery, while 9 infected females laid an average of 48.4 eggs per gallery. The average length of egg galleries constructed by noninfected females was 13.8 inches, by infected females, 8.2 inches. The other 10 females died of unknown causes.

Similar studies involving *Ips pilifrons* Sw. infected by *C. reversus* revealed that noninfected female beetles laid an average of 40.2 eggs per gallery, infected females an average of 10.5, a reduction of 74 percent. In this study, 5 infected females produced 43 larvae of which 27 were infected. Parasites per larvae averaged 12, although 3 larvae contained 56, 75, and 100 parasites, respectively. Galleries constructed by the infected beetles were considerably shorter than those constructed by noninfected females (fig. 5).

Separate studies were made on the same insect which involved *C. reversus* and *Parasitylenchus* sp., together with an entomophagous parasite, *Tomicobia tibialis* Ashm., a parasite of the adult beetle. *C. reversus* was superior to both *Parasitylenchus* sp. and the insect parasite in reducing brood production. Female beetles infected with *C. reversus* produced an average of 4.7 individuals, females infected with *T. tibialis* produced an average of 7.3 individuals, and those infected with *Parasitylenchus* sp. produced 22.5; noninfected beetles produced an average of 40.6. All beetles infected with *T. tibialis* ultimately died but only after broods had been produced. The insect parasite appeared to have little effect on male beetles. Nonparasitized females mated to parasitized males produced a normal number of offspring.

Contortylenchus elongatus, a nematode parasite of *Ips confusus* and *I. lecontei*, is an effective agent in reducing the brood produced by both beetles. Massey (1960), working with *I. confusus*, determined that the average number of eggs produced in a 2-week period by infected females of paired beetles was 12.5, by noninfected females, 26.0. Brood produced in a 4-week period by infected females averaged 24.3, while noninfected females averaged 57.9, a 58 percent reduction due to infection. Maximum number of larvae, pupae, and adults

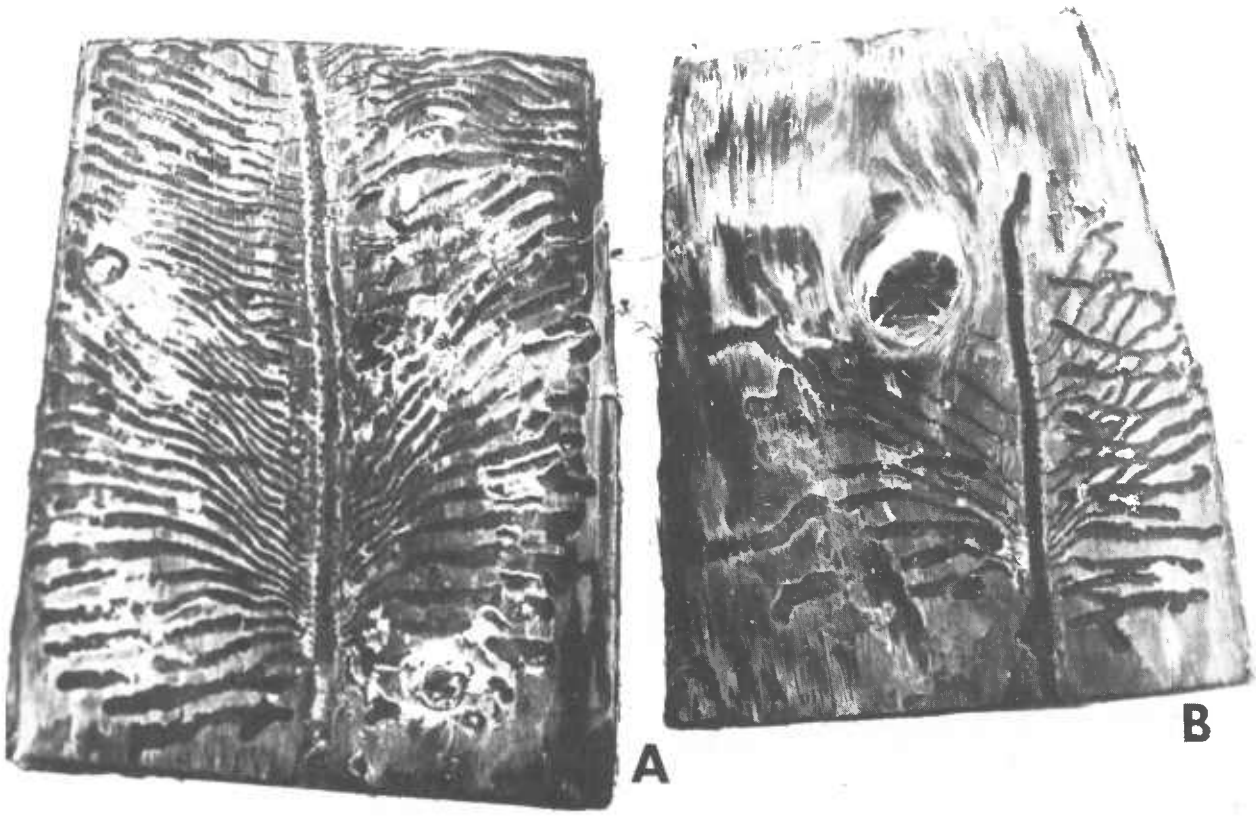

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Figure 5.—*A.* Galleries produced by noninfected females, *Ips pilifrons*; *B.* galleries produced by females infected with *Contortylenchus reversus*.

produced by an infected female was 49 compared with 108 by noninfected females. The beetle progeny also were more likely to be infected with the nematode parasite when the female or both sexes were parasitized than when the male alone was infected. Forty-seven percent of the brood was infected when the adult female was parasitized, 53 percent when both adults were infected, and 6.2 percent when males were infected. Beetles parasitized by the nematode constructed egg galleries that averaged only 4.5 inches as compared with 7.1 inches for noninfected females. *C. elongatus* has a similar effect on *I. lecontei.*

Reid (1958) studied the effect of *Sphaerularia hastata* on the mountain pine beetle in the East Kootenay region of British Columbia and found that 33 infected females laid an average of 38.4 eggs per gallery while 88 noninfected females laid an average of 56.9. Infected beetles moved very lethargically and did not attempt to escape when removed from their galleries. Antennae and legs often trembled noticeably.

BIOLOGICAL NOTES ON ASSOCIATES

The majority of nematodes found associated with bark beetles are, in a strict sense of the word, phoretics. They are carried from gallery to gallery, tree to tree, beneath the wing covers of the beetles, in the intersegmental folds of the abdomen, and on the various tarsal and tibial joints of the legs. Particularly interesting is the habit of members of the genus *Ektaphelenchus*. The nematodes form small, leathery cocoons beneath the wing covers of adult beetles and are transported in this manner. Cocoons made by *Ektaphelenchus obtusus* Massey, 1956 beneath the wing covers of *D. rufipennis* may contain as many as 75 females and a single male. The cocoons evidently burst after or during construction of the egg gallery as the galleries contain numerous mature and immature individuals of the species. On rare occasions, *E. obtusus* has been recovered from the body cavity of the spruce beetle. Infections are relatively light—at the most, 6 or 7 individuals in the hemocele. It is possible that in time the nematode will became a true parasite.

In the Aphelenchoidea, other than *Ektaphelenchus*, *Cryptaphelenchus*, and *Bursaphelenchus* are commonly phoretic and depend on fungal growth in bark beetle galleries for their survival. Members of the genus *Laimaphelenchus* are commonly associated with bark beetles, although they have never been observed either in adult or immature form as actual bark beetle phoretics. McBeth (1937) observed *Laimaphelenchus penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941 feeding on a larva of *Parasitorhabditis* sp. Members of the genus *Seinura*, according to Hechler (1963) and Linford and Oliveira (1937), are commonly predaceous on other nematodes.

In the Rhabditoidea, members of the genera *Mikoletzkya, Neocephalobus, Diplogasteroides, Rhabdontolaimus, Cylindrocorpus*, and *Acrostichus* are commonly carried by the beetles. *Macrolaimus and Santafea*, along with *Geraldius* and *Plectus*, are commonly recovered from bark infested with beetles, but they may be inhabitants of the outer bark and its associated growth, such as lichens and Spanish moss rather than true inhabitants of bark beetle galleries since they have been collected from bark of noninfested trees. It is possible that they may be carried by other insects.

Evidence indicates that members of the genus *Mikoletzkya* prey on the eggs of bark beetles. Eggs in galleries of the mountain pine beetle with dense populations of *Mikoletzkya pinicola* (Thorne 1935) Baker 1962 fail to hatch while those which are lightly infested by the nematode produce a normal population. This predatory habit is mentioned elsewhere in the literature as it concerns diplogasterids. Cobb, in Merrill and Ford (1916), observed *Mikoletzkya aerivora* (Cobb, 1916) Baker, 1962 feeding on grasshopper eggs. Steiner (1930) felt that *Neodiplogaster pinicola* Steiner, 1930 was predaceous on the eggs and small larvae of *Pissodes strobi* (Peck.).

Parasitorhabditis is abundantly associated with various scolytid species. Members of this genus, while parasitic in the gut of their host, are able to produce successive sexual generations in bark beetle galleries.

The superfamily Tylenchoidea is represented by two genera that are abundantly associated with bark beetles. They are *Neoditylenchus* and *Sychnotylenchus*. Both apparently depend on fungal growth occurring in scolytid galleries for survival. They are insect phoretics.

Several genera belonging to the superfamily Neotylenchoidea have been recovered in association with bark beetles. Probably most common are members of the *Nothotylenchus;* however, all members of this large group are relatively few in comparison to members of the Rhabditoidea and Aphelenchoidea. Their lack of abundance is somewhat anomalous when one considers that all the important internal parasitic nematodes of bark beetles belong to the superfamily Neotylenchoidea.

DISCUSSION

Much remains to be learned on the biology, ecology, and life histories of nematode parasites of bark beetles; only the surface has been scratched. While the basic life histories and host relationship of many of the important species have been established, little is known of their ecology. Much information is needed on the effect of environmental conditions such as moisture, drought, and biotic factors on the free-living forms. Additional knowledge is essential on the effect of beetle vigor and beetle nutrition on the parasitic stages of the nematodes.

All efforts to rear the parasites on artificial media have failed. At present they can be reared only in their host. Research should be expanded to develop methods for artificial rearing. Once this door is opened, possibilities for research on the animals in relation to their host are infinite.

While the animals offer interesting possibilities in the biological control of bark beetle populations, extensive research will be essential before their use in such a manner can be forecast.

It may be possible to increase the lethal potential of the parasites by cross inoculating them to host species of the same genus or closely related genera.

It has been demonstrated that many of the parasites sterilize their host. It may be possible to sterilize one or both sexes of a given beetle population by the planned introduction of infected beetles.

Research has revealed that, for the most part, life histories of the parasites are synchronized with their host. Adult parasites are usually produced in adult beetles. It may be possible to enhance the effect of the parasite by altering its life history so that mature nematodes are produced in immature beetles. It has been demonstrated in the laboratory that *Contortylenchus reversus,* parasitizing host larvae growing under stress, develop to maturity within the larvae and cause its death.

Under laboratory conditions, populations of beetles can be eradicated by breeding infected males and females, or infected females to noninfected males. It is possible that such a system would be even more successful under field conditions where other assisting biotic factors such as entomophagus parasites and mites are more prevalent.

Egg galleries of beetles infected with nematodes may be used in the biological evaluation of bark beetle infestations. *Scolytus ventralis* infestations, at present, can be evaluated simply by the presence or absence of short galleries produced by infected beetles.

Many biotic factors affect bark beetle populations. Nematodes are one of the factors. It is hoped that the information contained in this bulletin will provide for extensive research on all factors affecting the ecology of the beetles.

TAXONOMY

Classification of nematodes belonging to the superfamily Neotylenchoidea, parasitic in bark beetles, is considerably confused. The confusion is brought about for the most part by the dearth of morphological characters that can be applied to the parasites and to their free-living counterparts and to the lack of research both taxonomically and biologically on the group as a whole. As noted in the historical review, very little work has been done in the United States. Europeans have studied the worms both systematically and biologically in considerable detail but their research has been confined to the relatively few bark beetle species which occur on that continent. In the United States, only a few taxonomic studies are available to the researcher. In 1967, Nickle proposed a classification in which all insect parasitic nematodes would be placed in the family Sphaerulariidae (Lubbock, 1861) Skarbilovich, 1947. He proposed reducing the family Allantonematidae (Periera, 1931) Chitwood and Chitwood, 1937 to subfamily rank on the assumption that Sphaerulariidae was an older family name and therefore predated the family Allantonematidae. Nickle assumed, however, that *Sphaerularia* type genus of the family Sphaerulariidae and *Allantonema* type genus for the family Allantonematidae are so closely related that they can be adequately included under one family Sphaerulariidae. I do not agree with this proposal. The habits of *Sphaerularia* and morphological characters of the parasitic females preclude their placement in the same family as *Allantonema* and closely related genera.

Nor do I agree with Nickle's reducing the family Contortylenchidae to subfamily rank. The nematodes exhibit sufficient morphological characters to deserve family ranking. These characters, such as the deeply cleft vulva, body form, structure of stylet and other internal organs, and homomorphic body shape easily separate the animals from *Allantonema* and *Parasitylenchus*. The parasitic females of the last named genera quite often are amorphous in shape and structure.

Nickle also proposed the separation of the genus *Parasitylenchus* into several new genera through the erection of one new genus *Neoparasitylenchus* and the raising of the subgenera *Sulphuretylenchus* Rühm, 1956, *Metaparasitylenchus* Wachek, 1955 and *Proparasitylenchus* Wachek, 1955 to generic rank. I am very familiar with nematodes included in the changes, and do not agree with the new generic proposal nor the raising of the subgenus *Sulphuretylenchus* to generic rank on the basis of body form only. As previously stated, body shape in the parasitic females of *Parasitylenchus* may be quite amorphous. This amorphism could be related to host and related environmental factors. In addition, it is very difficult to distinguish morphological characters other than those variables for specific designation in the free-living forms. Males develop to sexual maturity in bark beetle galleries and infective-stage females are impregnated as immatures in the egg tunnels. Neither sex exhibits characters of sufficient importance to require generic rank.

Internal parasites of bark beetles of the superfamily Aphelenchoidea are included in only one genus, *Parasitaphelenchus*. The genus *Sphaerularia,* family Sphaerulariidae, originally included in this superfamily, has been rightfully transferred to the superfamily Neotylenchoidea by Jairajpuri and Siddiqi (1969).

For the most part, nematode associates of bark beetles are closely related taxonomically to soil and free-living forms. Many of the groups, however, are known only as insect associates. The majority of members of the aphelenchoid genera *Bursaphelenchus, Ektaphelenchus, Cryptaphelenchus,* and *Laimaphelenchus* are bark beetle or tree-infesting weevil associates. The same can be said of the tylenchoid genera *Neoditylenchus, Sychnotylenchus, Stictylus, Deladenus,* and *Anguillonema.* All are morphologically related to free-living

counterparts but have adapted themselves to a bark beetle related environment.

By far the greatest number of species associated with bark beetles are included in genera belonging to the superfamily Rhabditoidea. The genera *Mikoletzkya, Parasitorhabditis, Rhabdontolaimus, Diplogasteroides,* and *Acrostichus* are quite prominently associated with bark beetles and for the most part are taxonomically distinct. Their classification has been properly portrayed with free-living and plant parasitic forms from which they have probably developed. The system of classification of associated nematodes used in this bulletin has been adapted from Baker (1962) and Golden (1971).

Parasites

Neotylenchoidea (Thorne, 1941) Jairajpuri and Siddiqi, 1969

Allantonematidae (Pereira, 1931) Chitwood and Chitwood, 1937
- Allantonematinae Pereira, 1931 (Chitwood and Chitwood, 1937)
  - *Allantonema* Leuckart, 1884
    - *A. orthotomici* n. sp.
    - *A. paramorosum* n. sp.
  - *Parasitylenchus* Micoletzky, 1922
    - *P. avulsi* Massey, 1958
    - *P. coronatus* n. sp.
    - *P. elongatus* Massey, 1958
    - *P. ipinius* n. sp.
    - *P. leperisini* n. sp.
    - *P. oriundus* n. sp.
    - *P. ovarius* n. sp.
    - *P. parasitus* n. sp.
    - *P. pilifronus* Massey, 1958
    - *P. scrutillus* Massey, 1964
    - *P. senicus* n. sp.
    - *P. stipatus* Massey, 1966
    - *P. undulatus* n. sp.

Contortylenchidae Rühm, 1956
- *Contortylenchus* Rühm, 1956
  - *C. brevicomi* (Massey, 1957) Rühm, 1960
  - *C. bullus* n. sp.
  - *C. cribicolli* n. sp.
  - *C. elongatus* (Massey, 1960) Nickle, 1963
  - *C. grandicolli* (Massey, 1957) Rühm, 1960
  - *C. orthotomici* n. sp.
  - *C. pityophthori* n. sp.
  - *C. reversus* (Thorne, 1935) Rühm, 1956
  - *C. spirus* (Massey, 1957) Rühm, 1960
  - *C. terebranus* n. sp.

Sphaerulariidae (Lubbock, 1861) Skarbilovich, 1947
- Sphaerulariinae (Lubbock, 1861) Pereira, 1931
  - *Sphaerularia* Dufour, 1837
    - *S. dendroctoni* Massey, 1956

Genus *Allantonema* Leuckart, 1884

Synonym: *Tylenchomorphus* Fuchs, 1915

Type species: *Allantonema mirabile* Leuckart, 1884

Free-living forms: Cuticle smooth or with transverse striae. Lips distinct. Stylet well developed. Dorsal esophageal gland opening relatively far posterior to base of stylet. Vulva posterior, lips continuous with body contour. Anal opening distinct. Spicules paired, tylenchoid. Bursa peloderan. Tail conoid to a subacute terminus.

Parasitic form bean shaped, cuticle smooth or with transverse striae. Lip region overgrown by body expansion. Stylet obscure. Lumen of esophagus usually visible for short distance from base of lips. Body growth usually obscuring vulval opening. Ovary appearing to float free in body cavity. Ovoviviparous.

***Allantonema orthotomici* n. sp** **Figure 6**

	Length	Width	V
Parasitic females:	0.61 mm	0.18 mm	90%
	0.83 mm	0.16 mm	

Body bean shaped. Cuticle smooth. Lip region not set off, conical in young specimens, broadly rounded in older specimens. Spear not visible in specimens examined. Portions of esophagus traceable a short distance posterior to lip region. Vulva prominent in young females, lips continuous with body wall. Vagina oblique, very short. Ovary reflexed many times together with uterus, filling body cavity. Posterior portion of body cavity filled with developing eggs and larvae. Anal opening distinct in young females. Both vulva and anus are obscure in old parasitic females. Terminus broadly rounded.

Larvae from body cavity of host: body straight, cylindroid. Cuticle with coarse transverse striae. Lip region broadly rounded with definite constriction. Cephalic framework mod-

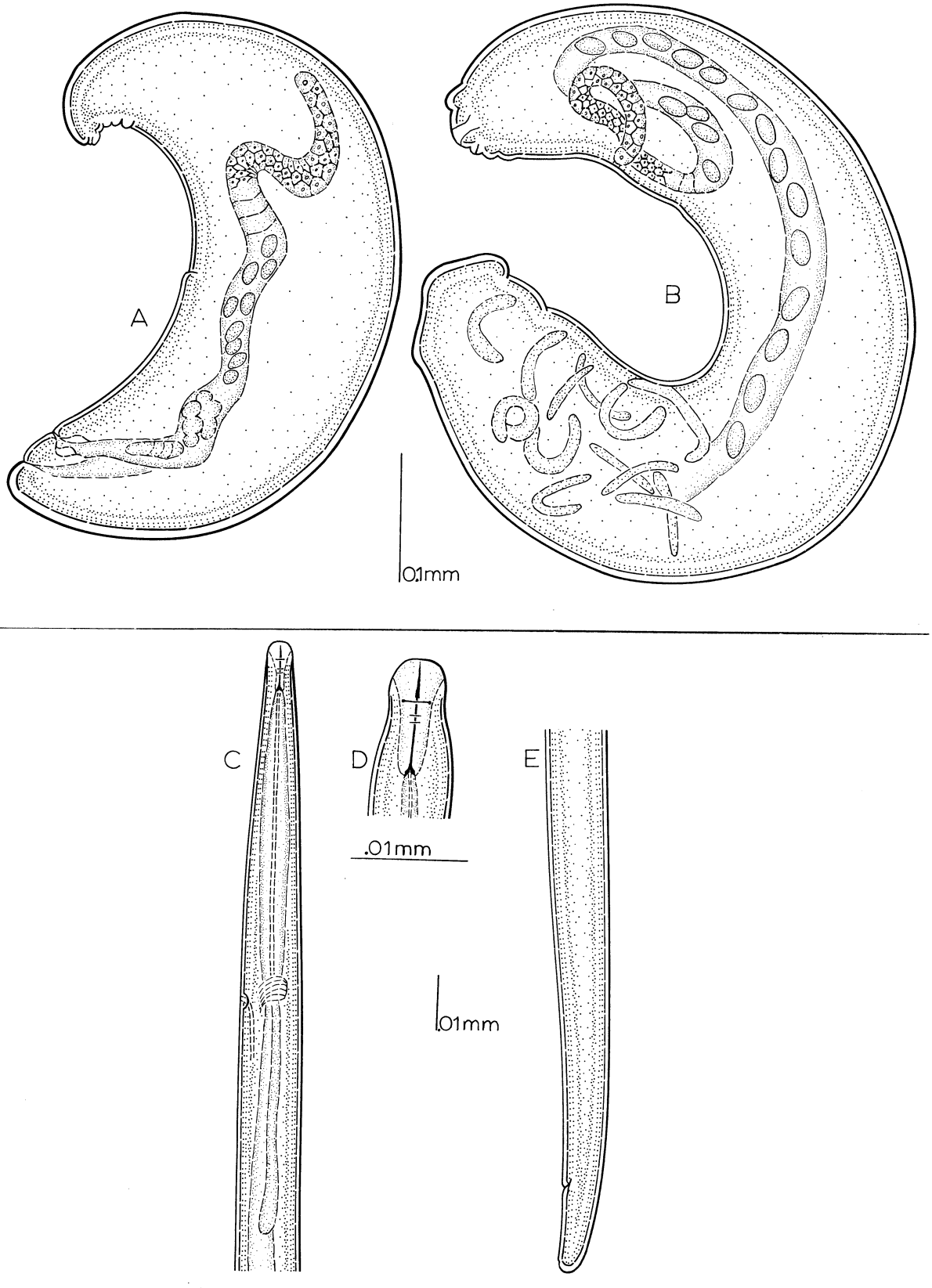


Figure 6.—*Allantonema orthotomici* n. sp.: *A.* Young, parasitic female; *B.* old, parasitic female; *C.* larva, head, and neck; *D.* larva, head; *E.* larva, tail.

erately sclerotized. Spear 10 μ in length, slender with distinct basal knobs. Esophageal glands extending 4 body widths posterior to nerve ring. Excretory pore passes through hemizonid, opposite nerve ring. Genital primordia positioned in posterior one-third of body. Anal opening rudimentary. Tail conoid to a broadly rounded terminus.

Diagnosis.—Related to *Allantonema philonthi* Wachek, 1955. Parasitic females are generally smaller. Differs in the apparent absence of a stylet in the parasitic forms and in their generally smaller size.

Type host.—Parasitic in body cavity of *Orthotomicus ornatus* Swaine.

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 15-Z.

***Allantonema paramorosum* n. sp.** **Figure 7**

Mature parasitic females:
nine measured from four beetles.

	Length	Width
	0.65 mm	0.28 mm
	0.67 mm	0.25 mm
	0.68 mm	0.24 mm
	0.76 mm	0.36 mm
	0.88 mm	0.19 mm
	0.98 mm	0.33 mm
	1.05 mm	0.27 mm
	1.12 mm	0.27 mm
	1.30 mm	0.30 mm
Average	0.89 mm	0.27 mm

Body usually bean shaped, approximately 3 times longer than wide; however, length of some specimens may be 5 times width. Cuticle with moderately fine transverse striae. Fat globules intermittently attached to cuticle over entire body surface. Lip region broadly rounded and overgrown by body expansion. Stylet not discernible in 12 specimens available. Rudiments of esophagus visible for a short distance posterior to lip region. Vulva terminal, in some specimens not discernible because of overgrowth of body. Ovary reflexed numerous times, together with uterus filling body cavity. Posterior portion of body occupied entirely by uterus and developing eggs and larvae. Terminus broadly rounded. Ovoviviparous.

Larvae from body cavity of host: Body straight, cylindroid. Cuticle with moderately coarse transverse and longitudinal striations. Lip region not set off, rather broadly rounded. Framework moderately distinct. Stylet exceedingly fine without basal knobs or thickenings. Esophageal glands indistinct. Nerve ring very prominent. Excretory pore slightly posterior to nerve ring. Genital primordia prominent and located in posterior one-half of body. Anal opening distinct. Tail conoid to semiacute terminus.

Diagnosis.—Related to *Allantonema morosum* (Fuchs, 1929) Filipjev, 1934; differs from that species in the much smaller average size of parasitic females. Cuticle of the parasitic females with transverse striations. Cuticle of larvae with coarse longitudinal and transverse striae. Parasitic females also differ from *A. morosum* in apparent absence of a stylet.

Type host.—Body cavity of *Hylastes* sp.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 69.

Genus *Parasitylenchus* Micoletzky, 1922

Synonyms: *Metaparasitylenchus* Nickle, 1967
Sulphuretylenchus Nickle, 1967
Proparasitylenchus Nickle, 1967
Neoparasitylenchus Nickle, 1967

Type species: *Parasitylenchus dispar* (Fuchs, 1914) Micoletzky, 1922

Parasitic females: Ranging in size from short stout to long thick bodied. Cuticle smooth or with transverse striae of varying coarseness. Lip region usually overgrown by body growth. Stylet usually visible, short, stout, with or without basal knobs or thickenings, often displaced by developing ovary. Esophagus traceable for only a short distance from base of spear. Excretory pore and nerve ring both becoming obscure with body development. Vulva far posterior, at times terminal, usually visible only on younger specimens. Ovary, together with uterus, filling entire body cavity when fully developed. Anus closely associated with vulva, at times terminal. Terminus usually broadly rounded.

Free-living forms: Lip region continuous with body contour. Cephalic framework lightly sclerotized. Stylet usually stout, with or without basal knobs or thickenings. Dorsal esophageal glands prominent to obscure in some species. Esophagus appearing to join directly with gut. Vulva continuous with body wall. Vagina short, very narrow. Posterior portion of developing ovary filled with sperm cells. Anal opening usually obscure. Terminus variable in shape.

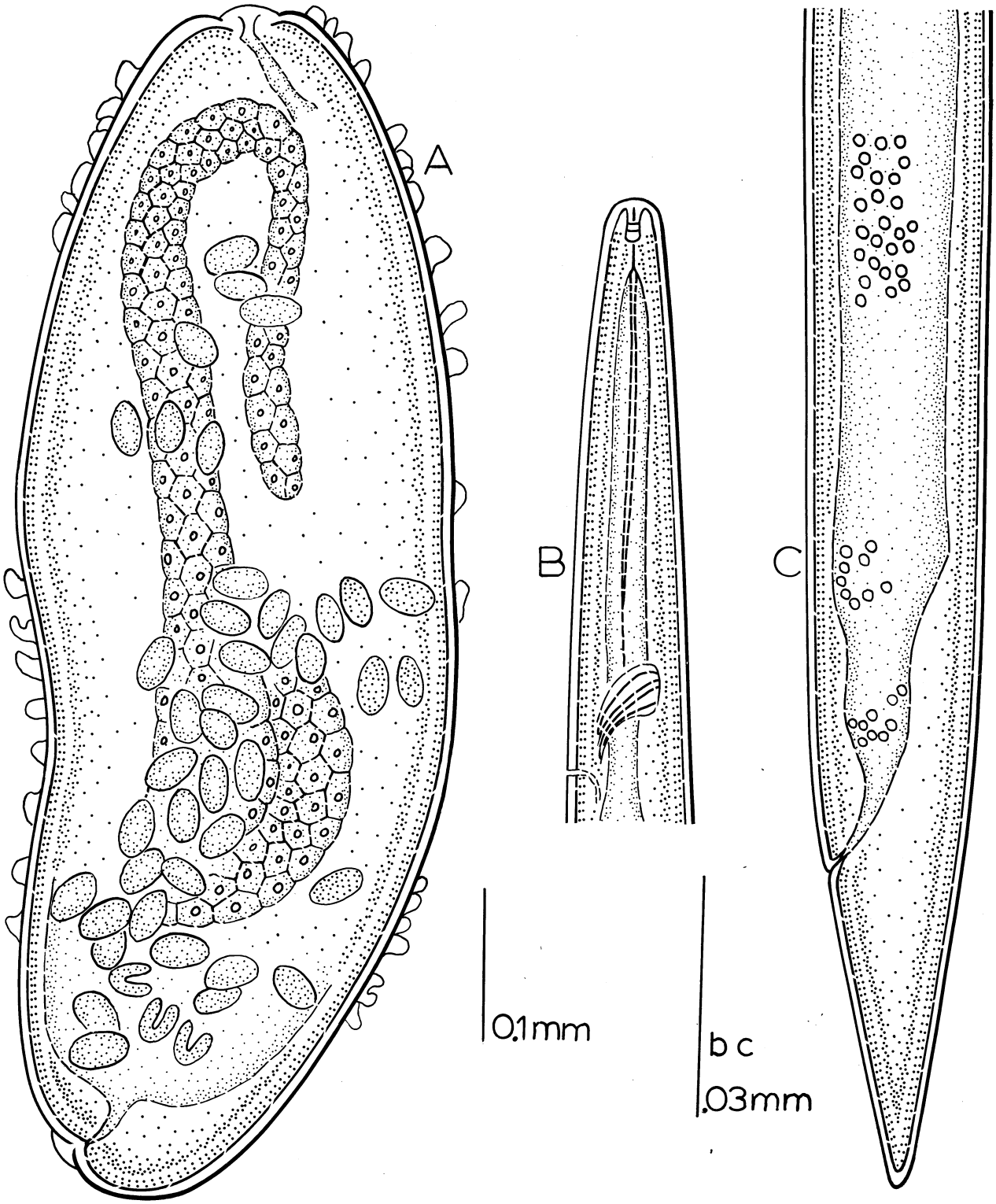


Figure 7.—*Allantonema paramorosum* n. sp.: *A.* Parasitic female; *B.* larva, head, and neck; *C.* larva, tail.

Male: Stylet very slender, with or without basal thickenings or knobs. Spicules paired and gubernaculum typically tylenchoid. Bursa peloderan.

Parasitylenchus avulsi **Massey, 1958** **Figure 8**

First-stage larvae: Length=0.29 mm; Width =0.016 mm; a=17; b=?; c=?; lip region flatly rounded; spear slender, faintly knobbed; esophagus a narrow tube, narrowing even more as it passes through the prominent nerve ring; excretory pore not visible, body cavity filled with large vacuolelike inclusions; anal opening not visible; tail narrowly rounded.

Parasitic females: Length=1.2–1.55 mm; Width=0.10–0.12 mm; a=11; b=?; c=54; V=98%. Body sausage shaped, narrowing only slightly at anterior and posterior ends, assuming circular shape when reflexed; cuticle smooth, regular, hypodermis composed of cells with large nuclei; lip region crown shaped, broadly rounded; spear moderately slender with prominent knobs, 13 μ in length; lumen of the esophagus traceable for a short distance from the base of the spear; ovary reaching almost to the base of the spear, reflexed one to several times in mature specimens; uterus occupying a prominent part of the body cavity; vagina a narrow slit; anal opening subterminal, only slightly separated from the vulva; terminus obtuse. Free-living forms unknown.

Diagnosis.—*Parasitylenchus* with crown-shaped lip region. Differs from *Parasitylenchus cossoni* Wülker, 1929 in shape of lip region and subterminal location of vulva. It differs from *P. scolyti* in its larger size and shape of terminus.

Type host.—*Ips avulsus* (Eichh.).

Type locality.—Talladega National Forest, Alabama.

Type specimens.—Collection No. 15-J.

P. avulsi was taken from the body cavity of adult *Ips avulsus* found associated with *Dendroctonus frontalis* Zimm. and *Ips grandicollis* (Eichh.).

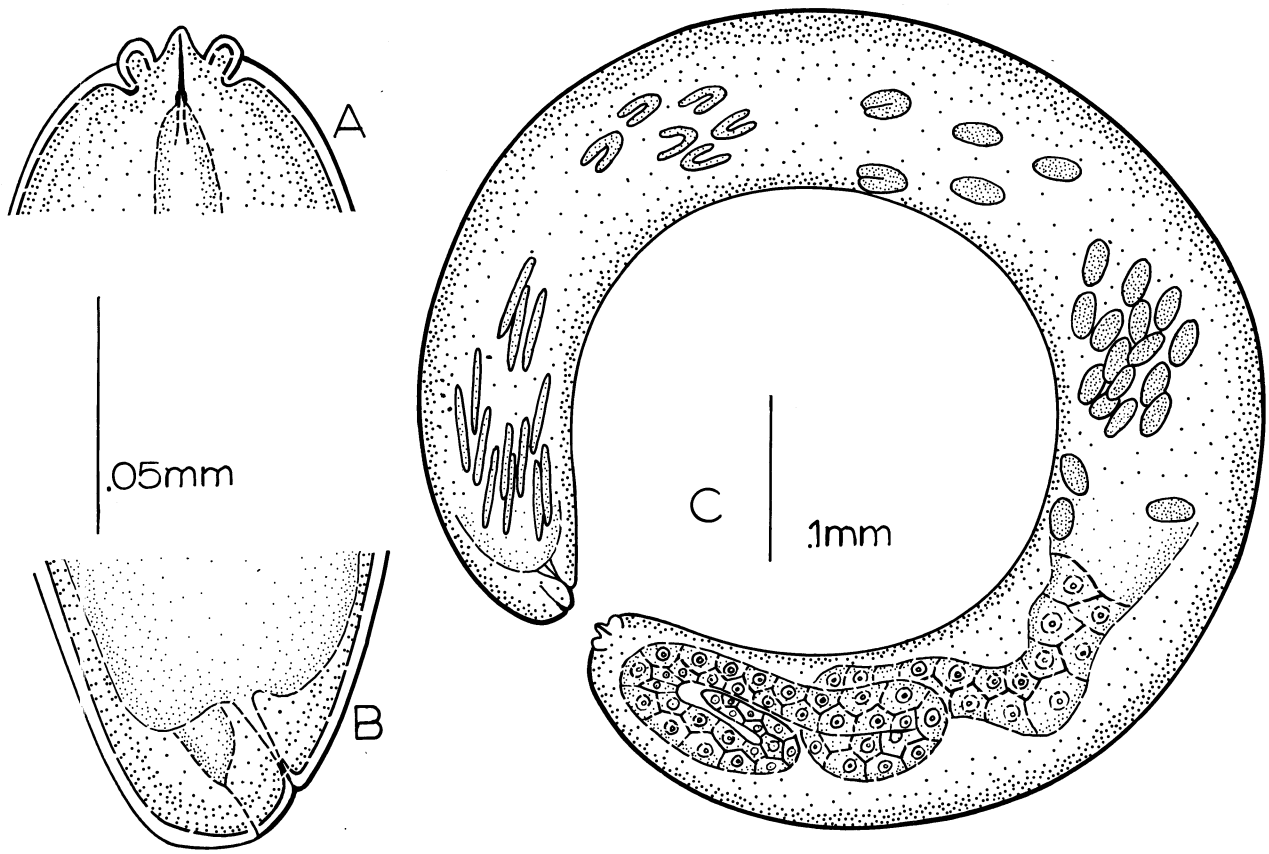


Figure 8.—*Parasitylenchus avulsi* Massey, 1958: *A.* Head; *B.* tail; *C.* parasite female.

***Parasitylenchus coronatus* n. sp.** **Figure 9**

Parasitic females: Length=2.1–2.3 mm; Width–185–200 μ; V=99–100%.

Body ventrally arcuate, at times forming a complete circle. Cuticle relatively thick with distinct transverse striae visible over entire body length. Lip region distinct, overgrown by body and appearing nipplelike in lateral view. Stoma and stylet readily visible. Stylet slender, 13μ in length, with small basal thickenings, at times displaced by growth of ovary. Esophagus distinct, lumen visible for a short distance. Excretory pore, hemizonid, and nerve ring not visible. Vulva opening at terminus or slightly anterior to it, obscure in older specimens. Ovary single, reflexed many times, together with uterus filling entire body cavity. Anal opening and rectum not distinguishable. Tail broadly rounded, with a titlike terminus in some specimens. Ovoviviparous. Free-living forms unknown.

Diagnosis.—Related to *Parasitylenchus avulsi;* differs from that species in its much larger size, in the presence of transverse striae, and in absence of a discernible anal opening.

Type host.—Parasitic in body cavity of *Hylurgops pinifex* (Fitch).

Type locality.—Gorham, Maine.

Type specimens.—Collection No. 35-Y.

***Parasitylenchus elongatus* Massey, 1958** **Figure 10**

Eggs: Hatch within uterus of living female.

First-stage larvae: Length=0.30 mm; Width =0.03 mm; spear not visible; lip region rounded; anal opening not visible; tail obtuse.

Infective-stage females: Length=1.16–1.20 mm; a=78.8–79.2; b=?; c=?; V=95%.

Cylindroid, elongate. Cuticle without lateral incisures, transverse striae fine. Lip region not set off. Cephalic framework lightly sclerotized. Stylet coarse, with distinct basal thickenings, 10–11 μ in length. Dorsal esophageal gland outlet obscure. Extended esophageal glands indistinct. Nerve ring prominent. Excretory pore immediately posterior to nerve ring, passing through hemizonid. Lips of vulva at times slightly protuberant. Vagina short, indistinct. Ovary single, outstretched, posterior portion

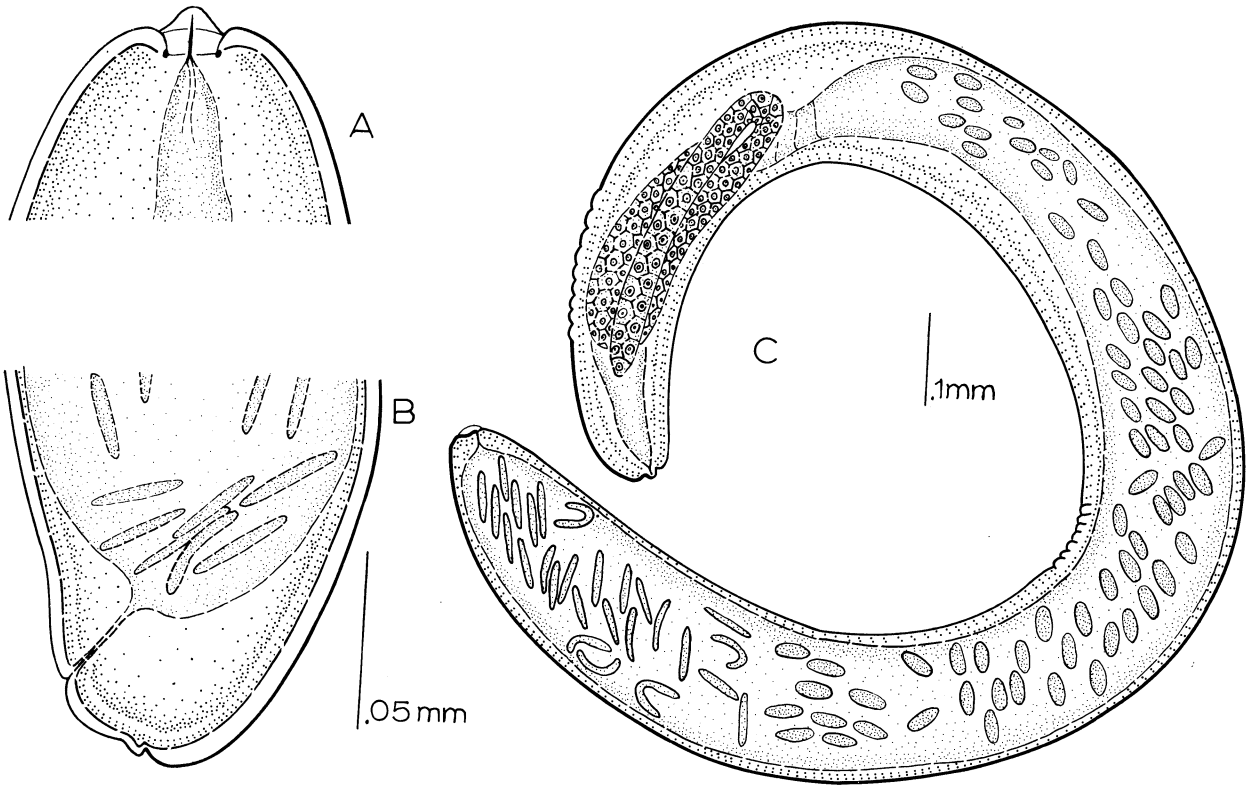


Figure 9.—*Parasitylenchus coronatus* n. sp.: *A.* Head; *B.* tail; *C.* parasitic female.

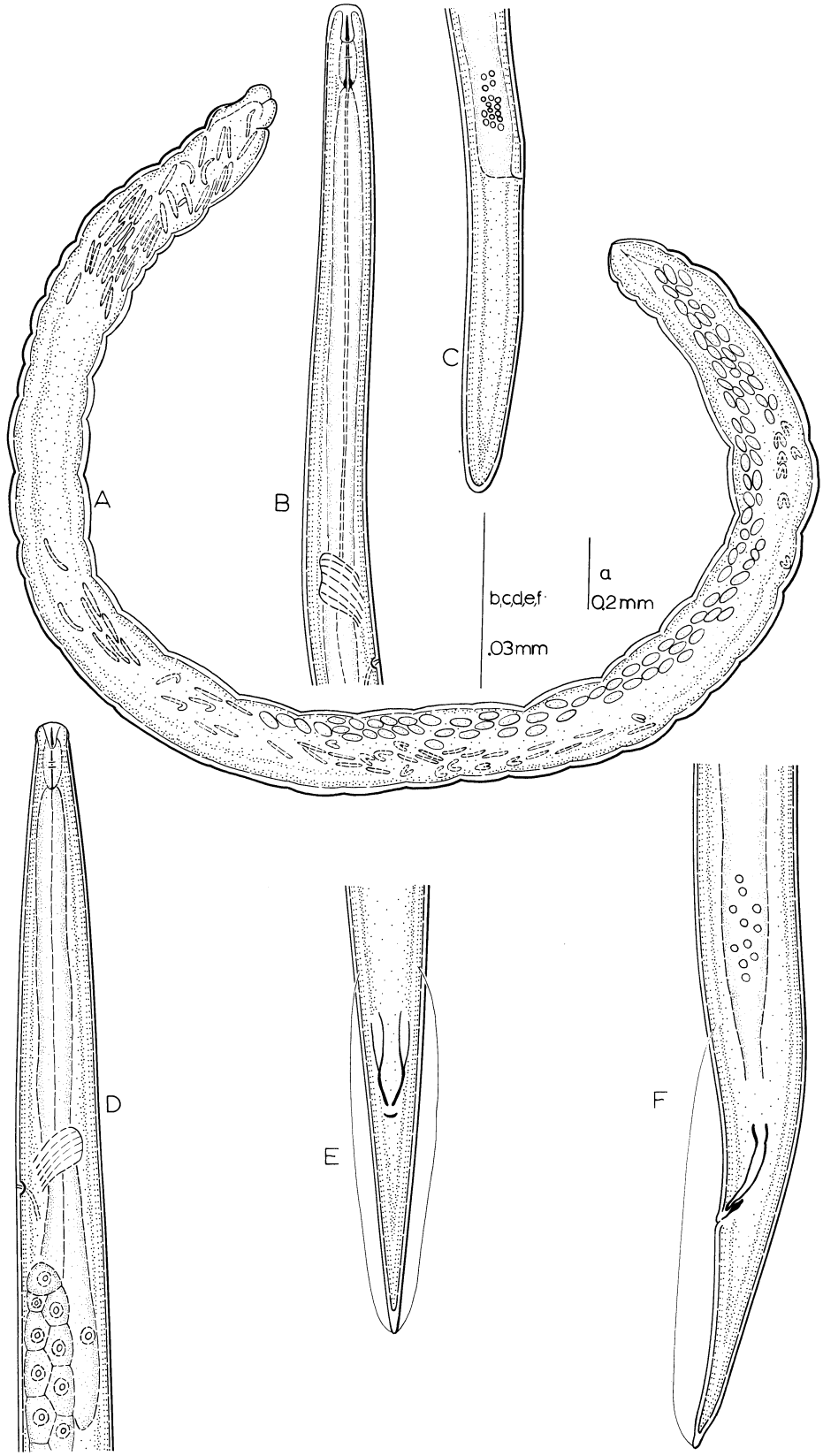


Figure 10.—*Parasitylenchus elongatus* Massey, 1958: *A.* Parasitic female; *B.* infective-stage female, head and neck; *C.* infective-stage female, tail; *D.* male, head and neck; *E.* ventral view, male tail; *F.* lateral view, male tail.

packed with sperm cells. Anus and rectum obscure. Tail cylindroid to an obtuse terminus.

Immature parasitic females from larval insects: Length=1.6–2.7 mm; Width=0.18 mm; cuticle very finely striated, hypodermal cells with large nuclei; lip region rounded; spear moderately coarse, knobbed; lumen of esophagus visible for a considerable distance from base of spear; genital primordium apparent over approximately one-half body length; vulva and anal opening not visible.

Immature parasitic females from adult beetles: Length=4.7–4.9 mm; Width=0.25 mm; body elongate, becoming reduced in length because of distortion of body wall; cuticle thick, wrinkled, appearing to be almost annulated; lip region flattened, in many specimens distorted and misshapen; spear moderately coarse, 11 μ in length, often displaced by developing ovary; ovary reflexed several times; uterus occupying a major portion of body cavity and becoming distended with larvae as eggs hatch; vulva protuberant; anal opening invisible; tail obtuse.

Male: 1.20–1.25 mm; a=53; b=?; c=26.

Body straight. Cylindroid, slender. Cuticle with exceedingly fine transverse striae. Lip region rounded, set off by constriction. Cephalic framework indistinct. Stylet 8–9 μ long, exceedingly slender, with very small basal thickenings. Dorsal esophageal gland outlet obscure. Extended esophageal glands obscure, although visible in some specimens. Excretory pore adjacent to nerve ring and passing through hemizonid. Testis single, outstretched, at times reaching to within body width of nerve ring. Spicules and gubernaculum typically tylenchoid. Bursa enveloping tail and joining body wall one body width anterior to proximal end of spicules. Tail conoid to acute terminus.

Diagnosis.—Elongate *Parasitylenchus* with broadly rounded lip region and obtuse tail. Differs from other species of the genus in its greater length and width.

Type host.—*Scolytus ventralis* Lec.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 12-D (Holotype), 35-B (Allotype).

Parasitylenchus ipinius n. sp. **Figure 11**

Juvenile parasitic females: Length=0.70–0.88 mm ; Width=58 μ; V=94–95%.

Mature parasitic females: Length=1.5–1.6 mm; Width=102–114 μ; V=96–97%.

Body ventrally arcuate. Cylindroid. Cuticle relatively thin. Lip region not set off, with convolutions as figured. Stylet slender, 13 μ in length, with small basal thickenings, shaft only slightly tapering, at times slightly displaced by ovary. Lumen of esophagus traceable for a short distance from base of spear. Excretory pore, hemizonid, and nerve ring not discernible. Vulva distinct, vagina very short. Ovary single, reflexed several times. Oocytes arranged anteriorly in three rows; in mature specimens, ovary, eggs, and larvae filling entire body cav-

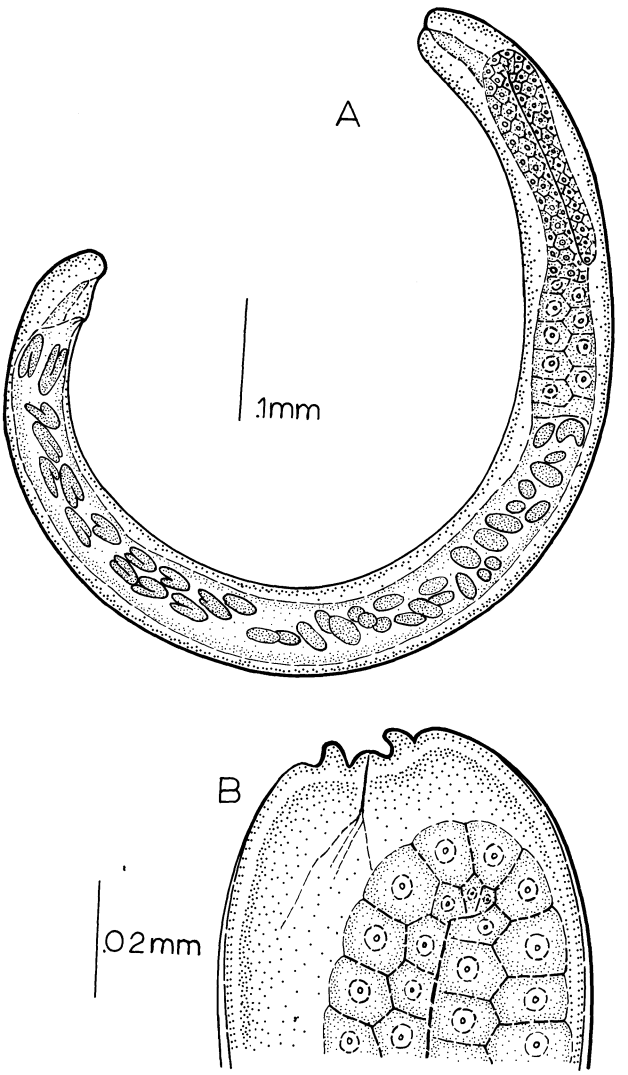


Figure 11.—*Parasitylenchus ipinius* n. sp.: *A.* Parasitic female; *B.* parasitic female, head.

ity. Anus distinct, at times opening at terminus. Terminus usually rounded, at times with convolutions. Oviparous or ovoviviparous. Sexual stages unknown.

Diagnosis.—Related to *Parasitylenchus ovarius*. Differs in more slender stylet, smaller size, and convolutions of lip region.

Type host.—Body cavity of *Ips pini* (Say).

Type locality.—Gorham, Maine.

Type specimens.—Collection No. 35-V.

***Parasitylenchus leperisini* n. sp.** **Figure 12**

Free-living infective-stage females: Length =0.70 mm; a=60; b=?; c=?; V=90%.

Body cylindroid, slender. Cuticle without lateral incisures, transverse striae moderately coarse. Lip region continuous with body contour, rounded. Cephalic framework lightly sclerotized. Stylet relatively stout with prominent basal knobs, 10–11 μ in length. Dorsal esophageal gland outlet obscure. Extended esophageal glands obscure. Excretory pore anterior to nerve ring. Lips of vulva slightly protuberant. Vagina very short. Ovary single, posterior seven-eighths filled with spermatozoa, anterior portion consisting of 4–8 oocytes arranged in a single row. Anus and rectum obscure. Tail conoid to subacute terminus.

Free-living males: Length=0.70–0.72 mm; a=40–48; b=?; c=26.4–26.7.

Body cylindroid, slender. Cuticle with moderately coarse transverse striations. Lip region continuous with body contour broadly rounded. Cephalic framework lightly sclerotized. Stylet very slender, 9–10 μ in length, with prominent basal knobs. Dorsal esophageal glands obscure. Excretory pore anterior to nerve ring. Testis single, outstretched, short, posterior portion filled with small, highly refractive sperm cells. Spicules and gubernaculum tylenchoid. Spicules short, delicately developed. Bursa peloderan. Tail conoid to subacute terminus.

Parasitic juvenile females: Length=0.76–0.90 mm; a=18–23; b=?; c=?; V=92–95%.

Body cylindroid. Cuticle with transverse striae being obliterated by body development, except at lip region and caudal area. Lip region continuous with body contour, rounded, body expanded immediately posterior to lips. Cephalic framework lightly sclerotized. Stylet 10–11 μ in length, with prominent basal knobs. Dorsal esophageal gland outlet obscure. Corpus of esophagus and its lumen traceable only a short distance posterior from base of spear. Excretory pore prominent, far anterior, placement due to body development. Lips of vulva slightly protuberant, vagina short. Ovary single, posterior portion packed with spermatozoa, anterior portion becoming multiple-celled, reflexed. Anus and rectum visible, but indistinct. Tail conoid to narrowly rounded terminus.

Mature parasitic females:	Length	Width	V
	1.35 mm	60 μ	98%
	1.20 mm	60 μ	96%
	0.91 mm	50 μ	94%

Body cylindroid. Cuticle smooth, with irregular annulation in head and caudal regions. Lip region overgrown by body development. Stylet stout, with prominent basal knobs, 10–11 μ in length, not displaced by developing ovary. Corpus of esophagus and its lumen visible for only a short distance from base of spear. Excretory pore prominent, its outlet at stylet level, seeming change in position caused by body development. Lips of vulva slightly protuberant. Ovary single, reflexed many times, the oocytes for most part arranged in a double row. Anus and rectum visible but indistinct. Tail broadly rounded with a distinct titlike terminus.

Diagnosis.—Distinct because of the prominent excretory pore visible in all stages and because of its anterior location.

Type host.—Parasitic in body cavity of *Leperisinus aculeatus* (Say).

Type locality.—Chillicothe, Ohio.

Type specimens.—Collection No. 86-B.

***Parasitylenchus oriundus* n. sp.** **Figure 13**

Parasitic females:	Length	Width	V
	0.67 mm	60 μ	
	0.72 mm	50 μ	
	0.75 mm	50 μ	93–97%

Body ventrally arcuate, cylindroid. Cuticle with coarse transverse striations, not undulate. Lip region not set off, usually narrowly rounded, may be overgrown by body expansion in older specimens. Stylet 7–8 μ in length, slender, with small basal thickenings. Stoma obscure. Lumen of esophagus traceable for only a short distance from base of spear. Vulva strongly developed, vagina oblique. Ovary single, reflexed several times. Anus and rectum not discernible. Tail broadly rounded, usually terminating with a nipplelike mucro.

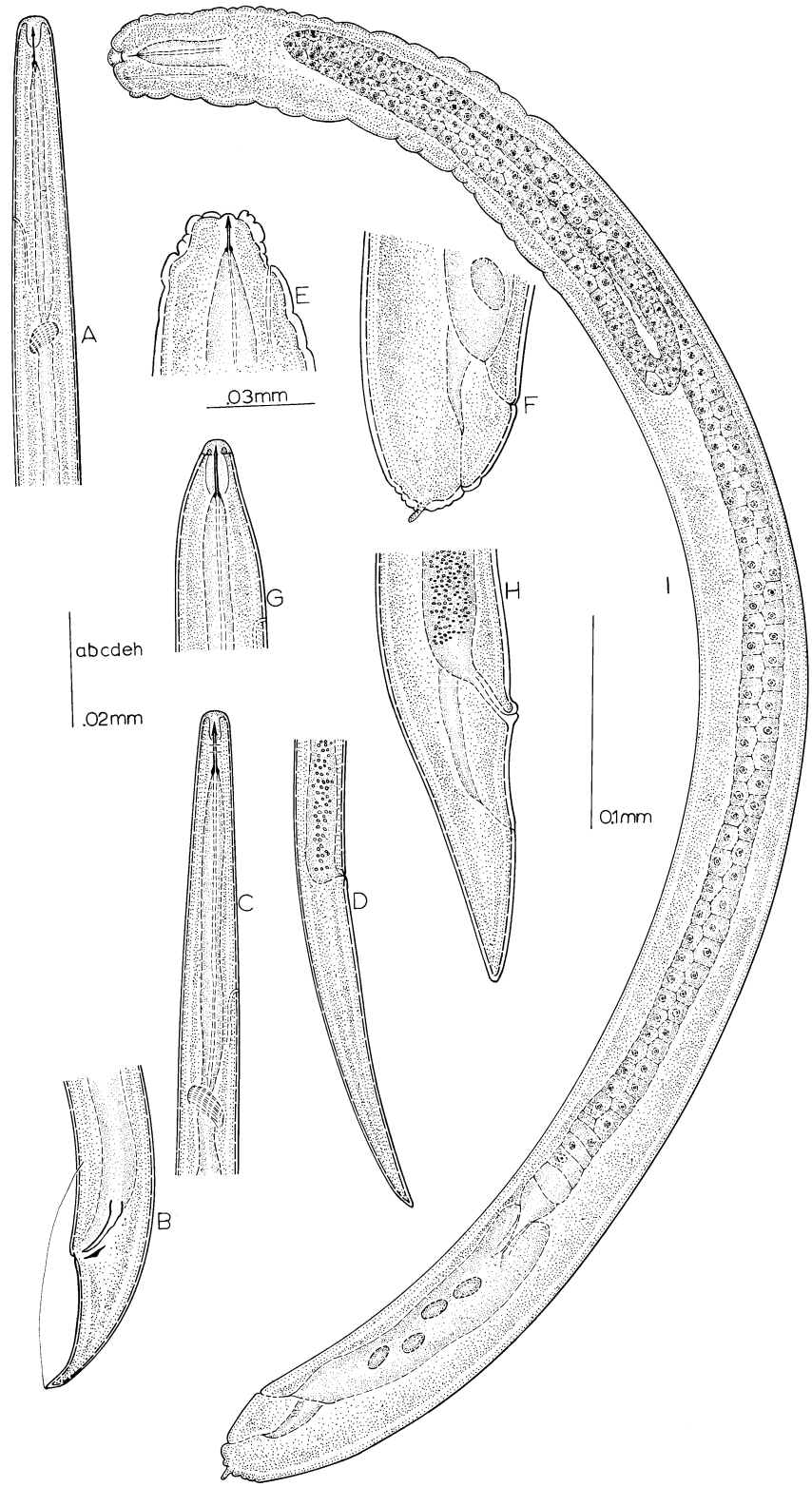


Figure 12.—*Parasitylenchus leperisini* n. sp.: *A.* Male, head and neck; *B.* male, tail; *C.* female infective-stage, head and neck; *D.* female infective-stage, tail; *E.* parasitic female, head; *F.* parasitic female tail; *G.* juvenile parasitic female, head; *H.* juvenile parasitic female, tail; *I.* mature parasitic female.

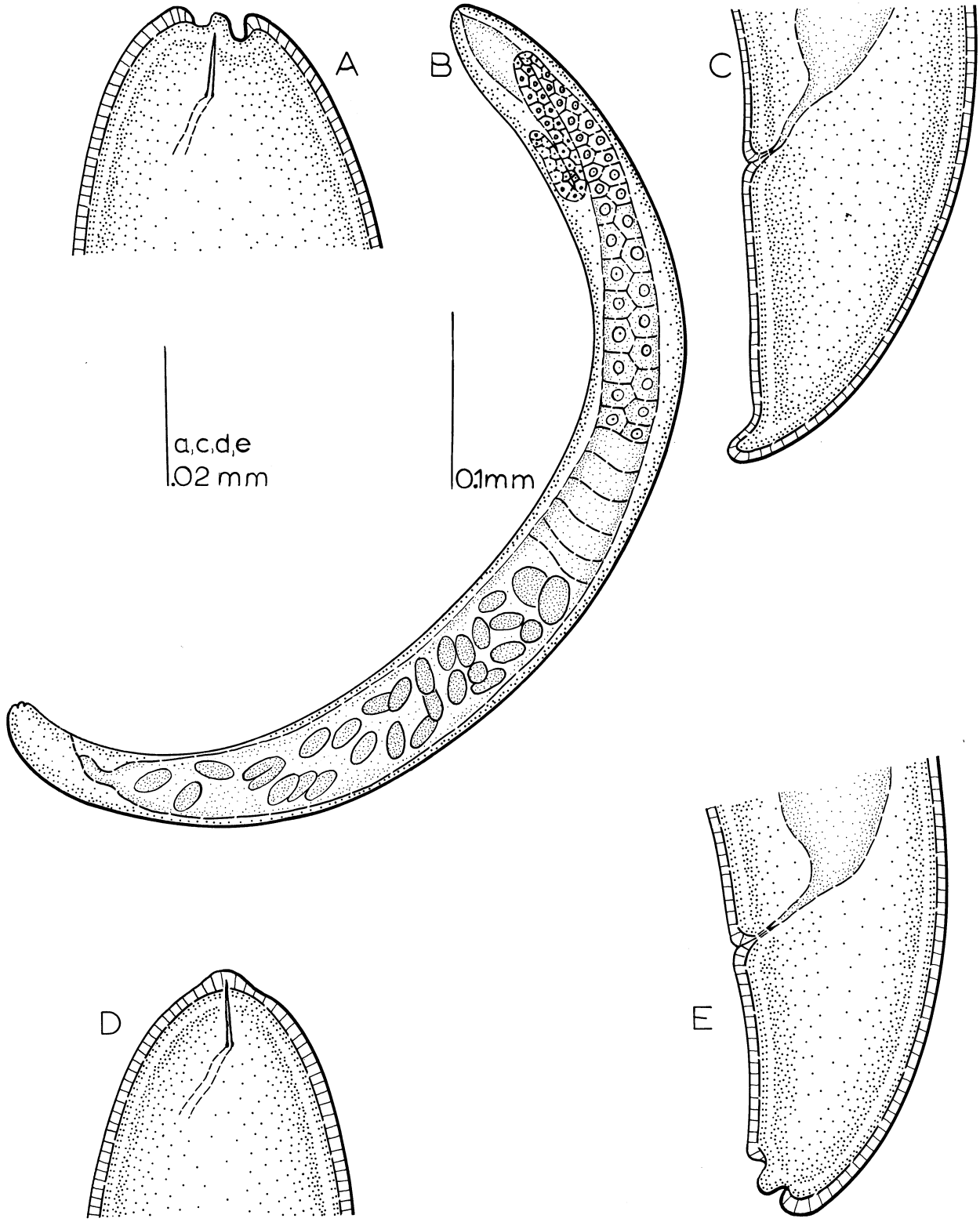


Figure 13.—*Parasitylenchus oriundus* n. sp.: *A.* Parasitic female, head; *B.* mature parasitic female; *C.* parasitic female, tail; *D.* parasitic female, head; *E.* parasitic female, tail.

Diagnosis.—Related to *Parasitylenchus ovarius*. Differs in its smaller size and character of lip region and in cuticular characteristics.

Type host.—Body cavity of *Orthotomicus caelatus* (Eichh.).

Type locality.—Freeport, Maine.

Type specimens.—Collection No. 35-W.

***Parasitylenchus ovarius* Massey, 1958** **Figure 14**

Eggs: Hatch within uterus of adult females.

First-stage larvae: Length=0.7 mm; Width =0.03 mm; cuticle with faint striations; lip region flattened to very slightly rounded; spear 10 μ in length, slender, minutely knobbed; esophagus a narrow tube, becoming constricted as it passes through the nerve ring; nerve ring prominent; excretory pore not visible in specimens examined; genital primordia apparent; anal opening not visible; body cavity filled with vacuolelike inclusions.

Parasitic female: Length=1.7 mm; Width =0.16 mm; a=11; b=?; c=8; body when relaxed assumes semicircular position, saclike in shape, broadest at middle, narrowing at anterior and posterior ends; lip region broadly rounded; spear slender, 14 μ in length, with prominent knobs, often displaced by growth of ovaries, becoming nonfunctional in older specimens; lumen of esophagus visible for only a short distance from base of spear; ovary single, reflexed; uterus filling a large portion of body cavity in mature specimens; vulva and anal opening closely separated; tail narrowly obtuse. Males unknown.

Diagnosis.—*Parasitylenchus ovarius* is closely related to *P. dispar* and *P. grossmannae* Rühm,

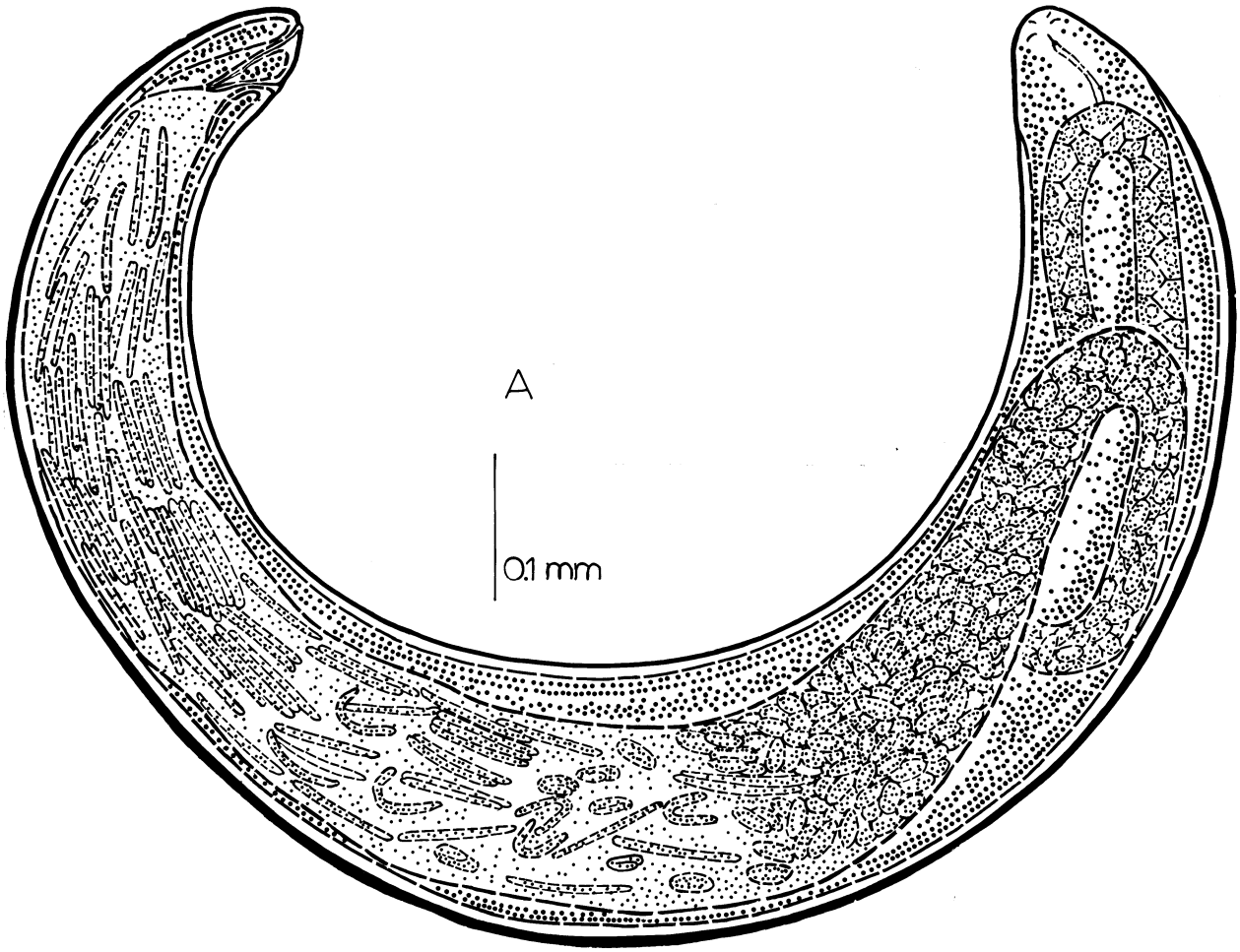


Figure 14.—***Parasitylenchus ovarius* Massey, 1958: *A.* Parasitic female.

1954. It differs from *P. dispar* in its larger size and terminal location of anal opening; from *P. grossmannae* in presence of discernible anal opening and more narrowly rounded lip region.

Type host.—*Ips pilifrons* Sw.

Type locality.—Uncompahgre National Forest, Norwood, Colorado. Only adult beetles were parasitized.

Type specimens.—Collection No. 15-E.

***Parasitylenchus parasitus* n. sp.** **Figure 15**

Parasitic females:	Length	Width	V
	2.0 mm	208 μ	
	3.2 mm	200 μ	98%

Body sinuous to straight. Cuticle thick, without undulation, very faint transverse striae. Lip region rounded. Stylet slender, 12–13 μ, with basal thickenings. Stoma not discernible. Vulva slightly anterior to terminus. Ovary reflexed several times. Anus and rectum not discernible. Terminus broadly rounded.

Diagnosis.—Related to *Parasitylenchus ovarius*. Differs in cuticular characteristics and placement of the vulva.

Type host.—Body cavity of *Polygraphus hoppingi* Sw.

Type locality.—Flagstaff, Arizona.

Type specimens.—Collection No. 35-X.

***Parasitylenchus pilifronus* Massey, 1958** **Figure 16**

Parasitic female: Length=3.8–5.4 mm; Width=0.23 mm; body elongate, anterior one-third of body widest, tapering toward posterior end, cuticle translucent, hypodermis composed of large irregular transparent cells as figured; lip region broadly rounded; spear 13 μ long, slender, with prominent knobs; ovary single, reflexed one to several times, often almost reaching base of spear; vulva and anal openings not apparent. Males unknown.

Diagnosis.—*Parasitylenchus* with transparent cuticle; differs from other species in the genus in peculiar arrangement of hypodermal cells and in their lack of color.

Type host.—*Ips pilifrons.*

Type locality.—Uncompahgre National Forest, Norwood, Colorado.

Type specimens.—Collection No. 15-M.

***Parasitylenchus scrutillus* Massey, 1964** **Figure 17**

Egg: Oval. 47 x 23 μ. Hatch within uterus of parasitic females.

First-stage larvae: 0.22 mm; a=21; b=?; c=?

Cuticle moderately thick with fine transverse striations. Head broadly rounded, almost flat. Spear not observed. Body cavity filled with large vacuoles. Esophagus, nerve ring, excretory pore, and anal openings not seen. Terminus broadly rounded.

Young parasitic females: Length=2.0–2.4 mm; Width=0.35 mm.

Cuticle thick with fine transverse striations. Head broadly rounded. Spear short, thick, with prominent knobs. Esophagus well developed, occupying three-fourths of body cavity in region of neck. Nerve ring and excretory pore not apparent. Ovary single, reflexed several times, reaching almost to base of spear in some specimens. First-stage larvae present in uterus. Vulva and anal opening not apparent. Terminus broadly rounded, similar to shape of head.

Mature parasitic females: Length=2.0–2.4 mm; Width=0.35–0.40 mm.

Cuticle thick with fine transverse striations, wrinkled. Head broadly rounded. Spear short, prominently knobbed, in many specimens displaced, evidently nonfunctional. Esophagus traceable for only a short distance from base of spear. Nerve ring and excretory pore not apparent. Walls of the ovary not apparent. Developing eggs present only one body width from anterior end. First-instar larvae present in posterior portion of body cavity. Vulva and anal opening not apparent. Terminus broadly rounded, approximately size and shape of head.

Males: Unknown.

Diagnosis.—Similar in shape to *Parasitylenchus ovarius* Massey, 1958; differs in length and absence of discernible vulva and anal opening.

Type host.—*Scolytus ventralis.*

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 12-P.

***Parasitylenchus senicus* n. sp.** **Figure 18**

Parasitic females:	Length	Width
	0.62 mm	88 μ
	0.70 mm	117 μ
	0.80 mm	110 μ
	0.92 mm	80 μ

Body relatively straight. Cuticle thick, with

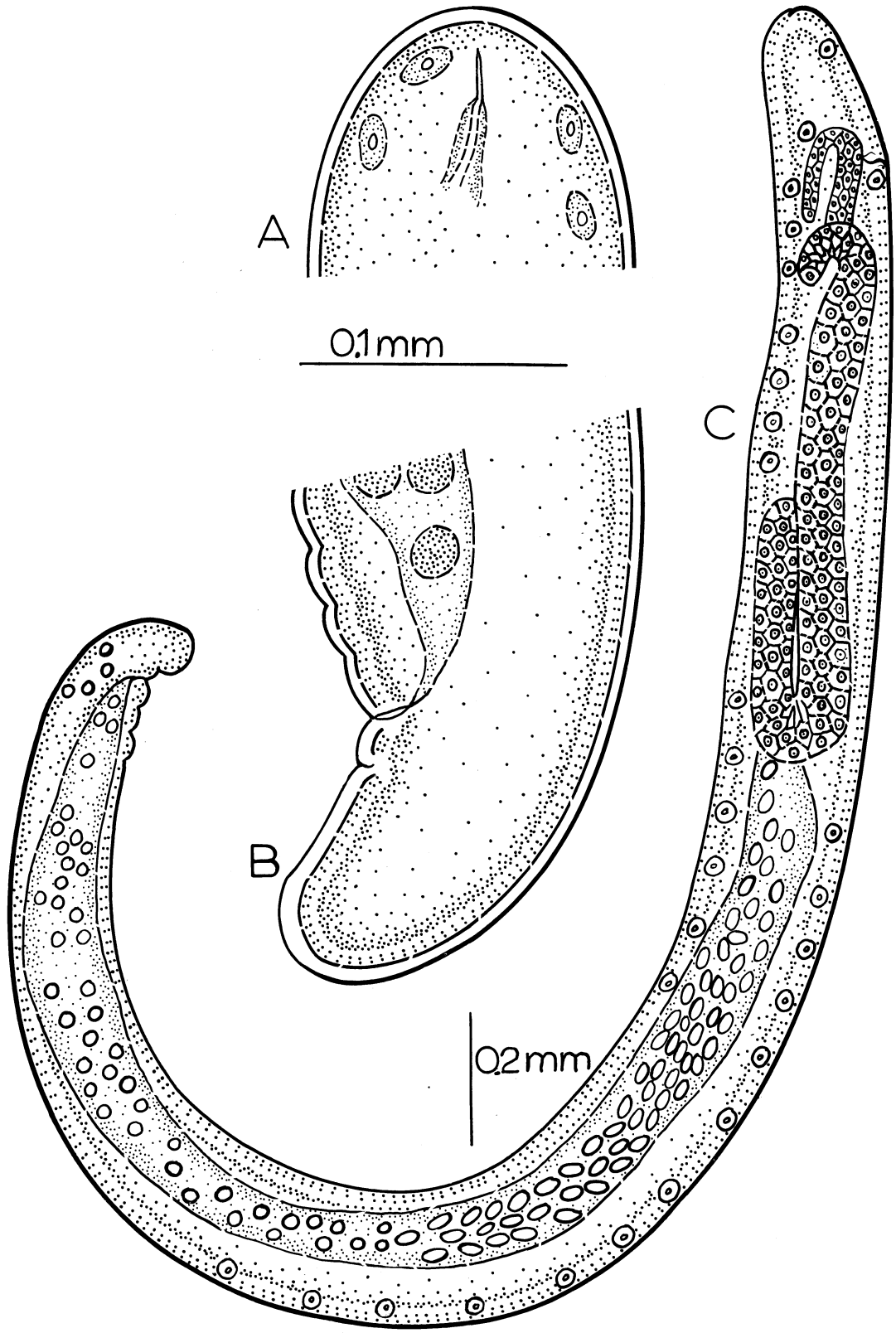


Figure 15.—***Parasitylenchus parasitus*** **n. sp.:** ***A.*** **Parasitic female, head;** ***B.*** **parasitic female, tail;** ***C.*** **mature parasitic female.**

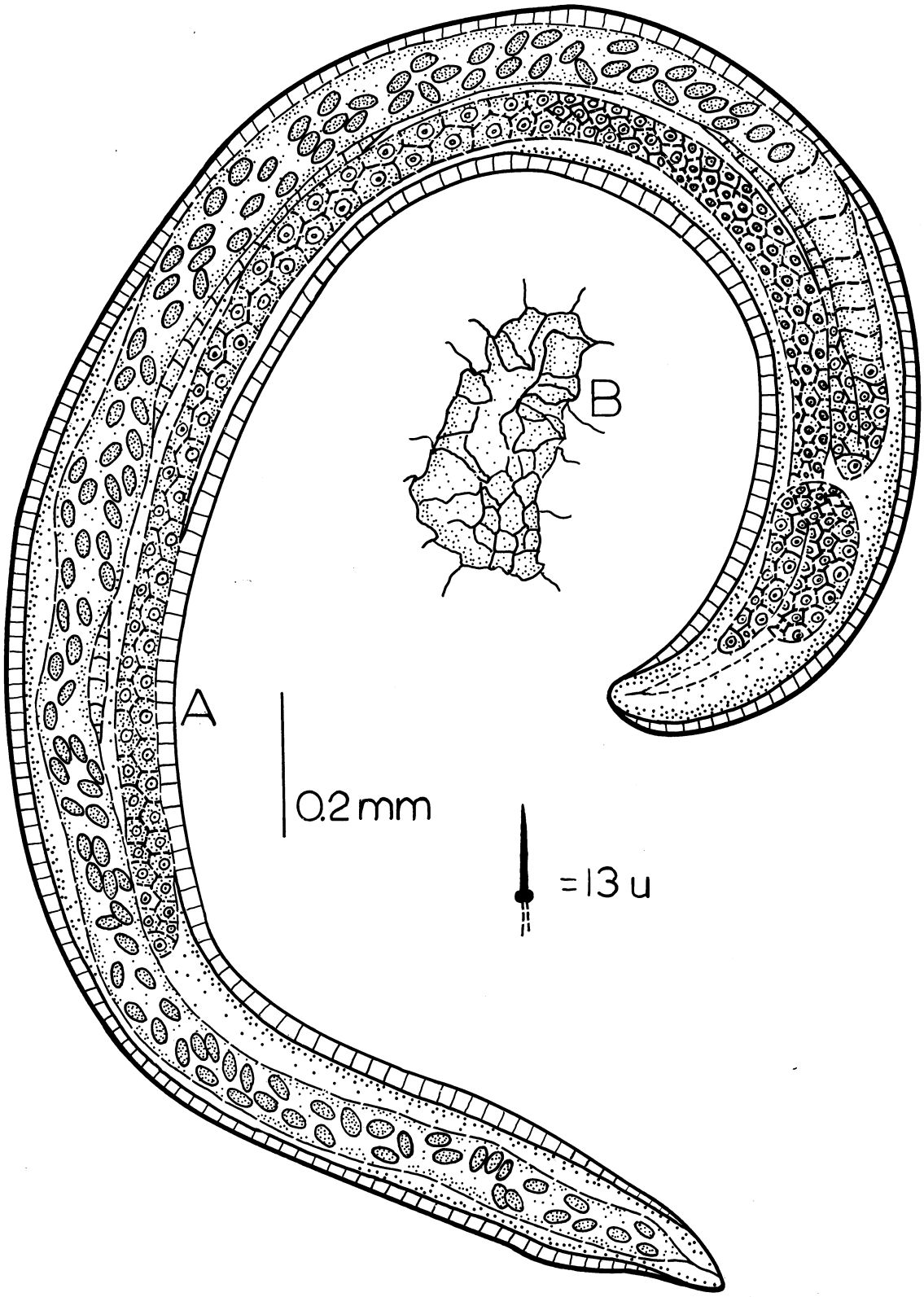


Figure 16.—*Parasitylenchus pilifronus* Massey, 1958: *A.* Mature parasitic female; *B.* hypodermal pattern; *C.* stylet.

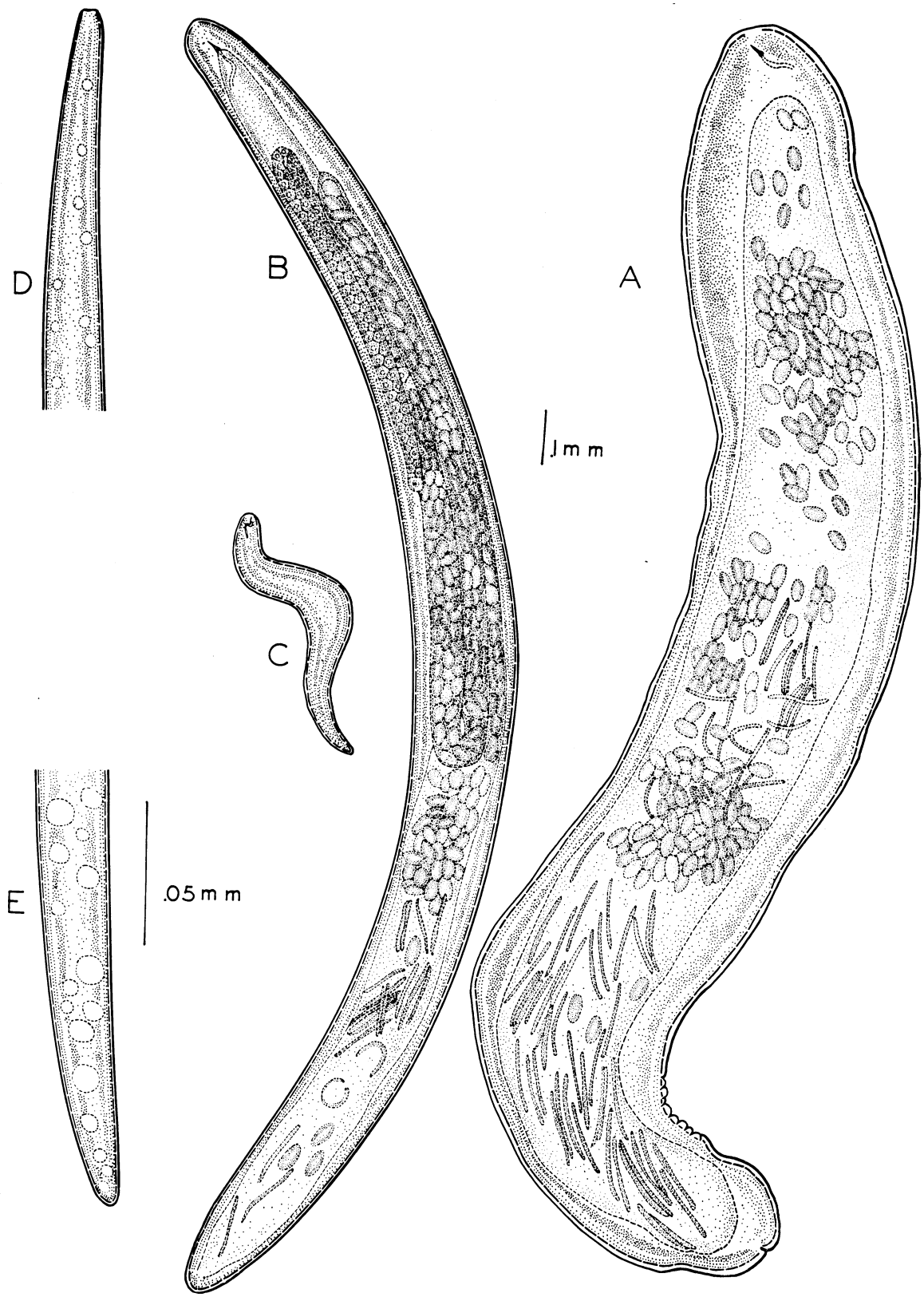
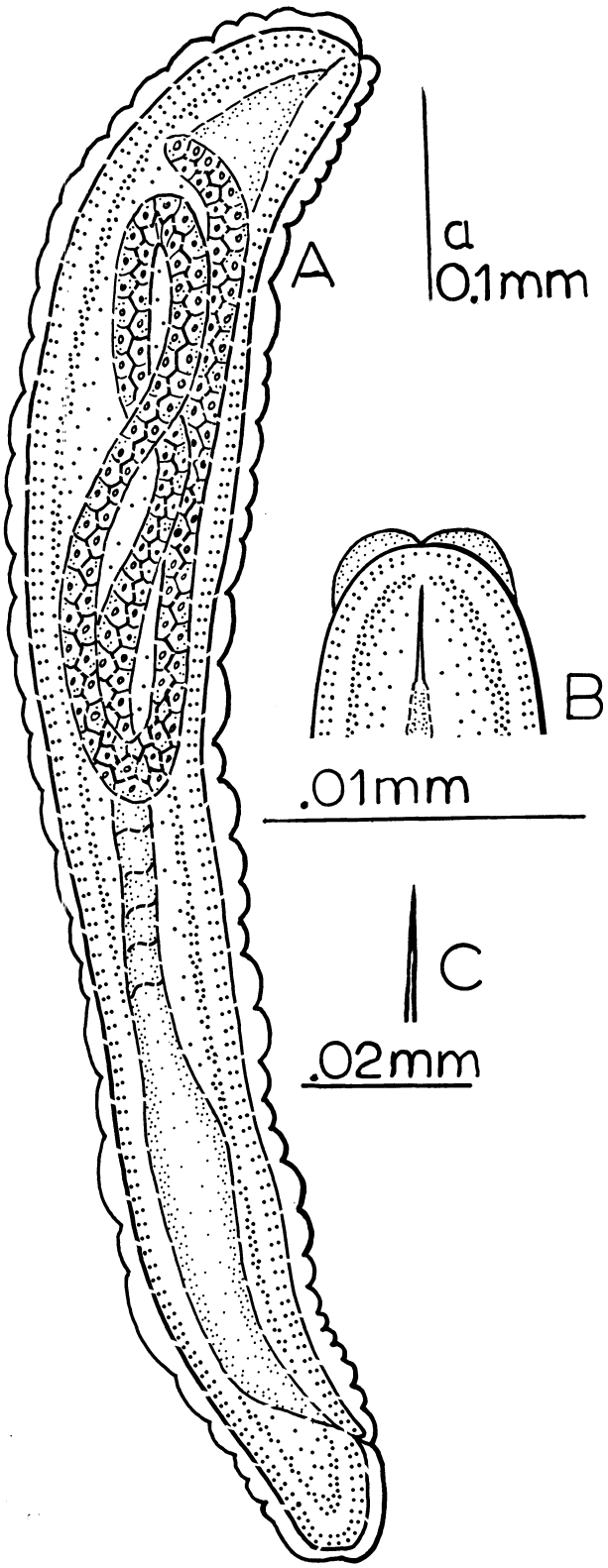


Figure 17.—*Parasitylenchus scrutillus* Massey, 1964: *A.* Mature parasitic female; *B.* juvenile parasitic female; *C.* developing parasitic female; *D.* first-stage larvae, head and neck; *E.* first-stage larvae, tail.



coarse transverse striations, undulant. Lip region partially enveloped by body expansion. Stylet coarse, without basal knobs, 10–11 μ in length, often displaced by development of sexual organs. Stoma obscure. Esophagus traceable for only a short distance from base of stylet. Vulva slightly anterior to terminus. Ovary single, reflexed several times. Anus and rectum not discernible. Terminus broadly rounded. Ovoviviparous.

Newly hatched larvae:	Length	Width
	0.25 mm	17 μ
	0.29 mm	20 μ

Body straight, cylindroid, filled with fat bodies. Cuticle with very fine transverse striations. Lip regions distinguished by 4 cuticular folds. Cephalic framework indistinct. Stylet fine, without basal knobs, 6 μ in length. Neck set off by slight constriction. Excretory pore 3–4 body widths posterior to head. Anus and rectum not discernible. Tail conoid to broadly rounded terminus.

Diagnosis.—Distinguished from other members of the genus by its very small size and cuticular folds at lip region of newly hatched larvae.

Type host.—Body cavity of *Pityophthorus* sp.

Type locality.—Mt. Taylor, New Mexico.

Type specimens.—Collection No. 35-L.

Parasitylenchus stipatus **Massey, 1966** **Figure 19**

Mature parasitic females: Length = 5.0–7.25 mm; Width = 0.25–0.28 mm.

Cuticle smooth, thick. Head rounded in some specimens, flattened in others. Stylet 15–16 μ in length, with prominent knobs, displaced and evidently nonfunctional. Esophagus a straight tube, the lumen traceable for only a short distance from base of spear. Ovary single, reflexed several times, in many specimens occupying most of body cavity, the posterior end filled with first-instar larvae. Vagina a faintly visible transverse slit only 1 body width anterior to terminus. Anal opening at terminus.

Free-living males: 1.25–1.41 mm; a = 44–47; b = 5.0; c = 13.0–13.8.

Cuticle with very faint transverse striations,

Figure 18.—*Parasitylenchus senicus* n. sp.: *A.* Mature parasitic female; *B.* newly hatched larva, head; *C.* stylet.

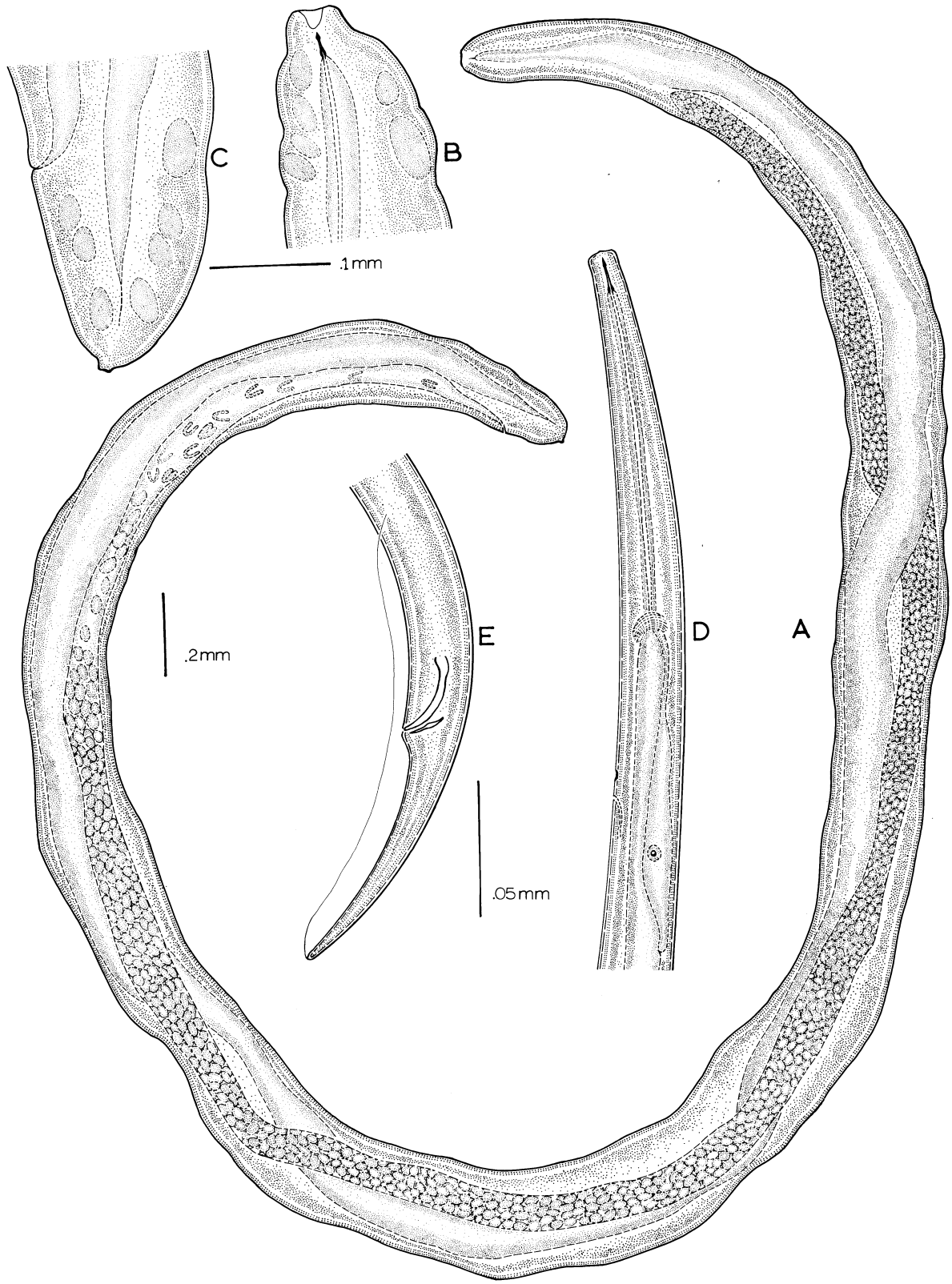


Figure 19.—*Parasitylenchus stipatus* Massey, 1966: *A.* Mature parasitic female; *B.* parasitic female, head; *C.* parasitic female, tail; *D.* male, head and neck; *E.* male, tail.

interrupted by 2 widely spaced lateral incisures. Lip region hardly set off, lips distinct. Stylet 12 μ in length, slender, with prominent basal knobs. Dorsal esophageal gland 5 body diameters long, joining esophagus at nerve ring. Nerve ring 5 body diameters behind base of lips. Excretory pore 3 body diameters posterior to nerve ring. Hemizonid immediately anterior to excretory pore. Testis single, outstretched. Spicules paired, arcuate. Gubernaculum platelike, slightly more than one-third length of spicules. Bursa envelops tail. Terminus finely rounded.

Diagnosis.—Parasitic females are similar in character to *Parasitylenchus elongatus* Massey, 1958, but differs in the discernible vulval and anal opening and greater length and width of *P. stipatus*. Free-living males of *P. stipatus* differ from males of *P. elongatus* in length and shape of tail, greater body width, and prominence of dorsal esophageal gland.

Type host.—*Dendroctonus adjunctus* Blandford.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 35-C (Allotype); 35-E (Holotype).

***Parasitylenchus undulatus* n. sp.** **Figure 20**

Parasitic females:	Length	Width
	1.59 mm	82 μ
	1.48 mm	91 μ
	1.68 mm	132 μ
	1.75 mm	74 μ

Body cylindroid. Cuticle relatively thick, smooth, undulant. Lip region variable in shape, flat to rounded in some specimens, partially overgrown by body expansion. Stylet exceedingly slender, with small basal knobs, at times displaced by growth of internal organs, 9 μ in length. Stoma obscure but visible in most specimens. Esophagus visible for only short distance posterior to stylet attachment. Vulva approximately 1 body width anterior to terminus. Ovary single, reflexed many times. Anal opening terminal. Tail with a titlike terminus in most specimens. Oviparous.

Diagnosis.—Differs from other species in the genus in the exceedingly fine stylet and the distinctive undulant cuticle.

Type host.—Body cavity of *Pseudohylesinus nebulosus* (Lec.).

Type locality.—Cibola National Forest, New Mexico.

Type specimens.—Collection No. 35.

Genus *Contortylenchus* Rühm, 1956

Type species: *Contortylenchus diplogaster* (Linstow, 1890) Rühm, 1956

Free-living males and females: Body cylindroid, usually slender. Lips usually continuous with body contour. Cuticle smooth or with transverse striae, with or without lateral incisures. Stylet well developed, with or without basal knobs or thickenings, male stylet usually more slender than female. Esophagus with or without extended glands, when present obscure. Vulva distinct. Ovary single, posterior portion packed with refractive spermatozoa. Anus and rectum obscure. Tail conoid to a variable-shaped terminus. Males: Testis single, posterior portion packed with developing spermatozoa. Spicules and gubernaculum tylenchoid. Bursa peloderan. Tail conoid to acute or subacute terminus.

Parasitic females: Large bodied, short and stout or long and sinuous. Cuticle with or without transverse striations. Lip region usually conical, but may be broadly rounded with lips actually overgrown by body development. Stylet relatively stout, with or without basal knobs, never displaced by ovarial development. Esophagus usually traceable through entire length, juncture with intestine obscure. Ovary single, reflexed many times. Oocytes arranged in from 2–3 rows. Uterus long, containing many eggs in mature specimens, anterior portion acting as spermatheca. Tail dorsally arcuate. Vulva usually a deep depression. Vagina comparatively short. Anus and rectum usually visible but obscure. Terminus with or without mucro. Oviparous.

Tail conformation in parasitic females are of considerable aid in distinguishing the various species occurring in the United States. Tails for each species are illustrated in figure 21.

A. *Contortylenchus elongatus*
B. *C. grandicolli*
C. *C. terebranus*
D. *C. brevicomi*
E. *C. cribicolli*
F. *C. reversus*
G. *C. spirus*
H. *C. orthotomici*
I. *C. pityophthori*
J. *C. bullus*

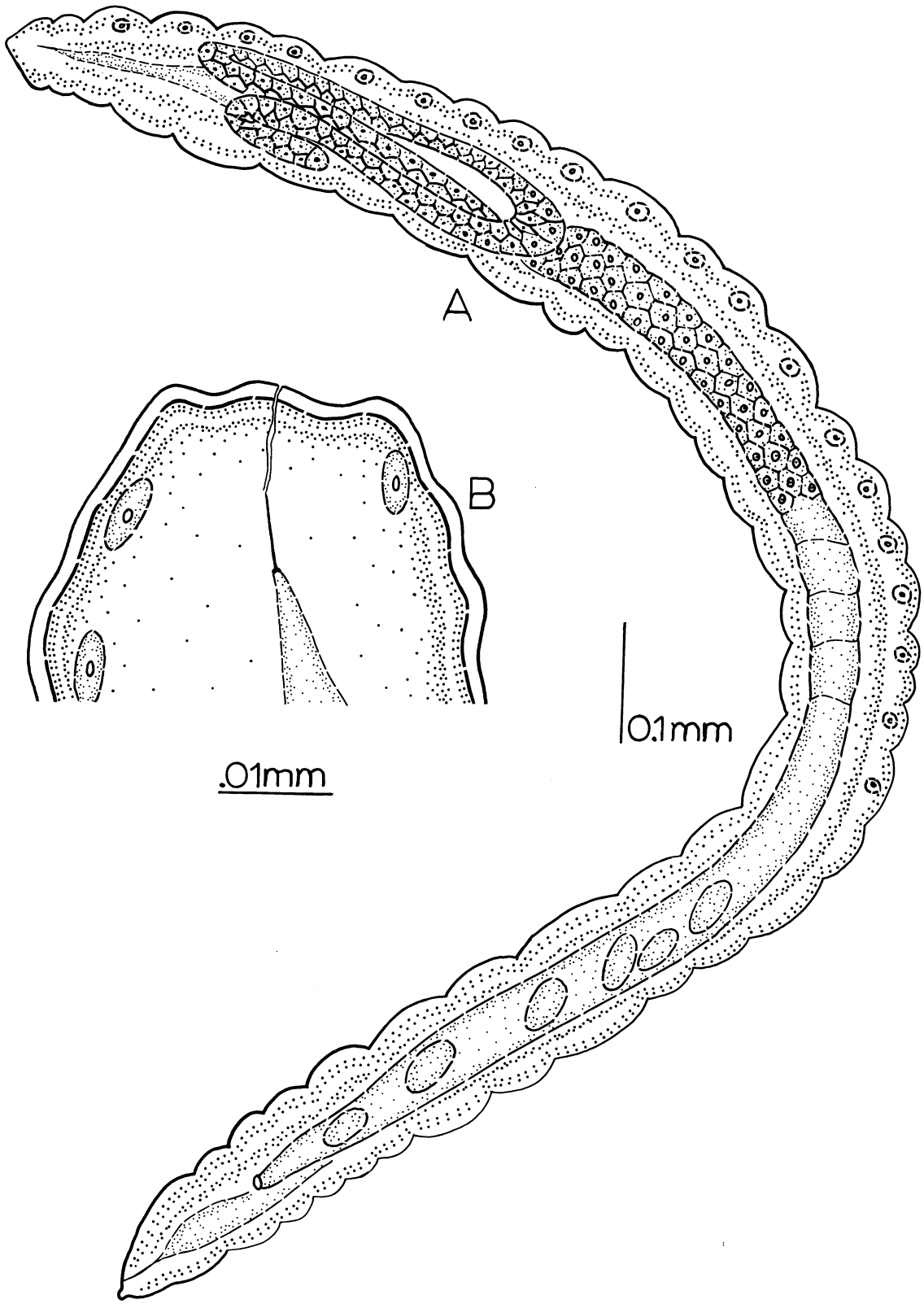


Figure 20.—*Parasitylenchus undulatus* n. sp.: *A.* Parasitic female; *B.* parasitic female, head.

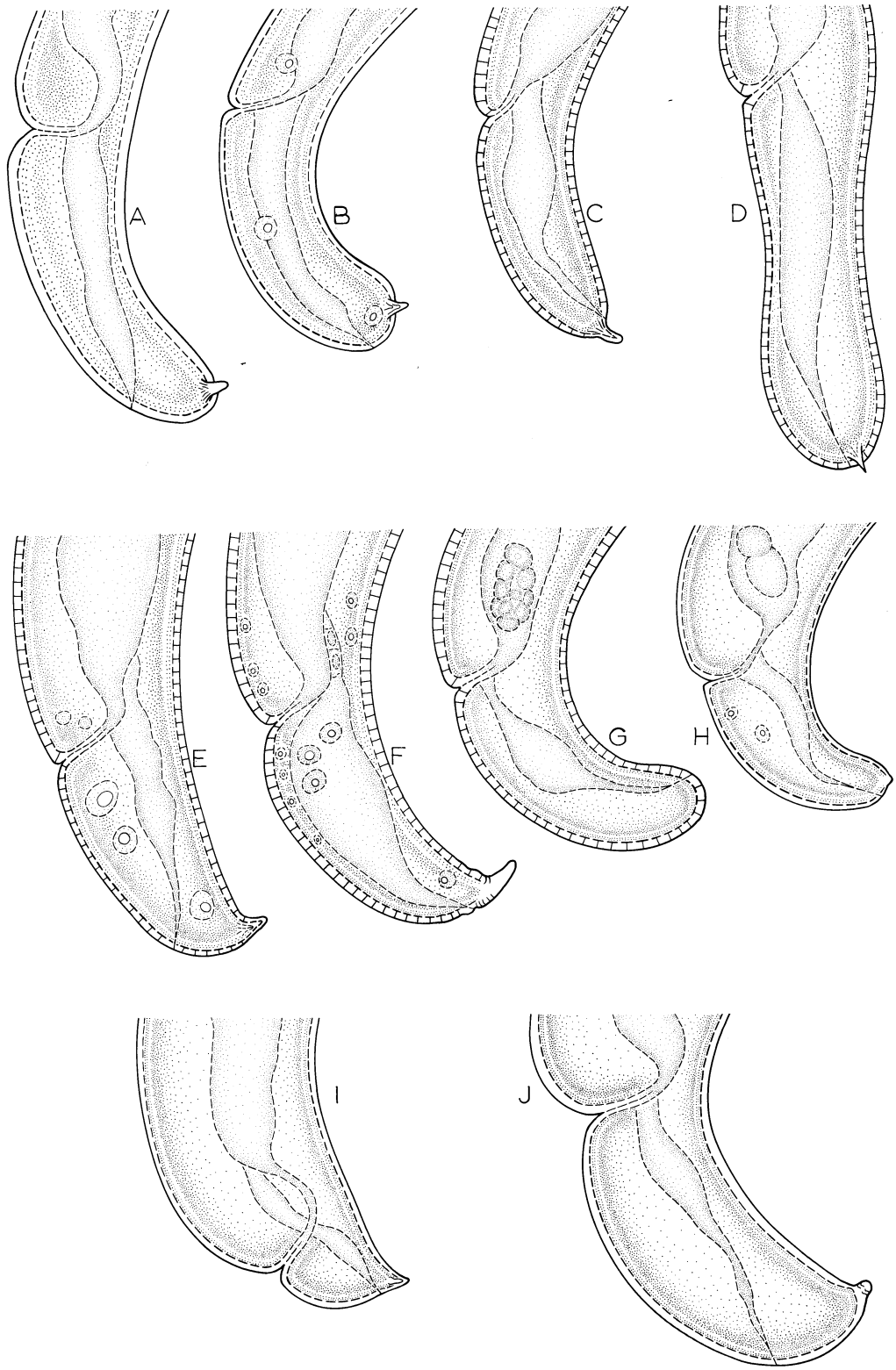


Figure 21.—Tails for each species: *A. Contortylenchus elongatus*; *B. C. grandicolli*; *C. C. terebranus*; *D. C. brevicomi*; *E. C. cribicolli*; *F. C. reversus*; *G. C. spirus*; *H. C. orthotomici*; *I. C. pityophthori*; *J. C. bullus*.

***Contortylenchus brevicomi* (Massey, 1957) Rühm, 1960** **Figure 22**

Synonym: *Contortylenchus barberus* (Massey, 1957) Rühm, 1960.

Eggs deposited before segmentation, 20 x 50 μ, laid in body cavity of infected beetles.

First-stage larvae: Length=0.4–0.5 mm; Width=20 μ; a=17; b=4.8; c=?

Cuticle very finely striated, lip region rounded and expanded. Spear very slender, minutely knobbed. Esophagus a narrow tube. Nerve ring prominent. Excretory pore slightly posterior to nerve ring. Genital primordia apparent. Anal opening not discernible.

Parasitic females: Length=2.1–3.9 mm; Width=70–120 μ.

Body bent dorsally, tapering conspicuously toward head. Cuticle thick, moderately to coarsely striated, becoming annulated at the anterior end, annules more apparent in some specimens. Body ventrally constricted at vulva. Tail broad, obtuse with a distinct mucro. Length from posterior end to vulva 70 μ. Spear slender, short, with or without knobs. Esophagus a straight tube. Lumen of the esophagus distinct for only a short distance from the spear. Ovary outstretched, about three-fourths as long as body. Vagina a broad transverse slit. Spermatheca present, filled with spermatozoa. Anal opening obscure.

Male: Length=0.65–0.85 mm; Width=10 μ; a=56; b=?; c=21; T=56–72.

Body much more slender than that of female, tapering slightly toward anterior end. Cuticle finely to moderately striated. Spear slender, approximately as long as body at its greatest width, knobs distinct. Esophagus a straight tube without bulb, narrowing as it passes through the prominent nerve ring. Excretory pore slightly posterior to nerve ring. Testis outstretched. Vas deferens distended with spermatozoa. Spicula curved, about one-half as long as tail. Gubernaculum thin, troughlike, slightly curved. Bursa enveloping tail, extending forward to a point slightly anterior to spicula.

Males are not parasitic and are found only in galleries of the host.

Diagnosis.—*Contortylenchus* with dorsally bent body, distinct mucro, moderately to coarsely striated cuticle, cuticle thick.

Type host.—*Dendroctonus brevicomis* Lec. Parasitic females also collected from *Dendroctonus frontalis.*

Type locality.—Salmon National Forest, Idaho.

Type specimens.—Collection No. 7A-2.

***Contortylenchus bullus* n. sp.** **Figure 23**

	Length	Width	V	Vulva-Terminus
Parasitic females:	1.09 mm	79 μ	92%	82 μ
	1.21 mm	82 μ	92%	88 μ
	1.22 mm	70 μ	91%	102 μ
	1.27 mm	94 μ	92%	97 μ
	1.58 mm	97 μ	92%	120 μ
	1.67 mm	82 μ	91%	138 μ

Body posture circular. Cylindroid. Cuticle moderately thick, with moderate to coarse transverse striations. Lip region conelike. Cephalic framework indistinct. Stylet coarse, 12 μ in length, with distinct basal knobs. Lumen of esophagus traceable for a short distance from the base of spear. Vulva moderate to shallow constriction. Vagina transverse. Ovary single, reflexed several times. Anus one-half body width anterior to terminus. Tail broadly rounded to a short, nipplelike mucronate terminus.

Diagnosis.—Distinctive shallow vulval depression and characteristic obtuse nipplelike mucro distinguish this species from other members of the genus.

Type host.—Parasitic in body cavity of *Hylurgops pinifex.*

Type locality.—Caroline County, New York.

Type specimens.—Collection No. 35-Q.

***Contortylenchus cribicolli* n. sp.** **Figure 24**

	Length	Width	V	V-T
Parasitic females:	1.56 mm	79 μ	94%	91 μ
	1.73 mm	108 μ	93%	111 μ
	1.97 mm	108 μ	94%	117 μ
	2.16 mm	88 μ	94%	120 μ

Body dorsally arcuate, usually forming a near complete circle. Cylindroid. Lateral striae moderately fine to coarse. Lip region conical, not set off. Cephalic framework indistinct, but visible. Usually visible spear relatively slender, with distinct basal knobs or thickenings, 9 μ in length. Lumen of esophagus visible for a short distance from base of spear. Dorsal esophageal gland outlet not observed. Vulva forming a shallow cleft, almost continuous with body wall. Vagina slightly oblique. Ovary single, reflexed

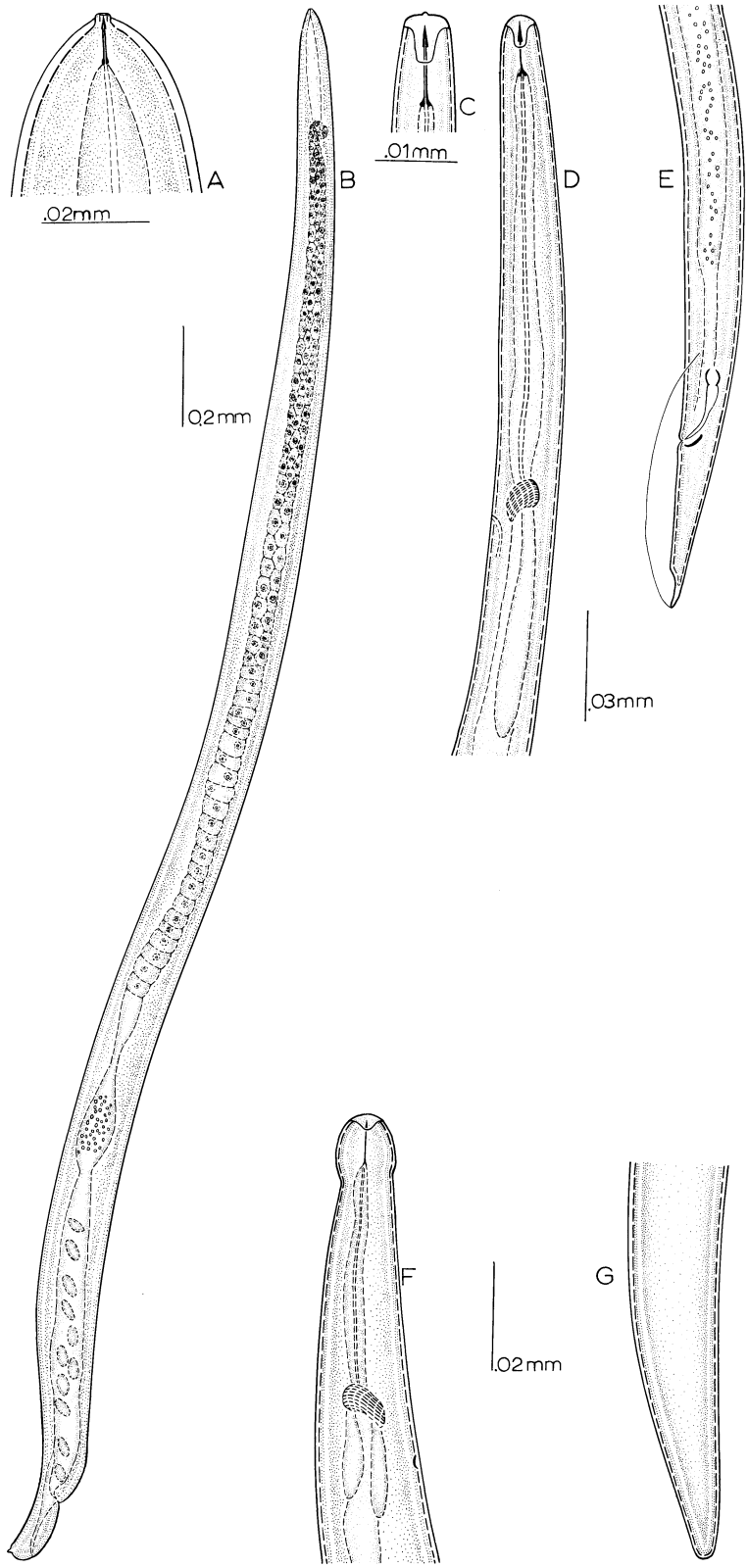


Figure 22.—*Contortylenchus brevicomi* (Massey, 1957) Rühm, 1960: *A.* Parasitic female, head; *B.* parasitic female; *C.* male, head; *D.* male, head and neck; *E.* male, tail; *F.* larva, head and neck; *G.* larva, tail.

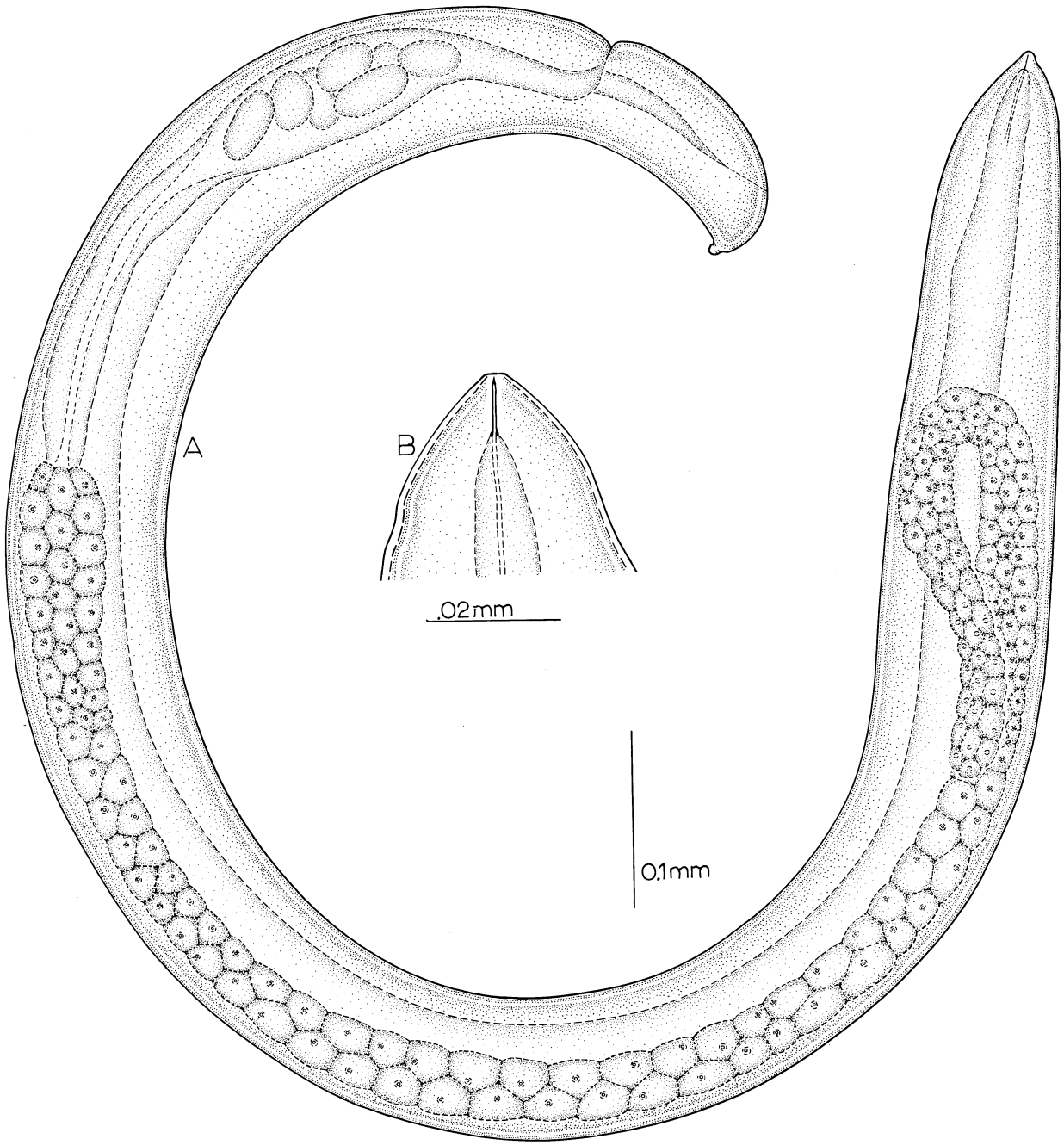


Figure 23.—*Contortylenchus bullus* n. sp.: *A.* Parasitic female; *B.* head.

several times in some specimens. Anal opening slightly anterior to terminus. Rectum obscure. Tail conoid to a broadly rounded terminus with a small dorsally located mucro.

Diagnosis.—Related to *Contortylenchus reversus;* differs in the shallow vulva opening, shape of tail from vulva to terminus, and its generally larger size.

Type host.—Body cavity of *Ips cribicollis* (Eichh.).

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 35-O.

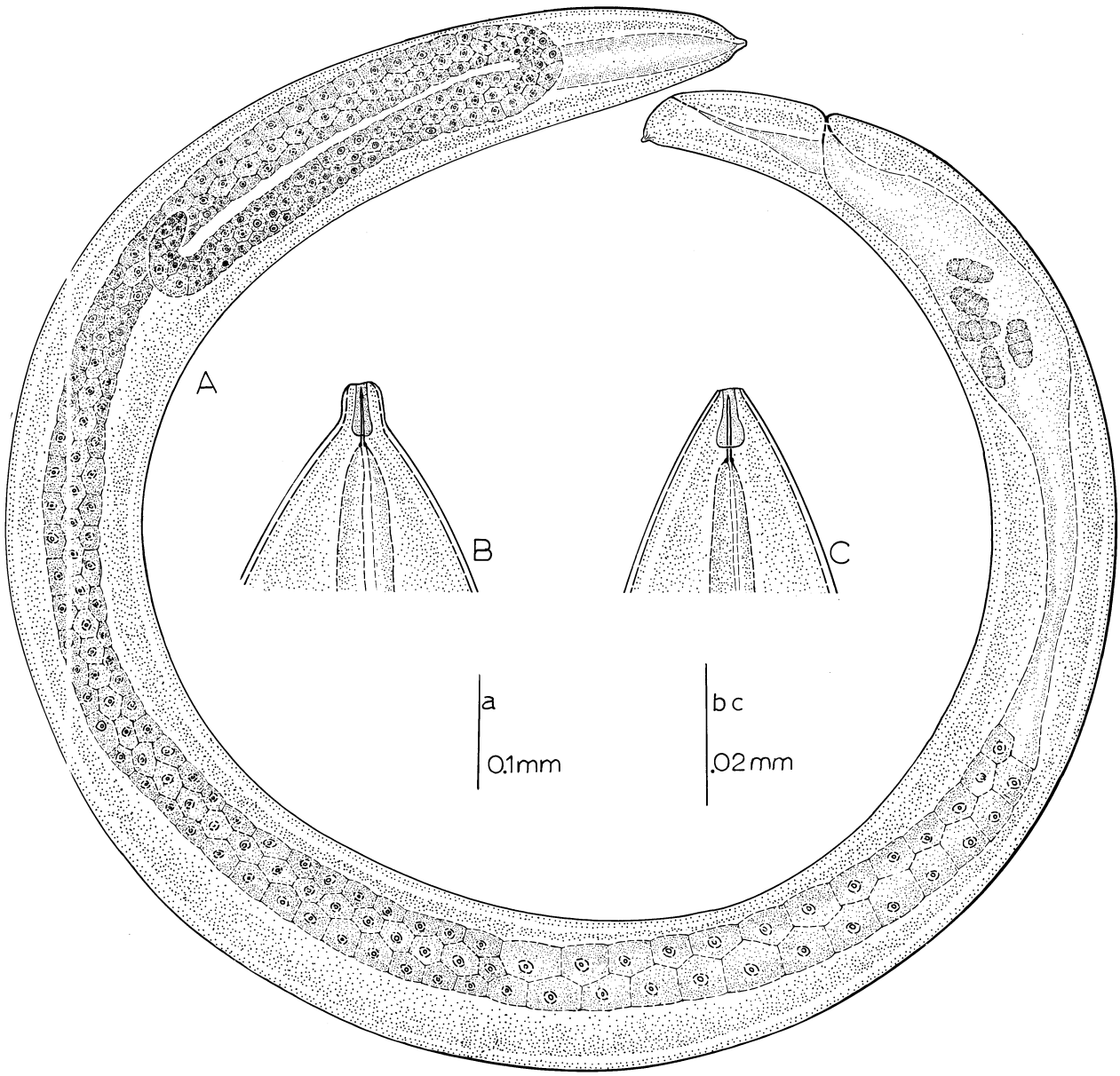


Figure 24.—*Contortylenchus cribicolli* n. sp.: *A.* Parasitic female; *B.* head; *C.* head.

***Contortylenchus elongatus* (Massey, 1960) Nickle, 1963**
Figure 25

Immature females: Length = 0.78 mm; Width = 43 μ.

Cuticle very finely striate, becoming almost annulate in head region. Body tapering only slightly toward head, beginning to constrict ventrally and bend slightly dorsally near vulva. A series of cells with very large nuclei at times extending the entire length of the body. Lip region narrowly rounded. Spear 14 μ in length, finely knobbed. Esophagus a narrow tube; lumen of esophagus traceable, posterior to prominent nerve ring. Genital primordia extending halfway to anterior end. Vagina a

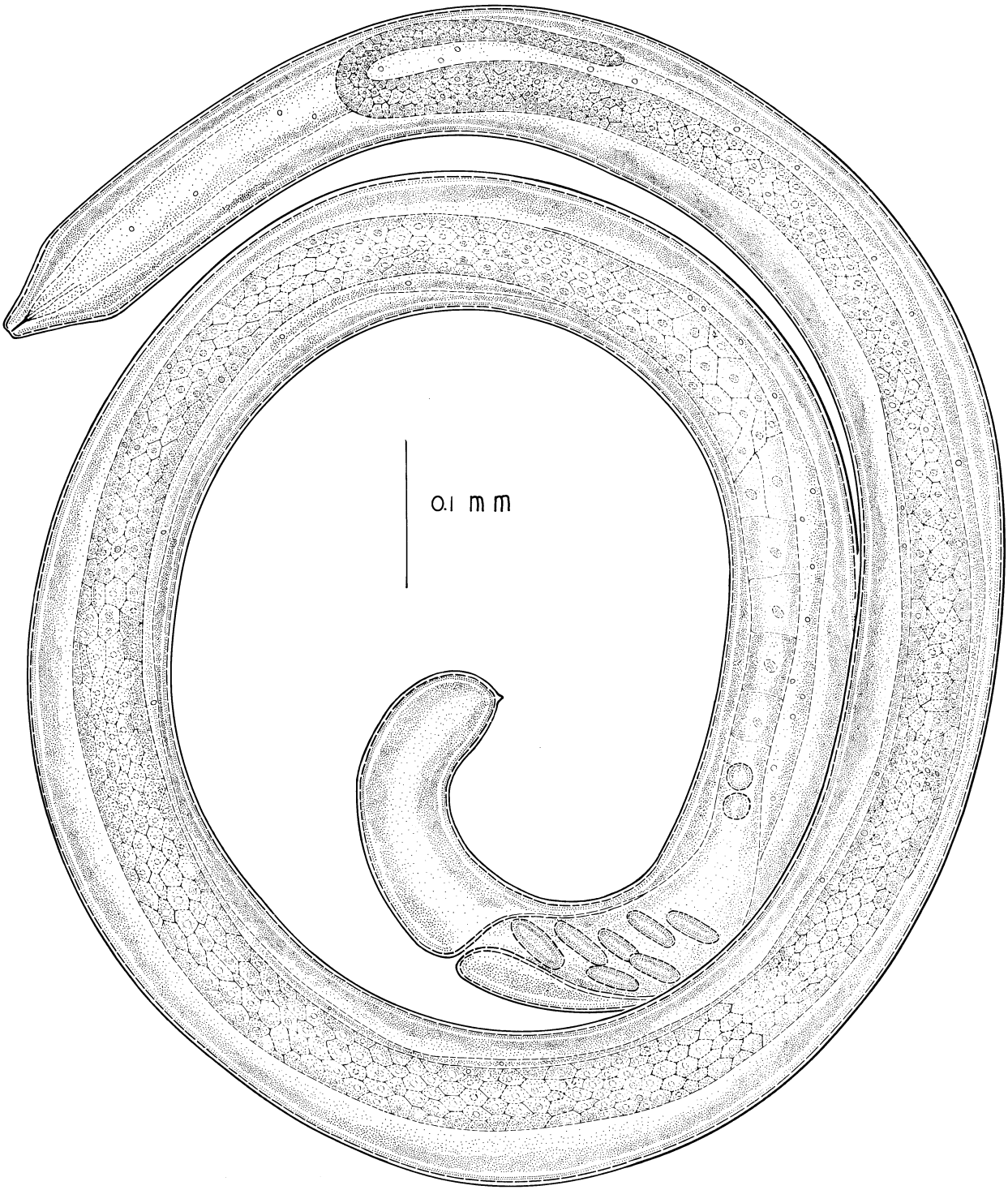


Figure 25.—*Contortylenchus elongatus* (Massey, 1960) Nickle, 1963.

prominent broad transverse slit; terminus to vulva 70 μ. Anal opening not discernible. Terminus narrowly rounded.

Mature parasitic females: Length = 4.25–6.3 mm; Width = 0.12–0.14 mm.

Cuticle moderately thick, transversely striated, the striations coarser in head region. Body tapering slightly toward head, bent dorsally near vulva. Body tends to coil when nema is killed by heat. Spear 14 μ in length. Lumen of esophagus visible for only a short distance from spear. Ovary reflexed at times one-half body length. Vagina a broad transverse slit. Anal opening not discernible. Tail broad, obtuse with distinct mucro. Length from terminus to vulva 360–450 μ.

Male: Length = 0.68 mm; a = 26; b = 6; c = 18.

Head as figured. Lip region rounded. Cuticle with fine transverse striations. Spear moderately coarse, knobbed, 14 μ in length. Esophagus beginning as a straight tube, narrowing as it passes through nerve ring, broadening into a ventrally lobed nonvalvular bulb. Excretory pore adjacent to bulb. Testis outstretched, at times almost reaching bulb of esophagus. Spicules paired, tylenchoid. Gubernaculum thin, troughlike, almost straight. Tail with a sharp mucronate tip, bursa enveloping tail and extending forward well beyond anterior end of spicula.

Type host.—*Ips confusus* (Lec.).

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 26-R.

Contortylenchus grandicolli **(Massey, 1957) Rühm, 1960** **Figure 26**

Larvae from body cavity: Length = 0.49–0.54 mm.

Body with slight ventral arcuation or straight, cylindroid. Cuticle relatively thick with moderately coarse transverse striations. Lip region rounded, not set off. Cephalic framework sclerotized. Stylet very slender, with or without basal thickenings, ca 10 μ long. Dorsal esophageal gland outlet not discernible. Several large glandular structures, variable in length, extending posteriorly from base of stylet, extended esophageal glands prominent and terminating ca 1½ body widths posterior to nerve ring. Nerve ring very prominent. Excretory pore not observed. Hemizonid immediately posterior to nerve ring. Genital primordia as figured. Anal opening discernible. Rectum usually obscure. Tail conoid to rounded terminus.

Parasitic females: Length = 1.7–2.3 mm; Width = 90–120 μ.

Body cylindroid, strongly bent dorsally until almost circular in some specimens. Neck tapering gradually to the broadly rounded lip region. Body cylindrical throughout, narrowing only slightly at extremities. Tail broadly rounded with small mucro. Cuticle thick, with moderate to coarse transverse striations. Some specimens with annules in head region. Four large glands present in head, their outlets not discernible. Spear slender, variably knobbed. Stylet length 11 μ. Esophagus a straight tube, lumen traceable for only a short distance from spear. Gut visible for entire length. Anal opening not discernible. Ovary usually outstretched but occasionally reflexed, occupying approximately two-thirds of body length. Spermatheca present, filled with spermatozoa. Vagina a broad transverse slit. Distance from posterior end to vulva 190–260 μ.

Diagnosis.—*Contortylenchus* with body strongly bent dorsally. Lip region broadly rounded. Tail with small mucro. Cuticle thick, strongly striated.

Type host.—*Ips grandicollis* (Eichh.).

Type locality.—Talladega National Forest, Alabama.

Type specimens.—Collection No. 26-F.

Contortylenchus orthotomici **n. sp.** **Figure 27**

	Length	Width	V	V-T
Parasitic females:	1.00 mm	64 μ	93%	67 μ
	1.02 mm	83 μ	93%	67 μ
	1.07 mm	79 μ	93%	64 μ
	1.13 mm	79 μ	92%	68 μ

Body posture a complete circle, cylindroid. Cuticle relatively thin with fine transverse striae, especially visible at head and neck. Lip region not set off, conical. Cephalic framework indistinct. Stylet moderately slender, 10 μ in length, with distinct basal knobs. Dorsal esophageal gland outlet obscure. Esophagus traceable for approximately a body width posterior to base of spear. Vagina prominent and transverse, one-half body width in length. Ovary single, reflexed in some specimens several times. Anal opening slightly posterior to terminus. Rectum obscure. Tail broadly rounded and

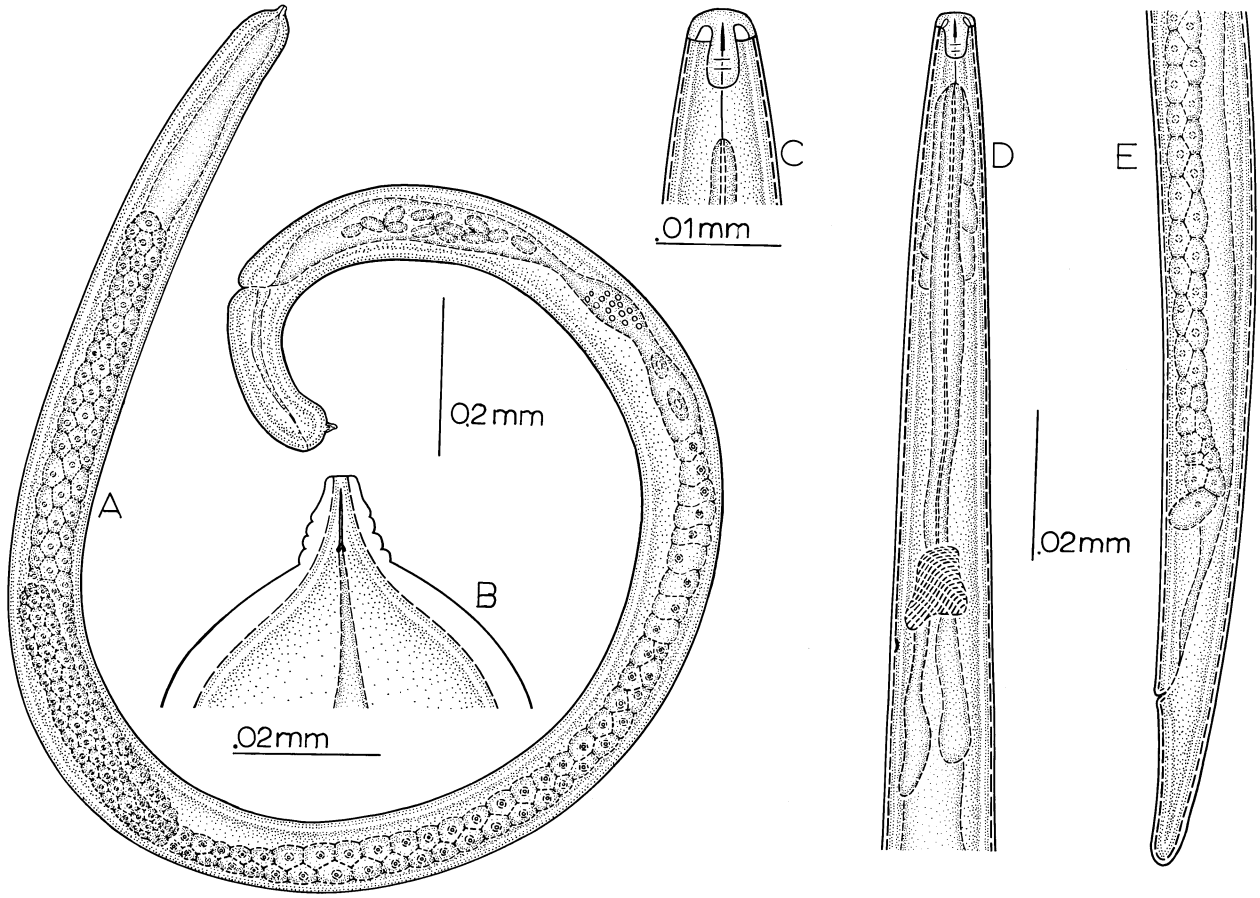


Figure 26.—*Contortylenchus grandicolli* (Massey, 1957) Rühm, 1960: *A.* Parasitic female; *B.* female, head; *C.* larva, head; *D.* larva, head and neck; *E.* larva, tail.

terminating in a small buttonlike mucro, in some specimens mucro absent. Oviparous.

Free-living sexual stages unknown.

Diagnosis.—*Contortylenchus* with slender stylet and deeply cleft vulva.

Type host.—Body cavity of *Orthotomicus caelatus.*

Type locality.—Hamden, Connecticut.

Type specimens.—Collection No. 35-S.

***Contortylenchus pityophthori* n. sp.** **Figure 28**

Parasitic females:	Length	Width	V	V-T
	0.44 mm	58 μ	91%	38 μ
	0.47 mm	64 μ	90%	47 μ
	0.50 mm	76 μ	90%	50 μ
	0.51 mm	58 μ	92%	38 μ
	0.53 mm	64 μ	91%	42 μ
	0.62 mm	91 μ	90%	58 μ

Body posture circular, cylindroid. Head and neck considerably narrower than body proper, with coarse transverse striae. Lip region narrowly rounded, cone-like. Cephalic framework indistinct. Spear 9 μ in length, with well developed basal knobs. Vagina a deep slit. Vagina oblique. Ovary single, reflexed several times, filling body cavity. Anal opening slightly anterior to terminus. Tail terminating in a large bluntly pointed mucro.

Larvae from body cavity: Length = 0.26–0.29 mm.

Body straight, cylindroid. Cuticle with fine transverse striations. Lip region rounded, slightly expanded. Cephalic framework lightly sclerotized. Stylet 9 μ in length, with distinct basal knobs. Extended esophageal glands terminating approximately 2 body widths posterior to nerve ring. Nerve ring prominent.

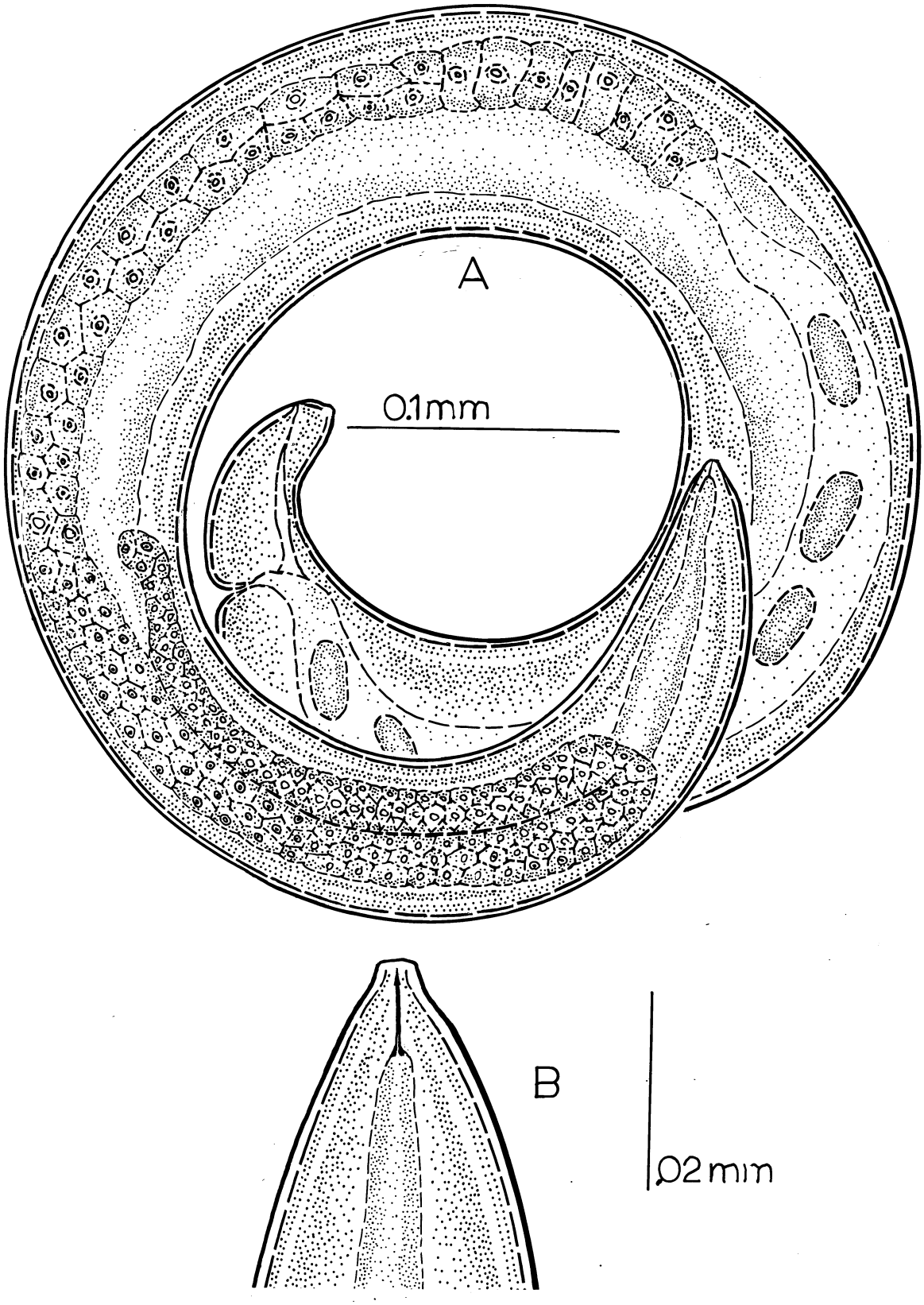


Figure 27.—*Contortylenchus orthotomici* n. sp.: *A.* Parasitic female; *B.* head.

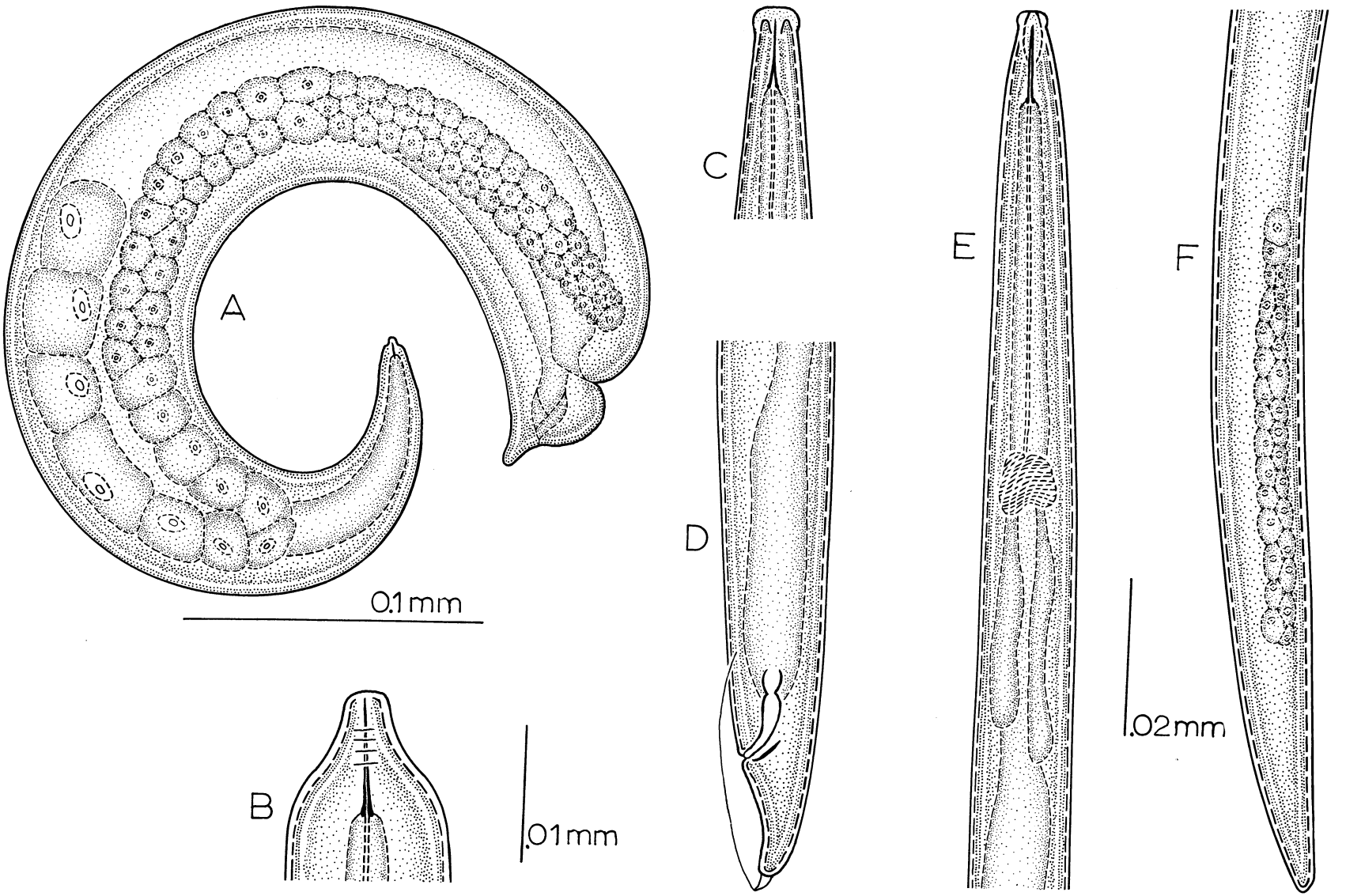


Figure 28.—*Contortylenchus pityophthori* n. sp.: *A.* Parasitic female; *B.* parasitic female, head; *C.* male, head; *D.* male, tail; *E.* larva, head and neck; *F.* larva, tail.

Genital primordia visible in posterior one-third of body cavity. Anal opening not observed. Tail conoid to a narrowly rounded terminus.

Males: Length = 0.29 mm; a = 19.53; b = 3.47; c = 23.1.

Body straight. Cylindroid. Lip region rounded, slightly expanded. Cephalic framework lightly sclerotized. Stylet 8 μ in length, with basal thickenings. Nerve ring prominent. Esophageal glands terminating 1–2 body widths posterior to nerve ring. Excretory pore not observed. Testis single, outstretched. Spicules and gubernaculum typically tylenchoid. Bursa joining body wall, slightly anterior to proximal end of spicules. Tail conoid to a heavily sclerotized mucronate terminus.

Males were taken from the body cavity of the host indicating that sexual development is complete before deposition in the host's gallery.

Diagnosis.—Differs from *Contortylenchus tomici* (Bovien, 1937) Rühm, 1956 in its generally smaller size and in shape and length of mucronate terminus.

Type host.—Body cavity of *Pityophthorus* sp.

Type locality.—Neola, West Virginia.

Type specimens.—Collection No. 35-N.

***Contortylenchus reversus* (Thorne, 1935) Rühm, 1956**
Figure 29

The following is Thorne's original description:

"Eggs: Deposited before segmentation. Size variable, 30 x 60 μ to 42 x 90 μ. Several hundred deposited by each female in the body cavity of the grub or adult beetle. Segmentation and hatching occur immediately after deposition.

"Newly hatched larvae: Length = 0.22–0.30 mm; Width = 12–16 μ.

"Cuticle finely striated. Lip region rounded and expanded. Tail conoid to the small blunt terminus. Spear exceedingly slender, without basal knobs. Esophagus a slender tube, narrowing as it passes through the nerve ring, then gradually expanding and merging with intestine. Excretory pore a little posterior to nerve ring.

"Second-stage larvae: Similar in appearance to young larvae except for uniformly tapering anterior end and developing gonads. Genital primordium visible at beginning of first molt, from which single ovary develops forward until it is about half as long as body, its terminus reflexed a distance equal to 3–5 body widths. A prominent gland usually is visible just back of nerve ring. During this stage little or no increase in body length but marked development in width.

"Intermediate forms between this stage and adults were not found. Apparently it is during this portion of the life cycle that the nemas leave their hosts and transfer to other beetles or grubs. However, none was found outside the bodies of the hosts and the method of transfer remains unknown.

"Females from grubs and adult beetles: Length = 1.0–1.8 mm; Width = 50–180 μ; V = 94–96%.

"Body bent dorsally, more or less cylindrical throughout greater part of its length, but tapering conspicuously to the very narrow lip region, which is not set off in any manner. Cuticle annulated near head and at terminus; on some specimens annules conspicuous, on others almost invisible. Body constricted at vulva, especially ventrally. Tail broad, bearing dorsal, hornlike, annulated terminal projection which actually is the upturned original tail of the immature nema. This "horn" apparently becomes upturned as body distends with growth of the internal organs, and pressure is relieved on the ventral side when the broad vulvar opening is formed at the last molt. Four labial papillae almost invisible even from a face view. Amphids lie close to oral opening. Four large glands are prominent features of head region. Spear 12–14 μ long, slender, with short ventrally located aperture. Knobs of spear vary from obscure to distinct. Lumen of esophagus visible only a short distance from spear. A series of 15–18 pairs of conspicuous lateral structures distributed throughout body. Vulva a broad transverse slit. Three glands lie opposite vulva, causing constriction of the organs. Anus and rectum obscure. Ovary extending forward about three-fourths length of body, then reflexed a distance equal to 1–2 body widths. Oviparous. Females generally burst when removed from the host.

"*Diagnosis.*—Oviparous. *Contortylenchus* with dorsally bent body bearing a prominent upright terminal "horn." A series of 15–18 pairs of conspicuous lateral structures distributed throughout the body."

Host.—Parasitic in the body cavity of *Dendroctonus ponderosae* Hopk.

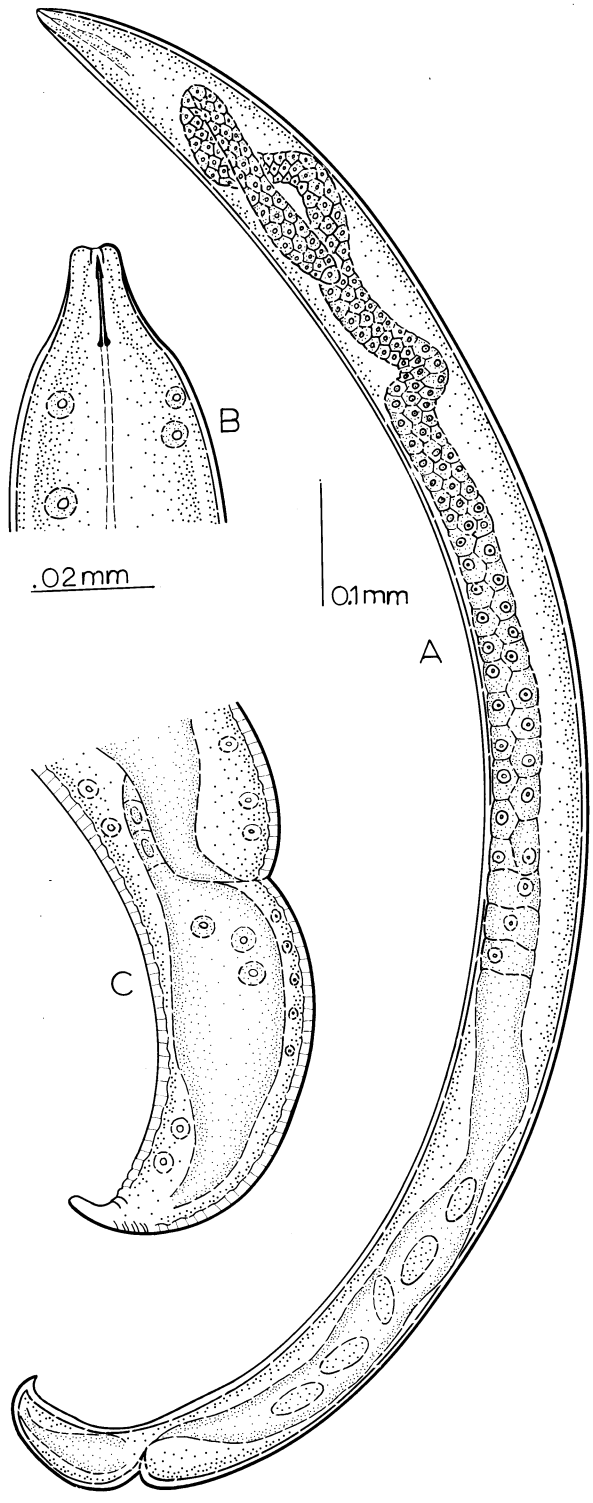


Figure 29.—*Contortylenchus reversus* (Thorne, 1935) Rühm, 1956: *A.* Parasitic female; *B.* head; *C.* tail.

***Contortylenchus spirus* (Massey, 1957) Rühm, 1960** **Figure 30**

Parasitic females: Length=2.70–2.75 mm; Width=100 μ.

Body assumes spiral shape when killed by heat, more or less cylindrical throughout but narrowing conspicuously in head region. Lip region narrowly rounded. Tail broadly rounded without mucro. Cuticle finely striated, annulated at anterior end in some specimens. Four large glands occupy large portion of head region, their outlets not traceable. Spear length 10 μ, slender, knobbed. Esophagus a straight tube, lumen traceable for only a short distance. Gut visible for entire length. Anal opening obscure. Ovary occupying three-fourths of body cavity, reflexed one to several times. Spermatheca not present and spermatozoa not observed in uterus. Vagina a broad transverse slit. Distance from posterior end to vulva 130 μ.

Eggs: 16 x 35 μ.

Diagnosis.—Contortylenchus with body formed in a springlike or spirallike shape. Four large glands prominent feature of head region. Lip region narrowly rounded. Tail broadly rounded without mucro. Apparently similar to *Contortylenchus diplogaster* (Linstow, 1890) Rühm, 1956 but differs in its larger size and absence of a caudal mucro.

Type host.—Ips pini. Some specimens of this species also have been collected from *Ips* spp. in New Mexico.

Type locality.—Uncompahgre National Forest, Norwood, Colorado.

Type specimens.—Collection No. 7-Q.

***Contortylenchus terebranus* n. sp.** **Figure 31**

Parasitic females:	Length	Width	V	V-T
	1.91 mm	70 μ	95%	114 μ
	2.07 mm	73 μ	94%	111 μ
	2.32 mm	64 μ	95%	108 μ
	2.38 mm	70 μ	95%	111 μ

Body posture in semicircle or coiled, cylindroid except at extremities. Cuticle thick with very coarse transverse striae. Lip region not set off, conical, in older specimens nose cone enveloped by body growth. Cephalic framework indistinct. Spear 10–11 μ in length, relatively coarse with distinct basal knobs or thickenings, becoming obscure in older specimens. Esophagus traceable for one to two body widths

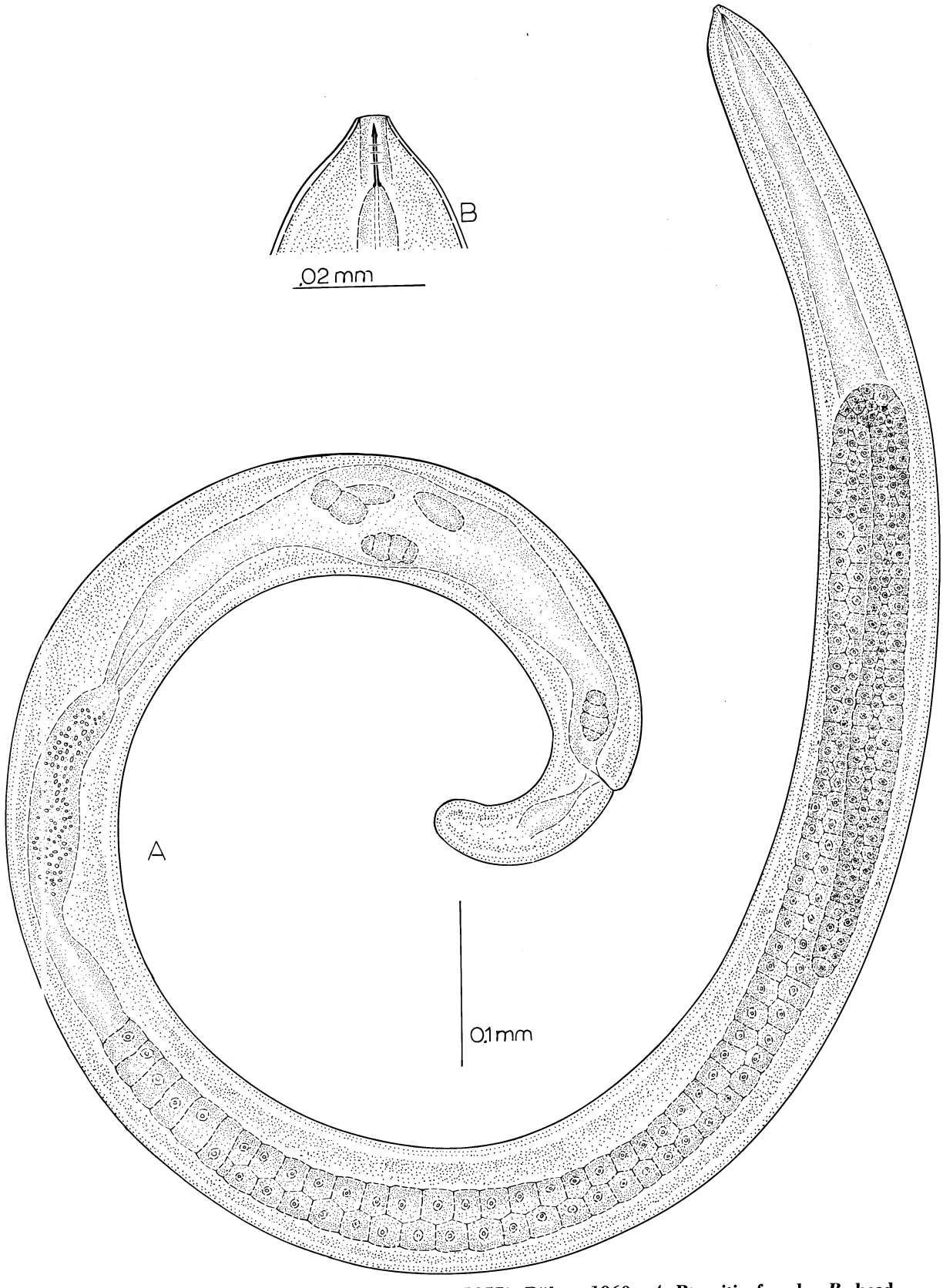


Figure 30.—*Contortylenchus spirus* (Massey, 1957) Rühm, 1960: *A.* Parasitic female; *B.* head.

from base of spear. Vulva very prominent; vagina oblique, approximately one-half body width in depth. Ovary single, outstretched and occupying most of body cavity in older specimens. Anus terminal, opening on dorsal side of mucro. Rectum indistinct. Tail broadly rounded with a heavily sclerotized, strongly developed mucro.

Infective-stage females: Length=0.48–0.52 mm; Width=15–16 μ.

Body posture straight, cylindroid. Cuticle comparatively thick, with very fine transverse striae. Lip region continuous with body contour, broadly rounded. Cephalic framework lightly sclerotized. Spear 13 μ in length, coarse, with well developed basal knobs. Dorsal esophageal gland outlet obscure. Excretory pore not observed. Nerve ring very prominent. Hemizonid not observed. Developing uterus filled with spermatoza. Anus and rectum obscure. Tail conoid to a narrowly rounded terminus.

Males: Length=0.49–0.61 mm; a=28–30; b=?; c=16.8–21.

Body posture straight, cylindroid. Cuticle relatively thick. Lateral striae very fine. Lip region continuous with body contour. Cephalic framework distinct, but lightly sclerotized. Stylet very slender, with or without basal thickenings, 10 μ in length. Esophageal glands obscure. Nerve ring very prominent. Excretory pore one-half body width posterior to nerve ring. Hemizonid not observed. Testis single, reflexed, posterior three-fourths filled with sperm cells. Spicules and gubernaculum typically tylenchoid. Bursa encompassing tail. Tail conoid, narrowly rounded to heavily sclerotized mucronate terminus.

Diagnosis.—*Contortylenchus* with distinctive lip region and with anal opening on dorsal side of mucronate terminus.

Type host.—Body cavity of *Dendroctonus terebrans* (Oliv.).

Type locality.—Lake City, Florida.

Type specimens.—Collection Nos. 7-V and 7-V-1.

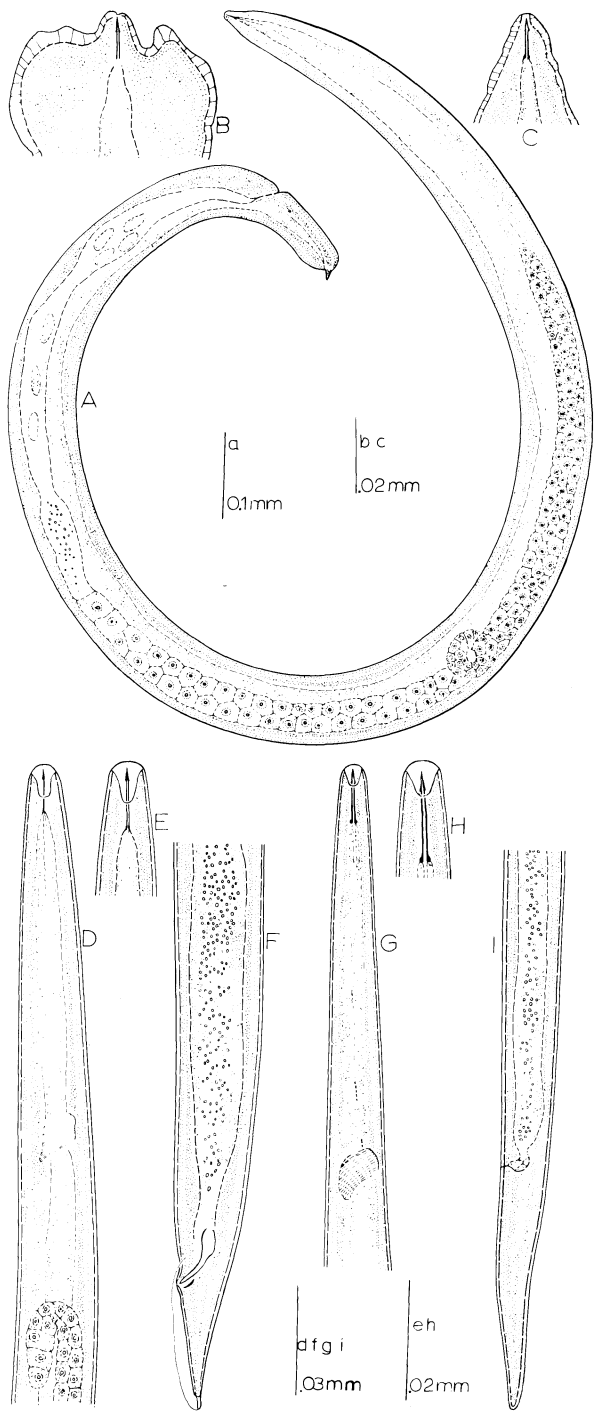


Figure 31.—*Contortylenchus terebranus* n. sp.: *A.* Parasitic female; *B.* head; *C.* head; *D.* male, head and neck; *E.* male, head; *F.* male, tail; *G.* infective-stage female, head and neck; *H.* infective-stage female, head; *I.* infective-stage female, tail.

Genus *Sphaerularia* Dufour, 1837

Type species: *Sphaerularia bombi* Dufour, 1837

Free-living forms: Cuticle with transverse striae. Lips continuous with neck region.

Cephalic framework indistinct. Stylet usually with basal knobs. Dorsal esophageal gland outlet discernible. Tail cylindroid to a narrowly rounded terminus. Spicules and gubernaculum tylenchoid. Bursa peloderan.

Parasitic females: Evaginated uterus is most prominent part of individual. As it protrudes from body wall cells enlarge and each contains prominent nucleus. Ovary is extruded with uterus and floats free in lumen. Females change little in size. However, as reproductive system extrudes, cuticle becomes wrinkled.

Sphaerularia dendroctoni **Massey, 1956** **Figure 32**

Synonym: *Sphaerulariopsis dendroctoni* (Massey, 1956) Nickle, 1963

Eggs: Deposited after segmentation, size 40 $\times 80$ μ, developed in uterus outside body wall. Hatching occurs immediately after deposition.

First-stage larvae: Length=0.48–0.67 mm; Width=20–25 μ.

Cuticle very finely annulated; tail conoid, rounded at the terminus; spear moderately fine with basal knobs.

Second-stage larvae: Similar in appearance to first-stage larvae. Length=0.64–0.70 mm; Width=20–25 μ; genital primordia becomes apparent in this stage. Female larvae can be determined by enlargement of vagina.

Male: Length=0.70–0.78 mm; Width=20 μ; a=43.3; b=6; c=48.7; T=75.

Cuticle very finely annulated; lip region flat to slightly rounded, set off by a very slight constriction, or rather a narrowing of the neck region, a little wider than high. Spear moderately fine with basal knobs, slightly longer than width of lip region; excretory pore slightly posterior to nerve ring and located approximately one-fifteenth of body length from anterior end; hemizonid adjacent to excretory pore; esophagus without median bulb, constricted as it passes through nerve ring, ending in a cylindroid basal bulb which slightly overlaps the intestine on dorsal side. Bulb with 3 prominent nuclei generally visible; testis outstretched or reflexed, at times almost reaching excretory pore, the lower third distended with spermatheca; spicula curved, three-fourths as long as tail; gubernaculum thin, troughlike, almost straight, about one-fourth as long as spicula; tail conical with a small, rounded terminus; bursa enveloping tail, extending a short distance anterior to proximal end of spicules.

Immature females: Length=0.80 mm; Width=32 μ.

Cuticle finely annulated in younger specimens, becoming strongly wrinkled with age, very deep wrinkles at variable regions on cuticle giving the appearance of segmentation. Lip region similar to that of male; ovary reflexed nearly half its length in some individuals; vulva narrow transverse slit, becoming greatly distended as genital organs descend within body cavity. Vagina protrudes as figured. Tail conical with small, rounded terminus.

Mature females: Uterus in this stage is the most prominent part of the individual. As it protrudes from the body wall, the cells enlarge to tremendous size, each with a prominent nucleus. Size of the uterus may reach a length of 1.6 mm and a width of 0.25 mm. Growth occurring outside body wall. Cells of the uterine wall, while more or less globular in juvenile females, becomes elongate with maturity, giving the uterine sac a smooth appearance. Size of female changes but little, but as the reproductive system extrudes, cuticle of the female becomes wrinkled. The spear becomes obscure and nonfunctional; anal opening disappears.

As the uterus enlarges and protrudes from the body of the female, it evidently turns inside out, carrying the ovary and vagina with it, so that the uterus remains attached to the anterior end of the extruded vagina. The anterior end of the ovary floats more or less freely in the lumen of the uterus, adjacent to the posterior end of the female. The uterus remains attached to the anterior end of the vagina and the eggs are deposited through a small opening at that end.

Type host.—*Dendroctonus rufipennis* (Kirby).

Type locality.—Red Table Mountain, Eagle County, Colorado.

Type specimens.—Catalog numbers 18 E,Z, and Y, Allotype 17.

Aphelenchoidea (Fuchs, 1937) Thorne, 1949

Aphelenchoididae (Skarbilovich, 1947) Paramonov, 1953

Aphelenchoidinae Skarbilovich, 1947

Parasitaphelenchus Fuchs, 1929

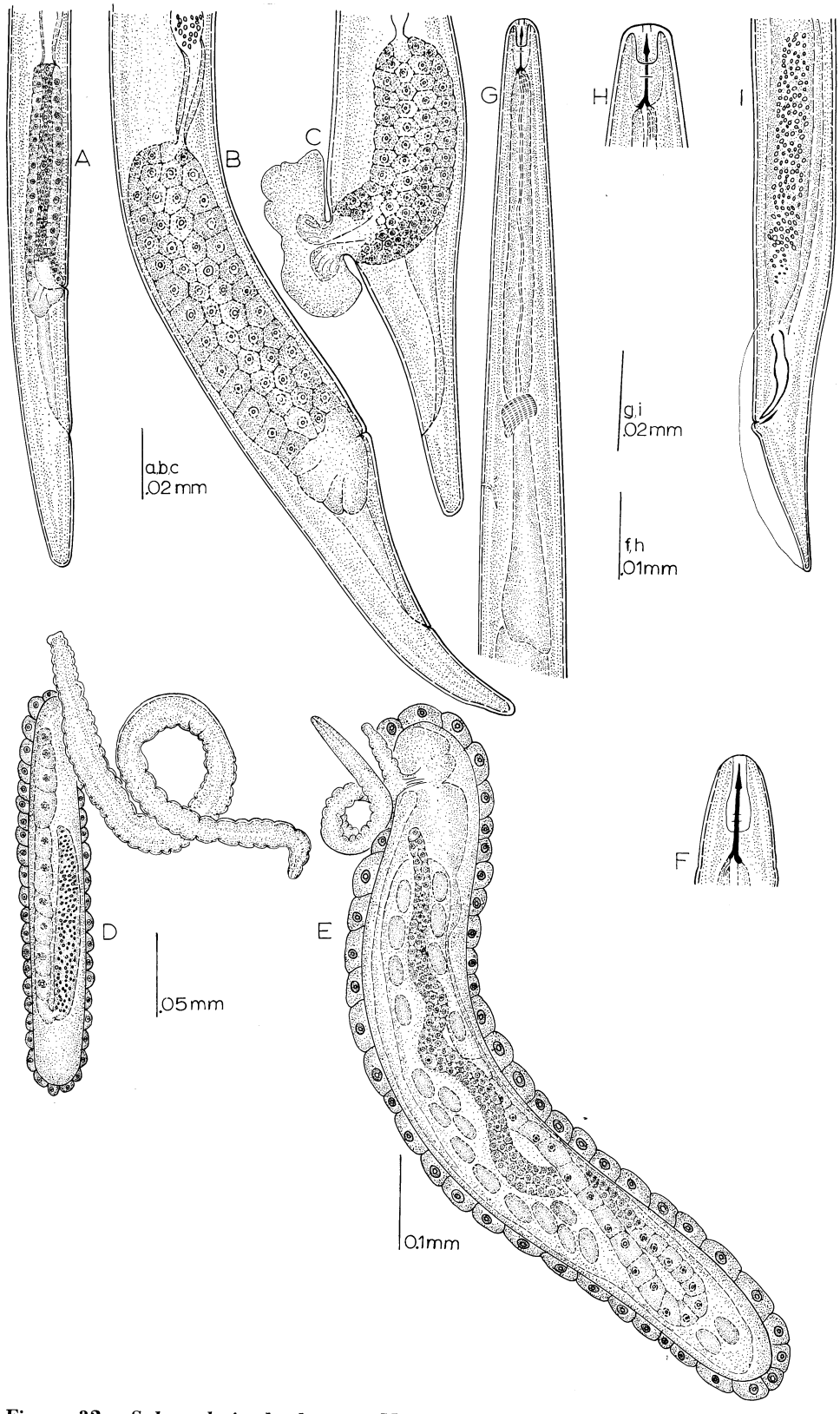


Figure 32.—*Sphaerularia dendroctoni* Massey, 1956: *A, B, C.* Female with uterus in initial stage of prolapse; *D, E.* females with prolapsed uterus; *F.* female, head; *G.* male, head and neck; *H.* male, head; *I.* male, tail.

P. acroposthion (Steiner, 1932) Rühm, 1956
P. becus n. sp.
P. dendroctoni Massey, 1966
P. gallagheri (Massey, 1960) J. B. Goodey, 1960
P. procerus n. sp.

Genus *Parasitaphelenchus* Fuchs, 1929

Type species: *Parasitaphelenchus uncinatus* (Fuchs, 1929) Fuchs, 1929

Body long and slender. Lips offset. Spear long, comparatively slender, with or without basal knobs or swellings. Metacorpus oblong, ovate, with well developed valve plates. Dorsal esophageal glands slender, elongate. Excretory pore may occur either anterior or posterior to metacorpus. Vulva far posterior, usually with well developed posterior uterine branch. Tail almost cylindroid from vulva to anus. Anal opening at times obscure. Spicules paired and fused along ventral shaft, usually with well developed ventral rostra. One to three pairs of subventral caudal papillae. Terminus mucronate.

Parasitic larvae: Lips obscure. Stylet obscure; however, vestibule apparent in many species. Metacorpus usually well developed, usually with apical and caudal cuticular projections.

Parasitaphelenchus acroposthion (Steiner, 1932) Rühm, 1956 Figure 33

Steiner's measurements except for length are inadequate. Lengths are: female=2.4 mm; male =1.6 mm. His original description follows:

"Body is very slender and elongate. Tail of female short and bluntly rounded; that of male also short, and its base similar to that of female but ends in a short horn-like process. Cuticle finely annulated, but no lateral membrane was seen. Lip region distinctly set off, exhibiting in a front view rounded well-separated lips. A cuticularized ring with six short rays encircles the oral opening. Structures of head end rather obscure, but amphids believed to be in position shown. This species, like other members of the genus, has four submedial papillae. The spear is extremely fine and appears to be composed of three different portions—an anterior conical portion rather well cuticularized, a succeeding short cylindrical portion rather well cuticularized, and then a long cylindrical portion which is hardly cuticularized and which, posteriorly, is set off from the esophageal canal only by the attachment of the protruding spear muscles. No basal swellings were seen. The esophageal bulb is well developed and of oval shape; it has rather long but thin valvulae. The radial muscles attached to the valvulae exclude a more glandular portion at the anterior and posterior ends of the bulb. The connection of the intestine with this bulb is much the same as in other forms of Aphelenchoidea. The nerve ring occurs a short distance behind the bulb. The intestine is of somewhat degenerate character; its cell walls can hardly be recognized, the whole organ being filled with reserve material. The rectum and anal opening are extremely fine and obscure. No excretory pore was seen. The vulvar opening is well marked because the body narrows just behind it. The female sexual apparatus is prodelphic; there is, however, a well-developed posterior branch of the uterus, and attached to it there appears to be a vestigial ovary extending nearly to the anus. The anterior ovary extends forward nearly to the nerve ring. The very short sexual apparatus of the male is of the proorchid type, with the end of the testis reflexed. It seems that the two spicula are amalgamated, forming a single spiculum, pointed at the outer end, but very wide at the inner end. The ventral apophysis is somewhat swollen proximally. Only one male was studied in ventral view; it showed in the anal region a peculiar lateral expansion somewhat resembling a vestigial bursa. Two papillae were distinctly seen on the inside of this expansion, one in the anal region and the other at the base of the horn-like process. It is doubtful whether these males are fully functional.

"*Diagnosis.—Parasitaphelenchus* of long, slender shape. Tail of female short, obtusely rounded; that of the male broadly conical at the base, mucronate. Spear rather narrow, of average length, without basal swellings. Esophageal bulb ovoid. Vulva well marked because the body narrows abruptly behind it. Male with slightly sublateral papilla in latitude of the anus, and another somewhat in front of terminal process."

Habitat.—Egg galleries of *Dendroctonus ponderosae.*

Locality.—Steiner collected the nematodes in Utah.

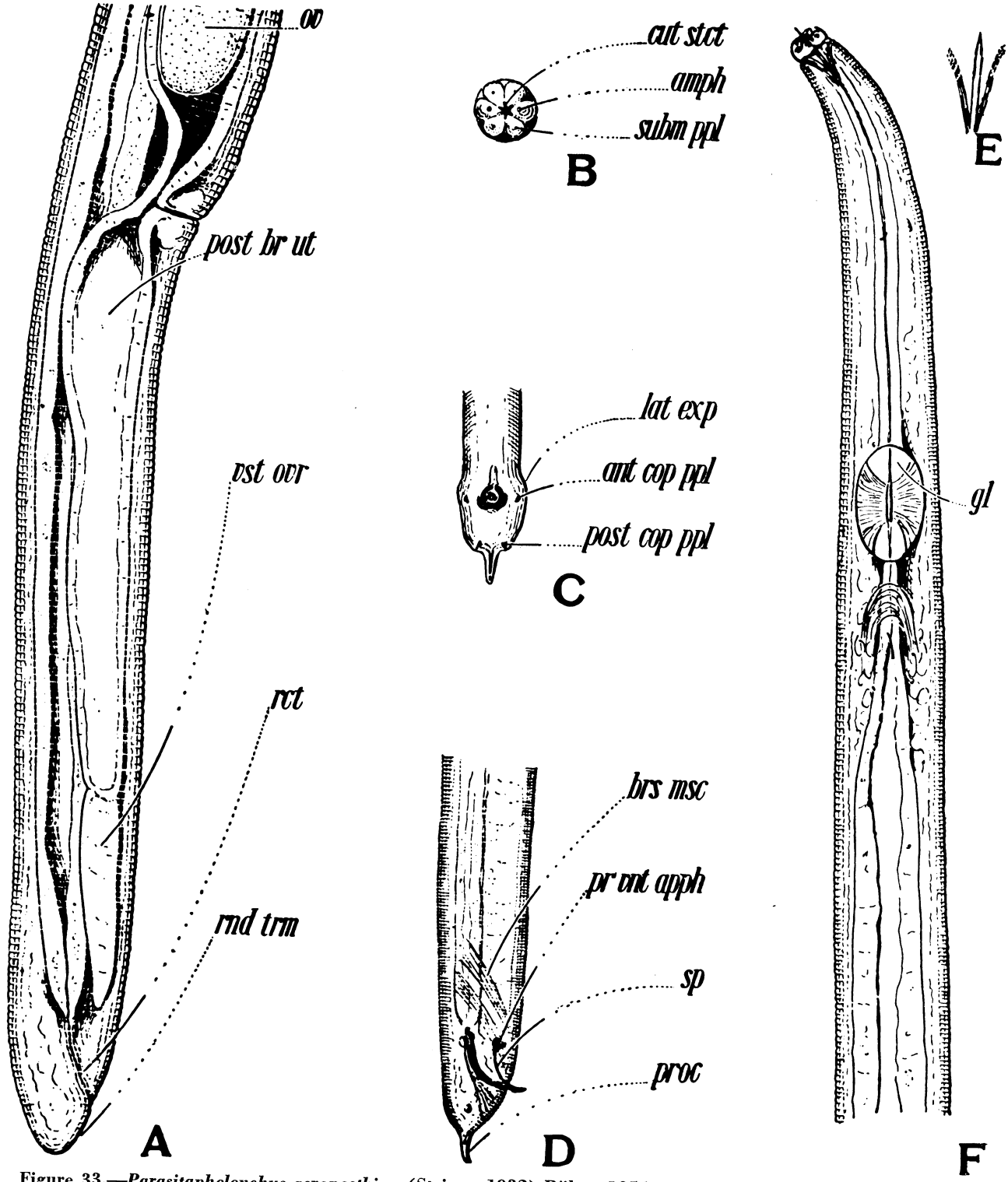


Figure 33.—*Parasitaphelenchus acroposthion* (Steiner, 1932) Rühm, 1956: *A.* Female, tail; *B.* face view; *C.* ventral view, male tail; *D.* lateral view, male tail; *E.* stylet; *F.* head and neck. (After Steiner, 1932).

***Parasitaphelenchus beccus* n. sp.** **Figure 34**

Female: 1.79–2.0 mm; a=76.3–85.1; b=20.4–21.3; c=?; V=89–92%.

Male: 1.12–1.22 mm; a=63.6–69.3; b=12.7–13.9; c=69.3–76.4.

Body sinuous, cylindroid. Cuticle without lateral incisures. Transverse striae very fine. Lip region rounded, set off, lips distinct. Cephalic framework sclerotized. Stylet relatively fine, 18 μ in length, with small basal thickenings. Retractor muscles prominent. Dorsal esophageal gland outlet obscure. Metacorpus oval, two-thirds as wide as long. Dorsal esophageal glands prominent, ca 5 body widths in length. Excretory pore over a body width anterior to metacorpus. Nerve ring one-half body width posterior to metacorpus. Hemizonid not observed. Body narrowing sharply at vulva, lips of which may or may not be protuberant. Vagina slightly oblique. Ovary outstretched, oocytes arranged in 3 rows at its anterior, oocytes in posterior portion in a single row. Posterior uterine branch ca 5 body widths in length. Anus and rectum obscure. Tail conoid to a broadly rounded or mucronate terminus.

Male: Testis single, outstretched. Spicules paired, typically parasitaphelenchoid. Two pairs of caudal papillae, 1 pair immediately preanal, 1 pair immediately anterior to a mucronate terminus.

Parasitic larvae: 0.61–0.70 mm; a=19.0–21.7; b=8.7–8.8; c=?

Body with slight ventral arcuation. Cuticle apparently smooth, without lateral incisures. Lip region rounded, not offset, with a hornlike mucro. Spear not visible, vestibule apparent. Metacorpus distinct. Excretory pore anterior to metacorpus. Nerve ring one-half body width posterior to metacorpus. Dorsal esophageal glands not observed. Body cavity filled with fat globules. Tail conoid to a fine hornlike mucronate terminus.

Diagnosis.—Related to *Parasitaphelenchus gallagneri*. Free-living sexual forms differ in the position of excretory pore, shape of metacorpus, and in length and coarseness of stylet.

Parasitic larvae differ in the shape of the lip region and in the shape of head and tail mucro.

Type host and habitat.—Associated with and parasitizing the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk., in Douglas-fir, *Pseudotsugae mensiesii* (Mirb.) Franco. Collected by Malcolm M. Furniss.

Type specimens.—Collection No. 59-E and 59-E-1.

***Parasitaphelenchus dendroctoni* Massey, 1966 Figure 35**

Parasitic form: 1.5 mm; a=23; b=25; c=? Cuticle smooth. Lips not discernible. Anterior and posterior ends of nema armed with cuticular flaps or mucros. Stylet without knobs, not visible in many specimens. Median bulb of esophagus ovate. Esophageal glands, excretory pore, nerve ring, hemizonid, and anal opening not discernible. Body cavity of most specimens examined filled with fat bodies that masked the presence of many diagnostic characters. Male and female specimens cannot be separated with any degree of certainty.

Type host.—*Dendroctonus adjunctus.*
Type locality.—Ruidoso, New Mexico.
Type specimens.—Collection No. 14-E.

Free-living form: Females: 2.5–3.7 mm; a=64–75; b=24–28; c=? V=90%. Males: 1.7–2.4 mm; a=74–82; b=21; c=96–119.

Cuticle smooth with no discernible transverse striations. Lip region only slightly set off. Stylet 15 μ long without basal knobs or thickenings. Median bulb of esophagus ovate; esophageal glands short, stout, extending approximately 3 body widths posterior to median bulb. Nerve ring approximately three-fourths body width behind median bulb. Excretory pore two and one-half body widths posterior to median bulb. Hemizonid one-half body width forward of excretory pore. Ovary outstretched, massive. Posterior uterine branch extending at times to within one body width of terminus. Two specimens examined had mature eggs in the posterior uterine branch. Vagina transverse. Body cylindroid posterior to vulva, ending in a broadly rounded, mucronate tail. Anal opening not discernible.

Male: Testis single, outstretched. Spicula elaborate as illustrated, less than a body width anterior to terminus. One pair of postanal caudal papillae immediately anterior to terminus. Tail broadly rounded, with mucronate tip.

Diagnosis.—Differs from all other species of the genus in its greater length, number of caudal papillae, and in shape and size of spicula.

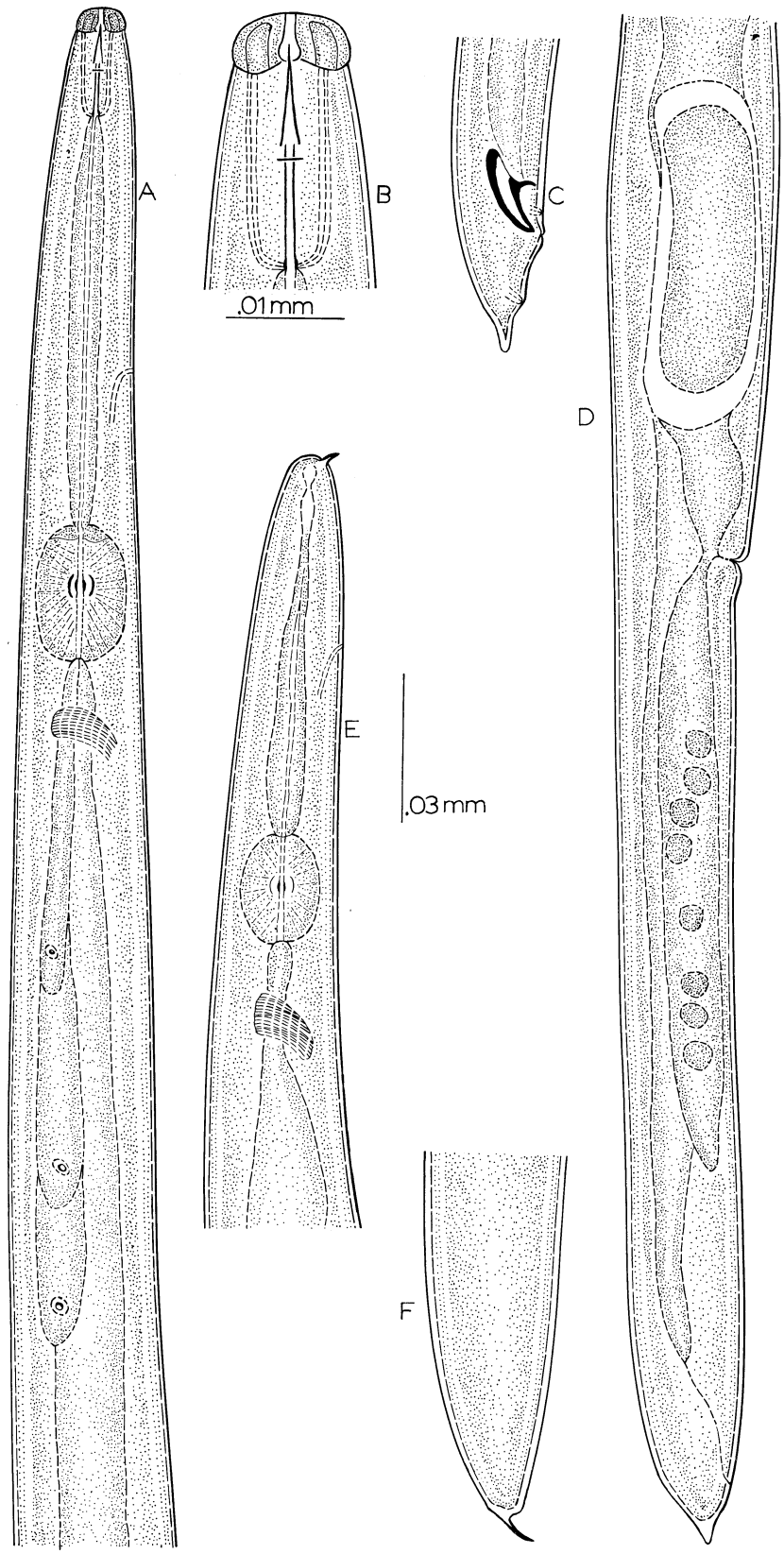


Figure 34.—*Parasitaphelenchus beccus* n. sp.: *A.* Head and neck; *B.* head; *C.* male, tail; *D.* female, tail; *E.* larva, head and neck; *F.* larva, tail.

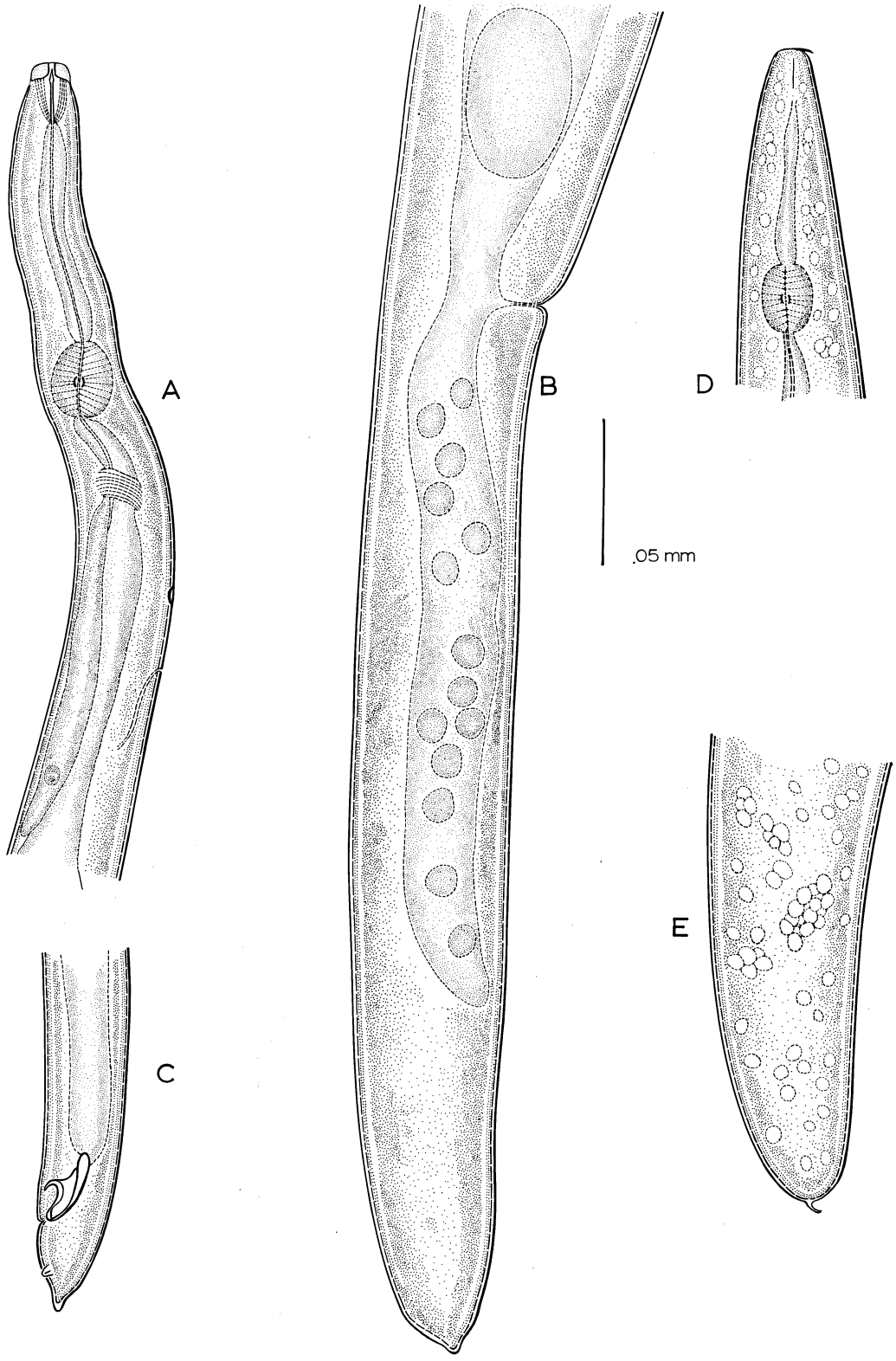


Figure 35.—*Parasitaphelenchus dendroctoni* Massey, 1966: *A.* Head and neck; *B.* female, tail; *C.* male tail; *D.* parasitic larva, head and neck; *E.* parasitic larva, tail.

Type habitat.—Ponderosa pine, *Pinus ponderosa* Laws.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 37-R.

***Parasitaphelenchus gallagheri* (Massey, 1960) J. B. Goodey, 1960 (redescribed)** **Figure 36**

Synonym: *Aphelenchoides gallagheri* Massey, 1960

Females: 1.42–1.73 mm; a=47.0–70.3; b=16.6–24.7; c=48.3–56.0; V=90%.

Males: 0.98–1.07 mm; a=39.0–60.6; b=12.8–14.5; c=51.8–55.3.

Body posture straight to sinuous, cylindroid. Cuticle without lateral incisures. Transverse striae moderately fine. Lip region slightly set off over 2 times wider than deep. Lips distinct. Cephalic framework lightly sclerotized. Spear 15 μ long, with distinct basal thickenings. Stylet muscles well defined. Dorsal esophageal gland outlet obscure. Metacorpus oblong, twice as long as wide. Dorsal esophageal gland over 4 body widths in length. Nerve ring one-half body width posterior to metacorpus. Excretory pore opposite hemizonid. Lips of vulva only slightly protuberant. Vagina oblique. Ovary outstretched. Oocytes arranged posteriorly in a single row, anteriorly in a double row. Posterior uterine branch 5–7 body widths in length, usually containing sperm cells. Anus and rectum visible but not prominent. Tail conoid, broadly rounded, with or without a terminal mucro.

Male: Testis single, outstretched. Spicules paired and generally distinct. The dorsal shaft usually more heavily sclerotized than the ventral shaft. Ventral rostrum finely produced. There are two pairs of caudal papillae, one pair immediately preanal, one pair immediately anterior to a relatively large, mucronate terminus.

Parasitic larvae: The following description is of larvae that are most commonly found in active adult beetles during the summer months. The exact instar was not determined.

Length=0.63–0.69 mm; a=26.8–33.7; b=7.9–8.4; c=18.1–19.5.

Body posture ventrally arcuate. Cuticle without lateral incisures or apparent striae. Lip region not set off. Hornlike apical and caudal cuticular projections. Cephalic framework indistinct. Stylet absent. Vestibule apparent in most specimens. Median bulb prominent, twice as long as wide. Nerve ring almost a body width posterior to metacorpus. Excretory pore opposite nerve ring, and at times passing through hemizonid. Genital primordia distinct. Anus and rectum obscure. Tail conoid with a prominent horn-like, mucronate terminus.

Larval forms in the genus bear definitive characters that at times are lacking in free-living adults. *Parasitaphelenchus gallagheri* larvae are distinctive in the small cephalic projections observed in lateral view.

Type habitat and host.—Free-living males and females associated with *Ips confusus* in pinyon, *Pinus edulis* Engelm. Parasitic larvae from body cavity of *Ips confusus.*

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 13-G (Allotype), 8–N (Holotype).

***Parasitaphelenchus procerus* n. sp.** **Figure 37**

Female: 1.76–1.94 mm; a=75.12–82.5; b=24.0–28.7; c=?; V=90–91%.

Male: 1.10–1.21 mm; a=75.2–82.6; b=14.5–15.2; c=75.2–82.6.

Body sinuous, cylindroid. Cuticle without lateral incisures. Transverse striae fine. Lips rounded, continuous with neck region. Cephalic framework lightly sclerotized. Spear slender, 11 μ in length, with very small basal thickenings, retractor muscles prominent. Metacorpus oblong, ovate, twice as long as wide. Dorsal esophageal gland outlet distinct, the gland 5–6 body widths long. Excretory pore a body width posterior to nerve ring. Hemizonid slightly anterior to excretory pore. Ovary single, outstretched. Lips of vulva continuous with body wall. Vagina oblique. Posterior uterine branch ca 5 body widths in length. Anus and rectum not discernible. Tail conoid to an acute mucronate terminus.

Male: Testis single, outstretched. Spicules paired with a finely produced curved ventral rostrum. There are two pairs of caudal papillae, one pair preanal, one pair immediately anterior to terminus. Tail conoid to an acute mucronate terminus.

Diagnosis.—Related to *Parasitaphelenchus dendroctoni.* Varies in structure of lip region,

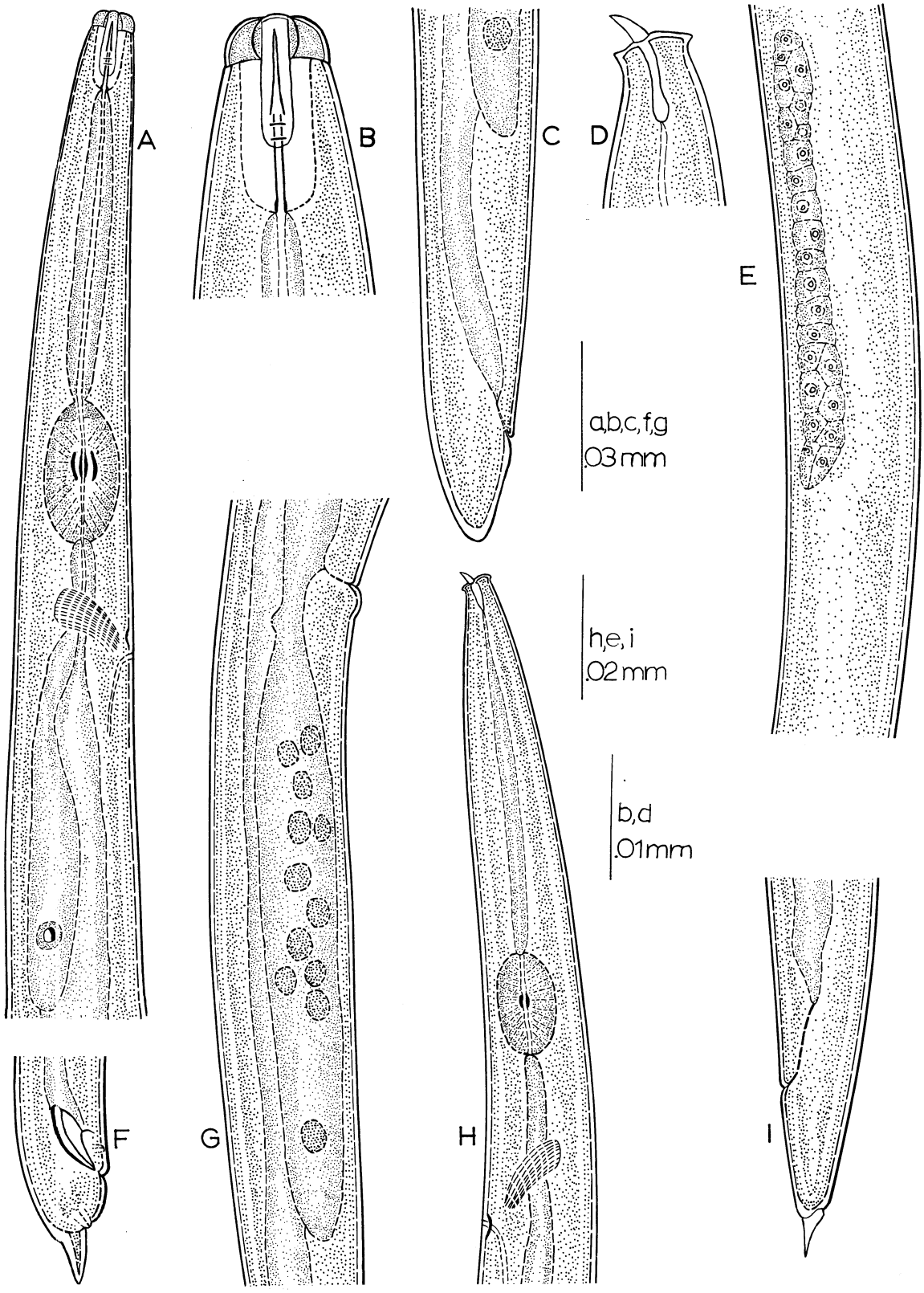


Figure 36.—*Parasitaphelenchus gallagheri* (Massey, 1960) Goodey, 1960: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* larva, head; *E.* larva, midbody; *F.* male, tail; *G.* body showing vulva and postuterine branch; *H.* larva head and neck; *I.* larva, tail.

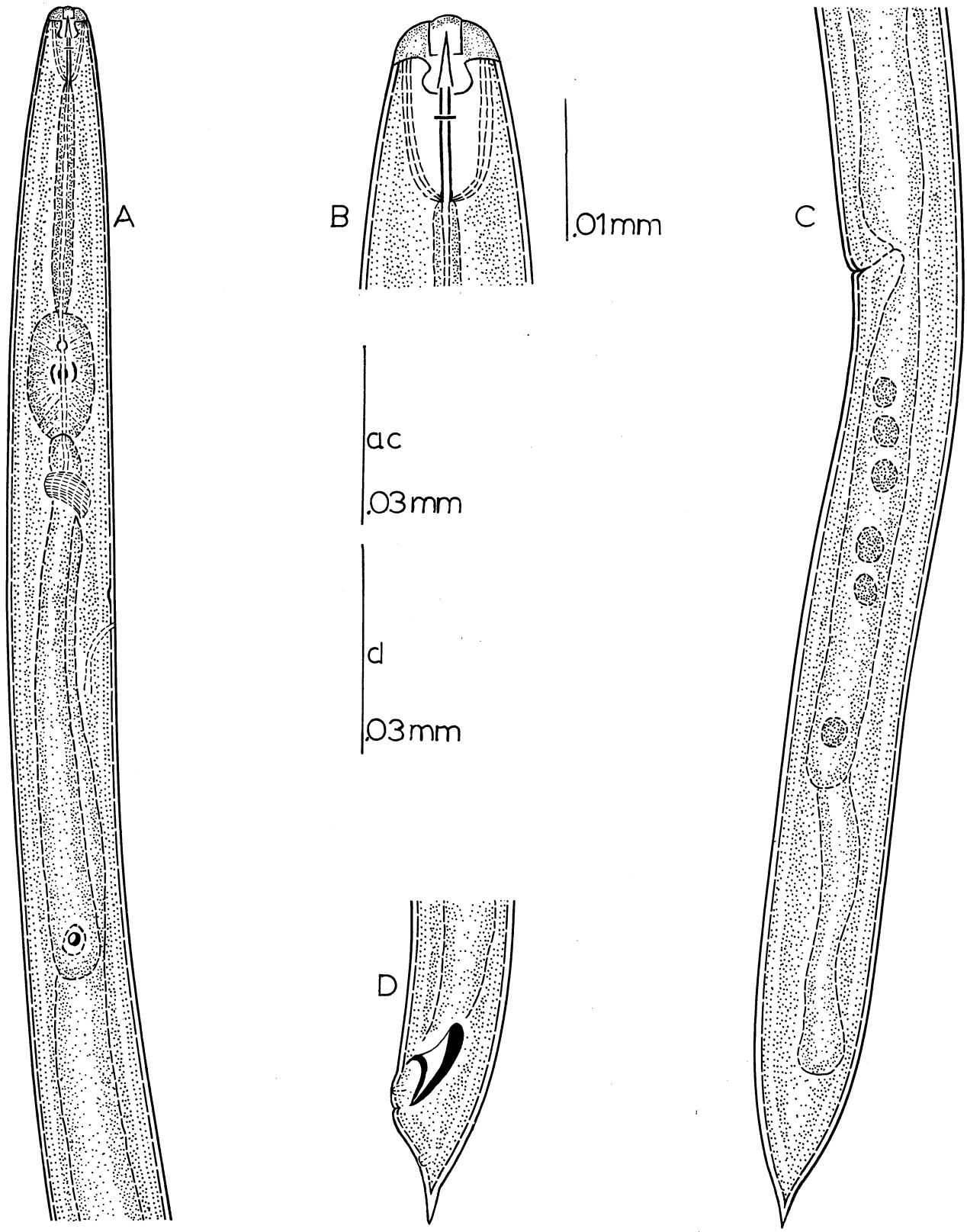


Figure 37.—*Parasitaphelenchus procerus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

in shorter length of stylet, and in general body proportions.

Type habitat.—Associated with *Ips calligraphus* (Germ.) in slash pine, *Pinus elliottii* Engelm.

Type locality.—Patrick, South Carolina.

Type specimens.—Holotype and Allotype Collection No. 59-F.

Associates

Rhabditoidea (Örley, 1880) Travassos, 1920

Rhabditidae Örley, 1880
- Rhabditinae (Örley, 1880) Micoletzky, 1922
  - *Cephaloboides* Rahm, 1928 n. rank
    - *C. rotundus* n. sp.
  - *Mesorhabditis* (Osche, 1952) Dougherty, 1953
    - *M. longistomis* n. sp.
- Protorhabditinae Dougherty, 1955
  - *Parasitorhabditis* (Fuchs, 1937) Chitwood and Chitwood, 1950
    Syn. *Rhabditis* (*Parasitorhabditis*) Fuchs, 1937
    - *P. cluniculus* n. sp.
    - *P. gracilis* n. sp.
    - *P. hastulus* n. sp.
    - *P. hylurgi* n. sp.
    - *P. ipini* n. sp.
    - *P. terebranus* n. sp.
- Bunonematinae Micoletzky, 1922 (Chitwood, 1935)
  - *Bunonema* Jägerskiöld, 1905
    - *B. newmexicana* Massey, 1964

Cylindrocorporidae Goodey, 1939
- *Cylindrocorpus* Goodey, 1939
  - *C. erectus* Massey, 1960

Diplogastridae (Micoletzky, 1922) Steiner, 1919 [2]
- Diplogastrinae Micoletzky, 1922
  - *Acrostichus* Rahm, 1928
    - *A. concolor* (Massey, 1962) Massey, 1970
    - *A. gubernatus* n. sp.
    - *A. ponderosus* Massey, 1962
    - *A. taedus* Massey, 1962
  - *Gerthornus* Massey, 1966
    - *G. balaenus* Massey, 1966
  - *Mikoletzkya* (Weingärtner, 1955) Rühm, 1960
    - *M. bandelieri* (Massey, 1960) Massey, 1966
    - *M. calligraphi* n. sp.
    - *M. cervicula* Massey, 1966
    - *M. diluta* Massey, 1966
    - *M. inedia* Massey, 1966
    - *M. langcauda* n. sp.
    - *M. pinicola* (Thorne, 1935) Baker, 1962
    - *M. pugnea* Massey, 1970
    - *M. ruminis* Massey, 1966
    - *M. tomea* Massey, 1966
  - *Mononchoides* Rahm, 1928
    - *M. adjunctus* Massey, 1966
- Neodiplogastrinae Paramonov, 1952
  - *Neodiplogaster* Cobb, 1924
    - *N. magulum* n. sp.
- Diplogasteroidinae Filipjev and Schuurmans Stekhoven, 1941
  - *Diplogasteroides* deMan, 1912
    - *D. bibrochus* n. sp.
    - *D. dimidius* n. sp.
    - *D. ipini* n. sp.
    - *D. marshalli* Massey, 1962
  - *Dirhabdilaimus* Paramonov and Turlygina, 1955
    - *D. nacogdochensis* n. sp.
  - *Rhabdontolaimus* (Fuchs, 1931) Filipjev and Schuurmans Stekhoven, 1941
    - *R. adephagus* n. sp.
    - *R. frontali* n. sp.
    - *R. janae* (Massey, 1962) n. comb.

Cephalobidae (Filipjev, 1934) Chitwood and Chitwood, 1934
- Panagrolaiminae Thorne, 1937
  - *Panagrolaimus* Fuchs, 1930
    - *P. concolor* Massey, 1964
    - *P. conophthori* n. sp.
    - *P. leperisini* n. sp.
  - *Neocephalobus* (Steiner, 1929) Steiner, 1934
    - *N. judithae* (Massey, 1964) n. comb.
  - *Panagrodontus* Thorne, 1935
    - *P. dentatus* Thorne, 1935
  - *Plectonchus* Fuchs, 1930
    - *P. molgos* n. sp.
    - *P. wyganti* Massey, 1964
  - *Panagromacra* Massey, 1964
    - *P. margaretae* Massey, 1964

[2] According to Baker and Sanwal, 1960, the genitive singular of the termination *gaster* would appear to be *gastros* and the latinizing of a family name with this termination would be *gastridae* and not *gasteridae*. The same spelling would also apply to Diplogasterinae and Neodiplogasterinae; accordingly the correct spellings are herein applied (page 133, Code of Zoological Nomenclature).

Panagrobelus Thorne, 1939
P. phloeosini n. sp.
P. scolyti Massey, 1964
Turbatricinae T. Goodey, 1943
Panagrellus Thorne, 1938
P. leperisini n. sp.
Teratocephalidae Andrassy, 1958
Teratocephalus deMan, 1876
T. angustus n. sp.
Chambersiellidae (Thorne, 1937) Sanwal, 1957, 1971
Chambersiellinae Thorne, 1937
Geraldius Sanwal, 1971
G. bakeri (Sanwal, 1957) Sanwal, 1971
Santafea Massey, 1963
S. croca Massey, 1963
S. damalis Massey, 1966
Macrolaiminae Sanwal, 1971
Macrolaimus Maupas, 1900
M. canadensis Sanwal, 1960
M. taurus Thorne, 1937

Genus *Cephaloboides* (Rahm, 1928) n. rank

Synonyms: *Rhabditis* (*Cephaloboides*) Rahm, 1928
Cuticuleria van der Linde, 1938

Type species: *Cephaloboides musicola* Rahm, 1928

Lips at times offset, with or without papillae, stoma 2–3 times deeper than wide. Cheilorhabdions rudimentary or absent. Esophagus with prominent median bulb. Ovaries paired. Spicules paired. Bursa leptoderan. Rays radially arranged. Tail in both sexes dome shaped with spicate terminus.

***Cephaloboides rotundus* n. sp.** **Figure 38**

Females: 0.82–1.0 mm; a=20–22; b=4.4–5.0; c=20.2–30.8; V=55–56%.

Males: 0.81 mm; a=18.4–19.7; b=4.1–4.5; c=15–25.

Body straight, cylindroid, cuticle with very fine transverse and longitudinal striations. Lips rounded, with fine setose papillae. Cheilorhabdions absent. Prorhabdions make up major part of stoma which is 20 μ in depth; meso, metarhabdions with two prominent teeth, the ventral tooth slightly anterior to dorsal tooth. Anterior part of esophagus forming a stomatal collar, corpus muscular, the posterior portion expanded into a prominent median bulb. Corpus and median bulb equal in length to isthmus and basal bulb. Nerve ring at mid-isthmus. Hemizonid not observed. Excretory pore opposite anterior end of basal bulb. Cardia conspicuous. Lips of vulva at times protuberant. Vagina transverse. Ovaries paired, at times reflexed their entire length. Uterus in each ovary serving as spermatheca. Anus and rectum conspicuous. Tail broadly rounded with a spicate terminus.

Male: Testis single, reflexed at times one-third its length. Spicules paired and separate, slightly ventrally arcuate capitate, 32–35 μ in length. Gubernaculum more or less lineate. Tail as in female. Bursa leptoderan, reduced. There are 7 pair of bursal rays.

Diagnosis.—Differs from *C. musicola* in shape of lips and its much smaller size.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Oak Creek Canyon, Arizona.

Type specimens.—Collection No. 61.

Genus *Mesorhabditis* (Osche, 1952) Dougherty, 1953

Synonym: *Rhabditis* (*Mesorhabditis*) Osche, 1952

Type species: *Mesorhabditis spiculigera* (Steiner, 1936) Dougherty, 1953.

Lips prominent, set off by constriction. Stoma cylindroid with short glottoid apparatus. Metarhabdions toothed. Vulva posterior. Ovary single. Bursa peloderan. Spicules slender, elongate, capitate amalgamated.

***Mesorhabditis longistomis* n. sp.** **Figure 39**

Females: 0.44–0.52 mm; a=24–26; b=3.6; c=8.7–10.3; V=75%.

Males: unknown.

Cuticle transversely striate, lateral field marked by three incisures. Lips set off by constriction, cephalic papillae prominent. Pharynx cylindroid, three times as long as width of head at base of lips. Prorhabdions composing approximately three-fourths of the stoma. Meso, meta, and telorhabdions fused into a glottoid apparatus, 2 conspicuous inward-pointing teeth above base of the pharynx. Amphids prominent, located at base of lateral lips. Corpus of esophagus about equal in length to isthmus and terminal bulb combined; terminal

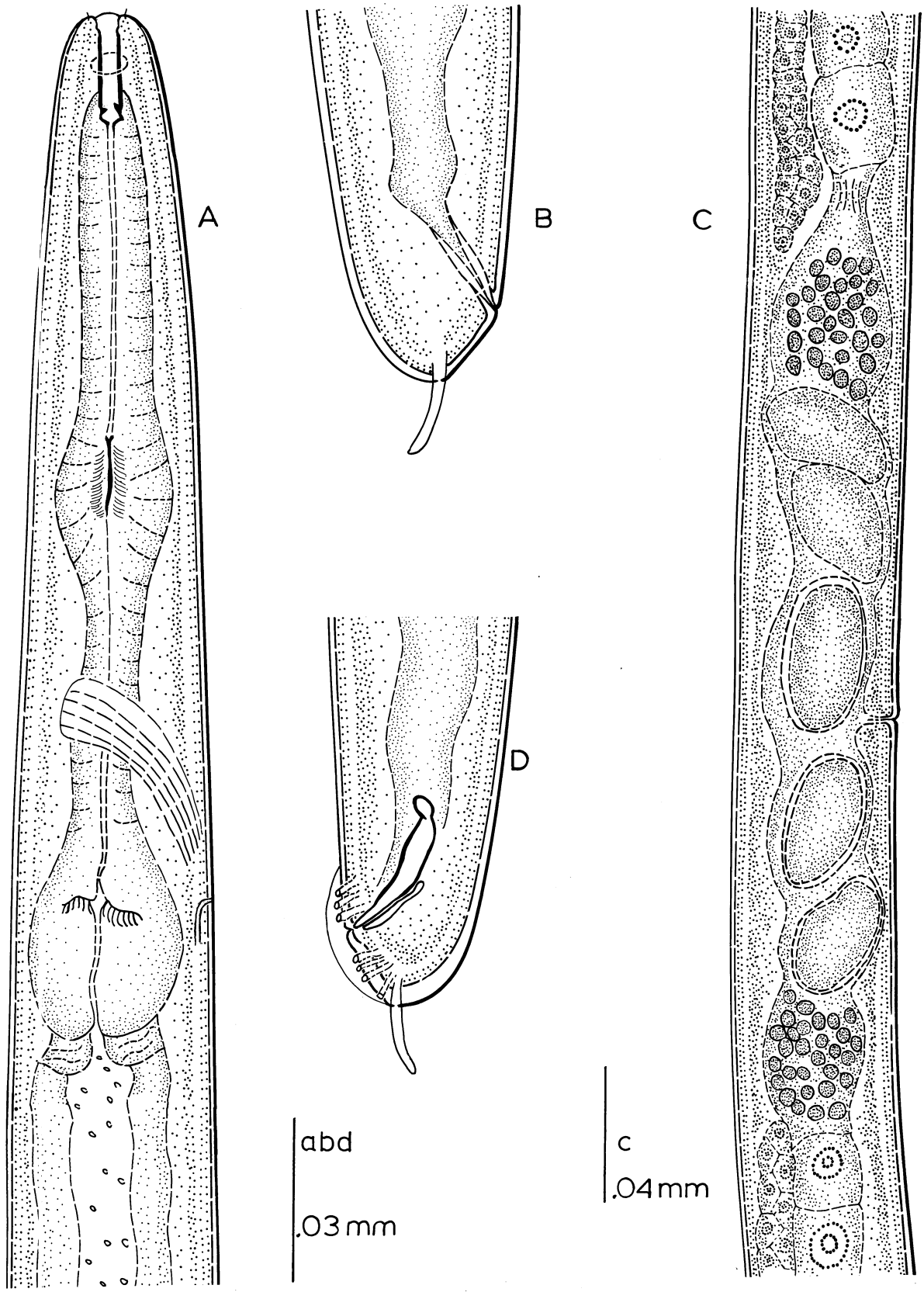


Figure 38.—*Cephaloboides rotundus* n. sp.: *A.* Head and neck; *B.* female, tail; *C.* female, midbody; *D.* male, tail.

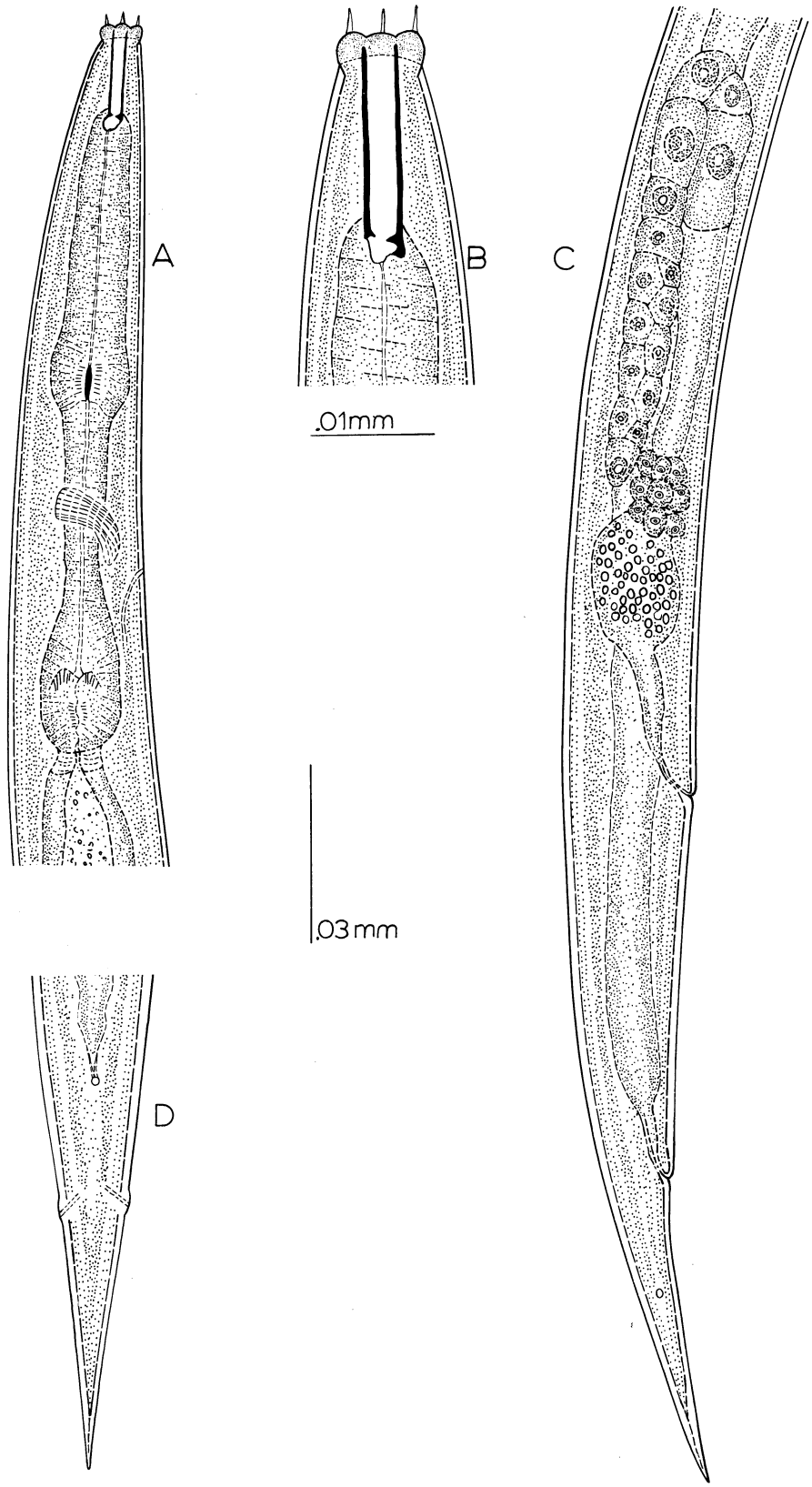


Figure 39.—*Mesorhabiditis longistomis* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody and tail *D.* ventral view, female tail.

bulb valvate. Nerve ring at middle of isthmus. Excretory pore slightly posterior to nerve ring. Hemizonid immediately anterior to excretory pore. Ovary single, short, reflexed. Lips of vulva protuberant. Vagina transverse. Length of tail about equal to distance between vulva and anal opening. Tail conoid to acute terminus.

Diagnosis—This species is closely related to *Mesorhabditis spiculigera* (Steiner, 1936) Dougherty, 1953. It differs from that species in the number of lateral incisures and its very short ovary.

Type habitat.—Associated with *Scolytus ventralis* in white fir, *Abies concolor* (Gord. and Glend.) Lindl.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 23-H.

This nematode was noted as sp. inquirenda Massey, 1964. Since that time, several additional specimens were collected in association with the spruce beetle and the specimen is given the specific designation of *M. longistomis.*

Genus *Parasitorhabditis* (Fuchs, 1937) Chitwood and Chitwood, 1950 Emended

Synonym: *Rhabditis* (*Parasitorhabditis*) Fuchs, 1937

Type species: *Parasitorhabditis obtusa* (Fuchs, 1915) Dougherty, 1953.

Lips angular to rounded. Stoma consisting of elongate prorhabdions. Meso, meta, and telorhabdions rudimentary or absent with or without slender teeth. Esophagus with or without median bulb, basal bulb valvate. Ovary single, reflexed, vulva at 90% or more. Anus and rectum conspicuous. Terminus obtuse to filamentous. Testis single, spicules spicate, fused at distal end. Gubernaculum variable in shape. Bursa peloderan with 8–12 pair of bursal rays.

Key to Species of *Parasitorhabditis* occurring in the United States

1.	Vulva at 95% or more	2
	Vulva at less than 95%	4
2.	Remnants of metarhabdions with 2 teeth, subdorsal and subventral	*cluniculus* n. sp.
	Remnants of metarhabdions without teeth	3
3.	Gubernaculum with distal prong	*hastulus* n. sp.
	Gubernaculum without distal prong	*ipini* n. sp.
4.	Esophagus of female with median bulb, remnants of dorsal metarhabdion with a slender tooth, cuticle with regular punctation	*hylurgi* n. sp.
	Esophagus without median bulb	5
5.	Remnants of metarhabdions without teeth, terminus of female sharply rounded	*gracilis* n. sp.
	Remnants of metarhabdions with 4 teeth, terminus of female with short filament ..	*terebranus* n. sp.

***Parasitorhabditis cluniculus* n. sp.** **Figure 40**

Female: 0.99–1.0 mm; a=20.5–22.4; b=5.1–5.4; c=56–58; V=95%.

Male: 0.78–0.81 mm; a=23–24.4; b=4.5–4.8; c=17.8–21.2.

Cylindroid. Cuticle thick. Transverse striae coarse, especially forward from anterior end of esophagus. Lips rounded to angular. Stoma 20 μ in depth. Remnants of metarhabdions with 2 small teeth. Corpus muscular, only slightly widened at base to form an obscure median bulb. Isthmus slender. Basal bulb valvate, basal bulb and isthmus one-third longer than corpus and median bulb. Nerve ring at midisthmus. Excretory pore slightly posterior to nerve ring and hemizonid. Lips of vulva protuberant. Vagina oblique. Ovary single and reflexed two-thirds its length. Quadricolumella conspicuous and of variable length, at times 4-5 body widths long. Uterus thick-walled and muscular. Anus and rectum conspicuous. Phasmid obscure. Tail conoid to a narrowly rounded terminus.

Male: Testis single, reflexed one-third its length. Spicules spike-like, 33 μ in length. Gubernaculum shaped as figured, 17 μ in length. Tail conoid to an acute terminus. Bursa pelo-

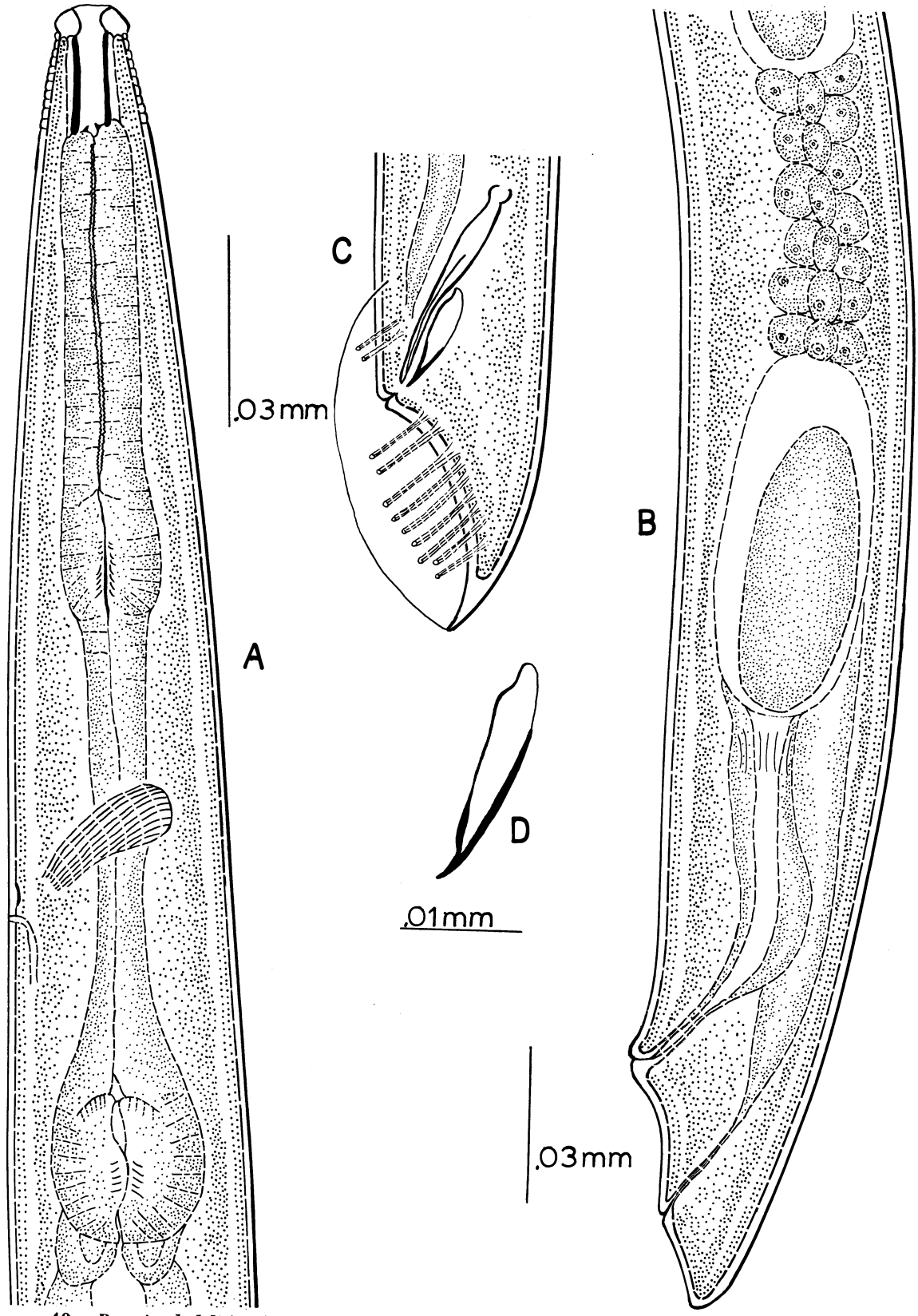


Figure 40.—*Parasitorhabditis cluniculus* n. sp.: *A.* Head and neck; *B.* female, tail; *C.* male, tail; *D.* gubernaculum.

deran. There are 11 pair of bursal rays arranged as illustrated.

Diagnosis.—Closely related to *Parasitorhabditis bidentati* Rühm, 1954. Differs in shape of female tail and in the shape of the gubernaculum. *P. bidentati* has only 10 pair of bursal rays.

Type habitat.—Associated with *Polygraphus hoppingi* in Engelmann spruce, *Picea engelmanni* Parry.

Type locality.—Flagstaff, Arizona.

Type specimens.—Collection No. 84-E.

***Parasitorhabditis gracilis* n. sp.** **Figure 41**

Female: 0.80 mm; a=24.9; b=5.0; c=27.4; V=93%.

Male: 0.76 mm; a=29; b=5.1; c=29.

Cylindroid, cuticle moderately thick with rather coarse, transverse striae. Lips angular. Stoma 14 μ deep. Pharynx without teeth, corpus muscular without median bulb, lumen heavily sclerotized, serrated. Isthmus very slender, isthmus and median bulb one-third longer than corpus. Nerve ring at midisthmus. Excretory pore and hemizonid slightly anterior to nerve ring. Hemizonid immediately anterior to excretory pore. Vulva with protuberant lips. Vagina oblique. Ovary single, reflexed two-thirds its length. Quadricolumella elongate, in some specimens, several body widths in length. Anus and rectum conspicuous. Phasmid conspicuous, opposite anal opening. Tail conoid to sharply rounded terminus.

Male: Testis single, reflexed. Spicules spicate, 34 μ in length. Gubernaculum as figured, 18 μ in length. Tail conoid to an acute terminus. Bursa peloderan. Nine pairs of bursal rays.

Diagnosis.—Related to *Parasitorhabditis hylurgi* n. sp., varies in its more slender shape, absence of cuticular punctation, and in size and shape of the spicules and gubernaculum.

Type habitat.—Associated with *Pseudohylesinus grandis* Sw. in white fir.

Type locality.—Grand Canyon, Arizona.

Type specimens.—Collection No. 84-J.

***Parasitorhabditis hastulus* n. sp.** **Figure 42**

Female: 0.67–0.75 mm; a=19–21; b=4.4–4.8; c=42.2–45.8; V=95%.

Male: 0.62–0.67 mm; a=25–26; b=4.2–4.6; c=20.8–23.7.

Body straight, cylindroid. Cuticle thick. Transverse striae fine. Lips open, angular without visible cephalic papillae. Stoma 5 times deeper than wide, rhabdions without teeth. Corpus and median bulb muscular. Lumen of corpus heavily sclerotized, serrate for three-fourths of its length. Basal bulb valvate, muscular. Basal bulb and isthmus longer than corpus and median bulb. Nerve ring at midisthmus. Excretory pore at anterior end of basal bulb. Hemizonid immediately anterior to excretory pore. Vulval lips protuberant. Vagina oblique. Ovary single, reflexed two-thirds its length. Quadricolumella 5-6 body widths in length. Uterus distinctive, thick walled, anterior portion very muscular. Anus and rectum conspicuous. Tail conoid to a bluntly rounded terminus.

Male: Testis single, reflexed one-third its length. Spicules paired, distally fused, spike-like, 39 μ in length. Gubernaculum with a distal prong, 19 μ in length. Bursa peloderan. Ten pairs of bursal rays. Tail conoid to an acute terminus.

Diagnosis.—Differs from other species in the genus in the shape of the gubernaculum and in the relatively long spicules.

Type habitat.—Associated with *Ips grandicollis* in loblolly pine, *Pinus taeda* L.

Type locality.—Beaumont, Texas.

Type specimens.—Collection No. 84-C.

***Parasitorhabditis hylurgi* n. sp.** **Figure 43**

Female: 0.89–0.90 mm; a=16.8–19; b=4.8–5.3; c=24.5–25.3; V=92%.

Male: 0.77–0.83 mm; a=18.9–21.9; b=4.4; c=21.9–29.4.

Cylindroid. Cuticle thick with coarse transverse striae. Punctations in symmetrical rows on head as figured. Stoma 20 μ deep. Remnants of dorsal metarhabdion with a very fine tooth. Corpus muscular, widened at its base into a median bulb, lumen heavily sclerotized, serrate. Basal bulb valvate, together with isthmus longer than corpus and median bulb. Nerve ring at midisthmus. Excretory pore opposite nerve ring. Hemizonid immediately anterior to excretory pore. Lips of vulva protuberant. Vagina oblique. Ovary single, in some specimens reflexed three-fourths its length. Quadricolumella well developed, variable in length. Uterus elongate. Anus and rectum conspicuous. Phas-

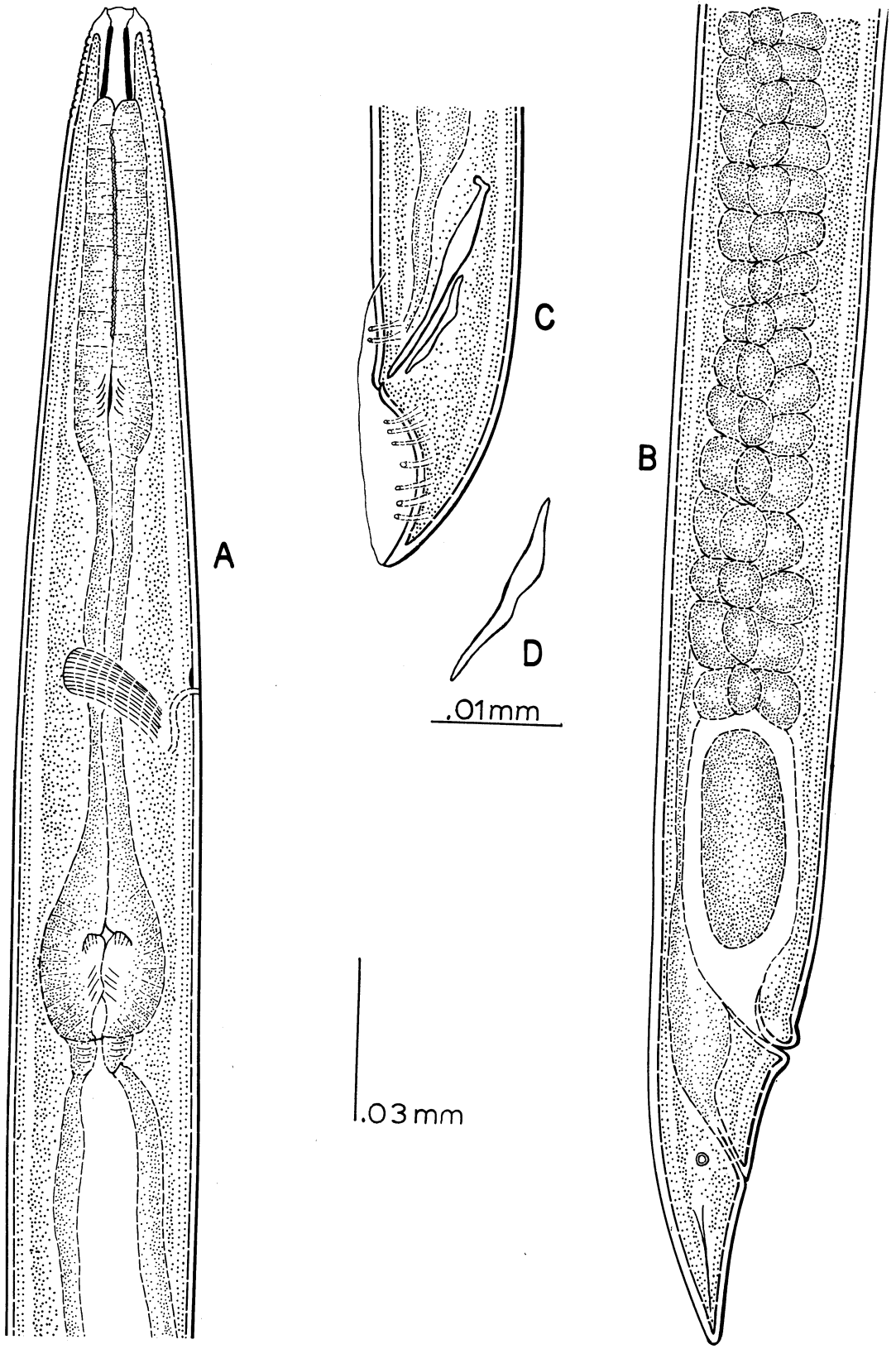


Figure 41.—*Parasitorhabditis gracilis* n. sp.: *A.* Head and neck; *B.* female, tail; *C.* male, tail; *D.* gubernaculum.

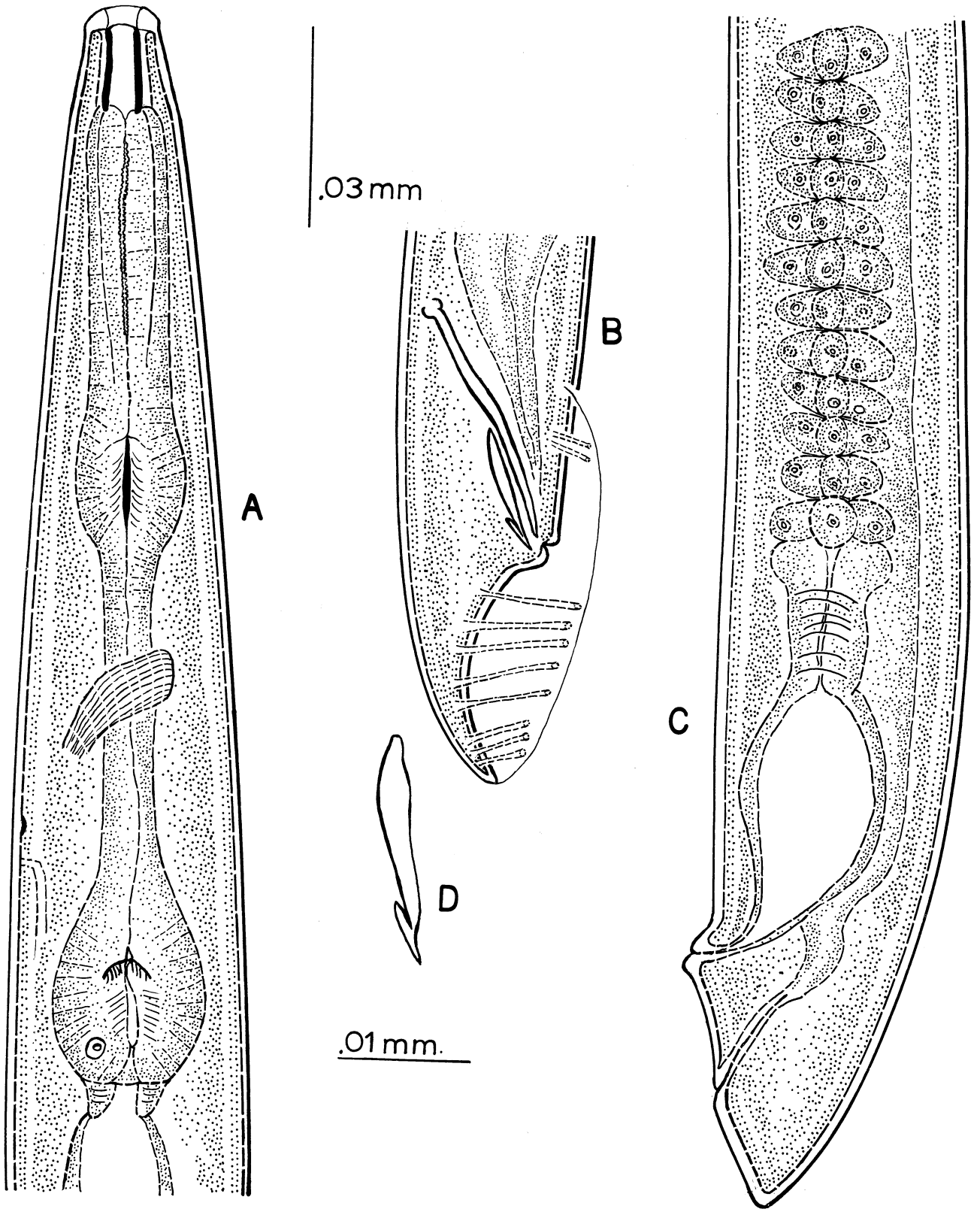


Figure 42.—***Parasitorhabditis hastulus*** **n. sp.:** ***A.*** **Head and neck;** ***B.*** **male, tail;** ***C.*** **female, tail;** ***D.*** **gubernaculum.**

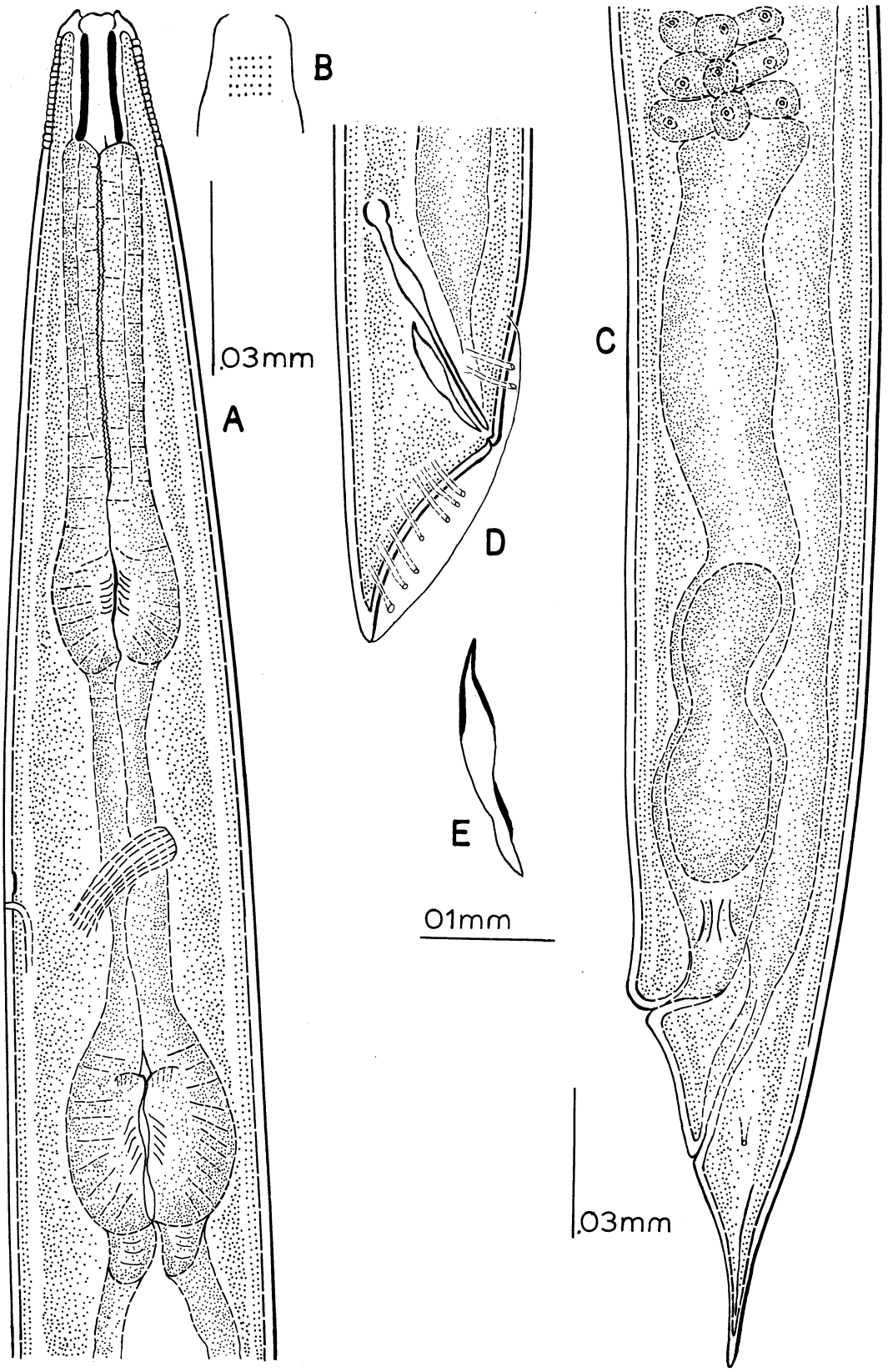


Figure 43.—*Parasitorhabditis hylurgi* n. sp.: *A.* Head and neck; *B.* cuticular pattern; *C.* female, tail; *D.* male, tail; *E.* gubernaculum.

mid prominent, located opposite anal opening. Tail conoid to an acute terminus.

Male: Cylindroid, body posture straight. Testis single, reflexed one-third its length. Spicules spike-like, 40 μ in length. Gubernaculum as figured, 21 μ in length. Tail conoid to an acute terminus. Bursa peloderan. There are 9 pairs of bursal rays.

Diagnosis.—Differs from other species in the genus in the unique cuticular pattern and shape of female tail. Gubernaculum distinctive.

Type habitat.—Associated with *Hylurgops pinifex* in red pine, *Pinus resinosa* Ait.

Type locality.—Caroline County, New York.

Type specimens.—Collection No. 84-F.

***Parasitorhabditis ipini* n. sp.** **Figure 44**

Female: 0.66–0.95 mm; a=20.3–22.6; b=4.4–5.1; c=75.3–108; V=95%.

Male: 0.61–0.75 mm; a=21; b=3.9–5.0; c=18.9–22.7.

Body straight, cylindroid, cuticle thick. Transverse striae fine to moderately fine. Lips angular to rounded. Stoma 19 μ in depth. Rhabdions without teeth. Corpus muscular without median bulb, the lumen heavily sclerotized, serrated. Isthmus and basal bulb much longer than corpus. Basal bulb muscular. Cardia prominent. Nerve ring approximately at midisthmus. Excretory pore and hemizonid variable in position from nerve ring to anterior portion of basal bulb. Excretory pore on some specimens passing through hemizonid. Lips of vulva protuberant. Vagina oblique. Ovary single, reflexed two-thirds its length. Quadricolumella short, less than a body width in length in some specimens. Uterus narrow, thin walled. Anal opening and rectum conspicuous. Phasmid obscure. Tail conoid to broadly rounded dome-shaped terminus, sometimes mucronate.

Male: Testis single, reflexed as much as one-third its length. Spicules paired, joined, spike-like, 35 μ in length. Gubernaculum as figured, 19 μ in length. Tail conoid to an acute terminus. Bursa peloderan. Nine pair of bursal rays, arranged as figured.

Diagnosis.—Related to *Parasitorhabditis obtusa* (Fuchs, 1915) Dougherty, 1953. Varies from that species in cuticular characteristics and in the length of tail of female, in the shape of gubernaculum, and in number of bursal rays.

Type habitat.—Associated with *Ips pini* in red pine.

Type locality.—Caroline County, New York.

Type specimens.—Collection No. 84.

***Parasitorhabditis terebranus* n. sp.** **Figure 45**

Female: 0.77–0.81 mm; a=19.7–20.1; b=4.2–4.3; c=26.2–27.3; V=93%.

Male: 0.75 mm; a=19.5; b=4.1; c=27.3.

Cylindroid. Transverse striae moderately fine. Lips angular to rounded with moderately prominent papillae. Stoma 21 μ in depth. Prorhabdions unique in that the anterior tips are bent. Remnants of metarhabdions with 4 teeth, 2 subventral, 2 subdorsal, only distinct in lateral view. Esophagus without median bulb, muscular, lumen of corpus heavily sclerotized, serrate. Isthmus and basal bulb muscular throughout, length of corpus equal in length to isthmus and basal bulb. Cardia very conspicuous. Nerve ring at midisthmus. Excretory pore slightly anterior to nerve ring. Lips of vulva protuberant. Vagina oblique. Ovary reflexed up to three-fourths its length. Quadricolumella variable in length, up to several body widths long. Phasmid, anus, and rectum conspicuous. Tail conoid to a short filamentous terminus.

Male: Testis single, reflexed. Spicules very slender. Spicate capitate, 34 μ in length. Gubernaculum as figured, 17 μ in length. Tail conoid to an acute terminus. Bursa peloderan. There are 9 pair of bursal rays.

Diagnosis.—Differs from all other species in genus in the short spicate terminus. Also distinctive as to the length of isthmus and basal bulb in relation to length of corpus of esophagus and in the unique prorhabdions.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Nacogdoches, Texas.

Type specimens.—Collection No. 45-C.

Genus *Bunonema* Jägerskiöld, 1905

Synonyms: *Craspedonema* Richters, 1908
Rhodolaimus Fuchs, 1930

Type species: *B. richtersi* Jägerskiöld, 1905

Body spindle shaped, tapering to a sharply pointed tail. Cuticle with dorsal and ventral

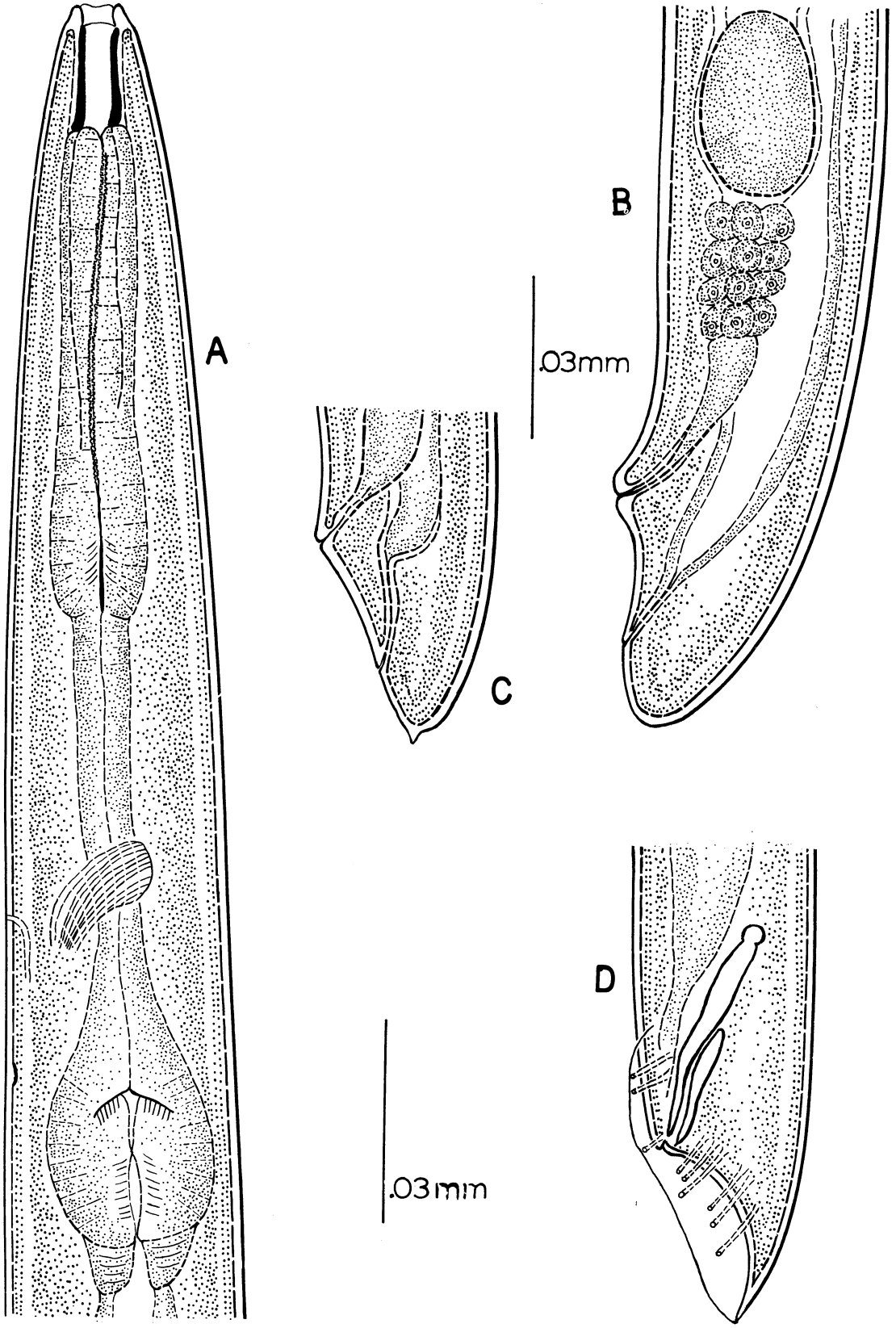


Figure 44.—***Parasitorhabditis ipini*** **n. sp.:** ***A.*** **Head and neck;** ***B.*** **female, tail;** ***C.*** **female, tail;** ***D.*** **male, tail.**

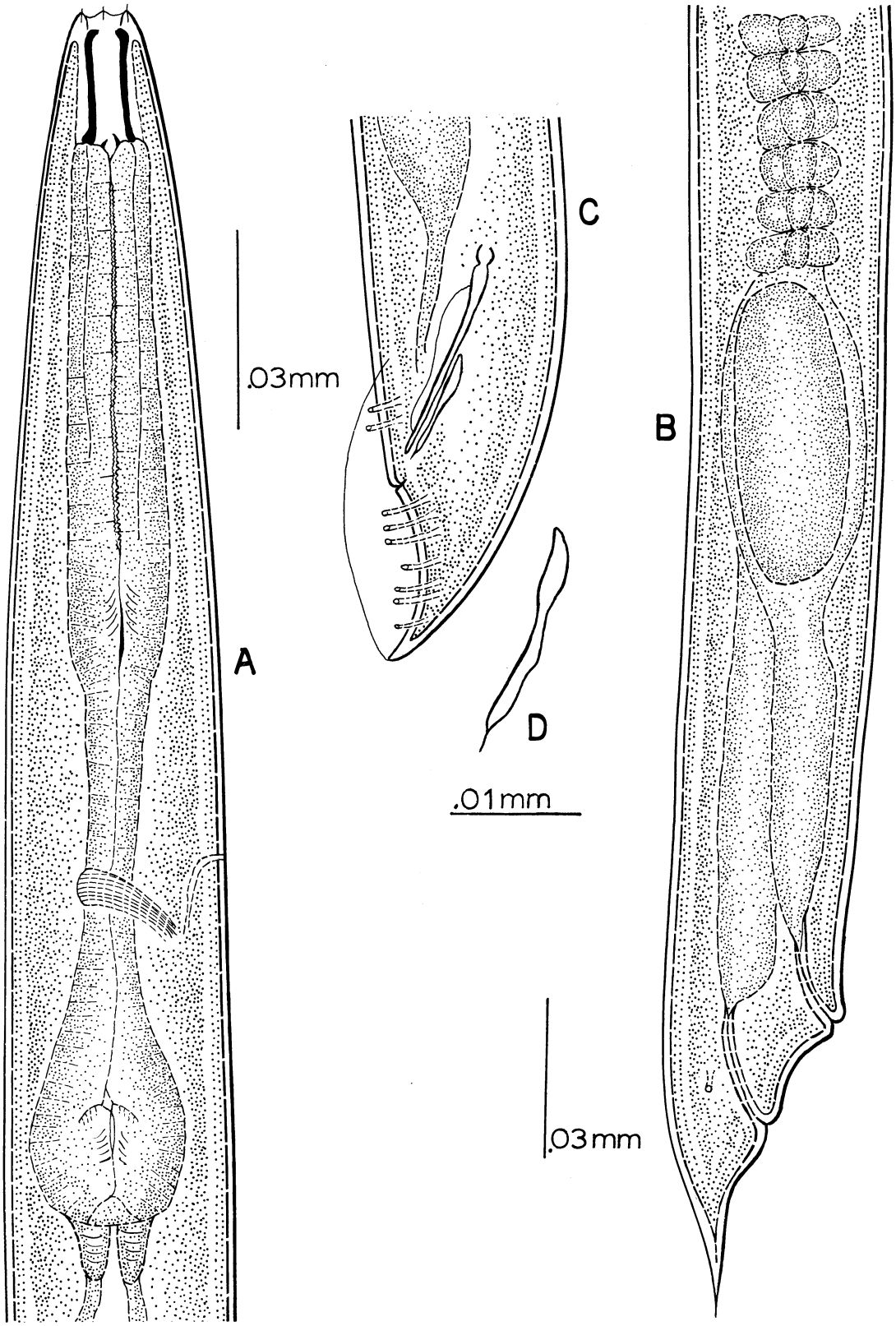


Figure 45.—*Parasitorhabditis terebranus* n. sp.: *A.* Head and neck; *B.* female, tail; *C.* male, tail; *D.* gubernaculum.

membranes throughout entire body length. Head asymmetrical with enlarged projecting lateral lips. Cheilo-, pro-, and mesostom forming an elongate cylinder. Esophagus rhabditoid. Ovaries paired. Spicules slender, paired ventrally arcuate. Bursa leptoderan with a varying number of rays.

***Bunonema newmexicana* Massey, 1964** **Figure 46**

Female: 0.34–0.43 mm; a=12; b=4; c=14; V=56%.

Male: 0.35–0.45 mm; a=15; b=5; c=9.

Cuticle with fine transverse striae between rows of wartlike protuberances. Head asymmetrical with 6 cephalic setae, typically bunonematitoid. Prorhabdions prominent, rhabditoid, slightly expanded at base. Meso, meta, and telorhabdions not apparent. Corpus and median bulb of esophagus somewhat shorter than isthmus and terminal bulb combined; terminal bulb valvate. Nerve ring approximately at middle of isthmus. Excretory pore not observed. Amphidelphic, ovaries short, reflexed, occupying only one-third of body length. Vagina transverse, lips slightly protuberant. Cuticle overhanging the anal opening. Tail conoid, terminus acute.

Male: Testis single, reflexed. Spicules paired, elongate, slender, ventrally arcuate, over twice length of gubernaculum. Gubernaculum troughlike, distal end almost encircling spicules, appears knobbed in lateral view. Bursa leptoderan, supported by 5 pairs of bursal rays. Four pairs of visible ventrosubmedian caudal papillae; 1 preanal, 2, 3, 4 at base of tail. Tail conoid, terminus acute.

Diagnosis.—B. newmexicana differs from described species of the genus in the location and number of bursal rays and position and number of caudal papillae. Sachs (1949) lists 6 subgenera in the genus. In the writer's opinion, these are superfluous.

Type habitat.—Associated with *Scolytus ventralis* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 31-B.

Numerous nematodes belonging to this genus have been recovered from trees infested with bark beetles; because of the dearth of described material and the unavailability of type specimens, no attempt has been made to describe them.

Genus *Cylindrocorpus* Goodey, 1939

Synonym: *Cylindrogaster* Goodey, 1927 (nec Stål, 1855).

Type species: *C. longistoma* (Stefański, 1922) Goodey, 1939.

Head with 6 forward-pointing conical lips. Stoma exceedingly long. Procorpus and corpus of esophagus fused into a cylindrical esophageal bulb; isthmus and terminal bulb distinct, terminal bulb non-valvate. Ovaries paired, reflexed. Testis single. Spicules paired ventrally arcuate, capitate. Tail with several pairs of papillae.

***Cylindrocorpus erectus* Massey, 1960** **Figure 47**

Female: 0.95 mm; a=16; b=5.5; c=8.8; V=47%.

Male: 0.77 mm; a=17; b=7.7; c=19.8.

Cuticle thin, with fine longitudinal and transverse striations, the striations more apparent at midbody. Body of female widest at middle, sharply narrowing anteriorly from region of esophagus and posteriorly to a long, finely pointed tail. Body shape of the male more uniform in width throughout its entire length. Head with 6 forward-pointing conical lips as figured. Stoma elongate, one-third the length of esophageal bulb, isthmus and terminal bulb combined and composed of a short cheilostom, cheilorhabdions buttonlike, a long protostom and a short telostom. Esophagus typical of the genus. Nerve ring slightly anterior to terminal bulb. Excretory pore not discernible in specimens examined. Lips of vulva slightly protuberant. Vagina a short transverse slit, located approximately at middle of the body. Ovaries paired, opposed and reflexed, each uterus usually containing one egg at a time.

Male: Testis single, reflexed, spicules as illustrated. Cuticle of the tail expanded to form a narrow bursa supported by 9 pairs of papillae as figured. Tail moderately short, finely spicate.

Diagnosis.—Cylindrocorpus, closely related to *curzii* Goodey, 1935. Differs from that species in its stouter body form: *C. erectus,* both sexes, a=16–17; *C. curzii,* female=19–30, male=23–28; shorter tail in the female, stouter tail of

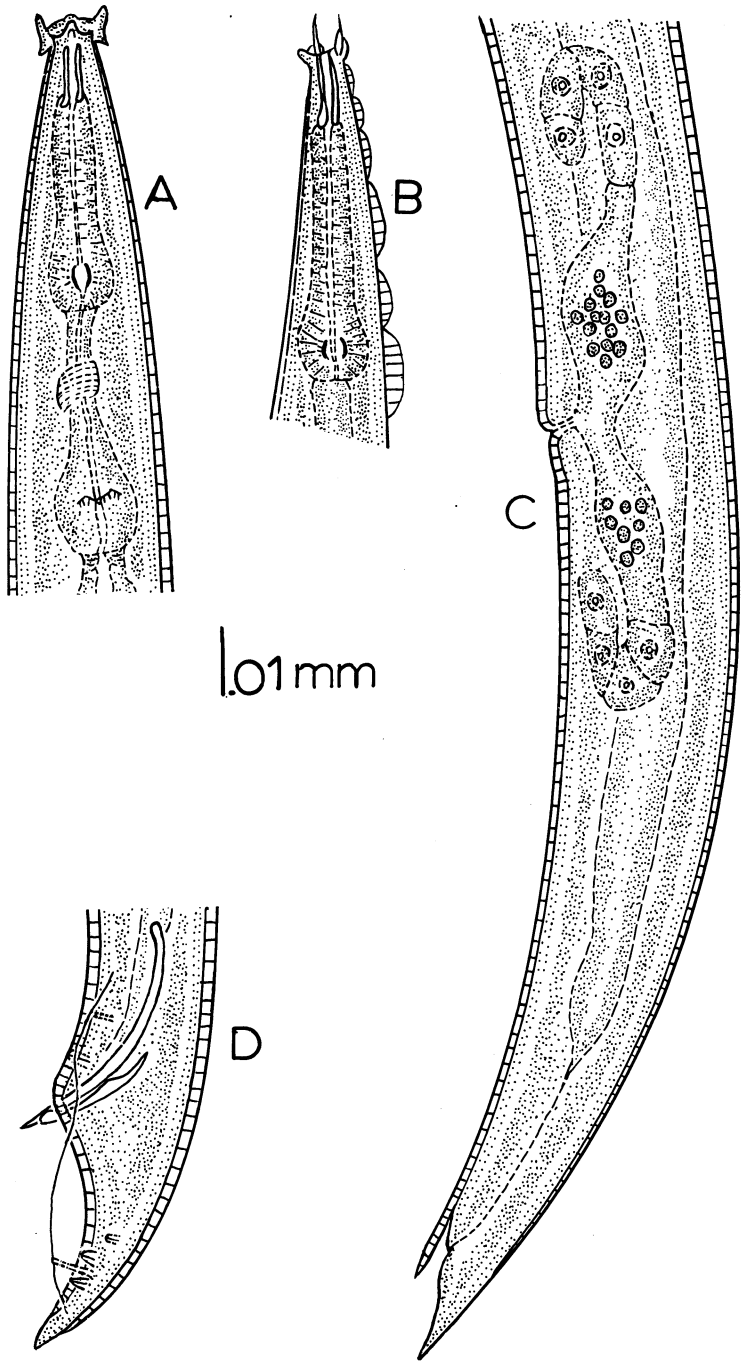


Figure 46.—*Bunonema newmexicana* Massey, 1964: *A.* Head and neck; *B.* head and neck, lateral view; *C.* female, tail; *D.* male, tail.

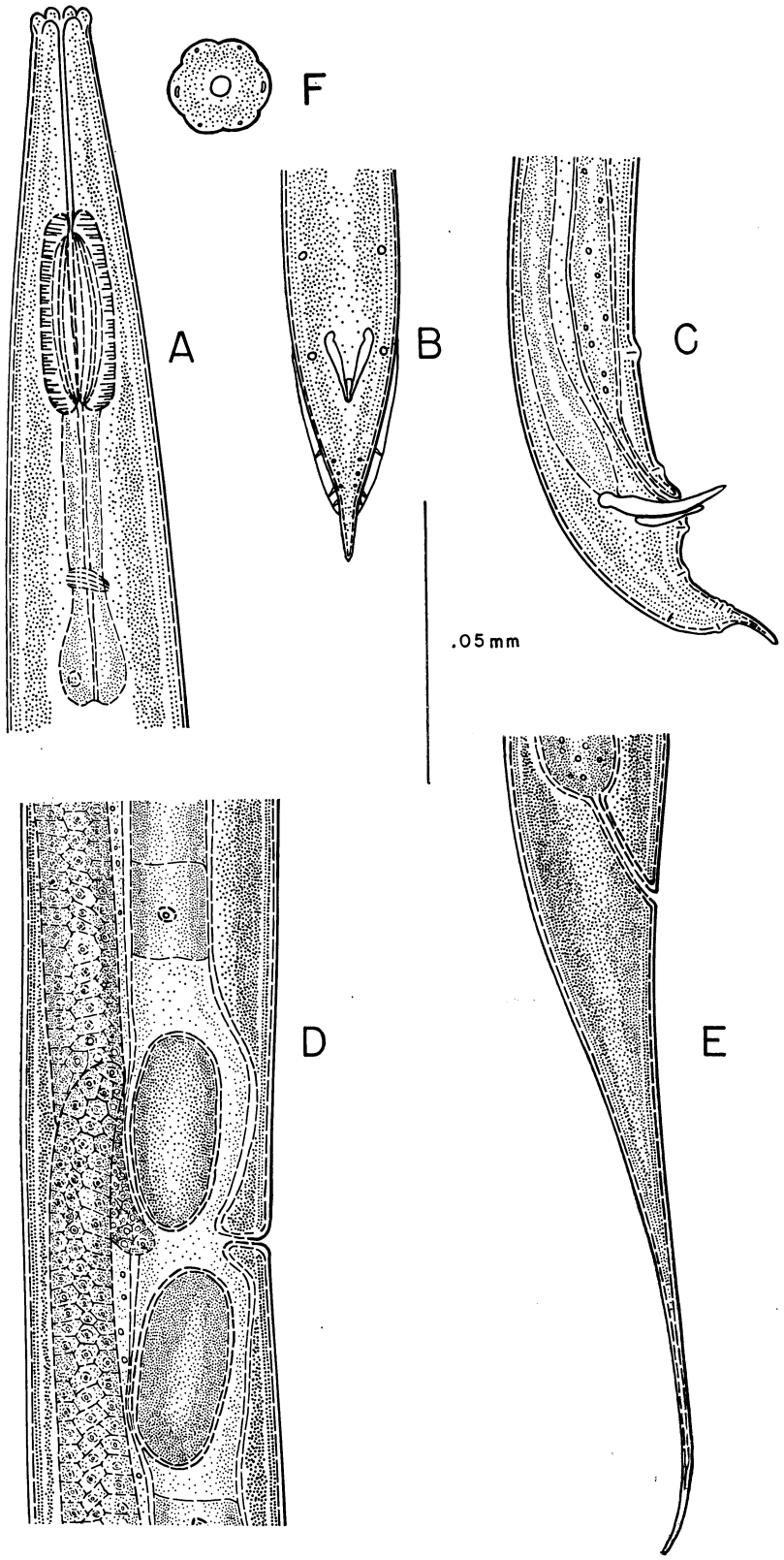


Figure 47.—***Cylindrocorpus erectus*** **Massey, 1960:** ***A.*** **Head;** ***B.*** **male, tail, ventral view;** ***C.*** **male, tail, lateral view;** ***D.*** **midsection female;** ***E.*** **female, tail;** ***F.*** **face view.**

the male. Inflated cuticle of the tail in the male is supported by only 9 pair of papillae.

Type habitat.—Associated with *Scolytus multistriatus* (Marsh) in American elm, *Ulmus americana* L.

Type locality.—Albuquerque, New Mexico.

Type specimens.—Collection Nos. 8-V, 25-G.

Genus *Acrostichus* Rahm, 1928; Massey, 1962

Synonyms: *Diplogasteritus* Paramonov, 1952
Filipevella Lazarevskaya, 1965

Type species: *Acrostichus toledoi* Rahm, 1928

Cuticle with very prominent longitudinal and moderately fine transverse striation. Head usually narrowed forward from anterior end of neck in lateral view. Stoma much deeper than wide, 10–15 μ in depth, 2.5–4 μ in width, consisting of a cheilostom with distinct prorhabdions. Meso, meta, and telorhabdions at times fused forming a glottoid apparatus armed with 2–4 dorsal and subventral teeth. Esophagus typically diplogasteroid. Females amphidelphic, ovaries usually strongly reflexed with either meeting or crossing in region of vulva. Females with a large reniform spermatheca. Spicules paired, ventrally arcuate cephalated. Gubernaculum massive, variable in shape. Preanal and caudal papillae variable in number. Tail in both sexes filiform.

Acrostichus concolor Massey, 1962, Emended, 1970

Figure 48

Female: 0.53 mm; a=14; b=5; c=3.7; V=47%.

Male: 0.50 mm; a=16; b=4; c=5.7.

Cuticle with prominent longitudinal striae. Body widest near middle, tapering only gradually toward extremities. Neck strongly narrowed from anterior fourth of esophagus forward. Amphid apertures minute, porelike, located near apices of lateral lips. Stoma 12 μ deep, 3.5 μ wide. Mesorhabdion armed with a dorsal tooth; the ventral metarhabdion with a subventral tooth, the anterior dorsal tooth the largest, the ventral metarhabdion with a small denticle. Isthmus and terminal bulb of esophagus two-thirds length of procorpus and median bulb. Nerve ring near middle of isthmus. Excretory pore adjacent to terminal bulb. Ovaries paired, reflexed, nearly meeting at midbody. Vagina a tranverse slit, opening into a reniform spermatheca. Tail filiform.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate, cephalated. Gubernaculum massive, almost as long as spicules. Eight pair of caudal papillae: 1 and 2 preanal subventral; 3 immediately postanal, 4, 5, 6, and 7 postanal subventral, located at base of body as it narrows into the tail proper; 8 subdorsal and adjacent to number 7. Phasmids prominent in some specimens. Tail filiform.

The species of *Acrostichus*, for the most part, can be distinguished by variations in size and shape of the massive gubernaculum. Gubernaculum of *A. concolor* distinguishes it from other species in the genus.

Type habitat.—Associated with *Scolytus ventralis* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 34-A.

Acrostichus gubernatus n. sp.

Figure 49

Female: 0.69–0.77 mm; a=18.7–21.4; b=6.0–6.2; c=2.5–3.0; V=39–43%.

Male: 0.57–0.59 mm; a=18.3–24.2; b=4.6–5.3; c=3.9–4.3.

Cylindroid. Cuticle with fine longitudinal and transverse striations, ornamentation consisting of 6 equally spaced striated lines in lateral view. Lips rounded, each with a very fine papilla. Cheilorhabdions and prorhabdions distinct. Dorsal mesorhabdion modified into a large heavily sclerotized tooth. Ventral metarhabdion with a subventral tooth. Corpus of esophagus widened at its base into a median bulb. Corpus and median bulb approximately one-third longer than isthmus and basal bulb, basal bulb nonvalvate. Cardia conspicuous. Nerve ring at midisthmus. Excretory pore opposite terminal bulb. Hemizonid immediately anterior to excretory pore. Vulva with 2 flaplike processes. Vagina transverse to oblique. Ovaries paired, opposed and reflexed, the terminal ends crossed. Uterus reniform, possibly acting as a spermatheca. Anus and rectum moderately conspicuous. Tail conoid to a very long filiform terminus.

Male: Testis single, reflexed 1 to 2 body widths. Spicules ventrally arcuate, paired, cephalated, 25 μ in length. Gubernaculum massive, shaped as figured, longer than spicules,

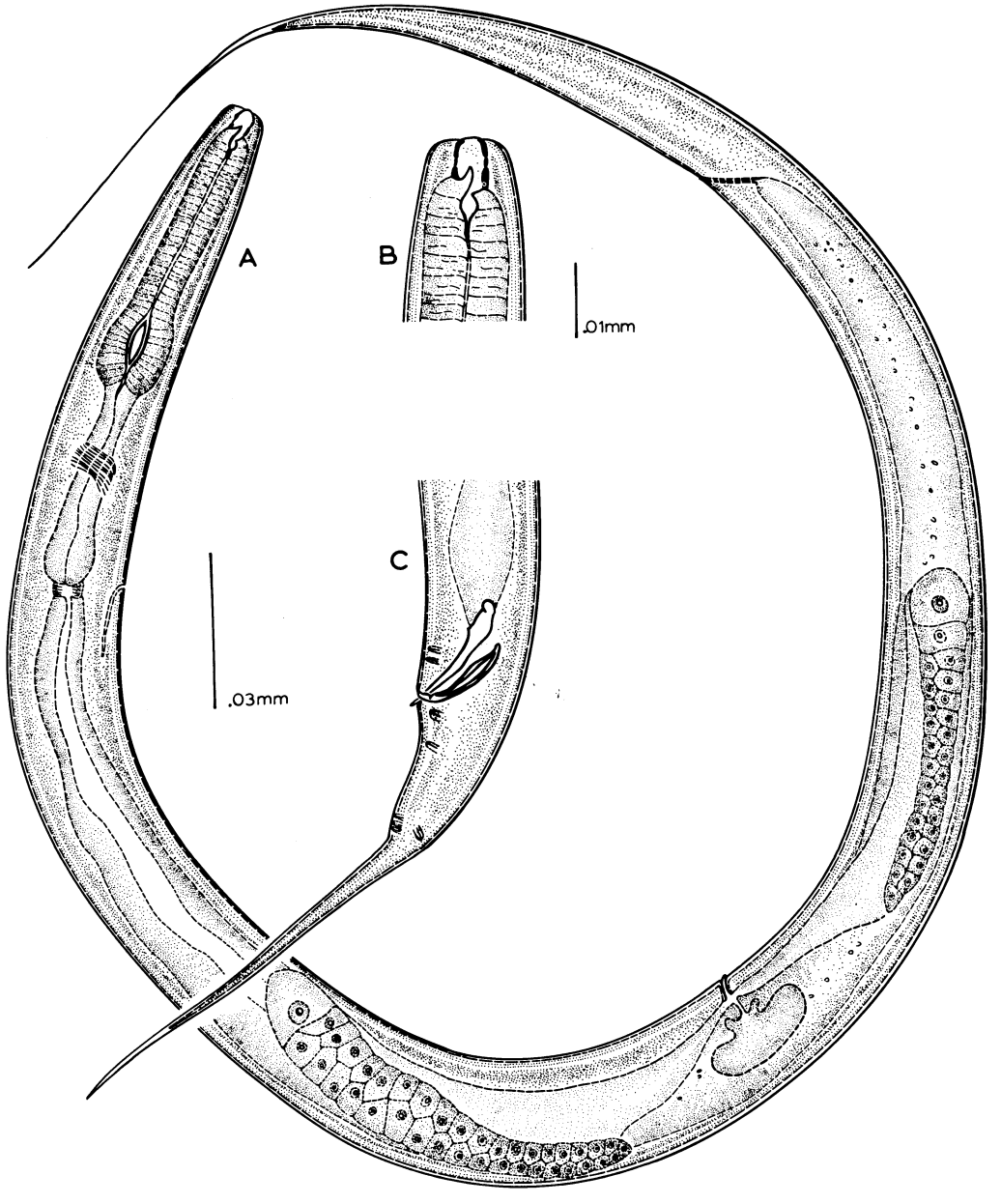


Figure 48.—*Acrostichus concolor* Massey, 1962, emended, 1970: *A.* Female; *B.* head; *C.* male, tail.

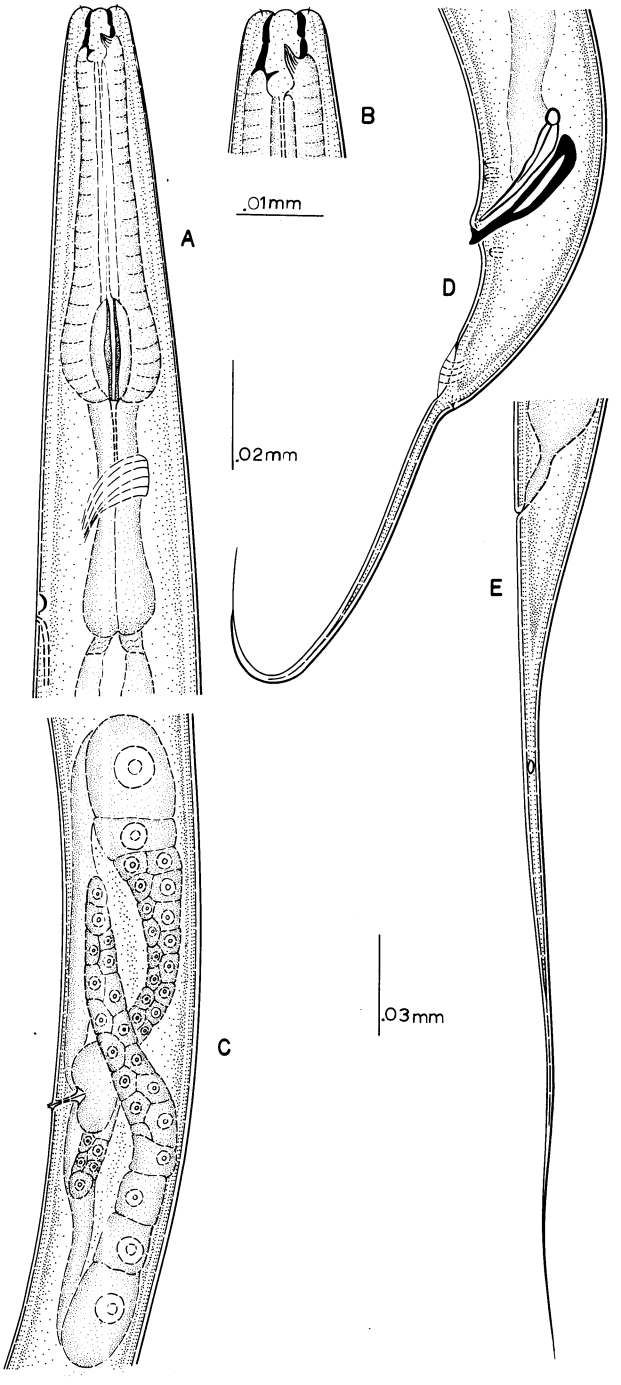


Figure 49.—*Arcostichus gubernatus* n. sp.: *A.* Head and neck; *B.* head; *C.* midbody, female; *D.* male, tail; *E.* female, tail.

27 μ long. There are 8 pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 5 pairs postanal ventrosubmedian, 1 pair immediately posterior to anal opening, and 4 pairs at the anterior end of the elongate terminus, 1 pair subdorsal, as illustrated. Tail ventrally arcuate to a long filiform terminus. Bursa rudimentary.

Diagnosis.—Differs from all other species in the genus in the massiveness of the gubernaculum and in the unique vulval flaps.

Type habitat.—Associated with *Dendroctonus rufipennis* in Engelmann spruce.

Type locality.—Mt. Taylor, New Mexico.

Type specimens.—Collection No. 34-C.

***Acrostichus ponderosus* Massey, 1962** **Figure 50**

Female: 0.6 mm; a=16; b=7; c=3; V=48%.

Male: 0.4 mm; a=15; b=5; c=5.

Cuticle with prominent longitudinal and transverse striations. Head narrowly rounded. Stoma 10 μ in depth, 3 μ in width. Cheilo and prorhabdions distinct. Dorsal mesorhabdion modified into large clawlike tooth. Dorsal metarhabdion with a small denticle. Ventral metarhabdion with a small subventral tooth. Esophagus with a muscular corpus and median bulb, basal bulb nonvalvate. Nerve ring at midisthmus. Excretory pore at base of basal bulb. Ovaries paired, opposed and reflexed, terminal ends crossed. Vagina a transverse slit. Lips of vulva at times protuberant.

Male: Testis single, reflexed for a short distance. Spicules paired, ventrally arcuate, cephalated. Gubernaculum massive, nearly as long as spicules. Nine pairs of caudal papillae located as figured. Tail conoid to a filiform terminus. Bursa rudimentary.

Diagnosis.—Differs from other species in the genus in the shape of the gubernaculum.

Type habitat.—Associated with *Ips ponderosae* Sw. in ponderosa pine.

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 5-C.

***Acrostichus taedus* Massey, 1962** **Figure 51**

Female: 0.63 mm; a=15; b=5.4; c=3.6; V=43%.

Male: 0.55 mm; a=18; b=4.4; c=5.5.

Cuticle with prominent longitudinal and fine transverse striations. Stoma 3 times deeper than wide. Cheilo, pro, and mesorhabdions

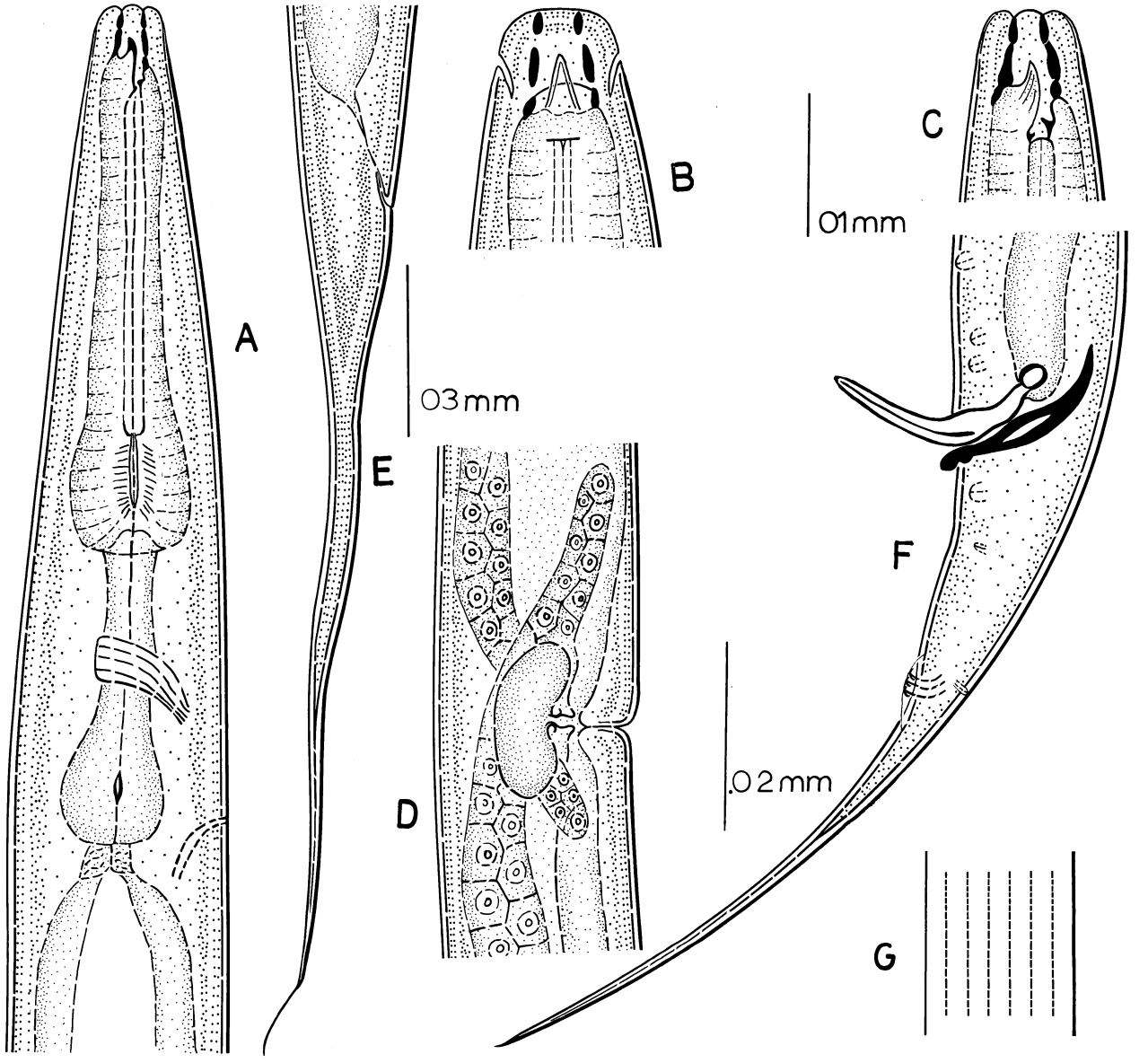


Figure 50.—*Acrostichus ponderosus* **Massey, 1962:** ***A.*** **Head and neck;** ***B.*** **head, ventral view;** ***C.*** **head, lateral view;** ***D.*** **midbody, female;** ***E.*** **female, tail;** ***F.*** **male, tail;** ***G.*** **cuticle pattern.**

distinct. Dorsal mesorhabdion modified into a very large tooth. Ventral metarhabdion armed with a comparatively large subventral tooth. Corpus of esophagus distinctly widened at base forming a median bulb, corpus and median bulb one-third longer than isthmus and nonvalvate basal bulb. Nerve ring at midisthmus. Excretory pore adjacent to nerve ring. Vagina transverse. Lips of vulva only slightly protuberant. Ovaries paired, opposed and reflexed, the terminal ends crossing. Tail conoid to a filiform terminus.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate, cephalated. Gubernaculum nearly as long as spicules and shaped as illustrated. Nine pairs of caudal papillae located as figured. Tail ventrally arcuate, conoid to a filiform terminus. Bursa rudimentary.

Diagnosis.—Differs from *A. ponderosus* in

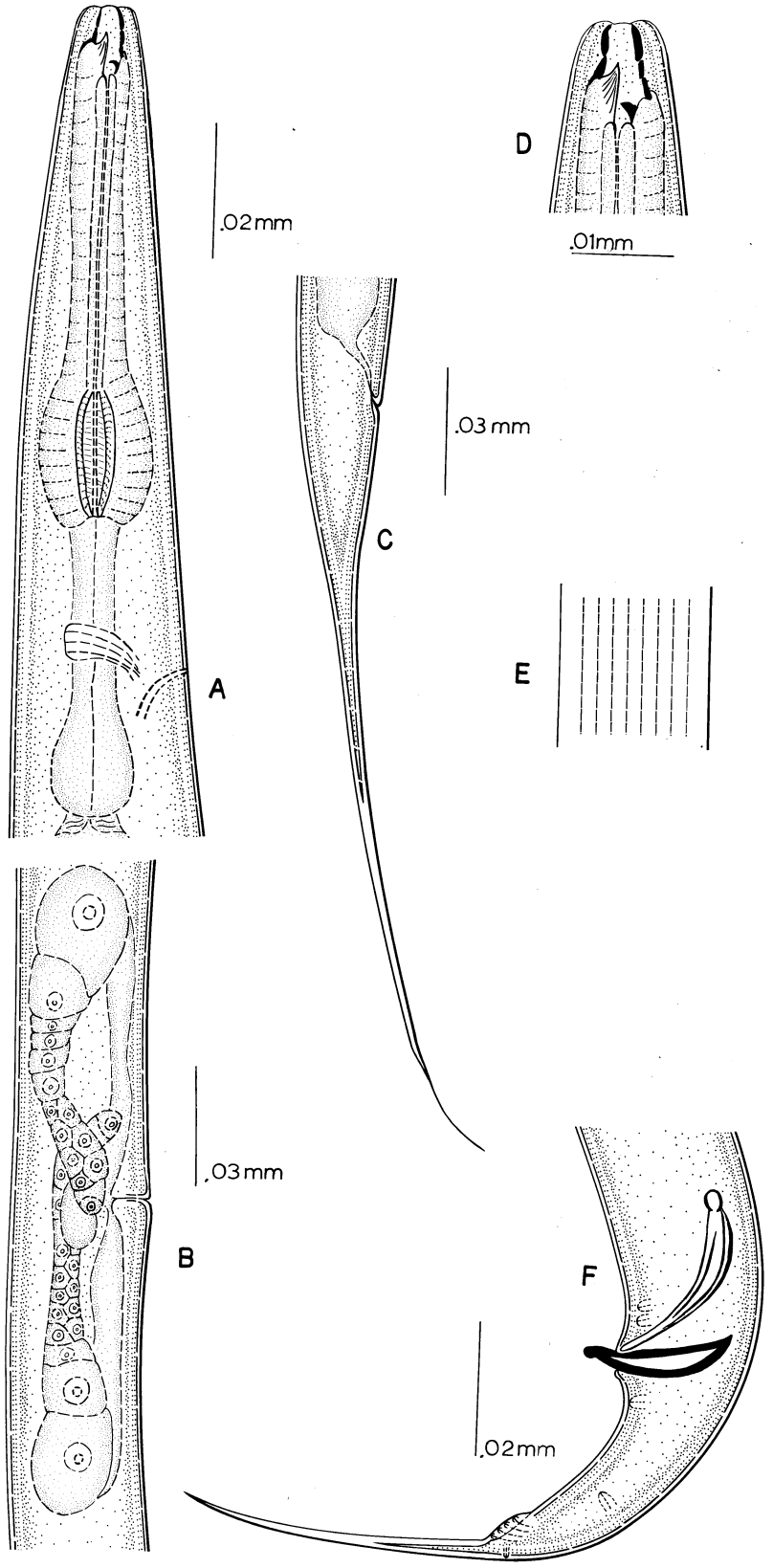


Figure 51.—*Acrostichus taedus* Massey, 1962: *A.* Head and neck; *B.* mid-body, female; *C.* female, tail; *D.* head; *E.* cuticular pattern; *F.* male, tail.

shape of gubernaculum, in esophageal characters, and in number of teeth in pharynx.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Lake City, Florida.

Type specimens.—Collection No. 10-H.

Genus *Gerthornus* Massey, 1966

Type species: *Gerthornus balaenus* Massey, 1966.

Cuticle with fine transverse and longitudinal striations. Head broadly rounded, with 6 lips, each lip bearing a prominent titlike papilla. Amphids open on outer contour of lips. Stoma very deep and broad, 30 μ by 14 μ. Cheilorhabdions and prorhabdions distinct, the prorhabdions sigmoid. Meso, meta, and telorhabdions fused. Stoma armed with several large teeth, both subdorsal and subventral. Ovaries paired; testis single. Male with several pairs of preanal and postanal caudal papillae. Tail of both sexes elongate.

Diagnosis.—Differs from other members of the subfamily in the character and shape of the stoma and its armature. The genus has affinities with *Odontopharynx* deMan, 1912, but differs in the character of the esophagus.

Gerthornus balaenus Massey, 1966 Figure 52

Females: 0.81–1.06 mm; a=22; b=4.2–4.8; c=6.5–9.5; V=54%.

Males: 0.73–0.81 mm; a=20–22; b=4.2–4.8; c=8.8–9.7.

Cuticle with fine longitudinal and transverse striations. Head broadly rounded, more or less flattened at the apex. Head composed of 6 lips, each carrying a prominent, titlike papilla at apices. Amphids well defined, opening on outer contour of lips. Stoma 30 μ deep, 14 μ wide. Cheilorhabdions distinct, forming apical arch of stoma and overlapping prorhabdions. Prorhabdions almost twice length of cheilorhabdions, sigmoid, proximal portions with knotlike swellings. Meso, meta, and telorhabdions fused, bearing 6 large teeth, 2 subdorsal, 4 subventral. The ventral mesorhabdions bear a rasplike plate as figured. Esophagus consists of a broad and very muscular procorpus, widening slightly into a median bulb. Nerve ring one-third body diameter posterior to median bulb. Excretory pore slightly less than 1 body width behind nerve ring. Hemizonid not seen. Ovaries paired, reflexed at times beyond vulval opening; proximal portion of each ovary containing spermatozoa. Vulva protuberant. Tail elongate, ending in a minutely rounded terminus.

Male: Testis single, at times reflexed 1–2 body diameters. Spicules paired, 75 μ long, slender, cephalated, ventrally arcuate. Gubernaculum keel shaped, one-third length of spicules with a sclerotized, forklike guiding process. There are 7 pairs of ventrosubmedian papillae, 3 preanal and 4 postanal, situated as figured. One pair of subdorsal papillae present. Tail and terminus as in female.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 42 (Holotype), 42-A (Allotype).

Genus *Mikoletzkya* (Weingärtner, 1955) Rühm, 1960

Synonyms: *Diplogaster* (*Mikoletzkya*) Weingärtner, 1955
Diplogaster (*Fuchsia*) of Micoletzky, 1922 (nec *Fuchsia* Spuler, 1910)
Fuchsia (Micoletzky, 1922) of Paramonov, 1952 and Rühm, 1956
Diplogaster (*Mikoletzkyella*) Weingärtner, in Meyl, 1956
Mikoletzkyella (Weingärtner in Meyl, 1956) Andrassy, 1958

Head broadly rounded. Cephalic papillae weak to prominent. Stoma is usually deeper than wide with prominent cheilo and prorhabdions. Dorsal metarhabdion bears a large clawlike tooth that extends well into the pharynx. Subventral metarhabdion also bears a large tooth which in some species extends into the protostom and appears to bisect the dorsal tooth in lateral view. Cuticle usually bears a series of longitudinal ridges. Esophagus typically diplogasteroid. Ovaries paired, usually reflexed. Testis single, sometimes reflexed. Spicules paired. Gubernaculum unique in appearance, thick proximally with a thin troughlike distal extension. There are usually 8 pairs of caudal papillae, although these may vary in number, 3 pairs and 5 pairs postanal with a group of 3 appearing immediately anterior to

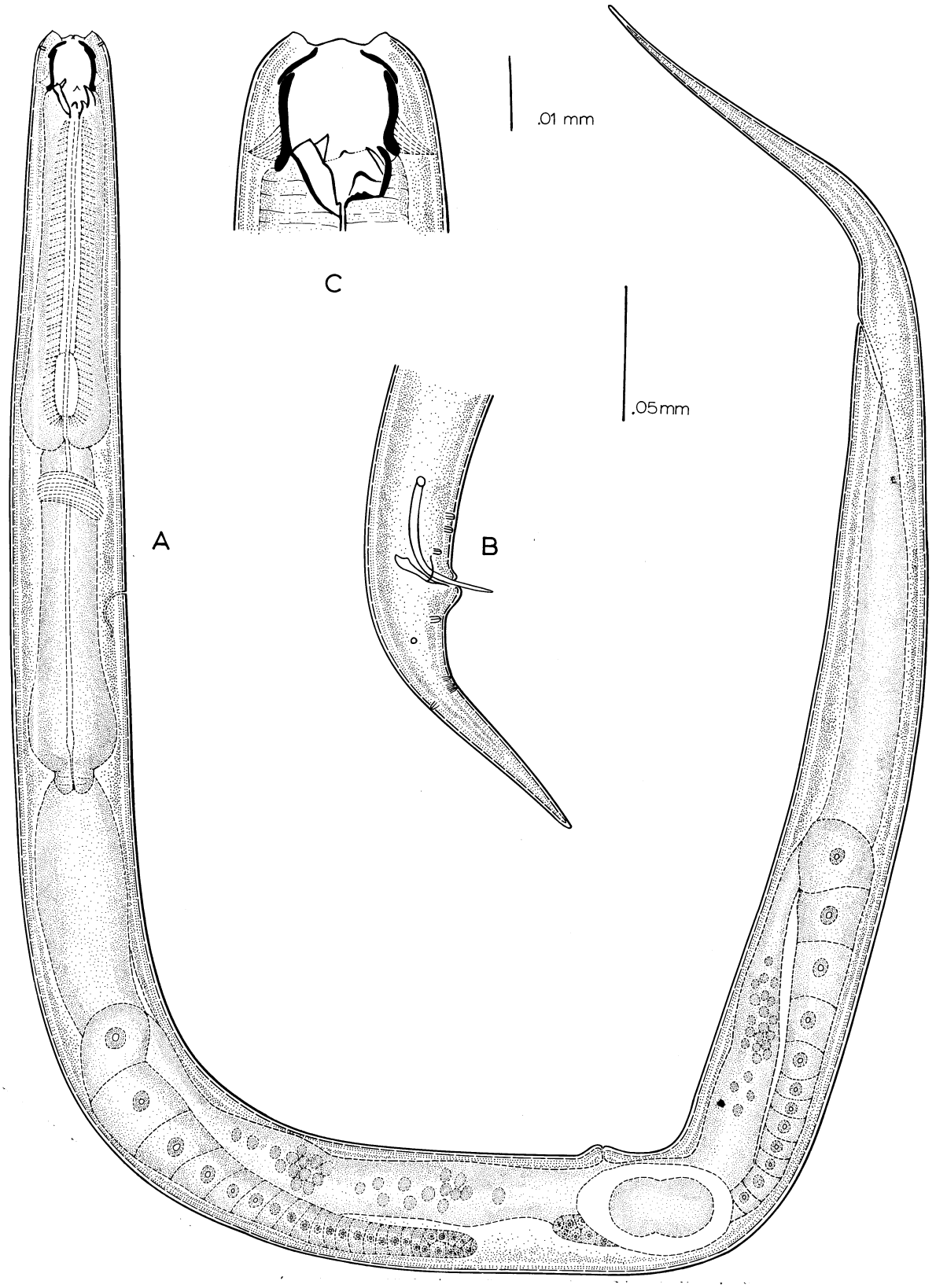
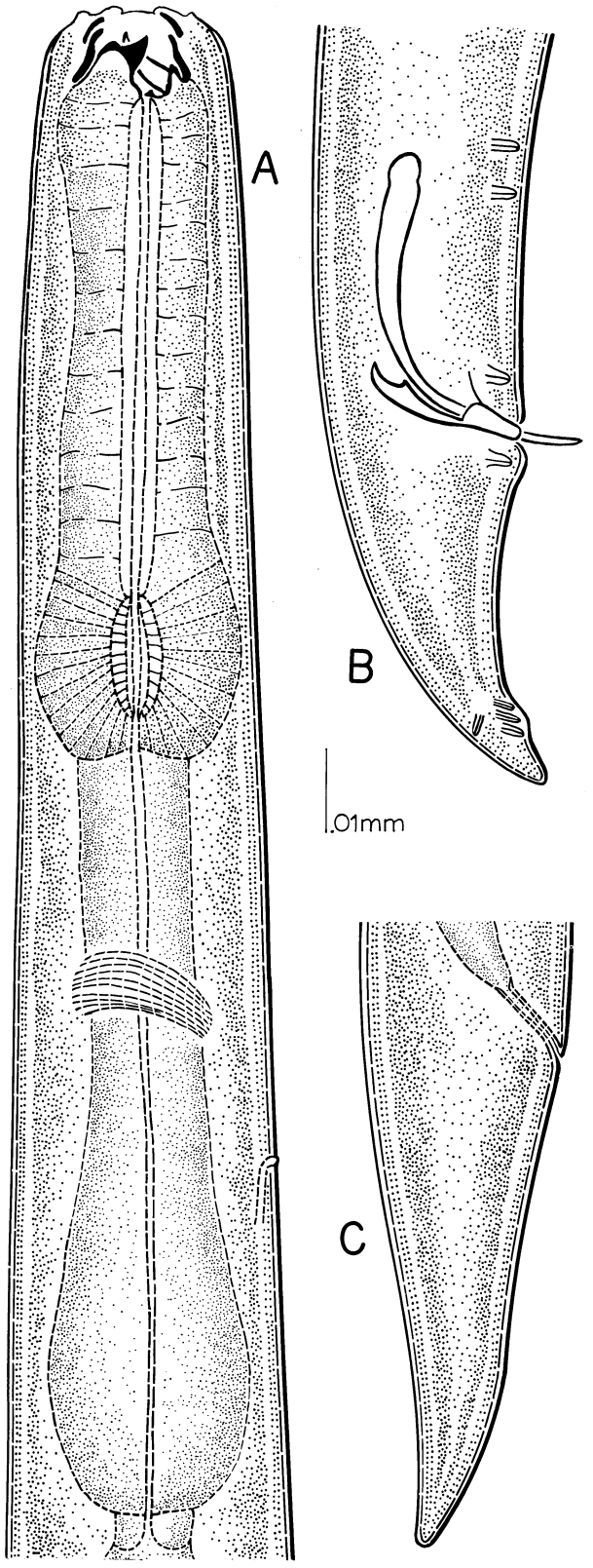


Figure 52.—*Gerthornus balaenus* Massey, 1966: *A.* Female; *B.* male, tail; *C.* head.



the terminus or its extension. Tail may be quite elongate or short and blunt.

***Mikoletzkya bandelieri* (Massey, 1960) Massey, 1966**
Figure 53

Female: 0.77–1.2 mm; a=21–26; b=4.4–5.4; c=13–17; V=53–56%.

Male: 0.64–1.0 mm; a=20–24; b=4.4–5.9; c=16–20.

Cuticle with prominent longitudinal striations. Head broadly rounded with moderately prominent apical papillae. Pharynx 13 μ wide, 10 μ deep. Cheilo and prorhabdions very distinct. Amphids at base of lateral lips. Dorsal metarhabdion developed into a large claw-like tooth, the ventral metarhabdion developed into a large subventral tooth extending past the subdorsal tooth at the middle of pharynx. There is a small buttonlike tooth at the base of the pharynx that appears to be developed at the junction of the telorhabdion, which is fused with the metarhabdion. Corpus of esophagus very muscular. Corpus and median bulb shorter than length of isthmus and terminal bulb combined. Nerve ring at middle of isthmus. Excretory pore midway between nerve ring and terminal bulb. Hemizonid not apparent. Vagina transverse. Lips of vulva protuberant. Amphidelphic, the ovaries reflexed. Spermatozoa present immediately preceding reflex of the ovary. Tail narrows to a conical terminus.

Male: Testis single, reflexed. Spicules paired, 42–47 μ in length, gubernaculum as illustrated, 16–18 μ in length. There are 8 pairs of preanal and caudal papillae arranged as figured. Terminus bluntly conoid.

Diagnosis.—Differs from other species of the genus in shape and length of tail and in length of corpus and median bulb of the esophagus.

Habitat.—*M. bandelieri* has been found associated with *Ips confusus* in pinyon, with *Dendroctonus frontalis* and *Ips avulsus* in loblolly pine, and with *Ips ponderosae* in ponderosa pine.

Distribution.—Collected from Talladega National Forest in Alabama and from Bandelier

Figure 53.—*Mikoletzkya bandelieri* (Massey, 1960) Massey, 1966: *A.* Head and neck; *B.* male, tail; *C.* female, tail.

National Monument and Santa Fe National Forest in New Mexico.

Type specimens.—Collection No. 2-B-1 (Holotype), 2-Z (Allotype).

***Mikoletzkya calligraphi* n. sp.** **Figure 54**

Female: 0.94 mm; a=26.4; b=5.3; c=13.2; V=56%.

Male: 0.85 mm; a=30; b=5.4; c=20.

Cylindroid. Cuticle with fine longitudinal and transverse striae. Lips rounded with small elevated titlike papillae. Cheilo, pro, and mesorhabdions distinct. Dorsal and ventral metarhabdions armed with 2 large teeth which cross at midpharynx. Meta and telorhabdions fused forming a heavily sclerotized opening to esophagus. Corpus of esophagus expanded at anterior end to approximate width of median bulb, muscular. Corpus and median bulb about equal in length to isthmus and basal bulb. Nerve ring at midisthmus. Both excretory pore and hemizonid obscure. Lips of vulva protuberant. Vagina transverse. Uterus developed into sausage shaped sac serving as a spermatheca. Ovaries paired, opposed and reflexed at times beyond vagina. Anus and rectum conspicuous. Tail conoid to a sharply rounded terminus.

Male: Testis single, reflexed. Spicules paired, ventral arcuation extreme, cephalated. Distal portion of shaft at right angles to manubrium, 60 μ in length. Gubernaculum shaped as figured. There are 6 pairs of caudal papillae, 2 preanal ventrosubmedian, 3 pairs ventral at base of tail, 1 pair dorsal at base of tail. Tail ventrally arcuate, conoid to a short spicate terminus.

Diagnosis.—Closely related to *M. bandelieri*, differs in length of spicules, number of caudal papillae, and shape of male tail.

Type habitat.—Associated with *Ips calligraphus* in slash pine.

Type locality.—Patrick, South Carolina.

Type specimens.—Collection No. 24-R.

***Mikoletzkya cervicula* Massey, 1966** **Figure 55**

Female: Unknown.

Male: 0.79–0.90 mm; a=22; b=4.7–5.6; c=15.

Cuticle with fine longitudinal and transverse striations. Head broadly rounded, grooves in lip ring not apparent. Six lips, each with a moderately prominent apical papilla. Amphids open on outer contour of lateral lips at contour of head. Cheilorhabdions and prorhabdions distinct, about equal in length, cheilorhabdions overlapping approximately one-third of prorhabdions. Meso, meta, and telorhabdions fused, a large, subdorsal, clawlike tooth situated on what appears to be the dorsal mesorhabdion; a large subventral tooth located on the same structure. Two large denticles at base of pharynx. Esophagus typically diplogasteroid. Nerve ring midway of isthmus. Excretory pore a little less than 1 body width behind nerve ring. Hemizonid not observed. Testis single, reflexed approximately 1 body width. Spicules paired, 50 μ long, ventrally arcuate, cephalated. Gubernaculum 17 μ long, with a thin, troughlike, distal extension. Seven pairs of caudal papillae: 3 preanal ventrosubmedian papillae, 3 postanal ventrosubmedian, and 1 subdorsal. Phasmids plainly visible. Terminus finely rounded.

Diagnosis.—Closely related to *M. thalenhorsti* (Rühm, 1956) Baker, 1962 and *M. pinicola* (Thorne, 1935) Baker, 1962. It differs from the former in dentation of the stoma and the length and shape of tail, and from the latter in dentation of stoma, shape, and in size of gubernaculum, and in the shorter tail and its shape.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 42.

***Mikoletzkya diluta* Massey, 1966** **Figure 56**

Female: 0.80 mm; a=20; b=6; c=10; V=52%.

Male: 0.67–0.83 mm; a=20–23.6; b=6–6.5; c=11.8–12.4.

Body tapers rapidly from midbody to head. Cuticle with fine longitudinal ridges from head to tail. Head narrowly rounded. Cephalic papillae not observed. Cheilo and prorhabdions distinct; meso, meta, and telorhabdions fused, all weakly sclerotized. The meso and metarhabdions bear a dorsal and subventral tooth. Dorsal tooth typical of genus, subventral variable in size and shape. A small tooth present at bottom of stoma, which is deeper than wide. Esophagus typically diplogasteroid, with isthmus and terminal bulb longer than corpus

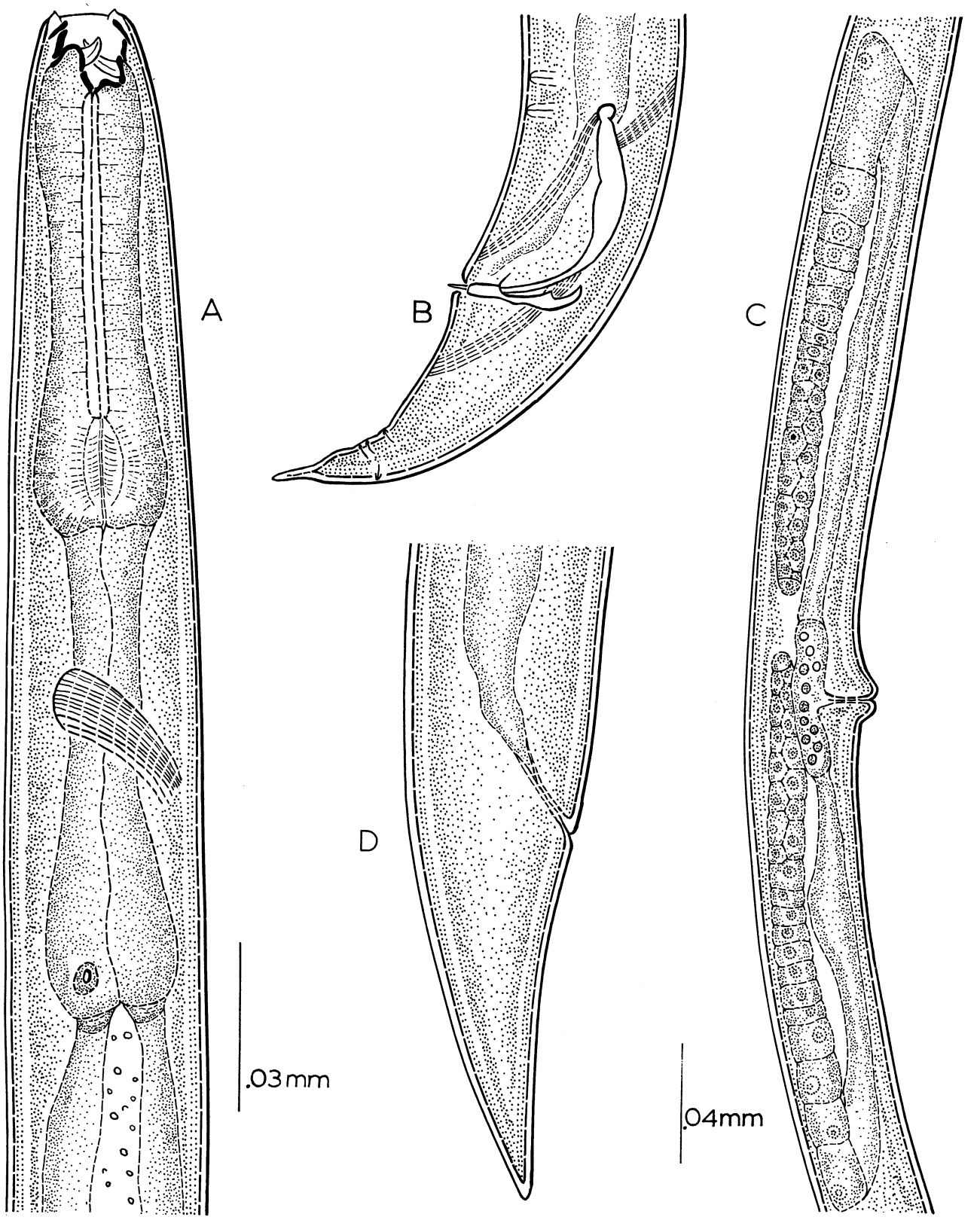


Figure 54.—*Mikoletzkya calligraphi* n. sp.: *A.* Head and neck; *B.* male, tail; *C.* female, midbody; *D.* female, tail.

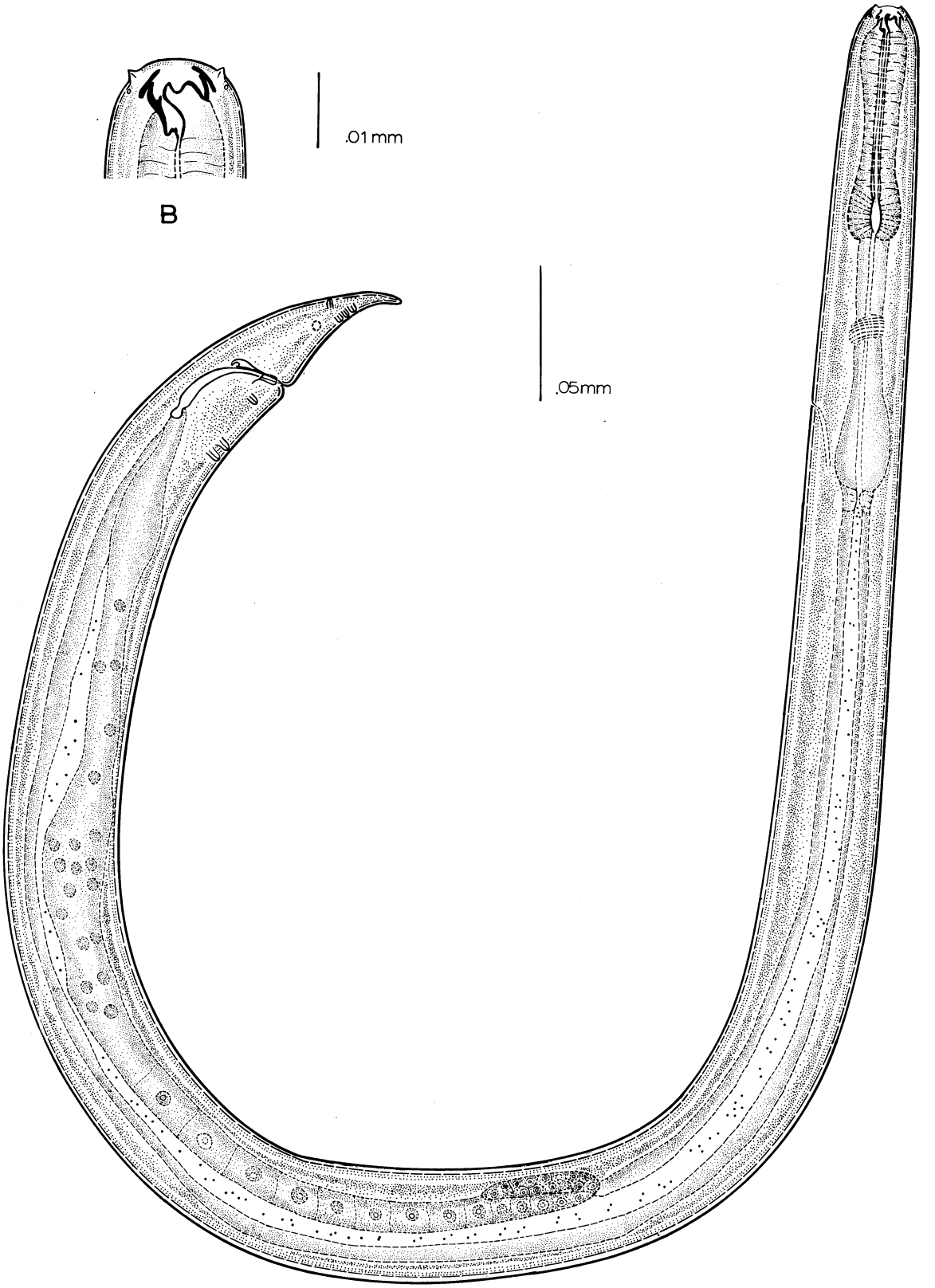


Figure 55.—*Mikoletzkya cervicula* **Massey, 1966:** ***A.*** **Male;** ***B.*** **head.**

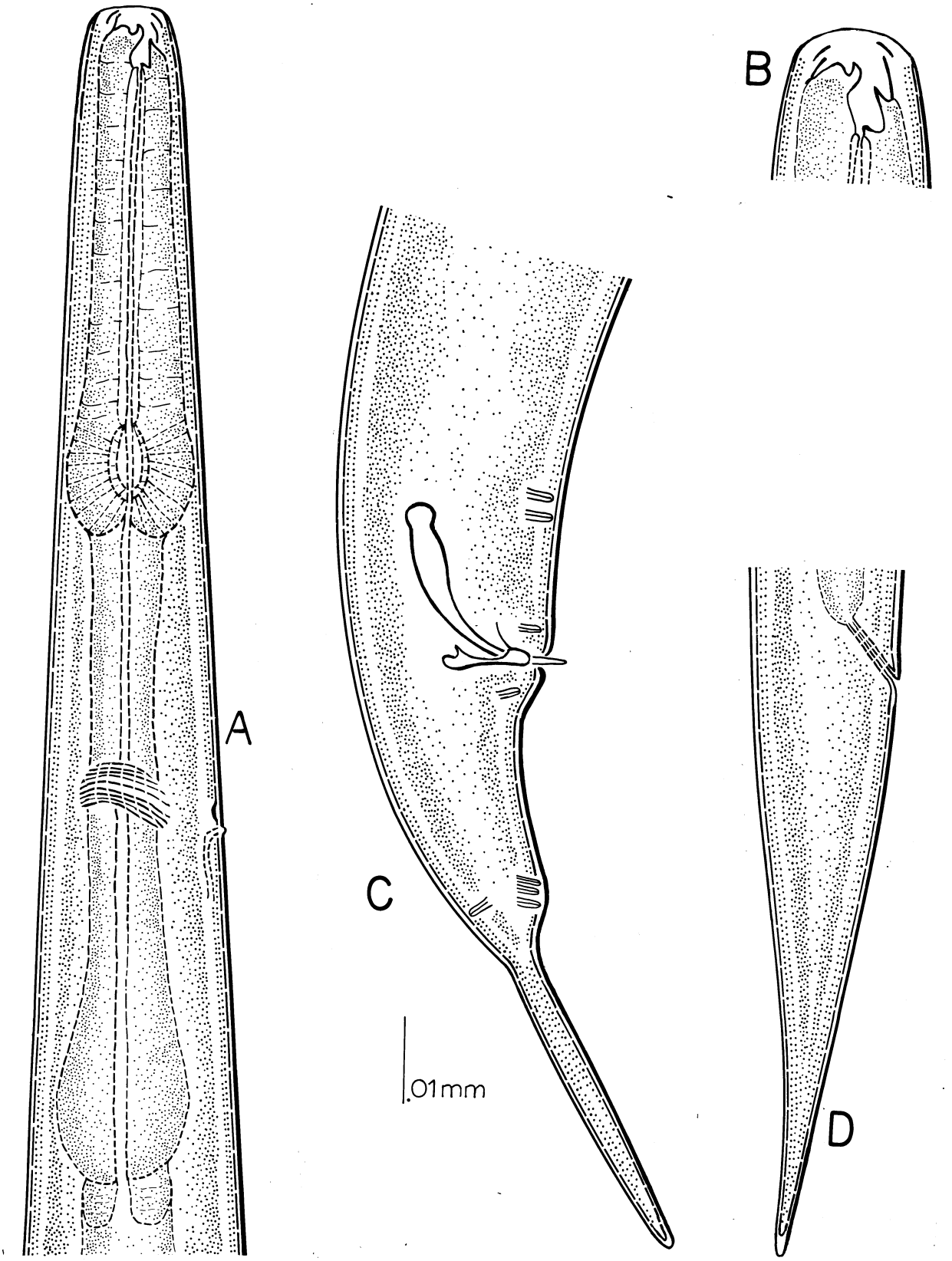


Figure 56.—*Mikoletzkya diluta* Massey, 1966: *A.* Head and neck; *B.* head; *C.* male, tail; *D.* female, tail.

and median bulb combined. Nerve ring 1½ body widths behind median bulb. Hemizonid opposite nerve ring, excretory pore posterior to hemizonid. Ovaries paired, reflexed approximately their entire length. Vagina a transverse slit vulva with protuberant lips. Tail conoid to a sharp terminus.

Male: Testis single, reflexed at midbody filling entire body cavity. Spicules paired, ventrally arcuate, cephalated, relatively short and stout, 23–31 μ in length. Gubernaculum 8–11 μ in length. There are 8 pairs of preanal and caudal papillae. Tail conoid to a spicate terminus.

Diagnosis.—Closely allied to *M. pinicola;* differs in the sclerotization of the pharynx, length of tail, and absence of discernible cephalic papillae.

Habitat.—Associated with *Scolytus ventralis* in white fir and *Dendroctonus pseudotsugae* in Douglas-fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 2-W.

***Mikoletzkya inedia* Massey, 1966** **Figure 57**

Female: 0.76–0.94 mm; a=23–30; b=5–6.2; c=12–14; V=55%.

Male: 0.66–0.75 mm; a=17–23; b=4.5–5.3; c=12.5–14.

Cuticle with fine longitudinal ridges extending the entire body length. Head with six small papillae. Cheilorhabdions and prorhabdions distinct, meso, meta, and telorhabdions fused. Metarhabdions bearing a large dorsal clawlike tooth and a subventral tooth as illustrated. Stoma much deeper than wide. Amphids porelike, opening at base of lateral papillae. Esophagus typically diplogasteroid. Isthmus and terminal bulb longer than corpus and median bulb combined. Nerve ring near middle of isthmus. Excretory pore immediately anterior to initial swelling of terminal bulb, hemizonid immediately anterior to excretory pore. Ovaries paired, at times reflexed to within a body width of vulva. Vagina a transverse slit, equidistant between terminal bulb and anal opening. Lips of vulva protuberant. Tail conical, ending in a narrowly rounded terminus.

Male: Testis single, sometimes reflexed; spicules paired, 38-45 μ in length, ventrally arcuate, cephalated; gubernaculum 15–18 μ long as figured. Eight pairs of preanal and caudal papillae. Tail conoid to a spicate terminus.

Diagnosis.—Closely related to *M. pinicola* from which it differs in size, shape, and structure of gubernaculum.

Type habitat.—Associated with *Ips* sp. and *Dendroctonus ponderosae* in ponderosa pine.

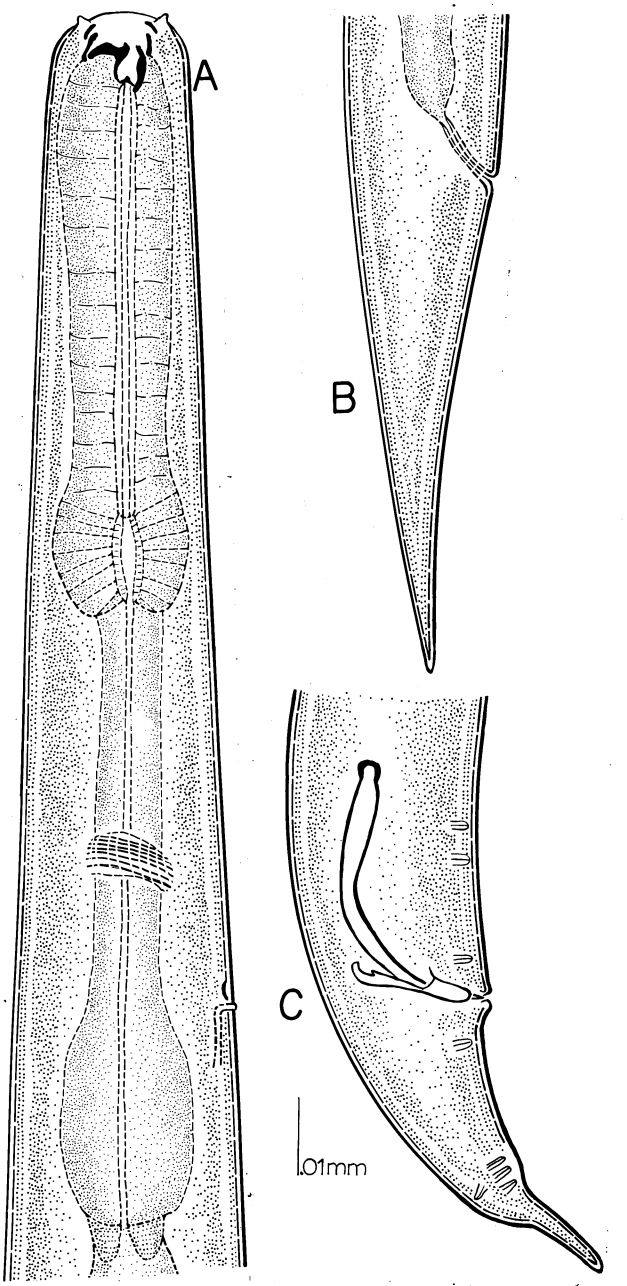


Figure 57.—*Mikoletzkya inedia* Massey, 1966: *A.* Head and neck; *B.* female, tail; *C.* male, tail.

Type locality.—Larimer County, Colorado.

Type specimens.—Collection No. 2-A (Holotype), 2-K (Allotype).

***Mikoletzkya langcauda* n. sp.** **Figure 58**

Female: 0.77–0.81 mm; a=15.5–18.5; b=4.3–4.7; c=5.7–6.1; V=51–52%.

Male: 0.63 mm; a=27; b=4.6; c=8.3.

Body straight. Cylindroid. Cuticle with moderately fine transverse and longitudinal striations. Head broadly rounded with titlike papillae. Cheilo and prorhabdions distinct. Dorsal meso, metarhabdion armed with a large tooth, a pair of subventral teeth on the ventral metarhabdion. Corpus of esophagus strongly muscled, slightly widened at base into a median bulb. Basal bulb and isthmus somewhat shorter than corpus and median bulb. Nerve ring at midisthmus. Excretory pore immediately posterior to nerve ring. Cardia distinct. Lips of vulva protuberant or continuous with body wall. Vagina transverse. Ovaries paired, reflexed past the vulval opening in some specimens. Anus and rectum distinct. Phasmid obscure. Tail conoid to an elongate acute terminus.

Male: Testis single, reflexed. Spicules paired, 37 μ in length, ventral arcuation extreme, proximal end at ca right angles to distal end. Gubernaculum as figured, the margins heavily sclerotized. There are 7 pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 1 pair immediately postanal ventrosubmedian, a group of three at the point of terminal extension, 1 pair dorsal and opposite the three terminal papillae. Phasmid distinct. Tail conoid to an elongate acute terminus.

Diagnosis.—Related to *M. tomea*. Differs in structure of pharyngeal armature and in coarseness of tail. *M. langcauda* is a generally smaller species.

Type habitat.—Associated with *Dryocoetes confusus* Sw. in corkbark fir, *Abies lasiocarpa* var. *arizonica* (Merriam) Lemm.

Type locality.—Carson National Forest, New Mexico.

Type specimens.—Collection No. 24-E (Holotype), 28-U (Allotype).

***Mikoletzkya pinicola* (Thorne, 1935) Baker, 1962** **Figure 59**

Female: 1.3 mm; a=25; b=7.1; c=15.1; V=51%.

Male: 1.1 mm; a=31; b=6.2; c=15.1.

The following is Thorne's original description: "Body moderately slender, tapering anteriorly until width near lip region is about one-half that at base of neck. Female tail convex-conoid to acute terminus, its length about 2½ times anal body diameter. Male tail ventrally arcuate, convex-conoid with spicate terminus. Cuticle marked by fine transverse and longitudinal striae. Longitudinal striae low, obscure, about 44 at midbody, decreasing in number toward the extremities. Viewed laterally, these longitudinal striae present double rows of refractive, dotlike markings where they cross the transverse striae. Lip region rounded, with six forward-pointing, conical papillae. Amphids appear as minute oval markings close to the lateral papillae. Pharynx obscurely hexagonal from a face view; viewed laterally it presents two distinct chambers bearing a central, massive, arcuate, dorsal tooth. Anterior portion of esophagus four-fifths as long as posterior but broader and more muscular. Excretory pore a short distance posterior to nerve ring. Intestine densely granular, its lumen sinuous. Ovaries reflexed past vulva. Vulva a transverse slit with protuberant labia.

"Male: Testis single, reflexed. Spicula yellow, arcuate, slightly cephalated. Gubernaculum thick proximally, with a thin troughlike distal extension in which the spicula glide. Eight pair of male caudal papillae.

"*Diagnosis.—Diplogaster* with the above measurements. Longitudinal striae 44 at midbody, low, obscure, their presence indicated by double rows of refractive dots. Tails of both sexes less than 7% of body length. Six labial papillae, forward-pointing, conical. Pharynx divided into two chambers, armed with single, massive, arcuate dorsal onchium. Female amphidelphic, ovaries reflexed past vulva. Spicula arcuate, cephalated. Gubernaculum thick proximally with thin troughlike distal extension. Eight pair of male caudal papillae."

Habitat.—Associated with *Dendroctonus ponderosae* in lodgepole pine, *Pinus contorta* Dougl.

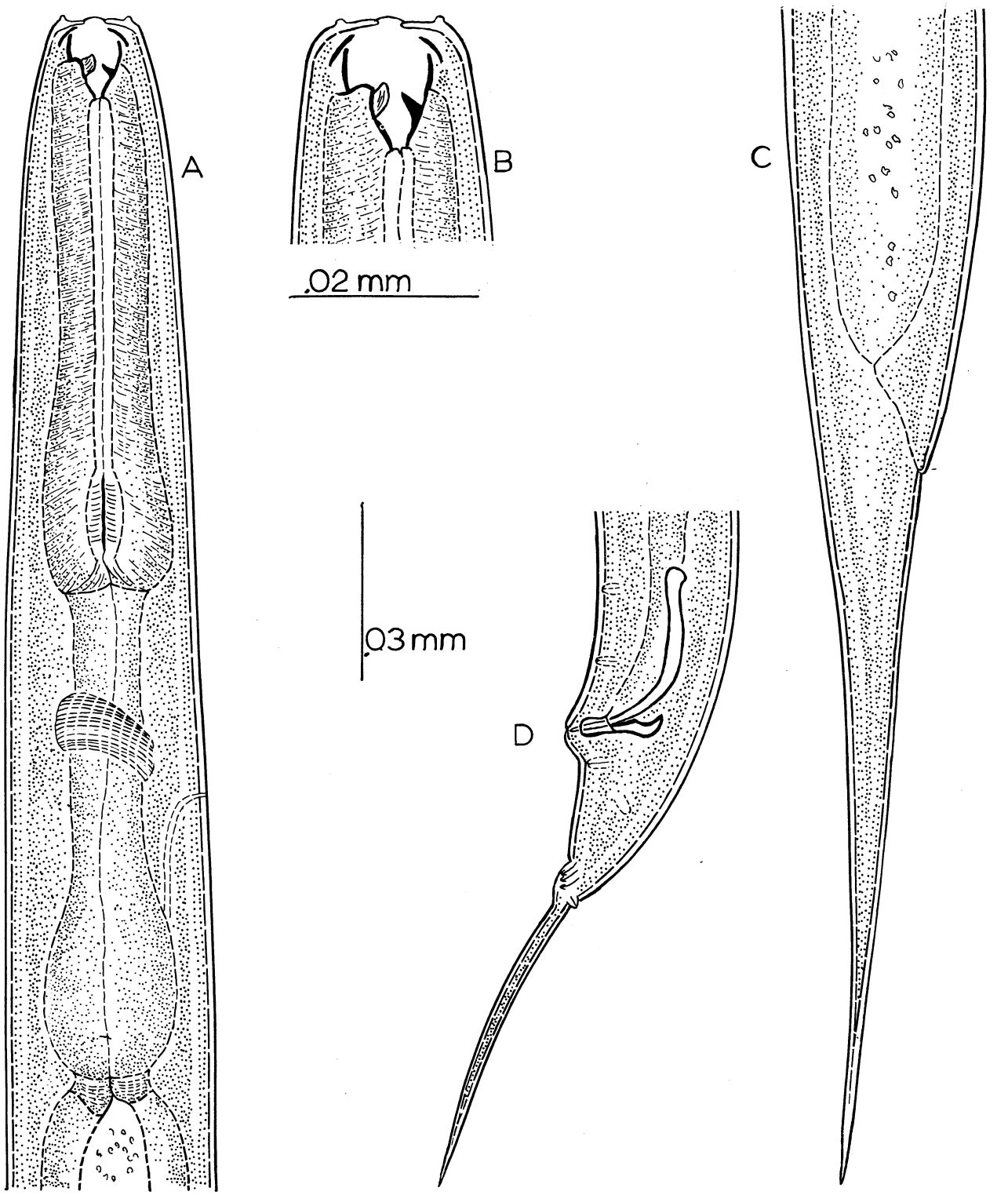


Figure 58.—*Mikoletzkya langcauda* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

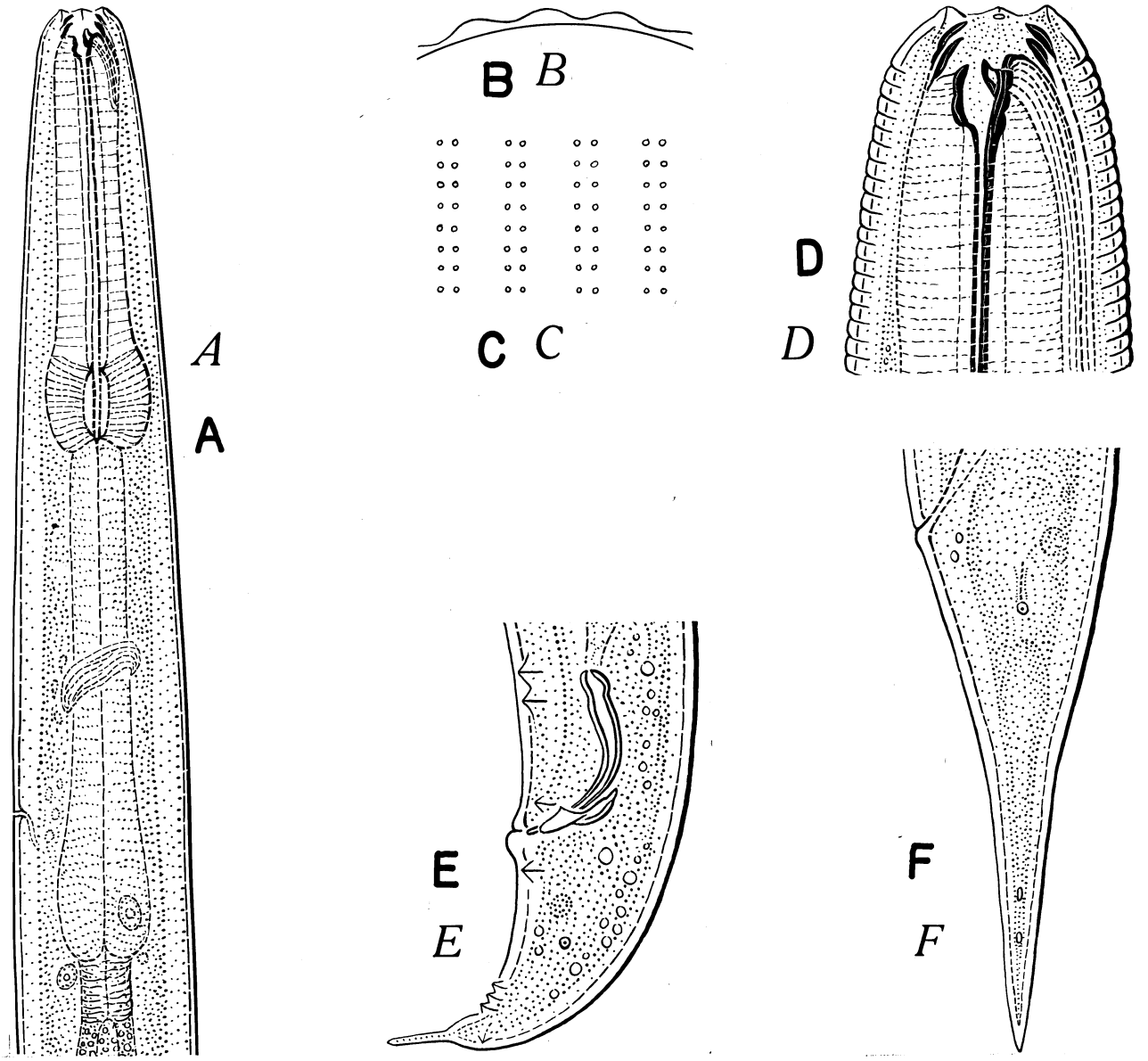


Figure 59.—*Mikoletzkya pinicola* (Thorne, 1935) Baker, 1962: *A.* Head and neck; *B.* body cross section; *C.* cuticular pattern; *D.* head; *E.* male, tail; *F.* female, tail. (After Thorne, 1935).

***Mikoletzkya pugnea* Massey, 1971** **Figure 60**

Female: 0.68 mm; a=25–26; b=5.4–6.8; c=11; V=55%.

Male: 0.59–0.66 mm; a=22–27; b=4.7–5.6; c=9–11.

Cuticle with moderately fine transverse and longitudinal striations. Head rather broadly rounded, with very small apical papillae. Pharyngeal depth and width about equal. Cheilo and prorhabdions distinct. Meso, meta, and telorhabdions fused. Meso, metarhabdions armed with a large subdorsal clawlike tooth; a subventral tooth on the same structure nearly meeting the subdorsal tooth at the middle of the pharynx; ventral telorhabdion with a small denticle. Esophagus typically diplogasteroid; corpus and median bulb as long as isthmus and terminal bulb; lumen of isthmus and terminal bulb very sinuous. Nerve ring located at anterior end of terminal bulb. Hemizonid not discernible. Excretory pore adjacent to posterior

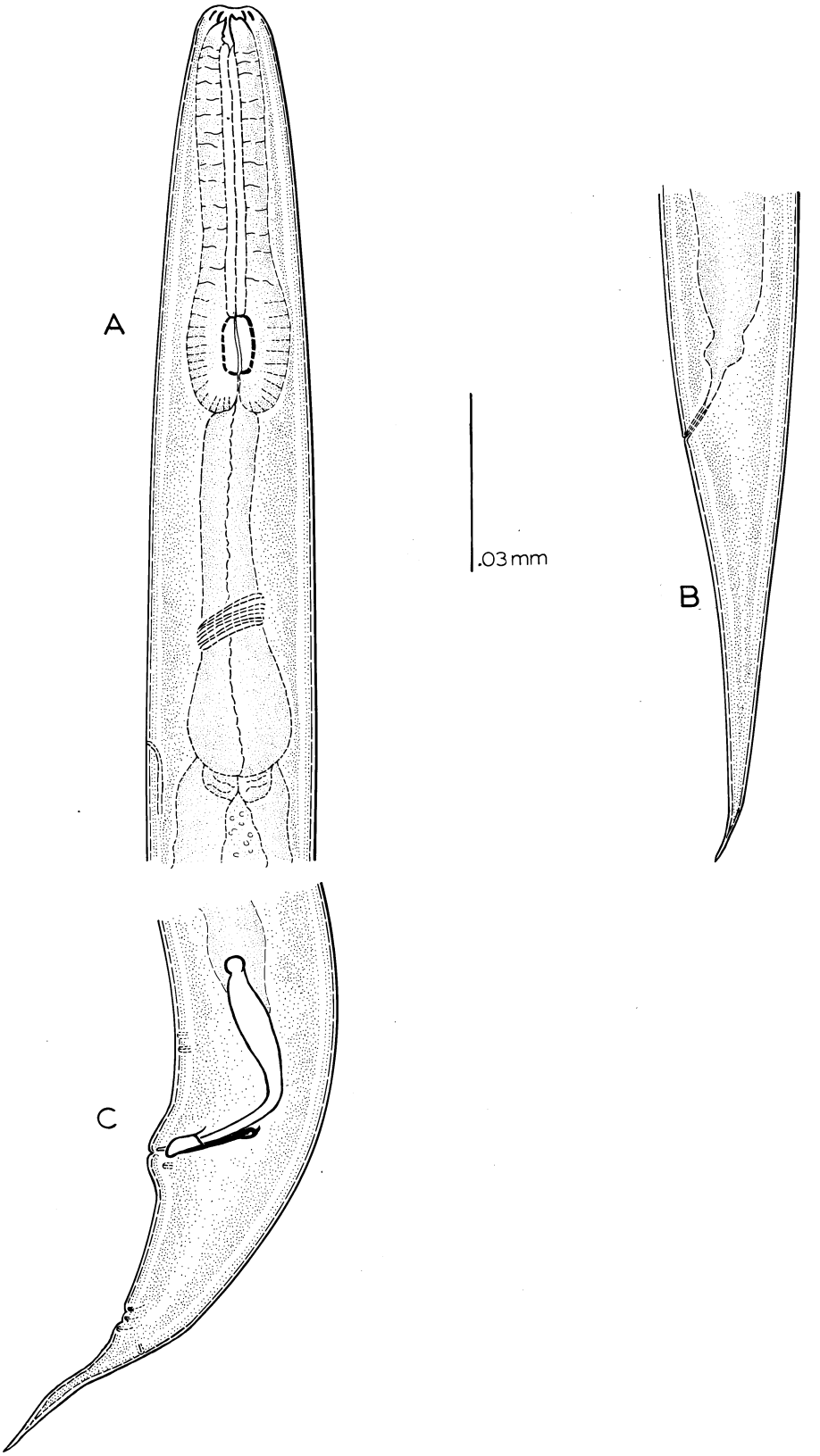


Figure 60.—***Mikoletzkya pugnea*** **Massey, 1971: *A.* Head and neck; *B.* female, tail; *C.* male, tail.**

portion of terminal bulb. Cardia well developed. Lumen of gut wide. Vulva with protuberant lips. Vagina a transverse slit. Anus and rectum conspicuous. Tail elongate conoid to a sharp terminus.

Male: Testis single, with slight reflex. Spicules paired, cephalated, exceedingly arcuate, distal end almost at right angles to proximal end. Gubernaculum one-third as long as spicules, shaped as figured. Seven pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 4 pairs postanal ventrosubmedian, 1 pair subdorsal. Tail conoid to an acute terminus.

Diagnosis.—Closely related to *M. ruminis* Massey, 1966; differs in the shape of the spicules and gubernaculum.

Type habitat.—Associated with *Hylurgops pinifex* in red pine.

Type locality.—Hamden, Connecticut.

Type specimens.—Collection Nos. 24-P and 24-O.

***Mikoletzkya ruminis* Massey, 1966** **Figure 61**

Female: 1.13–1.18 mm; a=22; b=5.4–6; c=11; V=55%.

Male: 0.88–0.97 mm; a=20–22; b=5.0; c=12–14.

Cuticle with coarse longitudinal ridges extending from head to tail. In lateral view there are 11 striations at midbody, each striation appearing as a row of dots. Head broadly rounded with six prominent apical papillae. Amphids porelike, opening at the base of the lateral papillae. Cheilo and prorhabdions distinct, coarse, the meso, meta, and telorhabdions fused. There is a large dorsal clawlike tooth developed by the meso and metarhabdions and a large subventral tooth produced by the same structure. Stoma 17 μ deep, 10 μ wide. Corpus and median bulb of esophagus very muscular, somewhat longer than isthmus and terminal bulb. Nerve ring more than one body width behind median bulb. Excretory pore not discernible. Amphidelphic, the ovaries reflexed more than one-half their length. Vagina transverse. Vulva with slightly protuberant lips. Tail conoid to a pointed terminus.

Male: Testis single, outstretched. Spicules paired, ventrally arcuate, cephalated, 47–58 μ in length. Gubernaculum expanded both distally and proximally as figured, the distal end

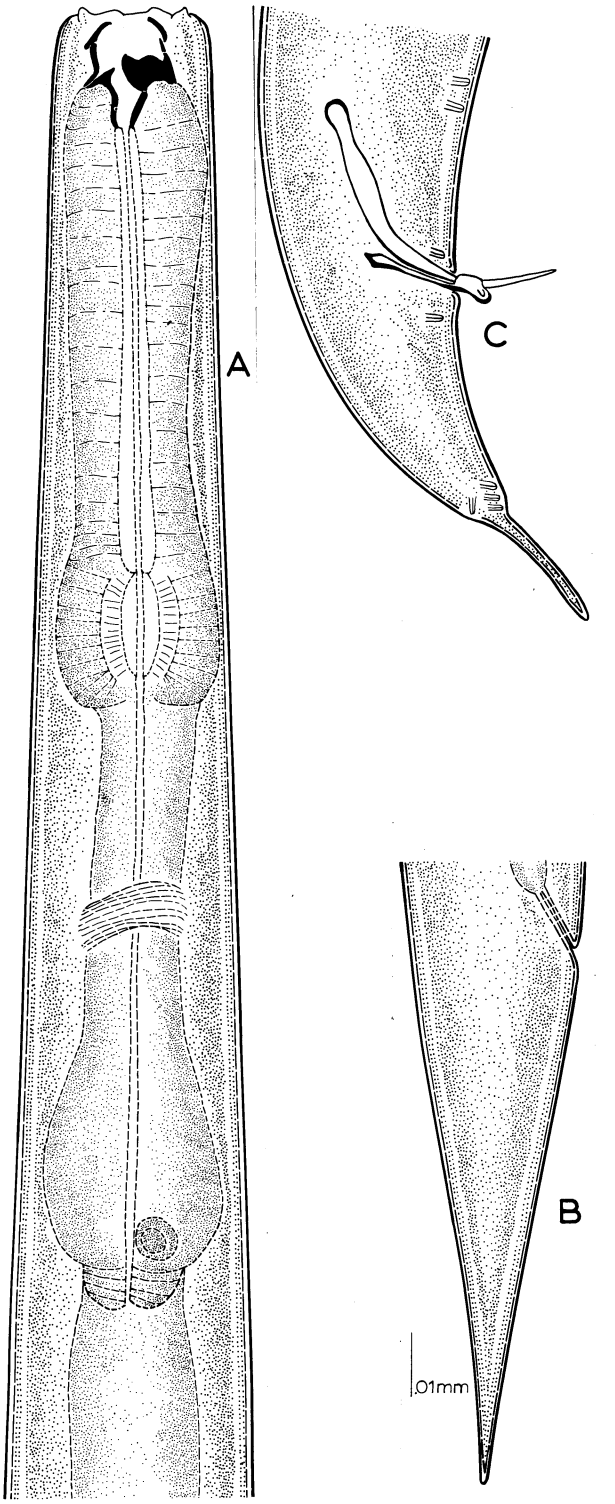
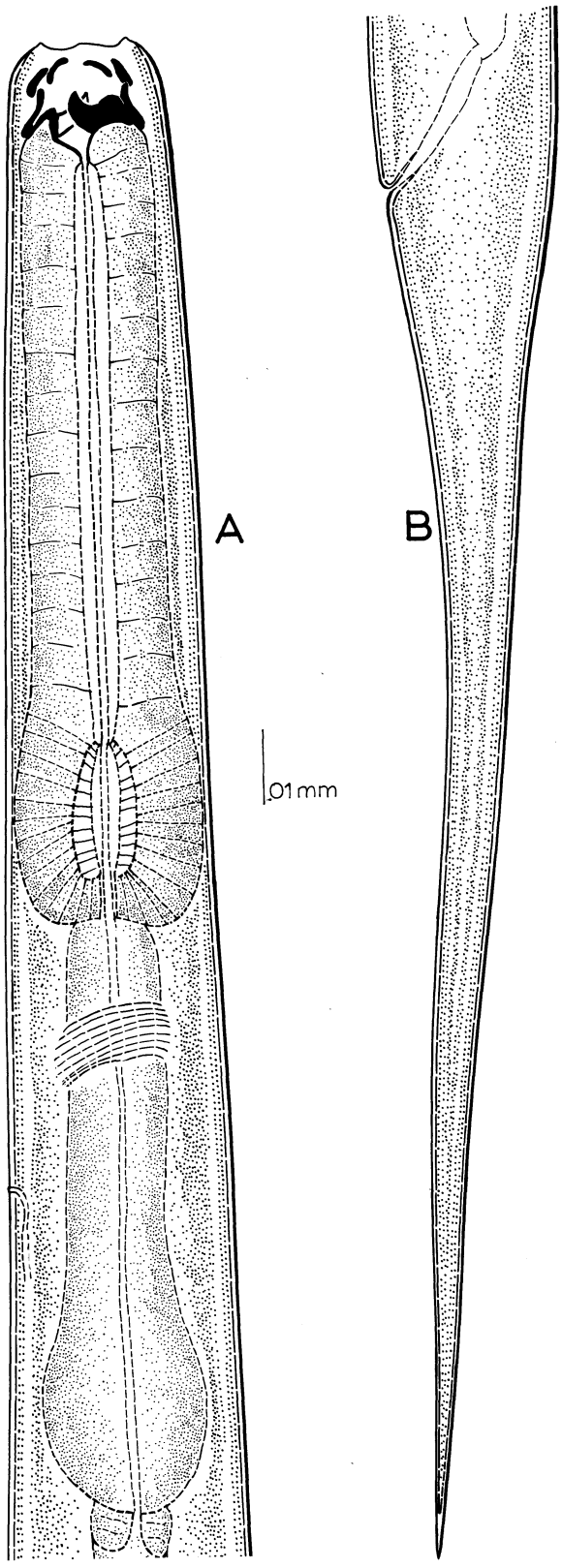


Figure 61.—*Mikoletzkya ruminis* Massey, 1966: *A.* Head and neck; *B.* female, tail; *C.* male, tail.



serving as a guide for spicules, 18–22 μ in length.

Diagnosis.—Differs from other species of the genus in shape and size of gubernaculum.

Type habitat.—Associated with *Dendroctonus rufipennis* in Engelmann spruce.

Type locality.—Type specimens collected on Rabbit Ears Pass in Routt County, Colorado. Other specimens have been taken from the galleries of *D. rufipennis* in Engelmann spruce near Libby, Montana.

Type specimens.—Collection No. 2-L.

***Mikoletzkya tomea* Massey, 1966** **Figure 62**

Female: 0.85–1.51 mm; a=18–24; b=4.3–5; c=4.3–6; V=48–50%.

Male: Unknown.

Cuticle with fine longitudinal striations extending from the head to the tail. Head broadly rounded with six cephalic papillae, cheilo and prorhabdions distinct, arranged as figured, with the prorhabdions overlapping the cheilorhabdions. Meso, meta, and telorhabdions fused, the meso, metarhabdions armed with a large dorsal clawlike tooth and with a large subventral clawlike tooth, the teeth crossing near the center of the pharynx. Amphids porelike, minute openings at base of lateral lips. Stoma 10 μ in width, 12 μ in depth. Corpus and median bulb of esophagus very muscular, their length exceeding that of the isthmus and terminal bulb. Nerve ring a third of a body width posterior to the median bulb. Excretory pore two-thirds of a body width posterior to nerve ring. Amphidelphic, the ovaries reflexed nearly to vulva. Lips of vulva slightly protuberant. Terminus long, filiform.

Diagnosis.—Differs from other species of the genus in the shape and length of tail, and in the massive pharyngeal armature.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Lake City, Florida.

Type specimens.—Collection No. 24.

Genus *Mononchoides* Rahm, 1928

Synonym: *Eudiplogaster* Paramonov, 1952.

Type species: *Mononchoides longicaudus* Rahm, 1928.

Cuticle with prominent longitudinal stria-

Figure 62.—*Mikoletzkya tomea* Massey, 1966. *A.* Head and neck; *B.* female, tail.

tions. Head rounded, papillated. Pharynx much deeper than wide, separated by a large dorsal clawlike tooth produced in the metastom and protruding into the protostom, anterior portion formed by cheilorhabdions and prorhabdions, much wider than the posterior portion formed by meso, meta, and telorhabdions which are fused. At times a rasplike plate appears in metastom. Amphids slightly posterior to lateral cephalic papillae. Esophagus typically diplogasteroid. Amphidelphic. Vulva at midbody. Testis single, sometimes reflexed. Spicules ventrally arcuate, cephalated. Gubernaculum variable in shape. Male with several pair of preanal and caudal papillae. Bursa vestigial or absent.

There is considerable confusion as to the systematic status of the genus *Mononchoides*. The genus was established by Rahm (1928). Subsequently it has been considered a synonym of *Diplogaster* and of *Eudiplogaster*. In the writer's opinion, *Mononchoides* is a valid genus, and several species placed in the genus *Eudiplogaster* are rightfully members of the genus *Mononchoides*.

***Mononchoides adjunctus* Massey, 1966** **Figure 63**

Female: 0.78–0.87 mm; a=22–26; b=5.9–6.6; c=2.9–3.9; V=40–43%.

Male: 0.70 mm; a=28; b=5.5; c=3.2.

Cuticle with moderately prominent transverse and longitudinal striations. Head broadly rounded. Six lips, each with an apical papilla. Lip ring with 16 longitudinal ridges, the grooves broadened proximally. Stoma much deeper than wide, with distinct cheilorhabdions and prorhabdions. Cheilorhabdions overlap prorhabdions. Meso, meta, and telorhabdions fused. Stoma divided into a wide anterior portion and a long posterior portion by a large, subdorsal, clawlike tooth rising from the mesorhabdion. Procorpus of esophagus very muscular, widening into a distinct valvular median bulb. Isthmus and terminal bulb two-thirds length of procorpus and median bulb. Nerve ring at middle of isthmus. Excretory pore one-third body width behind nerve ring. Hemizonid immediately anterior to excretory pore. Ovaries paired, each reflexed to vicinity of vulva. Lips of vulva only slightly protuberant. Tail very long, thread-like.

Male: Testis single, reflexed nearly 2 body diameters. Spicules paired arcuate, cephalated. Gubernaculum as illustrated. Viewed laterally, with a broad, shallow hook at proximal end. Seven pairs of caudal papillae, 6 ventrosubmedian, of which 2 are preanal, 4 postanal, and 1 pair subdorsal, situated at base of tail thread. Phasmid plainly visible. Tail similar to that of female.

Diagnosis.—*Mononchoides adjunctus* is closely related to *M. americanus* (Steiner, 1930), Chitwood and Chitwood, 1950, from which it differs in location of caudal papillae, nerve ring, and excretory pore, and in length and proportions of tail.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 43-A.

Genus *Neodiplogaster* Cobb, 1924

Synonym: *Tylenchodon* Fuchs, 1930.

Type species: *Neodiplogaster tropica* Cobb, 1924.

Head rounded, with prominent lip ring consisting of sclerotized ridges. Cheilo and prorhabdions obscure, dorsal meso-metarhabdions bearing a clawlike tooth. Telorhabdions forming a long, narrow pharyngeal tube, with knobbed to winglike sclerotized bases. Esophagus diplogasteroid. Amphidelphic. Vulva at or near midbody. Female tail conoid to acute or subacute terminus. Spicules paired, ventrally arcuate, several pair of caudal papillae. Bursa when present narrow and rudimentary. Tail ventrally arcuate to a subacute terminus.

***Neodiplogaster magulum* n. sp.** **Figure 64**

Female: 0.63–0.71 mm; a=21.6–23.3; b=4.90–5.82; c=10.28–12.26; V=52–56%.

Male: 0.76–0.80 mm; a=26.0–30.2; b=5.77–6.04; c=16.43–18.57.

Cylindroid. Cuticle with moderately coarse transverse striae and very prominent longitudinal striae arranged in a series of 11 evenly spaced lines at midbody. Lips rounded with very small apical papillae obscure in many specimens. Lip ring with 18 ridges. Cheilo and prorhabdions obscure. Dorsal meso, metarhabdions bearing a large claw-like tooth. Subventral meso, metarhabdions appearing as a forward-pointing tooth. Telorhabdions forming a long pharyngeal tube, with knoblike sclerotiza-

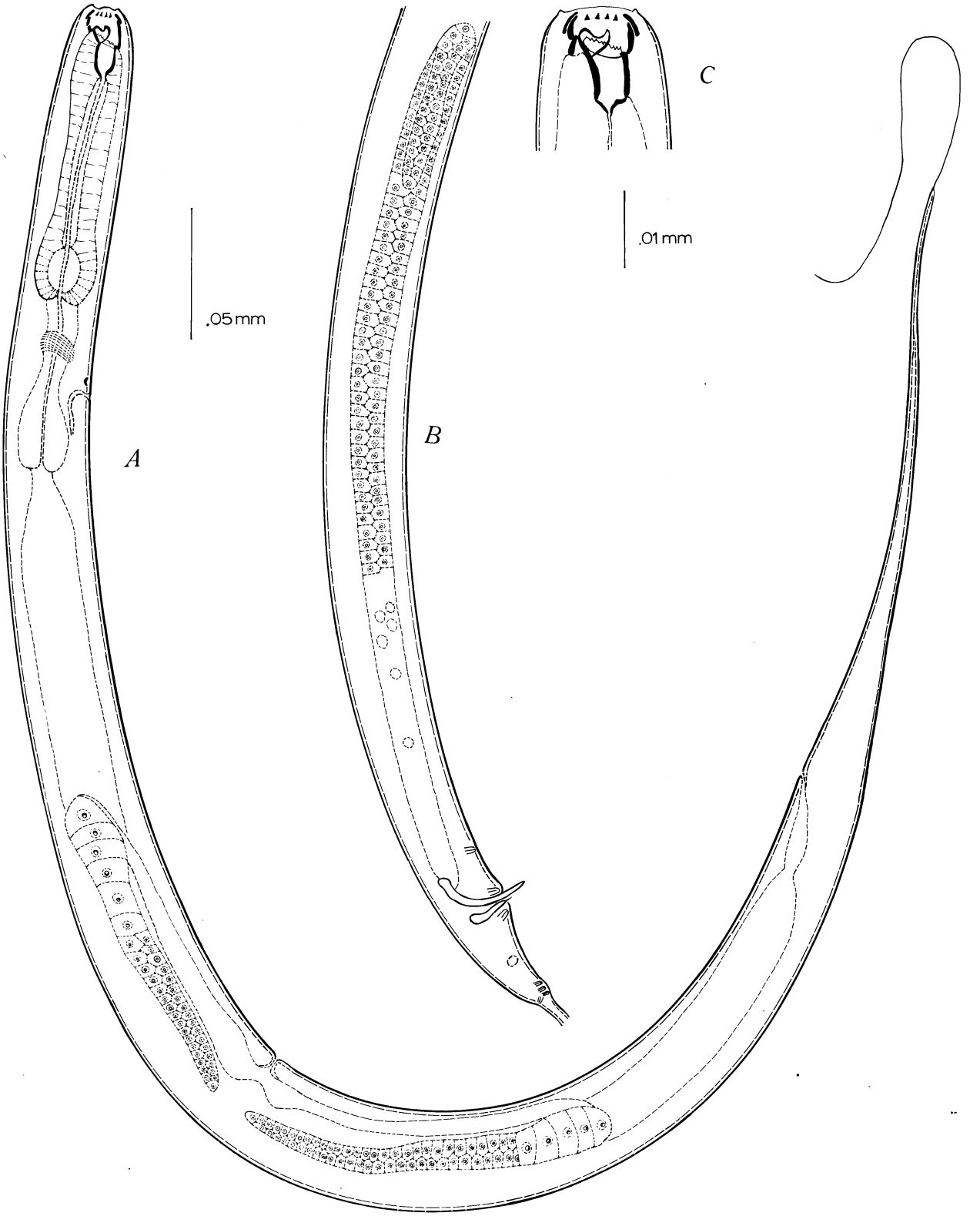


Figure 63.—*Mononchoides adjunctus* Massey, 1966. *A.* Female; *B.* male, tail; *C.* head.

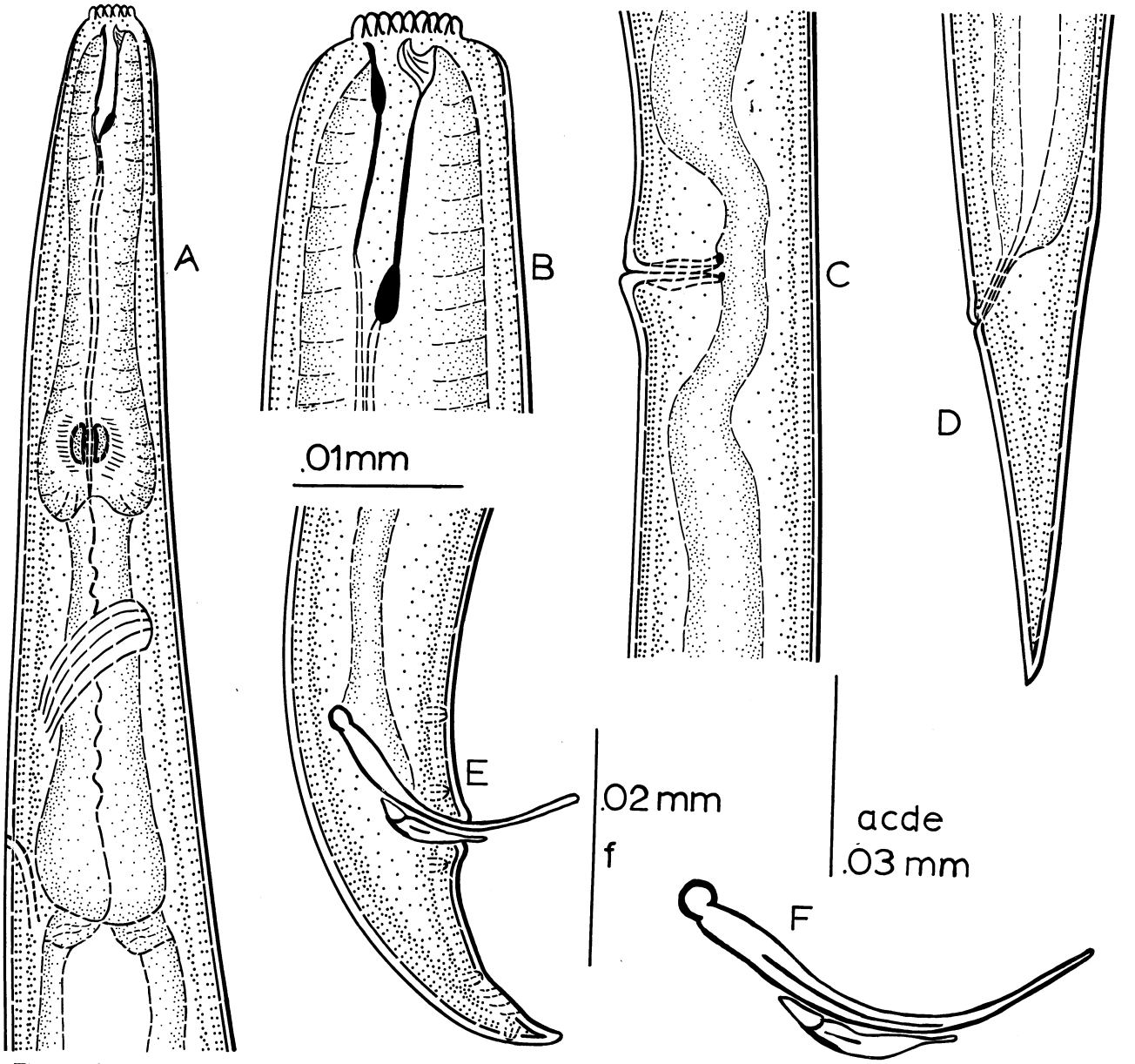


Figure 64.—*Neodiplogaster magulum* n. sp. *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail; *F.* spicule and gubernaculum.

tion at their bases. Esophagus diplogasteroid. Nerve ring at midisthmus. Excretory pore opposite terminal bulb. Lips of vulva protuberant. Vagina transverse with 2 heavily sclerotized processes at entrance to uterus. Ovaries paired, reflexed at times 2–3 body widths past vulva. Anus and rectum prominent. Tail conoid to a subacute terminus.

Male: Testis single, reflexed, massive, filling much of body cavity. Spicules paired, ventrally arcuate, 44–46 μ long. Gubernaculum shaped as figured, 17 μ in length. There are 9 pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 2 pairs postanal ventrosubmedian, a series of 4 immediately anterior to terminus, 1 pair dorsal, immediately anterior to terminus.

Diagnosis.—Immediately distinguished from *N. pinicola* by its distinctive cuticular pattern.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine. It is probable

that this nematode is a true associate of *Pissodes nemorensis* Germ. which was extensively associated with *D. terebrans* in the collection area.

Type locality.—Nacogdoches, Texas.

Type specimens.—Collection Nos. 70-H, 70-I.

Genus *Diplogasteroides* deMan, 1912

Synonyms: *Rhabditolaimus* Fuchs, 1915
Rhabditidoides Rahm, 1928

Type species: *Diplogasteroides spengelii* deMan, 1912.

Head with 6 lips. Stoma cylindrical consisting of a short cheilostom with distinct cheilorhabdions followed by a tubular protostom formed by distinct prorhabdions. Meso, meta, and telorhabdions fused forming a heavily sclerotized entrance to the esophagus. Dorsal meso, metarhabdions usually bearing slender teeth, ventral segments at times with small denticles or teeth. Esophagus diplogasteroid. Ovary single, prodelphic with or without a postuterine sac. Tail usually elongate to filiform. Spicules paired, ventrally arcuate, cephalated. Gubernaculum variable in form but usually keel shaped. Several pair of caudal papillae. Bursa rudimentary or absent.

***Diplogasteroides bibrochus* n. sp.** **Figure 65**

Female: 0.71–0.80 mm; a=18.8–21.1; b=5.7–6.0; c=7.1–7.8; V=74–76%.

Male: 0.78 mm; a=22.2; b=5.9; c=9.2.

Body slightly ventrally arcuate. Cuticle with fine transverse and longitudinal striations. Lips rounded with inconspicuous papillae. Stoma narrow, much longer than wide. Cheilorhabdions one-third length of prorhabdions. Dorsal meso, metarhabdion with two slender teeth, ventral segment with one ventral tooth immediately anterior to entrance of esophagus. Procorpus muscular, widening slightly into a median bulb. Isthmus and basal bulb equal in length to procorpus and median bulb. Nerve ring immediately anterior to basal bulb. Hemizonid obscure. Excretory pore opposite basal bulb. Cardia inconspicuous. Ovary single, reflexed at times approximately its entire length. Oocytes in a portion of ovary arranged in 3 rows. Lips of vulva protuberant. Vagina transverse. Posterior uterine branch rudimentary. Tail conoid to a filiform terminus.

Male: Testis single, reflexed. Spicules ventrally arcuate. Manubrium at right angles to distal end, cephalated. Gubernaculum keel shaped as figured. Eight pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 5 pairs postanal ventrosubmedian, 1 pair subdorsal, all located as illustrated. Tail conoid, long, slender, to a sharply rounded terminus.

Diagnosis.—Related to *D. marshalli.* Differs in the number of teeth in the buccal cavity and in conformation of tail in both sexes.

Type habitat.—Associated with *Dendroctonus rufipennis* in Engelmann spruce.

Type locality.—Mt. Taylor, New Mexico.

Type specimens.—Collection No. 30-J.

***Diplogasteroides dimidius* n. sp.** **Figure 66**

Female: 0.55 mm; a=22.7; b=5.10; c=5.5; V=71%.

Male: 0.52 mm; a=26.2; b=5.0; c=7.15.

Cylindroid. Cuticle with very fine transverse and longitudinal striations. Lips angular to rounded without visible papillae. Cheilorhabdions short, one-fourth length of prorhabdions. Meso, metarhabdions with 3 teeth, 1 dorsal, 1 subdorsal at junction of telorhabdion, 1 fine tooth on ventral segment. Procorpus widening only slightly to median bulb, muscular. Isthmus widening to a narrow basal bulb. Nerve ring at midisthmus. Excretory pore opposite posterior end of basal bulb. Cardia conspicuous. Ovary single, anterior reflexed. Lips of vulva slightly protuberant. Vagina transverse. Posterior uterine branch rudimentary. Anus and rectum conspicuous. Tail conoid to filiform terminus.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate, manubrium at approximate right angles to distal end. Gubernaculum keel-shaped, over one-third length of spicules. Seven pairs of caudal papillae, 2 pairs preanal, 5 pairs postanal, 1 pair of which are subdorsal. Tail conoid to filiform terminus.

Diagnosis.—Related to *Diplogasteroides picicola* Rühm, 1956. Differs in number and placement of pharyngeal teeth, shape of spicules, and much smaller size. *D. dimidius* has no visible labial papillae and does not possess a bursa.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 30-E.

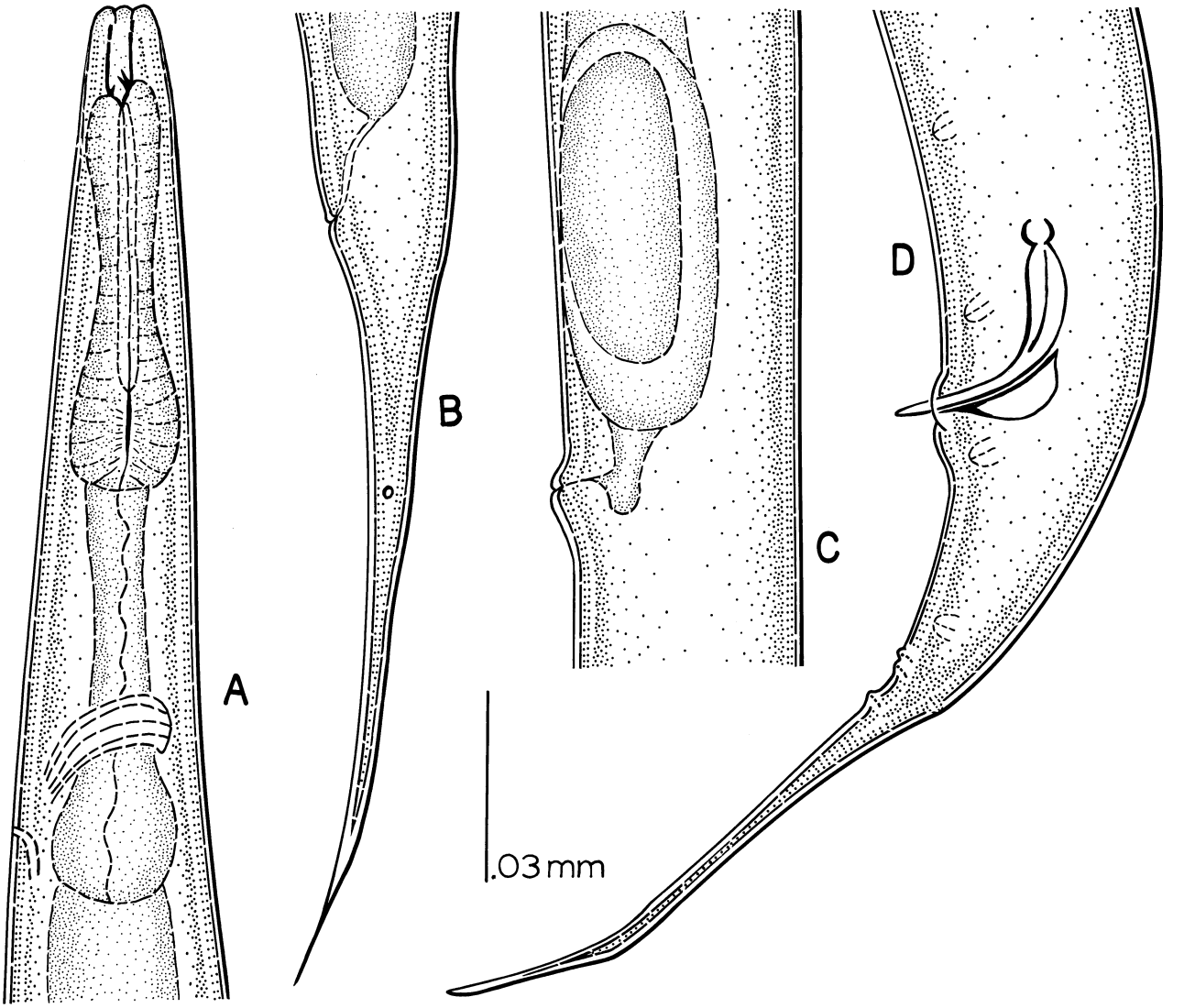


Figure 65.—*Diplogasteroides bibrochus* n. sp. *A.* Head and neck; *B.* female, tail; *C.* portion of female body illustrating vulva; *D.* male, tail.

***Diplogasteroides ipini* n. sp.** **Figure 67**

Female: 0.70 mm; a=21.2; b=7.05; c=6.35; V=72%.

Male: 0.69 mm; a=23.2; b=7.3; c=7.7.

Body cylindroid. Cuticle with very fine transverse and longitudinal striations. Lips rounded without visible papillae. Cheilorhabdions very short, one-fifth length of prorhabdions. Meso, metarhabdions bearing 3 teeth, 2 dorsal, 1 of which is situated immediately anterior to entrance of esophagus. Procorpus and median bulb longer than isthmus and basal bulb. Nerve ring at midisthmus. Excretory pore not observed. Hemizonid opposite basal bulb. Cardia prominent. Ovary single, reflexed at times to vulva. Lips of vulva slightly protuberant. Vagina transverse. Posterior uterine branch rudimentary. Anus and rectum conspicuous. Tail conoid to filiform terminus.

Male: Testis single, reflexed. Spicules paired, cephalated, ventral arcuation extreme as illustrated. Gubernaculum keel shaped, the proximal end with an acute sclerotized process. There are 8 pairs of caudal papillae, 3 preanal ventrosubmedian, 5 postanal, 4 ventrosubmedian, 1 pair subdorsal. Phasmid prominent.

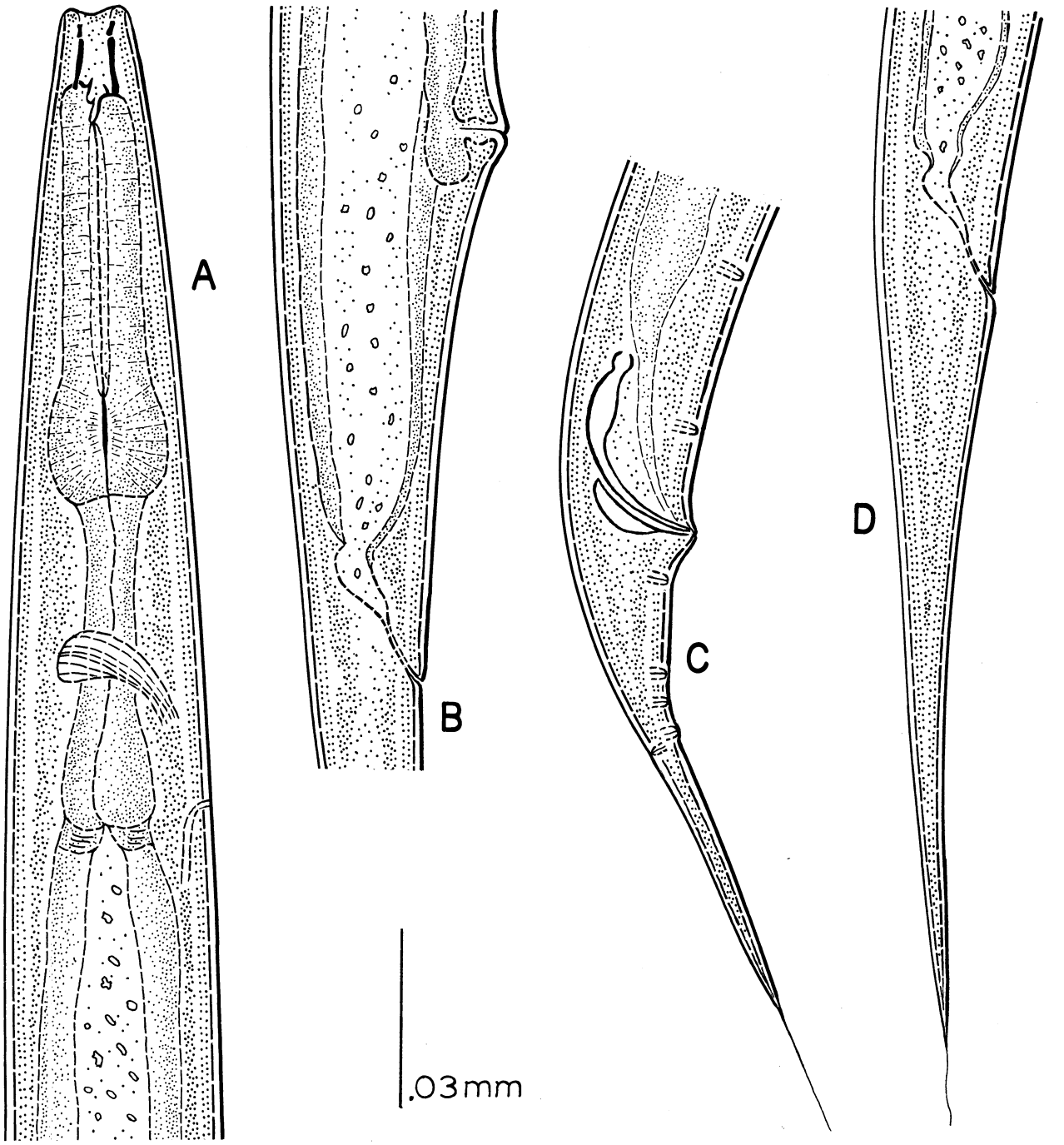


Figure 66.—*Diplogasteroides dimidius* n. sp. *A.* Head and neck; *B.* portion of female body illustrating vulva; *C.* male, tail; *D.* female tail.

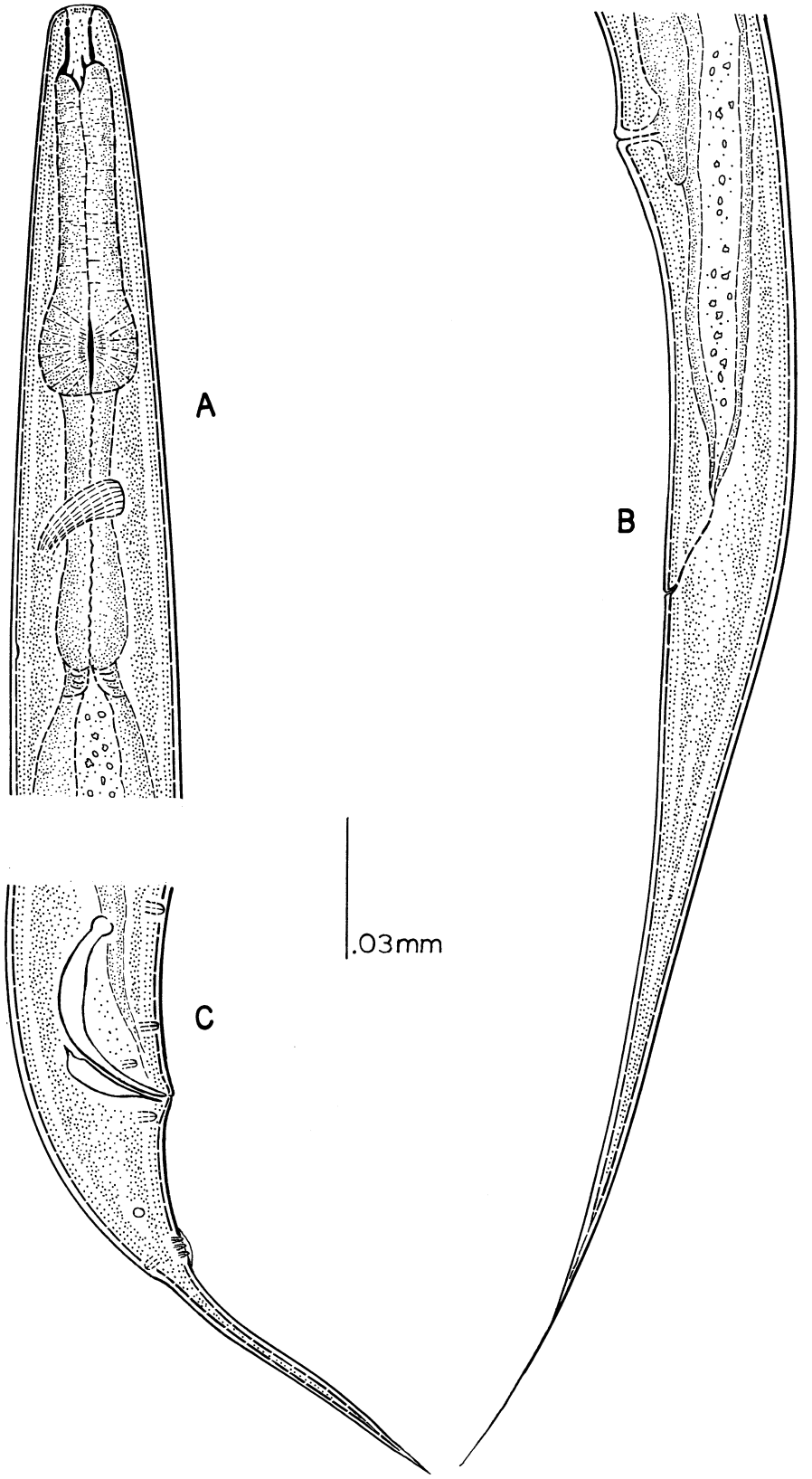


Figure 67.—*Diplogasteroides ipini* n. sp. *A.* Head and neck; *B.* female, tail; *C.* male, tail.

Tail conoid to filiform terminus. Bursa rudimentary.

Diagnosis.—Related to *D. dimidius,* varies in shape of gubernaculum and in presence of a rudimentary bursa.

Type habitat.—Associated with *Ips pini* in red pine.

Type locality.—Caroline County, New York.

Type specimens.—Collection No. 30-O.

***Diplogasteroides marshalli* Massey, 1962 Emended** **Figure 68**

Female: 0.58–0.75 mm; a=16; b=5.8; c=5.4; V=67%.

Male: 0.58–0.85 mm; a=16; b=5.2; c=7.4.

Body cylindroid. Cuticle with fine transverse and longitudinal striae. Head rounded with setose papillae. Stoma much deeper than wide. Cheilorhabdions and prorhabdions distinct, prorhabdions approximately 3 times the length of cheilorhabdions. Dorsal meso, metarhabdions with denticle, a small tooth on ventral segment near entrance to esophagus. Procorpus widening slightly into median bulb, which is indistinct in some specimens. Isthmus and basal bulb longer than procorpus and median bulb. Nerve ring slightly anterior to basal bulb. Excretory pore opposite basal bulb. Cardia distinct. Prodelphic, ovary reflexed three-fourths its length. Oocytes in portions of ovary arranged in 3 rows. Lips of vulva protuberant. Vagina slightly oblique. Posterior uterine branch rudimentary. Anus and rectum conspicuous. Tail conoid, elongate to a minutely rounded terminus.

Male: Testis single, reflexed. Spicules paired, cephalated, ventral arcuation extreme, manubrium at right angles to distal end. Gubernaculum keel shaped as illustrated, the distal end curved, proximal end with sclerotized process. Eight pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 5 pairs postanal ventrosubmedian, and 1 pair subdorsal. Tail ventrally arcuate to spicate terminus.

Diagnosis.—*D. marshalli* is distinguished by its nonfiliform tail, distinctive spicules and gubernaculum, and setose labial papillae.

Habitat.—Associated with *Ips calligraphus* in ponderosa pine.

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 29-A.

Genus *Dirhabdilaimus* Paramonov and Turlygina, 1955

Synonyms: *Neodiplogasteroides* (Rühm, 1956) Meyl, 1961
Diplogasteroides (*Neodiplogasteroides*) Rühm, 1956

Type species: *Dirhabdilaimus pini* (Fuchs, 1931) Paramonov and Turlygina, 1955.

Head with six lips, each with a fine or setose papillae. Cheilorhabdions distinct, very short, almost buttonlike. Pro and mesorhabdions forming a very long cylindrical stoma. Metarhabdions forming entrance to esophagus, usually bearing teeth. Corpus of esophagus muscular, posterior portion usually expanded into median bulb, isthmus muscular throughout much of its length, terminal bulb nonvalvate. Ovaries paired, reflexed. Female tail conical to acute or subacute terminus. Spicules paired, ventrally arcuate, cephalated. Several pair of caudal papillae with or without a peloderan bursa. Tail ventrally arcuate, short, usually terminating in a short digitate tip.

***Dirhabdilaimus nacogdochensis* n. sp.** **Figure 69**

Female: 1.12–1.17 mm; a=19–19.7; b=5.9–6.1; c=12.9–13.9; V=53%.

Male: 1.03–1.05 mm; a=18.4–18.8; b=5.9–6.2; c=22.1–24.1.

Body cylindroid. Cuticle with moderately fine lateral and longitudinal striations. Amphids porelike, opening laterally on lips. Lips rounded with setose papillae. Cheilorhabdions short, buttonlike. Pro and mesorhabdions fused, forming an elongate stoma 34 μ deep. Dorsal and ventral metarhabdions with two prominent teeth. Pharynx finely striated as figured. Corpus of esophagus widened slightly into a median bulb, corpus and median bulb nearly one-third longer than isthmus and basal bulb. Nerve ring at midisthmus. Excretory pore one-third body width posterior to basal bulb. Hemizonid only slightly posterior to basal bulb. Cardia prominent. Lips of vulva protuberant. Vagina short, transverse. Ovaries paired, opposed and reflexed, each ovary may be reflexed several times in some specimens. Each uterus containing 3-4 eggs in mature specimens. Anus and rectum conspicuous. Tail conoid to a rather elongate, acute terminus.

Male: Testis single, reflexed. Spicules paired,

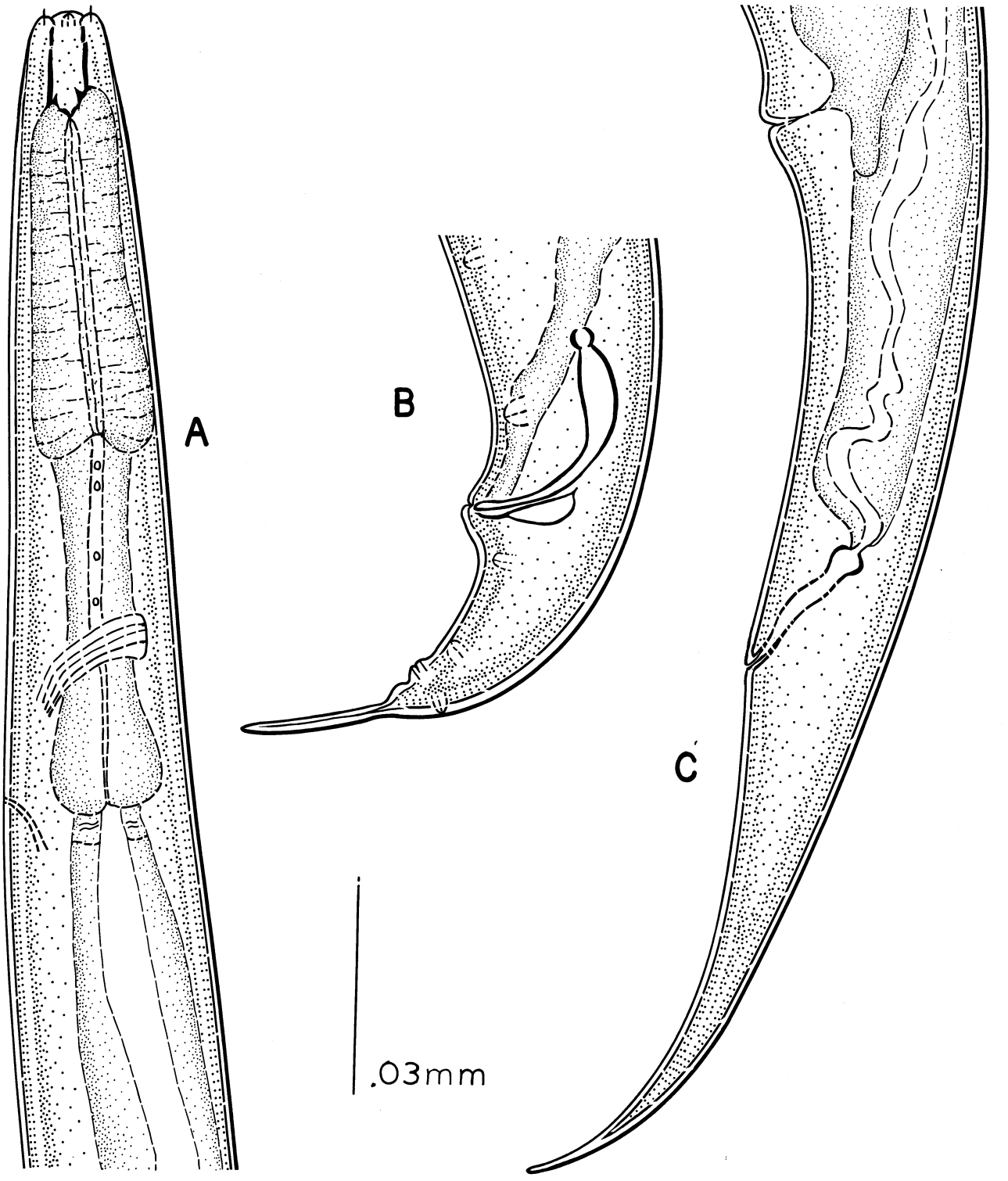


Figure 68.—***Diplogasteroides marshalli*** **Massey, 1962 emended.** ***A.*** **Head and neck;** ***B.*** **male, tail;** ***C.*** **female, tail.**

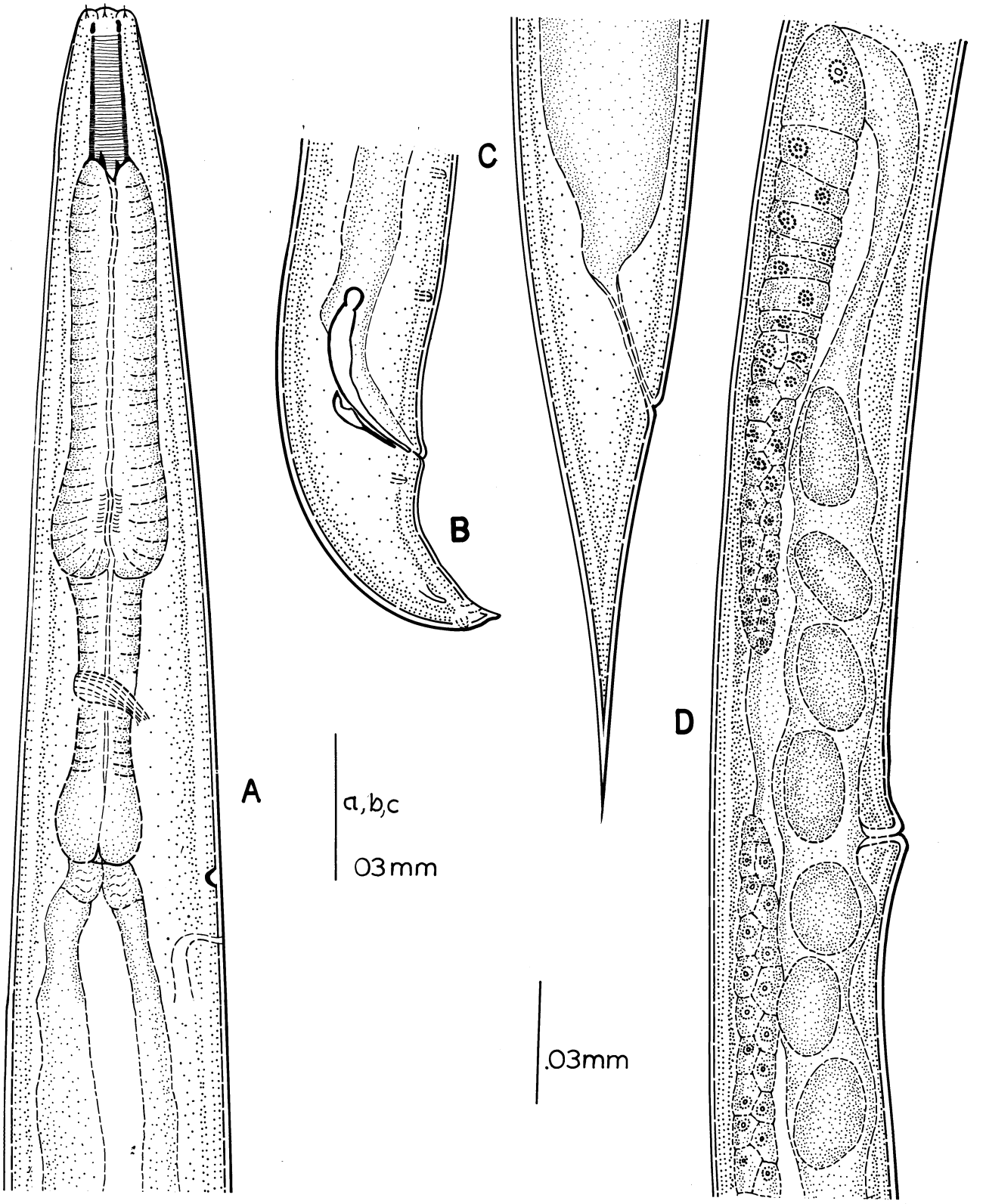


Figure 69.—***Dirhabdilaimus nacogdochensis*** **n. sp.** ***A.*** **Head and neck;** ***B.*** **male, tail;** ***C.*** **female, tail;** ***D.*** **female, midbody.**

ventrally arcuate. Gubernaculum with proximal end notched in lateral view, distal end heavily sclerotized. Phasmid distinct. There are six pair of caudal papillae, located as illustrated. Tail ventrally arcuate to a very short subacute terminus. Bursa not apparent in lateral view.

Diagnosis.—Differs from *Dirhabdilaimus carolinensis* Massey, 1967 by presence of striated pharynx.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Nacogdoches, Texas.

Type specimens.—Collection No. 45-B.

Genus *Rhabdontolaimus* (Fuchs, 1931) Filipjev and Schuurmans Stekhoven, 1941

Synonyms: *Rhabditolaimus* (*Rhabdontolaimus*) Fuchs, 1931
Anchidiplogasteroides Paramonov and Turlygina, 1955

Type species: *Rhabdontolaimus carinthiacus* (Fuchs, 1931) Filipjev and Schuurmans Stekhoven, 1941

Stoma about three times longer than wide. Rhabdions heavily sclerotized. Dorsal metarhabdion with denticular ridges bearing varying number of teeth. Corpus of esophagus muscular with a median bulb, basal bulb plus isthmus usually shorter than corpus plus median bulb. Vulva median, ovaries paired and opposed. Female tail conoid to sharply rounded or filiform terminus. Spicules paired, ventrally arcuate.

Male: Tail ventrally arcuate to a spicate or filiform terminus with 5 to 10 pairs of caudal papillae with or without rudimentary leptoderan bursa.

***Rhabdontolaimus adephagus* n. sp.** **Figure 70**

Female: 0.77–0.90 mm; a=29.3–30.8; b=5.5–6.4; c=10.1–14; V=51%.

Male: 0.70–0.79 mm; a=29.8; b=5.1–6.0; c=14.0–14.2.

Body cylindroid. Cuticle with fine transverse striations, prominent longitudinal striations. Lips distinct, rounded, with minute papillae. Cheilorhabdions buttonlike, distinct. Prorhabdions slender. Metarhabdions bearing 5 slender teeth, 3 dorsal, 2 subventral, only two visible in lateral view. Corpus of esophagus slender, median bulb conspicuous. Basal bulb slightly wider than isthmus, corpus and median bulb longer than isthmus and basal bulb. Nerve ring at midisthmus. Hemizonid opposite nerve ring, excretory pore immediately posterior to hemizonid. Cardia well developed. Lips of vulva at times quite protuberant. Vagina very muscular, transverse. Uteri serving as spermathecas. Didelphic, oocytes in a double row for approximately one-half ovary length, then in single row. Anus and rectum prominent. Tail conoid to a sharply rounded, elongate terminus.

Male: Testis single, at times reflexed. Spicules paired, ventrally arcuate, manubrium short. Gubernaculum as illustrated, the distal end slightly hooked. There are 4 pairs of ventrosubmedian caudal papillae, 2 pairs preanal, 2 pairs postanal, 1 pair subdorsal, located as in illustration. Tail ventrally arcuate, conoid to a spicate terminus.

Diagnosis.—Related to *Rhabdontolaimus frontali* n. sp. Differs in the coarseness of pharyngeal teeth and rhabdions, and in shape of gubernaculum.

Type habitat.—Associated with *Dendroctonus frontalis* in Virginia pine, *Pinus virginiana* Mill.

Type locality.—Keysville, Virginia.

Type specimens.—Collection No. 60-B.

***Rhabdontolaimus frontali* n. sp.** **Figure 71**

Female: 0.86 mm; a=24.5; b=5.8; c=10.8; V=51%.

Male: 0.80 mm; a=27.5; b=6.25; c=14.47.

Body cylindroid. Cuticle with faint transverse and longitudinal striae. Lips rounded, flaplike with minute papillae. Cheilostom short, cheilorhabdions buttonlike in lateral view. Protostom occupying fully half of buccal cavity, ventral prorhabdion almost twice length of dorsal prorhabdion. Meso, metarhabdions bearing teeth, 3 dorsal teeth rather long and slender, 2 subventral teeth rather short and stout. Corpus of esophagus muscular, procorpus widening only slightly as it forms a median bulb. Corpus and median bulb longer than isthmus and basal bulb, basal bulb nonvalvate. Nerve ring opposite anterior end of basal bulb. Excretory pore passing through hemizonid and located opposite basal bulb. Intestine thick walled, cells with a single nucleus. Lips of vulva protuberant. Vagina transverse. Ovaries at times reflexed their entire length. Oocytes

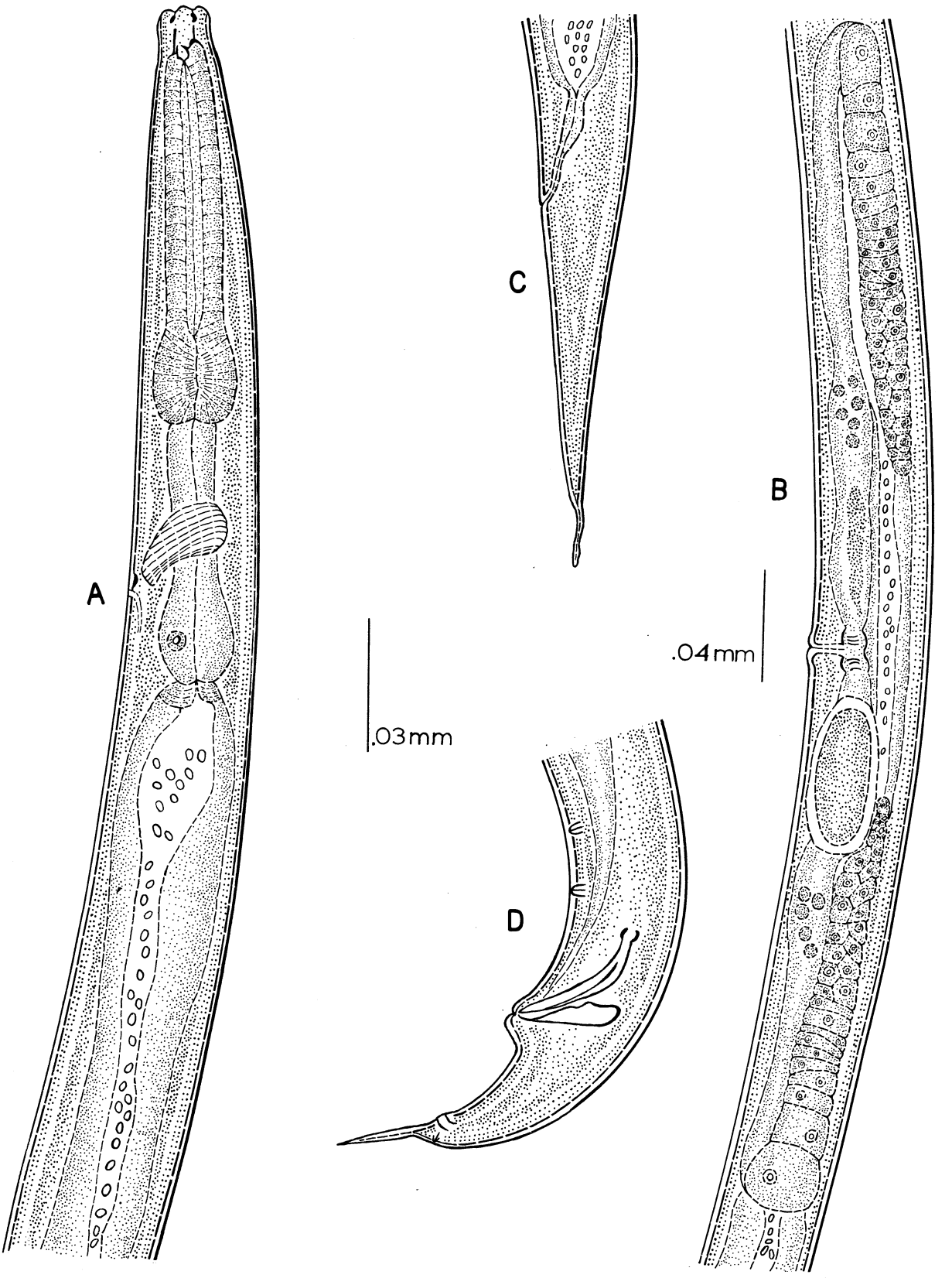


Figure 70.—***Rhabdontolaimus adephagus*** **n. sp.** ***A.*** **Head and neck;** ***B.*** **female, midbody;** ***C.*** **female, tail;** ***D.*** **male, tail.**

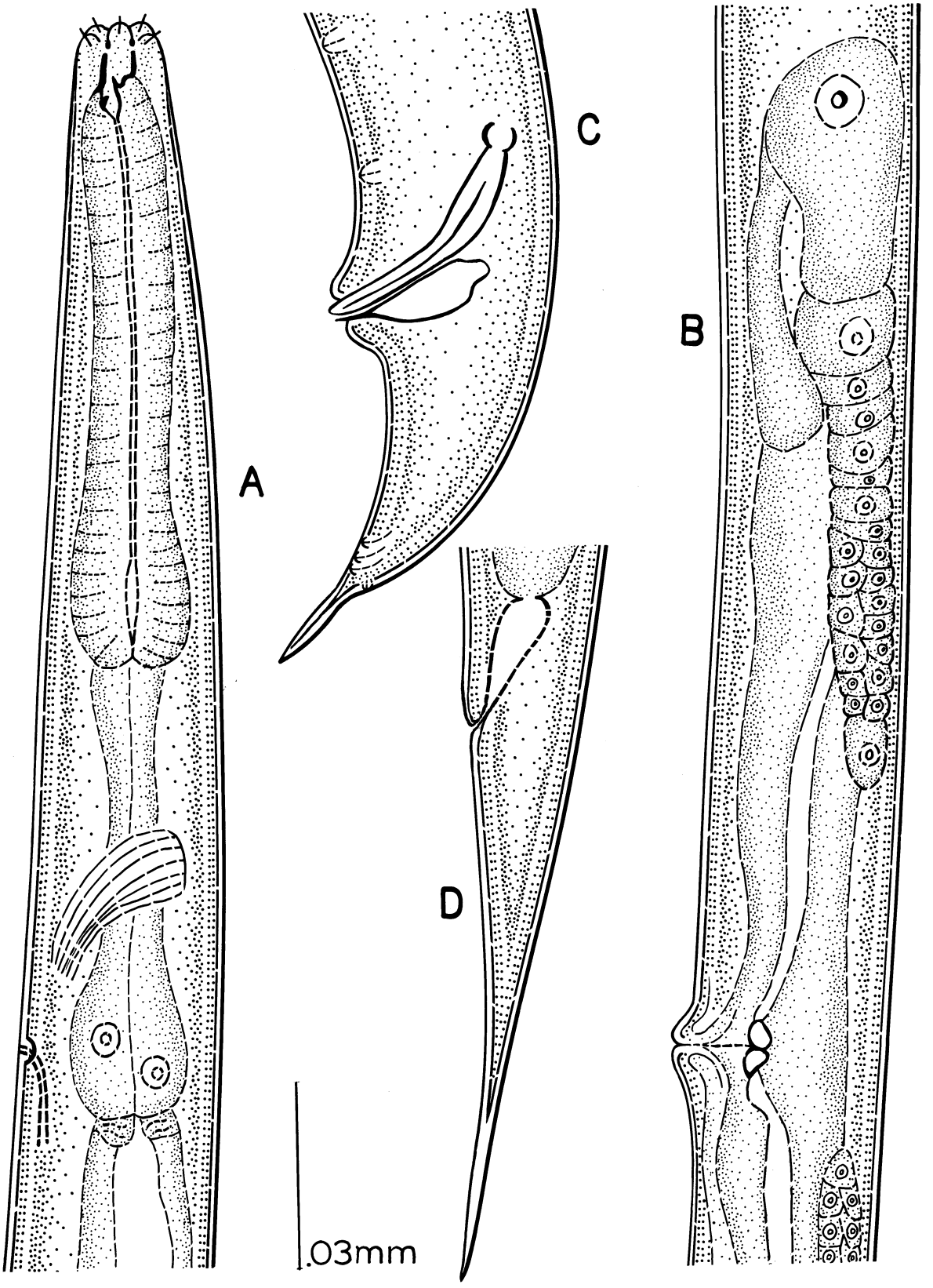


Figure 71.—***Rhabdontolaimus frontali*** **n. sp. *A.* Head and neck; *B.* female, midbody; *C.* male, tail; *D.* female, tail.**

arranged in double rows at their distal ends. Uterus with valvelike processes at entrance to vagina. Anus and rectum conspicuous. Tail conoid to an elongate, acute terminus.

Male: Testis single, outstretched. Spicules paired, ventrally arcuate, manubrium short, rounded, anterior end open. Gubernaculum as figured. There are 6 pairs of caudal papillae, 2 pairs preanal, 4 pairs postanal, all located as illustrated. Tail ventrally arcuate, conoid to a spicate terminus.

Diagnosis.—Related to *Rhabdontolaimus haslacheri* (Fuchs, 1931) Paramonov and Turlygina, 1955. Differs in pharyngeal conformation and in number and arrangement of caudal papillae.

Type habitat.—Associated with *Dendroctonus frontalis* in loblolly pine.

Type locality.—Beaumont, Texas.

Type specimens.—Collection No. 60-A.

***Rhabdontolaimus janae* (Massey, 1962) n. comb.** **Figure 72**

Synonyms: *Diplogasteroides janae* Massey, 1962
Masseyus janae Paramonov, 1964

Female: 0.9–1.1 mm; a=20; b=4; c=8; V=46%.

Male: 0.73 mm; a=21; b=5; c=11.

Body cylindroid. Cuticle with fine transverse striations. Head broadly rounded with 6 papillate lips each with setose papillae. Stoma much deeper than wide. Dorsal metarhabdion bearing 3 slender teeth, subventral segment with 2 small teeth near the entrance to esophagus. Esophagus consisting of a muscular procorpus widening into an ovoid median bulb. Isthmus moderately slender, its length combined with terminal bulb, shorter than procorpus and median bulb. Nerve ring near middle of isthmus. Excretory pore adjacent to terminal bulb and immediately posterior to hemizonid. Cardia conspicuous. Lips of vulva protuberant, vagina transverse. Didelphic, ovaries opposed and reflexed at times their entire length. Anus and rectum prominent. Tail conoid to filiform terminus.

Male: Testis single, reflexed, at times nearly reaching terminal bulb before reflexion. Spicules paired, ventrally arcuate, cephalated. Gubernaculum as figured. Seven pairs of caudal papillae located as in illustration. Tail ventrally arcuate, conoid to a spicate terminus.

Type habitat.—Associated with *Ips calligraphus* in longleaf pine, *Pinus palustris* Mill.

Type locality.—Olustee, Florida.

Type specimens.—Collection No. 30.

Massey, 1962 placed the species in the genus *Diplogasteroides*. Paramonov, 1964, using only Massey's illustrations and description, erected a new genus, *Masseyus*. It is the author's opinion that the species rightfully belongs in the genus *Rhabdontolaimus*.

Genus *Panagrolaimus*, Fuchs, 1930

Synonyms: *Pseudorhabditis* of Kreis, 1929 (nec Perroncito, 1880)
Asymmetricus Kreis, 1930

Type species: *Panagrolaimus detritophagus* Fuchs, 1930.

Lips usually duplex, rarely amalgamated, submedian usually asymmetrical. Cheilorhabdions and prorhabdions distinct. Meso, meta, and telorhabdions fused and combined forming entrance to esophagus, and at times bearing teeth. Corpus of esophagus elongate, cylindrical, or spindle shaped, longer than isthmus and valvate terminal bulb. Ovary single, reflexed to vicinity of rectum. Tail variable in shape. Testis single, spicules paired, ventrally arcuate. Several pair of caudal papillae. Bursa absent. Male terminus usually acute.

***Panagrolaimus concolor* Massey, 1964** **Figure 73**

Female: 0.86–0.90 mm; a=21; b=4.3; c=17; V=62%.

Male: 0.80 mm; a=27; b=4.7; c=16.

Cuticle marked by fine transverse striae. Lateral field marked by 2 parallel incisures occupying one-eighth of body width. Lips distinct, roundly conical, each with a small forward-pointing papillae. Cheilostom short, prorhabdions over twice length of cheilorhabdions; meso, meta, and telorhabdions fused, joined directly to lumen of esophagus. Corpus of esophagus nearly one-third longer than isthmus and terminal bulb combined; terminal bulb ovate, valvate. Nerve ring located three-fourths of a body width posterior to corpus. Excretory pore one-half body width posterior to nerve ring and at times passing through hemizonid. Ovary typically panagrolaimoid, reflexed to

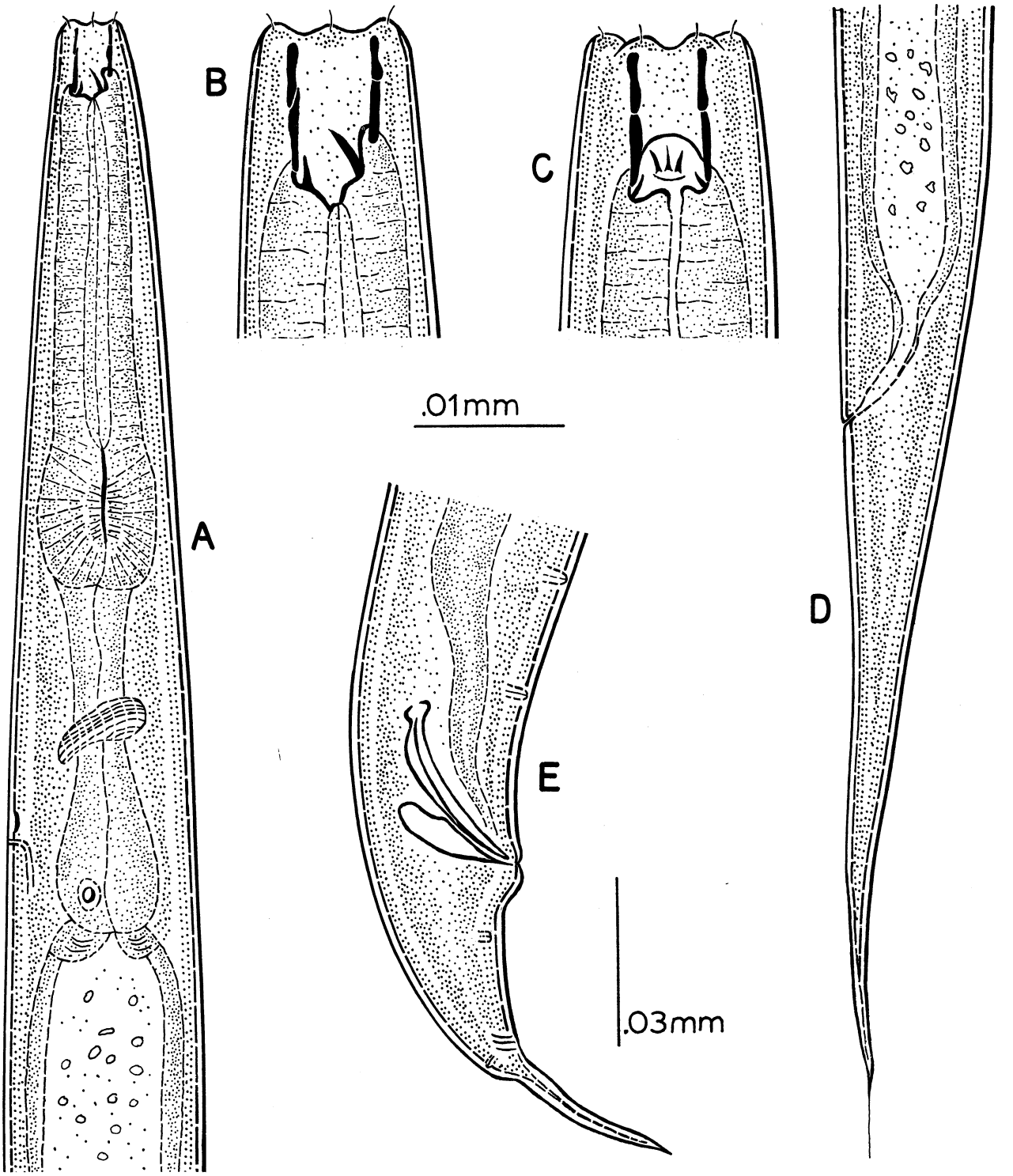


Figure 72.—*Rhabdontolaimus janae* (Massey, 1962) n. comb.: *A.* Head and neck; *B.* head, lateral view; *C.* head, ventral view; *D.* female, tail; *E.* male, tail.

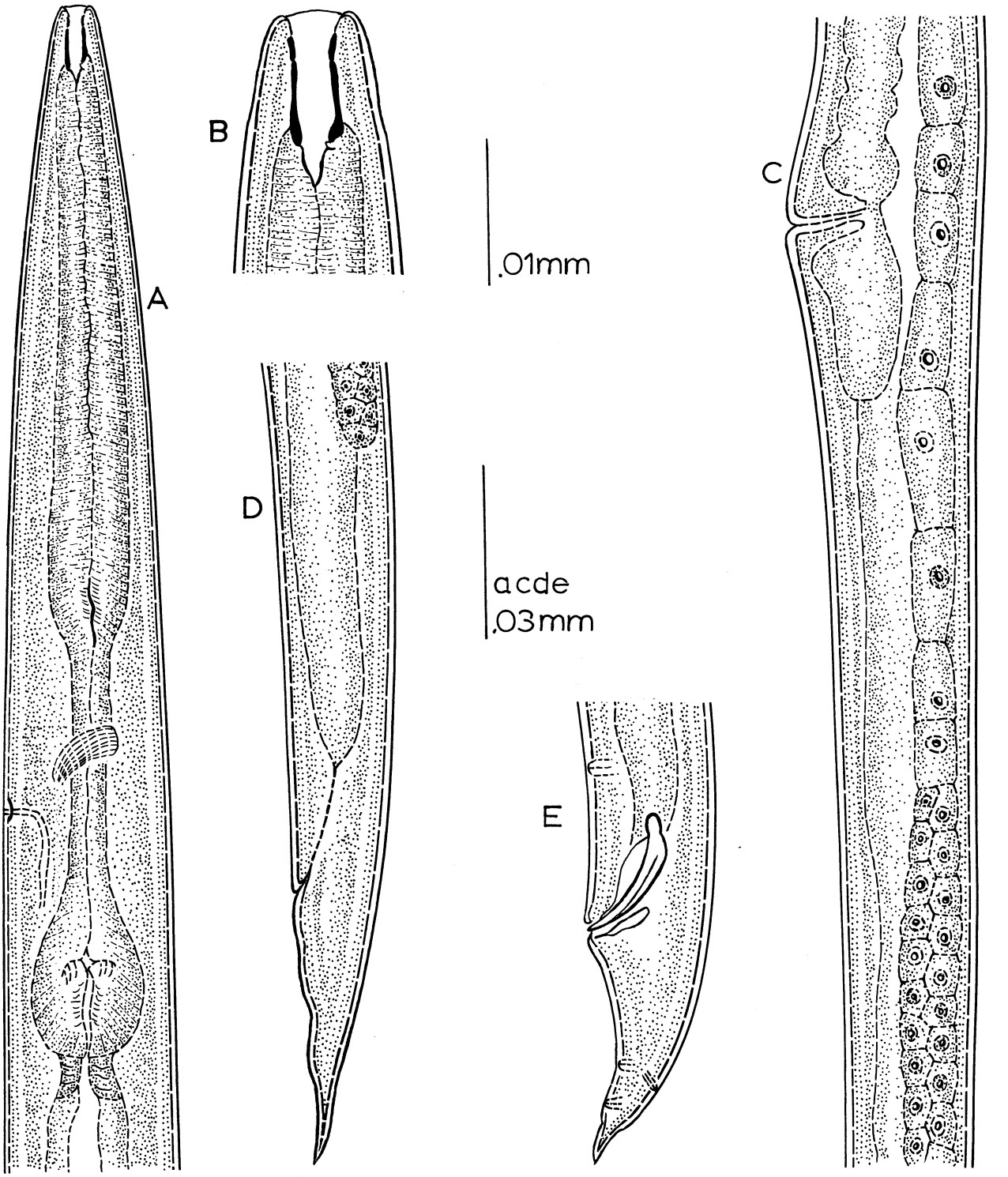


Figure 73.—*Panagrolaimus concolor* Massey, 1964: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

approximately 2 body widths anterior to anal opening, postuterine branch short, approximately 1 body width in length. Lips of vulva protuberant. Vagina transverse. Spermatozoa located throughout the entire length of uterus. Anal glands prominent. Terminus spicate, acute.

Male: Testis reflexed approximately one body width. Spicules paired, gubernaculum characterized by the strongly sclerotized distal end. Four pairs of ventrosubmedian caudal papillae, 1 preanal, located three-fourths of a body width anterior to the proximal end of the spicules, 2 and 3 postanal, 1 pair postanal, subdorsal. Terminus acute.

Diagnosis.—*Panagrolaimus concolor* differs from other species in the genus in the presence of 2 lateral incisures, in location of excretory pore, and in the strongly sclerotized distal portion of gubernaculum.

Type habitat.—Associated with *Scolytus ventralis* in white fir, also with *Dendroctonus rufipennis* in Engelmann spruce.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 10-T.

***Panagrolaimus conophthori* n. sp.** **Figure 74**

Female: 0.96 mm; a=27.3; b=5.06; c=16.4; V=57%.

Male: 0.95 mm; a=29.4; b=5.4; c=18.0.

Body cylindroid. Cuticle with moderately fine transverse and longitudinal striations, 4 lateral incisures. Lips rounded, distinct, without papillae. Amphids conspicuous. Cheilorhabdions distinct, less than one-half length of prorhabdions. Meso, meta, and telorhabdions fused. Dorsal metarhabdion with a distinct tooth. Dorsal view reveals two distinct denticles immediately posterior to prorhabdions, attachment indistinct but probably occurring subdorsally on either meso or metarhabdion. Esophagus panagrolaimoid, corpus with distinct valvelike apparatus at midpoint of its length. Nerve ring at midisthmus. Excretory pore opposite nerve ring. Cardia distinct. Lips of vulva protuberant, vagina oblique. Ovary single, panagrolaimoid. Posterior uterine branch slightly less than a body width in length. Anus and rectum conspicuous. Anal glands well developed. Phasmid prominent, located slightly anterior to terminus. Tail conoid to an acute terminus.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate, velum well developed. Gubernaculum shaped as illustrated. There are 4 pairs of caudal papillae, 1 pair preanal ventrosubmedian, 2 pairs postanal ventrosubmedian, 1 pair dorsal, all located as figured. Tail conoid to an acute terminus.

Diagnosis.—Related to *Panagrolaimus concolor,* but differs in the absence of visible cephalic papillae, in number of lateral incisures, and in shape of spicules.

Type habitat.—Associated with *Conophthorus coniperda* Schwarz in the cones of eastern white pine, *Pinus strobus* L.

Type locality.—Hamden, Connecticut.

Type specimens.—Collection No. 41-F.

***Panagrolaimus leperisini* n. sp.** **Figure 75**

Female: 1.05 mm; a=35.7; b=5.17; c=18.8; V=57%.

Male: 0.70 mm; a=27; b=4.4; c=16.2.

Cylindroid. Cuticle with moderately coarse transverse striae, fine, longitudinal striae, and marked by 3 lateral incisures. Lips rounded, papillate. Stoma 9–11 μ in depth. Cheilorhabdions distinct and somewhat shorter than the conspicuous prorhabdions. Meso, meta, and telorhabdions fused, meso, metarhabdions with a prominent dorsal tooth. Anterior end of the panagrolaimoid esophagus forming a collar around the base of the prorhabdions. Corpus longer than isthmus and basal bulb. Cardia distinct. Nerve ring at midisthmus. Excretory pore slightly posterior to nerve ring passing through hemizonid. Lips of vulva protuberant. Vagina short and slightly oblique. Ovary single, reflexed, in some specimens reflexed twice. Posterior uterine branch less than one-half body width in length. Anus and rectum conspicuous. Anal glands prominent. Phasmid distinct. Tail conoid to acute terminus.

Male: Testis single, reflexed one-third its length. Spicules paired, ventrally arcuate, cephalated, approximately 28 μ in length. Gubernaculum as figured, less than one-half the length of spicules. Five pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 2 pairs postanal ventrosubmedian, 1 pair subdorsal, all located as illustrated. Tail conoid to acute terminus.

Diagnosis.—Related to *Panagrolaimus subelongatus* (Cobb, 1914) Thorne, 1937, but dif-

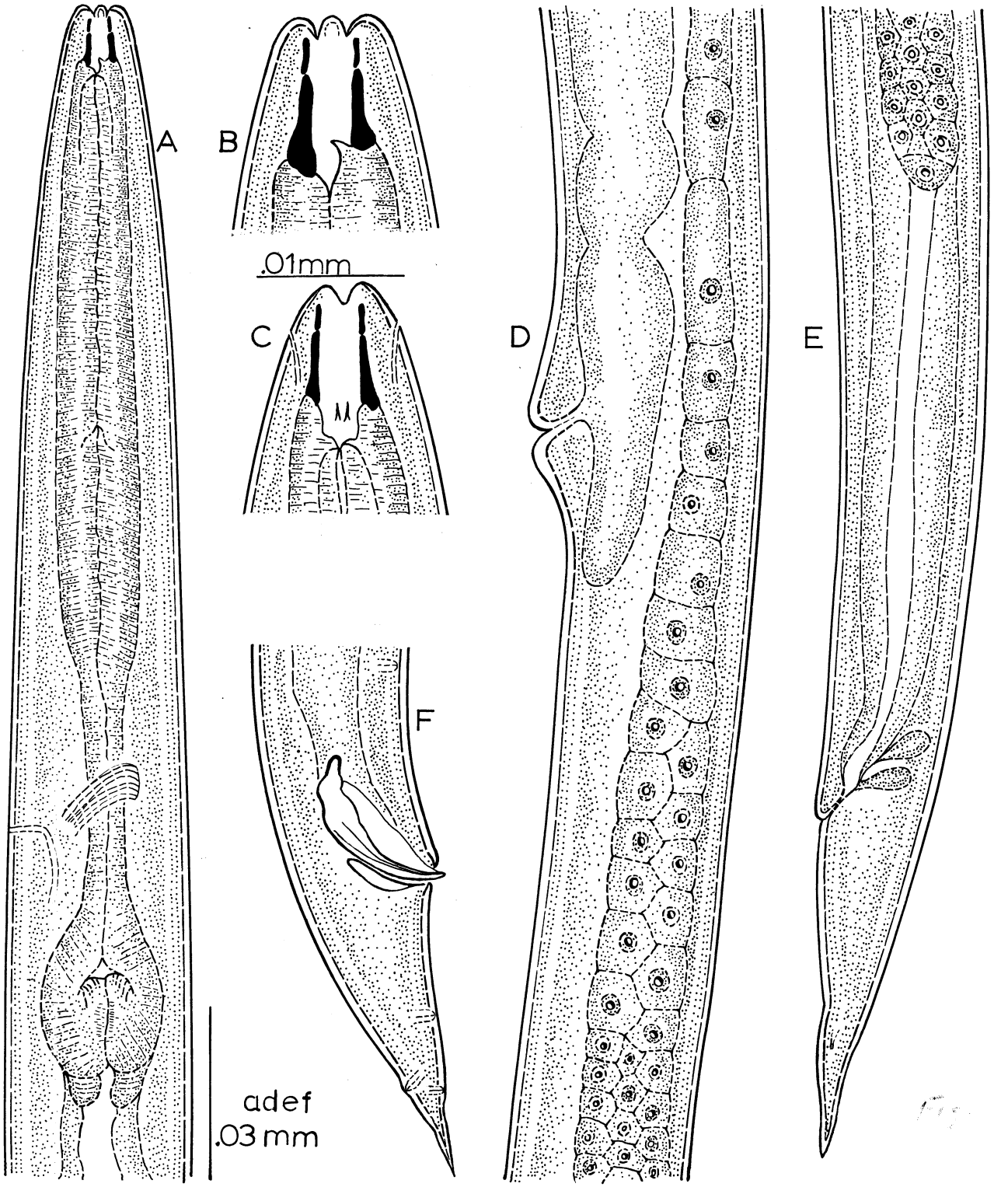


Figure 74.—*Panagrolaimus conophthori* n. sp.: *A.* Head and neck; *B.* head, lateral view; *C.* head, dorsal view; *D.* female, midbody; *E.* female, tail; *F.* male, tail.

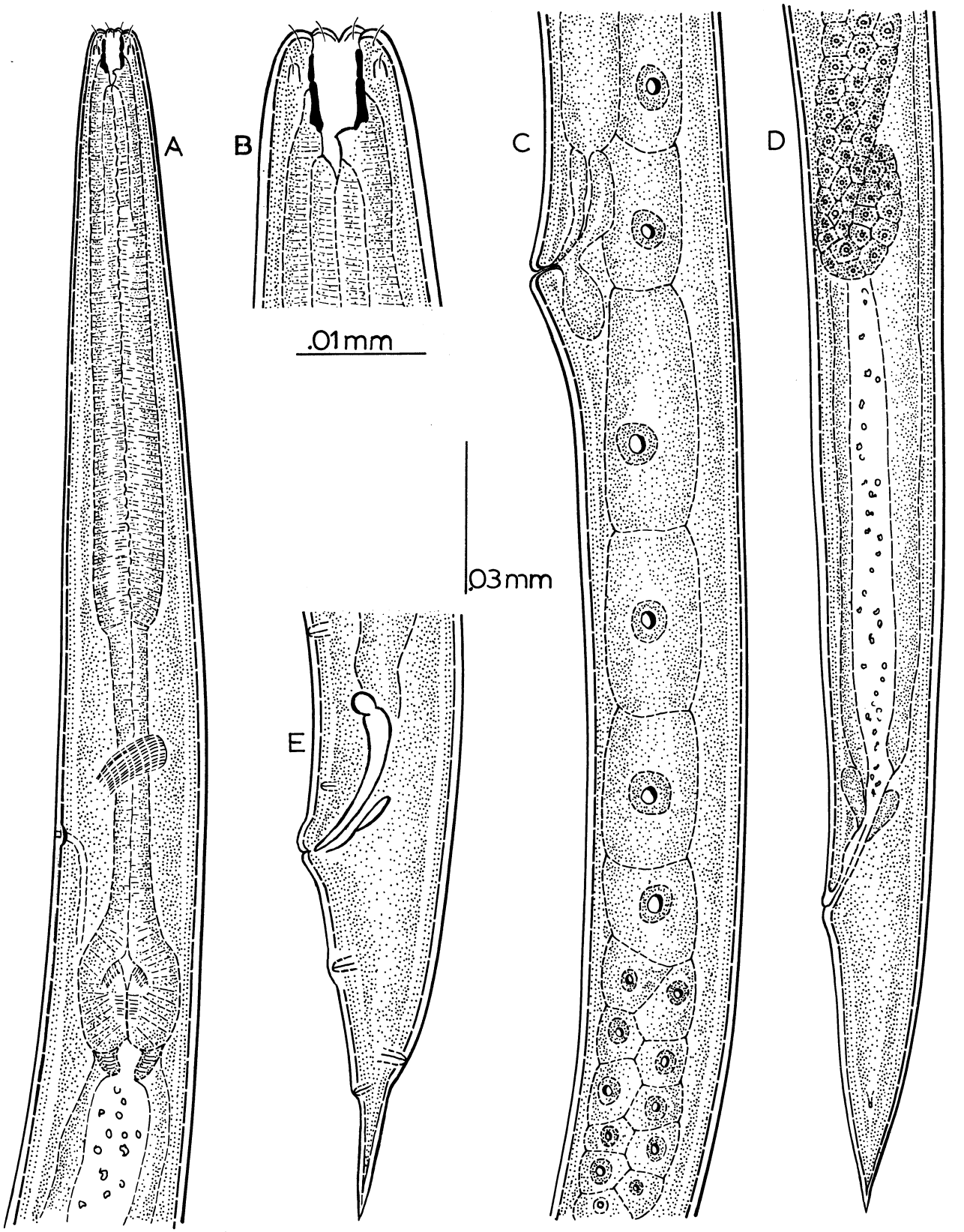


Figure 75.—*Panagrolaimus leperisini* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

fers in the more distinctive cheilo and prorhabdions and the presence of large tooth on dorsal meso, metarhabdions. Also differs in number of male caudal papillae.

Type habitat.—Associated with *Leperisinus aculeatus* in green ash, *Fraxinus pennsylvanica* Marsh.

Type locality.—Chillicothe, Ohio.

Type specimens.—Collection No. 82-P.

Genus *Neocephalobus* (Steiner, 1929) Steiner, 1934

Synonym: *Cephalobus* (*Neocephalobus*) Steiner, 1929

Type species: *Neocephalobus aberrans* (Steiner, 1929) Steiner, 1934.

Lips broadly rounded with papillae. Stoma divided into cheilostom with prominent cheilorhabdions and protostom with distinct prorhabdions, the dorsal prorhabdions forming a platelike tooth which extends slightly into the cheilostom. Esophagus consisting of a muscular corpus widened at its base, a slender isthmus, and a large valvate terminal bulb. Ovary single, reflexed to vicinity of anal opening. Tail conoid to an elongate, acute terminus. Testis single, spicules paired, cephaloboid in structure. Gubernaculum usually lineate. Several pair of caudal papillae with a single preanal ventrosubmedian papilla. Tail conoid to an elongate, acute terminus as in female.

Neocephalobus judithae (Massey, 1964) n. comb. Figure 76

Female: 0.75–0.78 mm; a=17; b=5; c=8; V=58%.

Male: 0.64–0.70 mm; a=20; b=4.4; c=13.

Cuticle with fine transverse striations. Lips distinct, each with a minute apical papillae. Depth of pharynx and width of head about equal. Cheilostom about one-half the depth of prostom, the cheilorhabdions distinct, convex in lateral view; meso, meta, and telostom fused, joined directly to lumen of esophagus. Corpus of esophagus equal in length to isthmus and terminal bulb combined; terminal bulb valvate. Nerve ring at middle of isthmus. Excretory pore adjacent to anterior end of terminal bulb, passing through hemizonid. Ovary single, reflexed, its terminus extending beyond anal opening. Lips of vulva protuberant. Vagina oblique. Uterus with stored sperm at anterior flexure. Tail elongate, conoid; terminus subacute to acute.

Male: Testis single, reflexed one to two body widths. Spicules paired, cephalated, ventrally arcuate. Gubernaculum one-third length of spicules, lineate. Four pairs of caudal papillae, 1 preanal ventrosubmedian, 2 postanal ventrosubmedian, 1 pair subdorsal. Tail elongate, terminus spicate, subacute to acute.

Diagnosis.—Related to *N. aberrans* (Steiner, 1929) Steiner, 1934. Differs in structure of pharynx.

Habitat.—Associated with numerous bark beetle species throughout the United States.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 10-R.

Genus *Panagrodontus* Thorne, 1935

Type species: *Panagrodontus dentatus* Thorne, 1935.

Body cylindroid. Lip region rounded, continuous with neck contour. Lips three, duplex, subventral being somewhat asymmetrical. Amphids minute, cheilostom obscure, hexagonal in face view. Protostom triquestrious. Dorsal mesorhabdion bearing a flat, plate-like tooth. Corpus of esophagus cylindrical. Basal bulb valvate. Ovary single, panagrolaimoid, extending to vicinity of anal opening. Postuterine sac rudimentary. Tail conoid to spicate terminus. Testis single, spicules paired, cephaloboid. Gubernaculum lineate. Several pair of caudal papillae. Tail conoid to spicate terminus.

Panagrodontus dentatus Thorne, 1935 Figure 77

Thorne originally described the species as follows:

Female: 0.6 mm; a=20; b=5; c=10; V=59%.

Male: 0.6 mm; a=25; b=5.5; c=10.

"Body tapering both ways from near middle. Tails of both sexes at first dorsally convex-conoid, then convex, ending in a somewhat spicate terminus which occupies one-third to one-half of the total tail length. Transverse striae moderately fine. Lateral field with three obscure incisures, the area about one-eighth as wide as body near the middle. Lip region rounded, continuous with neck contour. Lips three, duplex, the two subventral being some-

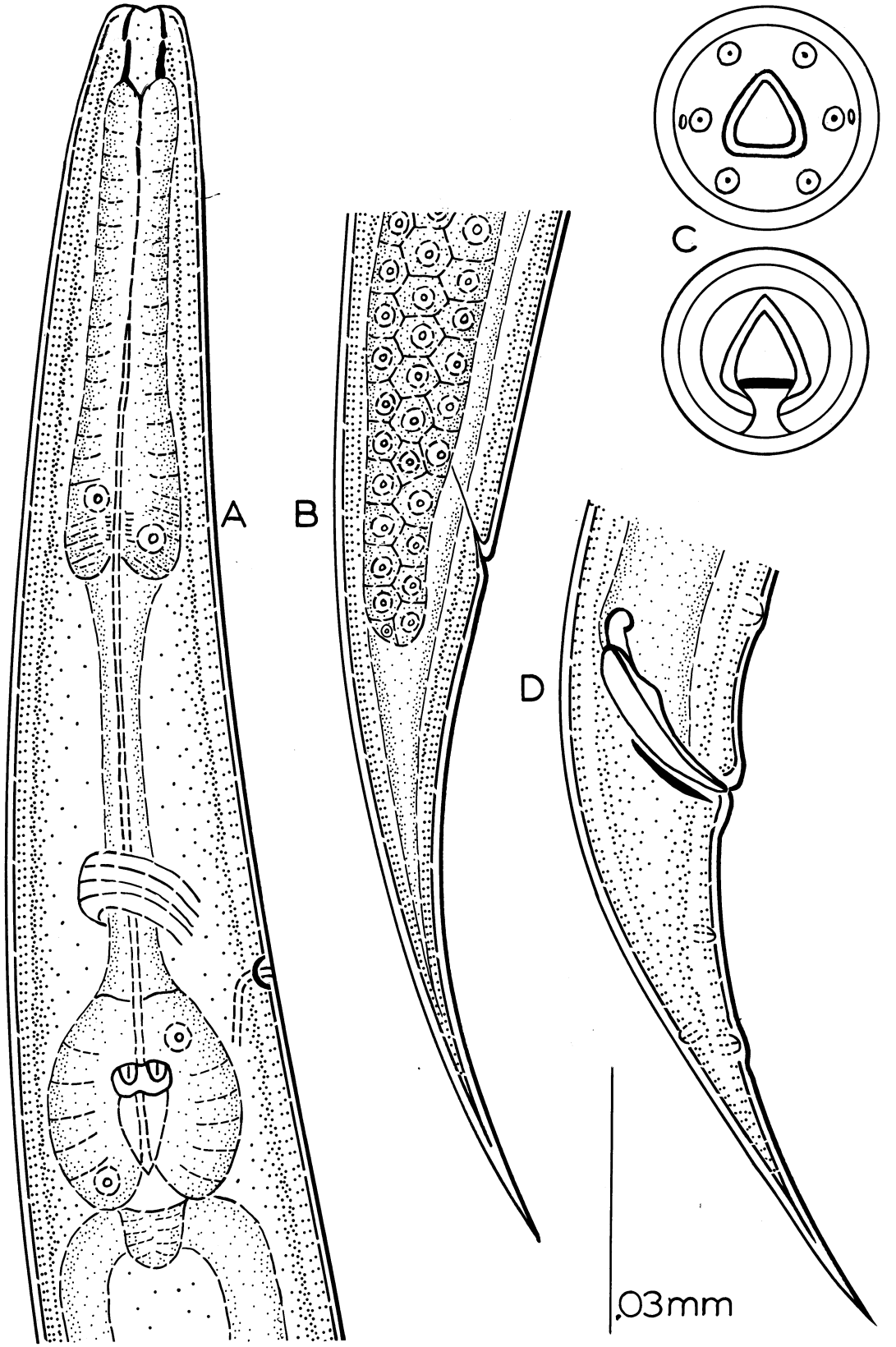


Figure 76.—*Neocephalobus judithae* (Massey, 1964) n. comb.: *A.* Head and neck; *B.* female, tail; *C.* face views; *D.* male, tail.

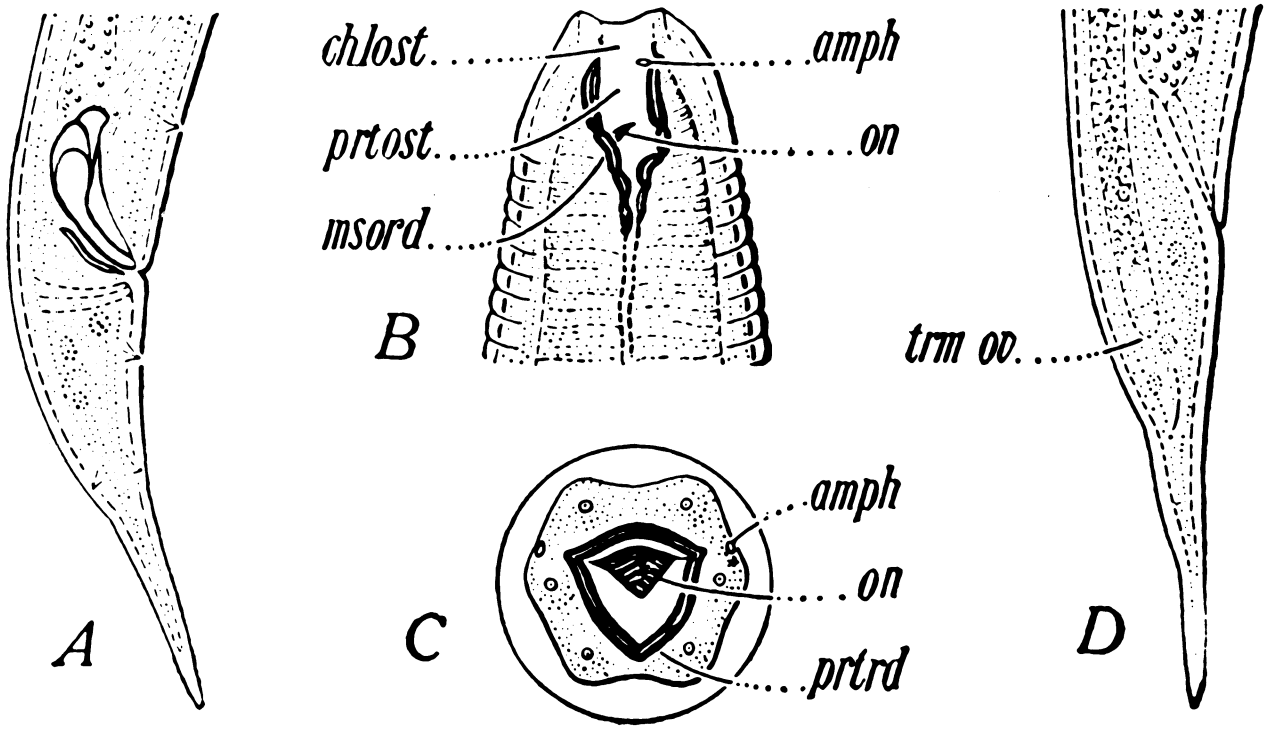


Figure 77.—*Panagrodontus dentatus* Thorne, 1935: *A.* Male, tail; *B.* head; *C.* face view; *D.* female, tail. (After Thorne, 1935).

what asymmetrical. Amphids minute. Pharynx: cheilostom obscure, hexagonal when seen in face view; protostom triquestrious; dorsal mesorhabdion bearing a flat tooth-like plate about 2 μ long opposed by a niche formed by the submedian mesorhabdions and metarhabdions. Esophagus: corpus cylindrical, at first almost filling body cavity; isthmus about equal in length to corpus; bulb half as wide as neck with conspicuous valvular apparatus. Intestinal walls at first thin then gradually becoming much thicker with a corresponding narrowing of the lumen. Vulva a transverse slit with elevated labia. Posterior uterine branch rudimentary, its length equal to 1 or 2 body widths. Ovary extending forward, then reflexed and outstretched, the terminus reaching the rectum or, frequently, extending into the tail. Average size of eggs 20 μ × 50 μ. Testis single, the terminal portion reflexed. Spicula, gubernaculum, and male caudal papillae as figured.

"*Diagnosis.—Panagrodontus* with above measurements. Pharynx armed with a single tooth located on the dorsal mesorhabdion. Tails of sexes similar, at first dorsally convex-conoid, then convex, ending in a somewhat spicate terminus. Spicula, gubernaculum, and male caudal papillae as figured."

Habitat.—Associated with *Dendroctonus ponderosae* in lodgepole pine.

Genus *Plectonchus* Fuchs, 1930 Emended

Type species: *Plectonchus cunicularii* Fuchs, 1930

Body cylindroid. Cuticle relatively thick, hyaline. Head rounded, lips with or without papillae. Pharynx very shallow. Cheilorhabdions obscure. Prorhabdions most conspicuous, part of stoma. Meso, meta, and telorhabdions flat, horizontal, forming anterior entrance to esophagus. Corpus of esophagus cylindrical. Basal bulb valvate. Vulva at approximately 70%. Ovary single, reflexed, distal end anterior to vulva. Postuterine sac absent. Tail conoid to a thick narrowly rounded terminus. Testis single. Spicules with slight ventral arcuation, bent sharply at manubrium, short, thick, cephalated. Gubernaculum grooved, more or less keel-shaped with processes at proximal and distal ends. Several pair of caudal papillae. Tail as in female.

***Plectonchus molgos* n. sp.** **Figure 78**

Female: 0.57–0.60 mm; a=20.4–24.4; b=5.1–5.6; c=9.7–11.3; V=75%.

Male: 0.51–0.57 mm; a=25.1–28.1; b=4.2–4.9; c=9.8–12.3.

Cylindroid. Cuticle exceedingly thick, hyaline, without longitudinal or transverse striae. Lips rounded with short hairlike papillae. Rhabdions fused, not distinguishable, forming a very shallow stoma without visible teeth. Esophagus panagrolaimoid with a cylindrical corpus, width at base and anterior end essentially the same, corpus longer than isthmus and basal bulb combined. Nerve ring slightly posterior to base of corpus. Excretory pore anterior to base of corpus. Hemizonid not observed. Ovary single, anterior to vulva, reflexed much of its length. Lips of vulva protuberant. Vagina slightly oblique. Postuterine branch absent. Lips of anus usually protuberant. Rectum only moderately conspicuous. Tail conoid to narrowly rounded terminus, constricted as figured.

Male: Testis single, reflexed. Spicules paired, short, approximately 19 μ in length, cephalated, ventrally arcuate. Gubernaculum as figured. Tail conoid, ventrally arcuate. Terminus as in female. There are 6 pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 2 pairs postanal ventralsubmedian, 2 pairs dorsal submedian.

Diagnosis.—Differs from *P. wyganti* in the presence of prominent cephalic papillae and in the thickness of the cuticle. *P. molgos* is generally a smaller, stouter species.

Type habitat.—Associated with *Hylurgops subcostulatus* (Mann.) in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 40-A.

***Plectonchus wyganti* Massey, 1964** **Figure 79**

Female: 0.7 mm; a=30; b=4.5; c=11.5; V=77%.

Male: 0.6 mm; a=32; b=4.6; c=10.8.

Cuticle with very fine transverse striations. Head consisting of 6 flattened lips each with an apical papillae, obscure. Stoma very shallow. Cheilorhabdions and prorhabdions forming the stomatal chamber, evidently fused and not distinguishable; meso, meta, and telorhabdions fused, very lightly sclerotized. Esophagus panagrolaimoid, the corpus equal in length to isthmus and terminal bulb combined, slender, tapering as it joins the isthmus; terminal bulb ovate, valvate. Nerve ring encircling isthmus well anterior to middle. Excretory pore one body width anterior to the base of the corpus. Ovary single, reflexed, laterally. Uterus containing sperms. Lips of vulva protuberant. Distance between vulva and anus only slightly greater than length of tail. Tail elongate, subacute.

Male: Testis reflexed, extending at times nearly to esophageal bulb. Spicules paired, cephalated, stout, ventrally arcuate. Gubernaculum two-thirds the length of the spicules, 7 pairs of ventrosubmedian caudal papillae (2 preanal, 5 postanal) and 2 pair subdorsal. Tail elongate, conoid, terminus acute. Phasmids prominent in both sexes.

Diagnosis.—Closely allied to *P. cunicularii* Fuchs, 1930, but differs in pharyngeal and tail characteristics and in the position of the excretory pore.

Type habitat.—Associated with *Scolytus ventralis* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 40.

Genus *Panagromacra* Massey, 1964

Type species.—*Panagromacra margaretae* Massey, 1964.

Head with 6 sclerotized forward-pointing labial processes. Cheilorhabdions well developed, coarse. Meso, meta, and telorhabdions distinct. Esophagus typically panagrolaimoid. Ovary single, reflexed. Testis single, reflexed. Spicules paired, cephalated. Gubernaculum distally bent, pronged, the prongs extending alongside the spicules. Several pairs of male caudal papillae.

Diagnosis.—Immediately distinguished from *Panagrolaimus* by the labial processes, the well-developed cheilorhabdions, and the distinctive gubernaculum. The genus has affinities with *Macrolaimus* in its pharyngeal characteristics.

***Panagromacra margaretae* Massey, 1964** **Figure 80**

Female: 1.55–1.77 mm; a=32; b=4.8–5.1; c=20–22; V=58–60%.

Male: 1.26–1.64 mm; a=27–37; b=4.4–5.3; c=20–24.

Cuticle with fine longitudinal and transverse

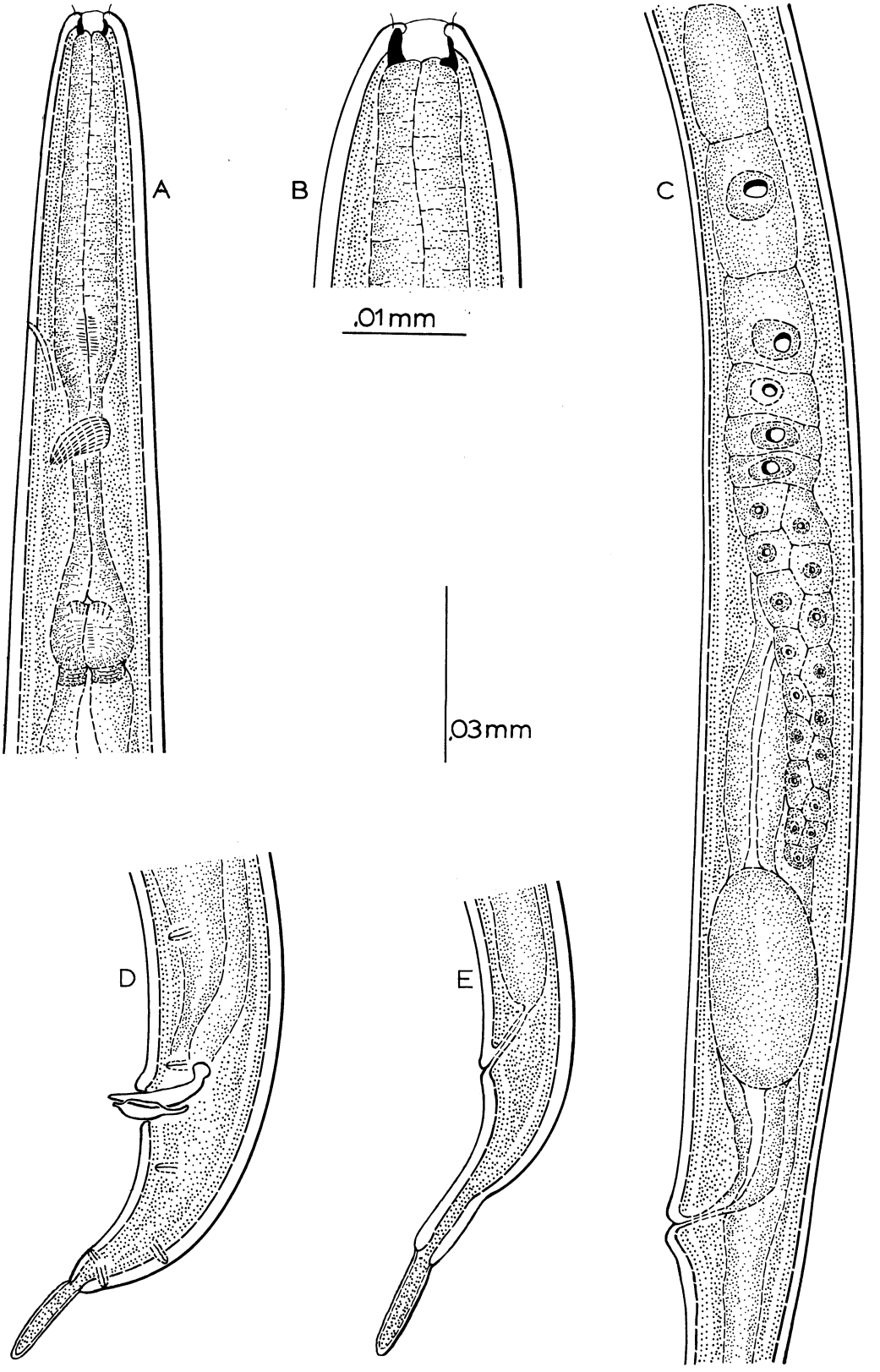


Figure 78.—*Plectonchus molgos* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* male, tail; *E.* female, tail.

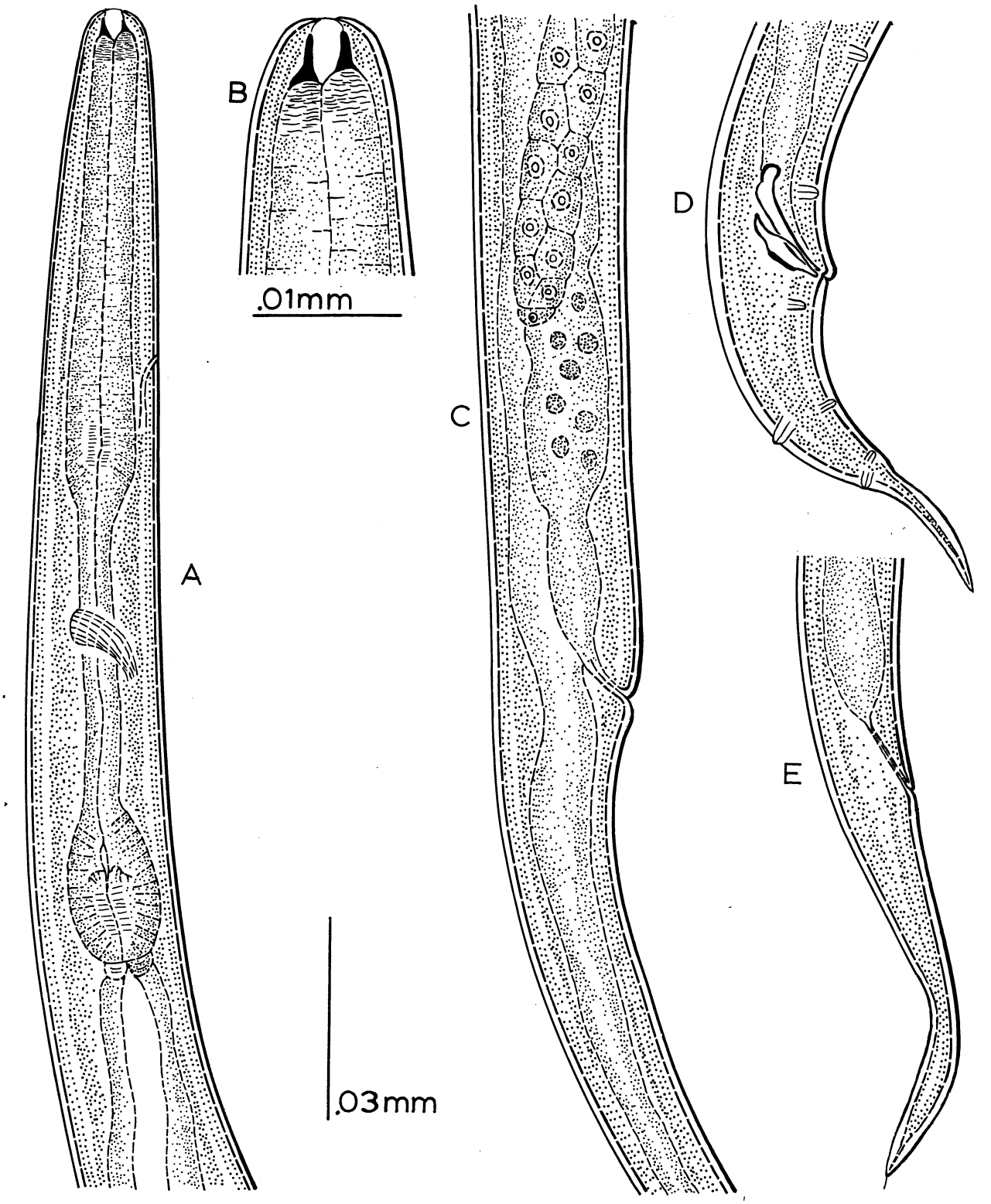


Figure 79.—*Plectonchus wyganti* Massey, 1964: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* male, tail; *E.* female, tail.

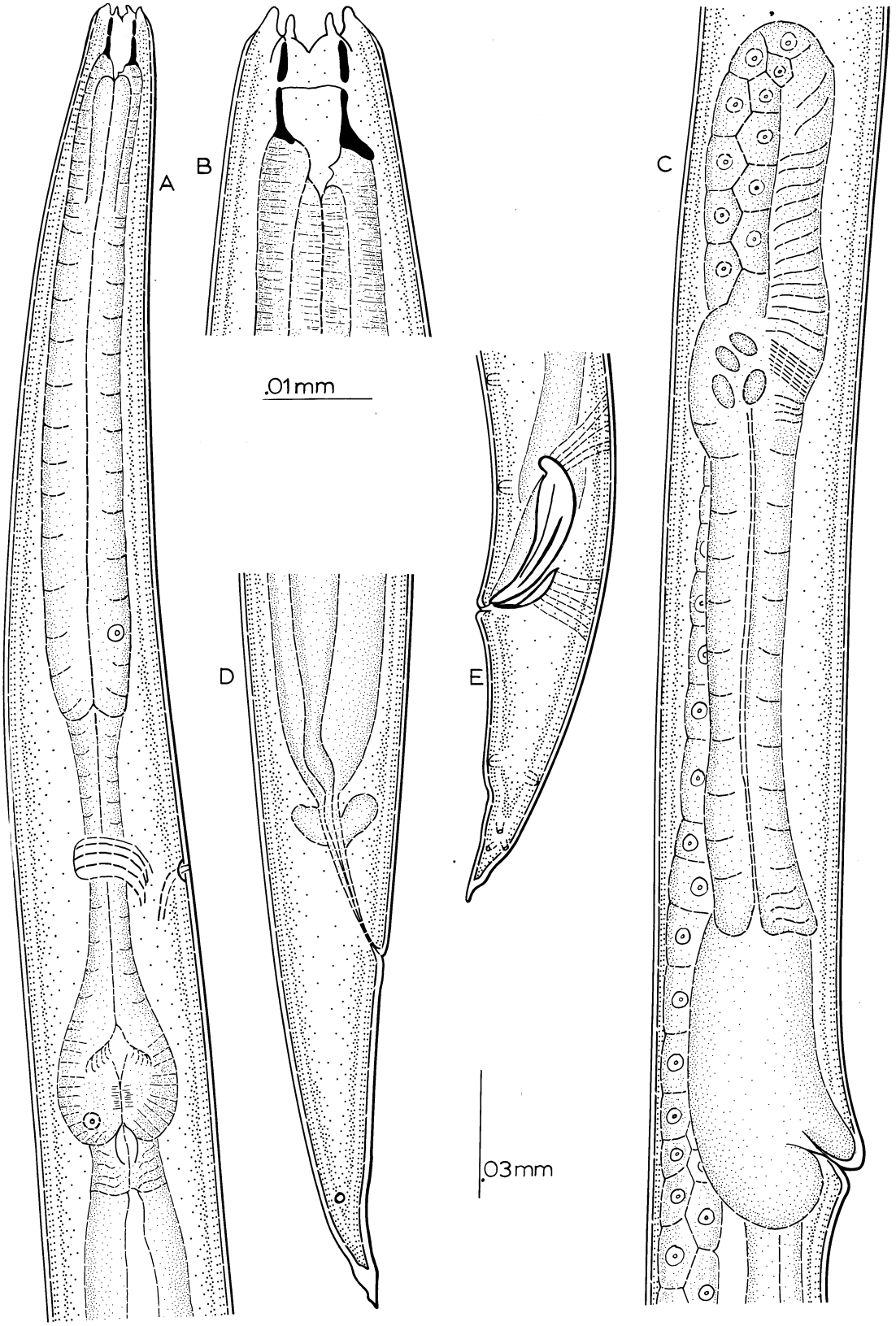


Figure 80.—*Panagromacra margaretae* Massey, 1964: *A.* Head and neck; *B.* head; *C.* female, mid-body; *D.* female, tail; *E.* male, tail.

striations. Lateral area marked by 3 incisures appearing as parallel bright lines along the entire body length. Head slightly constricted with 6 forward-pointing sclerotized labial processes appearing titlike in lateral view. Amphids posterior to papillae. Cheilorhabdions and prohabdions strongly sclerotized, cheilorhabdions nearly as long as prorhabdions, meso, meta, and telorhabdions distinct, enveloped by anterior end of esophagus. Esophagus panagrolaimoid, the isthmus about one-half the length of the corpus, terminal bulb valvate, cardia distinctive, as illustrated. Nerve ring near middle of isthmus. Excretory pore slightly posterior to nerve ring, at times passing through hemizonid or immediately posterior to it. Ovary single, reflexed, at times reaching vicinity of rectum. Uterus as illustrated, with a spermatheca near its anterior flexure. Vulva with protuberant lips. Vagina oblique. Anal glands prominent. Terminus acute.

Male: Testis reflexed. Spicules paired, ventrally arcuate. Gubernaculum distally pronged, the prongs extending along either side of the spicules as illustrated. Six pair of caudal papillie: 2 pair preanal ventrosubmedian, 2 postanal, 2 subdorsal, located as figured. Phasmid conspicuous. Tail bluntly conoid to an acute terminus.

Type habitat.—Associated with *Scolytus ventralis* in white fir. In addition, it is associated with *Dryocoetes confusus* in subalpine fir, *Dendroctonus adjunctus* in ponderosa pine, and *Dendroctonus rufipennis* in Engelmann spruce.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 39-B.

Genus *Panagrobelus* Thorne, 1939

Type species: *Panagrobelus incisus* Thorne, 1939.

Lips six, flaplike, inward-pointing with strongly sclerotized borders. Cheilorhabdions absent. Prorhabdions prominent. Meso, meta, and telorhabdions fused with or without denticles. Esophagus panagrolaimoid. Ovary single, reflexed to vicinity of anal opening. Posterior uterine branch short or rudimentary. Spicules ventrally arcuate, paired, cephalated. Several pair of caudal papillae.

***Panagrobelus phloeosini* n. sp.** **Figure 81**

Female: 0.65–0.76 mm; a=18.6–23.7; b=4.5–4.6; c=23.7–24.8; V=57–60%.

Male: 0.52–0.65 mm; a=25.4–27.7; b=3.6–4.2; c=16.2–18.5.

Cylindroid. Cuticle with fine transverse striations, 3 lateral incisures visible from terminus to anterior one-half of corpus of esophagus. Lips flaplike and pointed inwards. Prorhabdions stout, forming distinctive part of stoma. Meso, meta, and telorhabdions fused, meta, telorhabdions with a subventral tooth. Esophagus panagrolaimoid. Corpus cylindrical, longer than isthmus and basal bulb. Cardia conspicuous. Nerve ring at midisthmus. Excretory pore opposite nerve ring and opening through hemizonid. Lips of vulva protuberant. Vagina oblique. Ovary single, reflexed to within body width of terminus. Oocytes arranged in double row from distal end to within one and one-half to two body widths of vulva, then in single row. Nuclei of oocytes with large conspicuous nucleoli. Postuterine sac short, at times rudimentary. Anus and rectum only moderately conspicuous. Tail bluntly conoid to an acute terminus.

Male: Testis single, reflexed one-third its length. Spicules paired, ventrally arcuate, cephalated, head distinctive and very heavily sclerotized. Gubernaculum lineate, proximal and distal end each with a pointed protrusion. Tail slightly ventrally arcuate, conoid to an acute terminus. There are 5 pairs of caudal papillae, 2 pairs preanal ventrosubmedian, 2 pairs postanal ventrosubmedian, and 1 pair of dorsosubmedian.

Diagnosis.—Related to *P. scolyti* Massey, 1964. Differs in number of lateral incisures, in shape of spicules and gubernaculum, and in presence of subventral tooth on meta-telorhabdion.

Type habitat.—Associated with *Phloeosinus dentatus* (Say) in eastern redcedar, *Juniperus virginiana* L.

Type locality.—Keysville, Virginia.

Type specimens.—Collection No. 41-D.

***Panagrobelus scolyti* Massey, 1964** **Figure 82**

Female: 0.7–0.8 mm; a=23; b=4.7; c=22; V=62%.

Male: 0.75 mm; a=20; b=4.2; c=17.

Cuticle with fine transverse and longitudinal striations. Lateral area marked by 2 incisures.

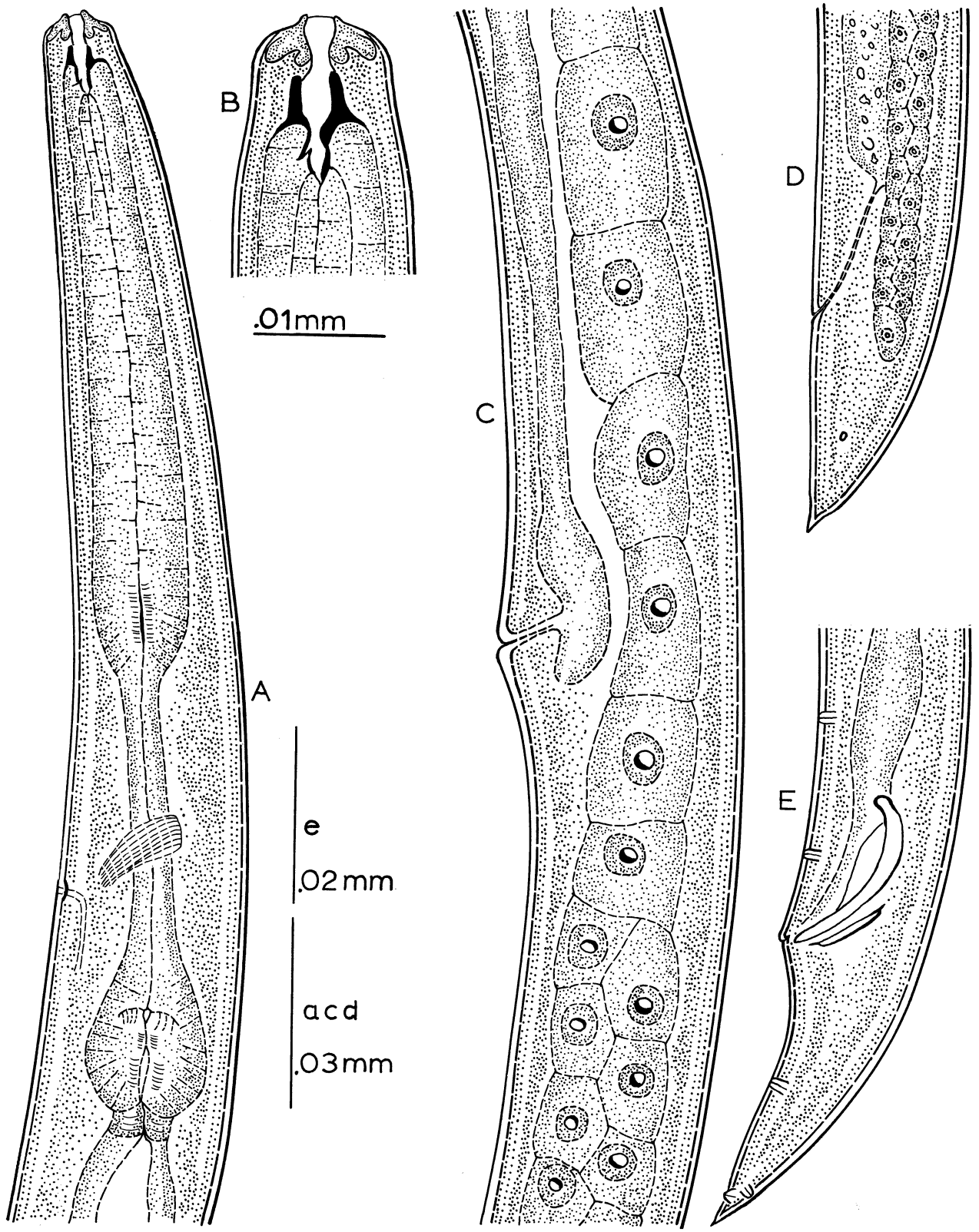


Figure 81.—*Panagrobelus phloeosini* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

Head with 6 flaplike lips pointing inward. Cheilorhabdions not distinct from prorhabdions, meso, meta, and telorhabdions fused, joined directly to lumen of esophagus. Esophagus panagrolaimoid, isthmus and terminal bulb somewhat shorter than corpus. Nerve ring at middle of isthmus. Excretory pore adjacent to anterior end of terminal bulb. Hemizonid immediately anterior to or surrounding excretory pore. Ovary single, reflexed nearly to rectum. Lips of vulva protuberant. Vagina oblique. Postuterine sac rudimentary. Anal glands prominent. Tail convex-conoid to acute terminus.

Male: Testis reflexed. Spicules paired, cephalated. Gubernaculum one-third the length of spicules, shaped as figured. Three to five pairs of ventrosubmedian caudal papillae and 1 pair subdorsal. Tail conoid to an acute terminus.

Diagnosis.—Closely related to *Panagrobelus incisus* Thorne, 1939, differs from that species in size and in the number and arrangement of the caudal papillae. Rühm (1956) made *P. incisus* a synonym of *P. coronatus* (Fuchs, 1930). In the writer's opinion, *P. incisus* is a valid species, because of its size and arrangement of the male caudal papillae. *P. scolyti* Massey, 1964 is distinct from *P. coronatus* (Fuchs, 1930) Thorne, 1939, in size and number and arrangement of male caudal papillae.

Type habitat.—Associated with *Scolytus ventralis* in white fir. In addition, it was found associated with *Dendroctonus adjunctus* in ponderosa pine, *Scolytus multistriatus* in American elm, and with *Leperisinus aculeatus* in green ash. It is one of the few nematode species associated with bark beetles in both coniferous and hardwood trees.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 41.

Genus *Panagrellus* Thorne, 1938

Synonym: *Turbator* Goodey, 1943.

Type species: *Panagrellus pycnus* Thorne, 1938.

Lip region narrow, low, rounded. Amphid apertures minute, porelike. Pharynx panagrolaimoid. Cheilostom broad, symmetrical followed by shallow triquestrious protostom with much heavier refractive walls. Meso, meta, telostom fused and connecting directly with lumen of esophagus. Esophagus panagrolaimoid. Corpus broadly cylindrical. Terminal bulb with conspicuous valvular apparatus. Ovary single, reflexed to vicinity of anal opening with or without postuterine sac.

Male: Testis single. Spicules elongate, linear, ventrally arcuate usually with striking cephalation and furcate terminus. Gubernaculum variable in shape, usually lineate. Several pairs of caudal papillae. Tails in both sexes elongate, acute.

***Panagrellus leperisini* n. sp.** **Figure 83**

Female: 0.82–0.97 mm; a=22.3–24.8; b=5.6–5.8; c=6.9–8.2; V=66–69%.

Male: 0.74–0.92 mm; a=22–25; b=6.0–6.3; c=8.2–8.4.

Cylindroid. Cuticle with very fine longitudinal and transverse striae, 4 lateral incisures, the outside incisures more heavily sclerotized than the inside. Lips rounded, each with a fine setose apical papillae. Stoma shallow, rhabdions only moderately sclerotized, cheilorhabdions composing two-thirds of stoma, one-third composed of prorhabdions, meso, meta, and telorhabdions all more or less fused. Dorsal prorhabdion produced into short, blunt tooth, dorsal meso, metarhabdion forming a flat toothlike projection. Esophagus panagrolaimoid. Isthmus relatively short in some specimens, the transition zone between corpus and isthmus indistinct. Nerve ring surrounding isthmus. Excretory pore opposite nerve ring. Hemizonid opposite basal bulb. Cardia short but distinct. Lips of vulva protuberant. Vagina oblique. Ovary single, reflexed at times past the anal opening. Mature specimens with larvae in uterus. Posterior uterine branch up to 3 body widths in length. Anus and rectum conspicuous. Tail conoid to an elongate, acute terminus.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate with a hammer-shaped head and a furcate terminus, velum distinct, extending from head to terminus. Tail ventrally arcuate, conoid to a long slender, acute terminus. Phasmid conspicuous. There are 6 pairs of caudal papillae, 2 preanal, 2 postanal, 2 subdorsal, all located as illustrated.

Diagnosis.—Related to *P. pycnus,* differs in structure of stoma.

Type habitat.—Associated with *Leperisinus californicus* Sw. in green ash.

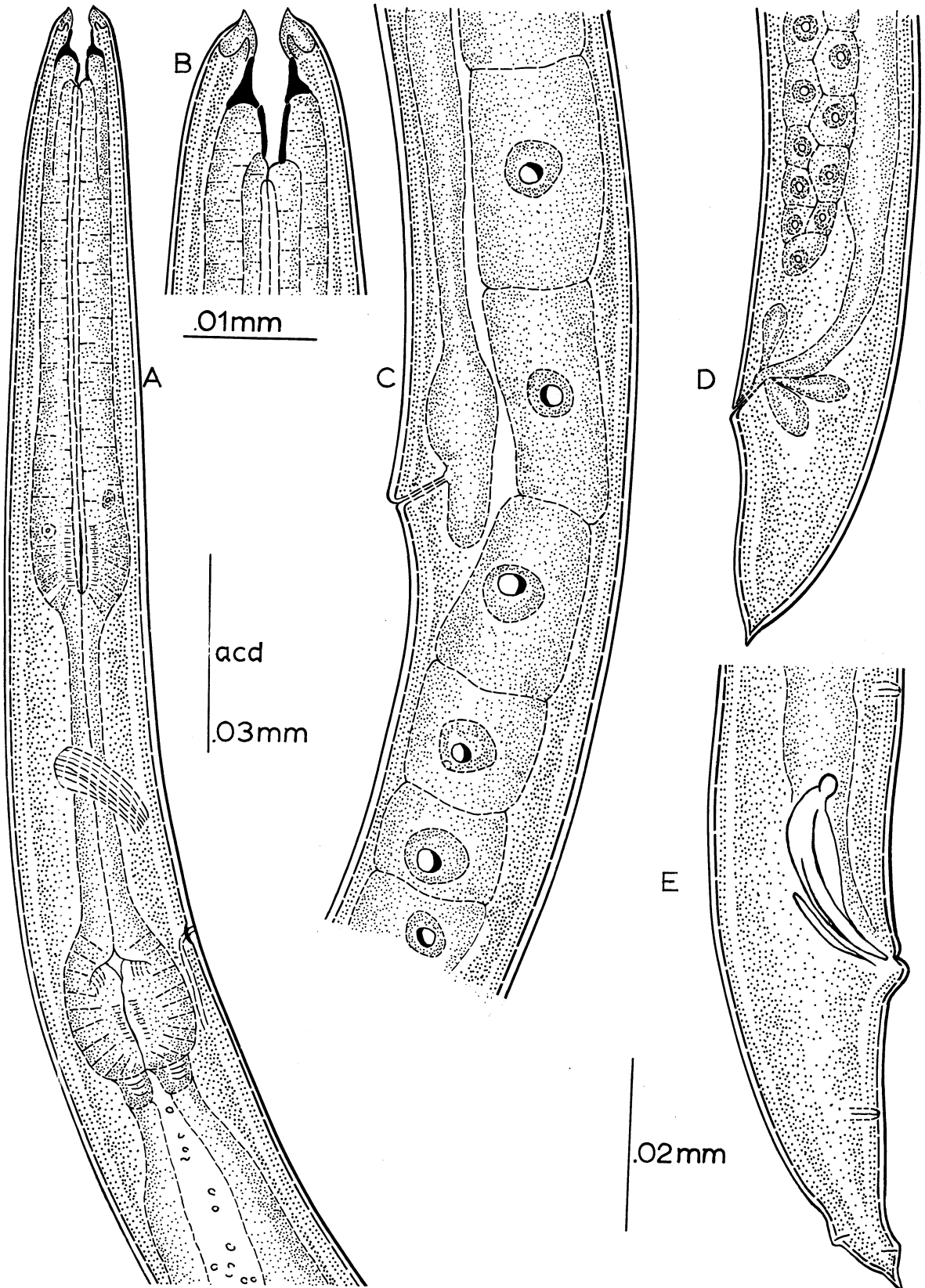


Figure 82.—*Panagrobelus scolyti* Massey, 1964: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

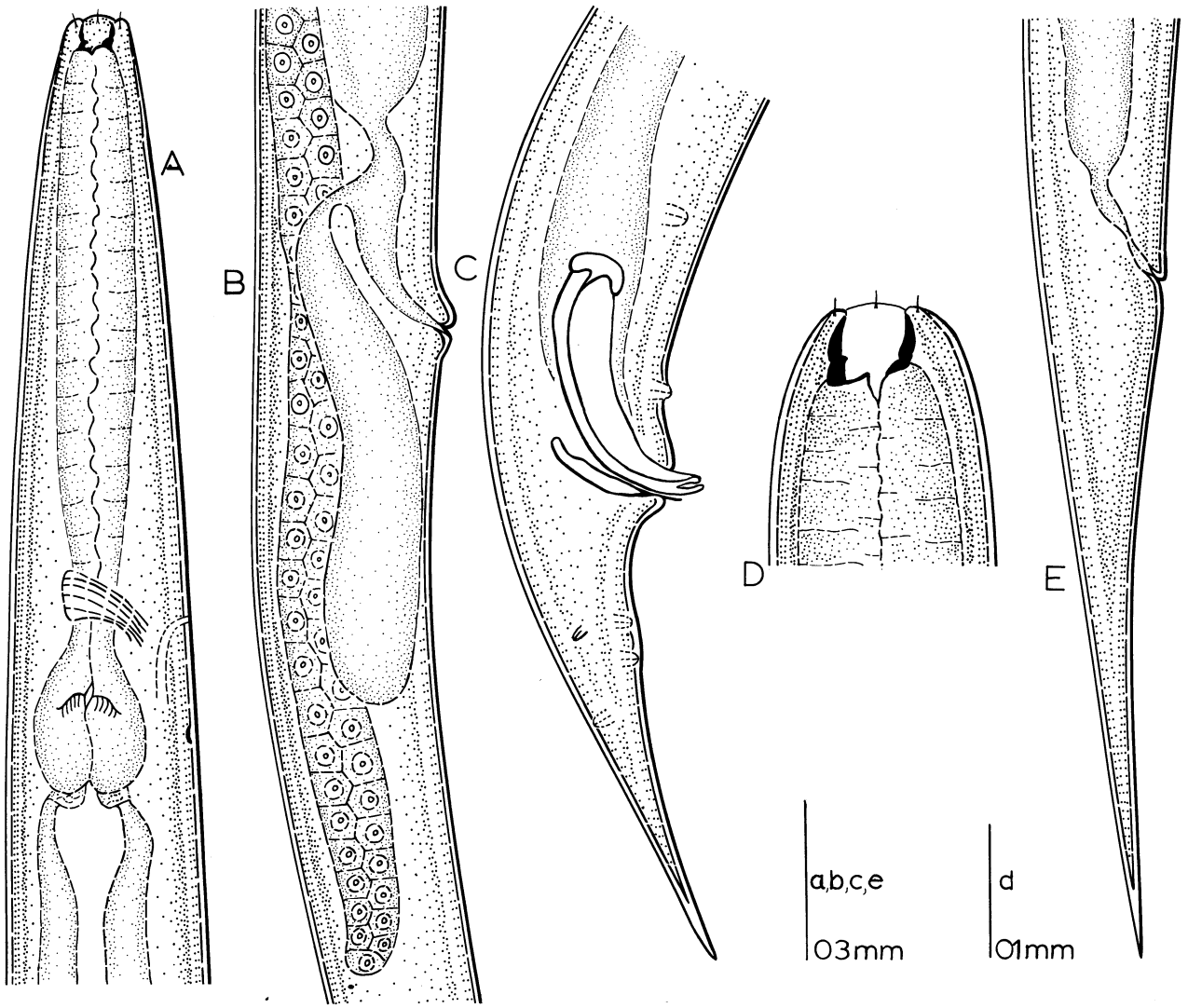


Figure 83.—*Panagrellus leperisini* n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* male, tail; *D.* head; *E.* female, tail.

Type locality.—Rugby, North Dakota.
Type specimens.—Collection No. 87-A.

Genus *Teratocephalus* deMan, 1876

Synonym: *Mitrephorus* Linstrow, 1877.

Type species: *Teratocephalus terrestris* (Bütschli, 1873) deMan, 1876.

Cuticle strongly annulated from head to terminus. Lips flaplike, their perimeters heavily sclerotized. Amphids porelike and located laterally at base of pharynx. Pharynx with distinct cheilostom and protostom, rhabdions distinct. Meso, meta, and telorhabdions forming entrance to esophagus. Anterior part of esophagus cylindrical, hardly narrowing at isthmus. Ovaries single, prodelphic. Tail very elongate to an acute terminus. Spicules paired, cephalated with or without gubernaculum. Several pairs of caudal papillae.

***Teratocephalus angustus* n. sp.** **Figure 84**

Female: 0.41 mm; a=27.6–28.8; b=3.8; c=4.8–5.6; V=50–52%.

Male: Unknown.

Slender, cylindroid. Cuticle coarsely annulated. Annules interrupted by 2 lateral inci-

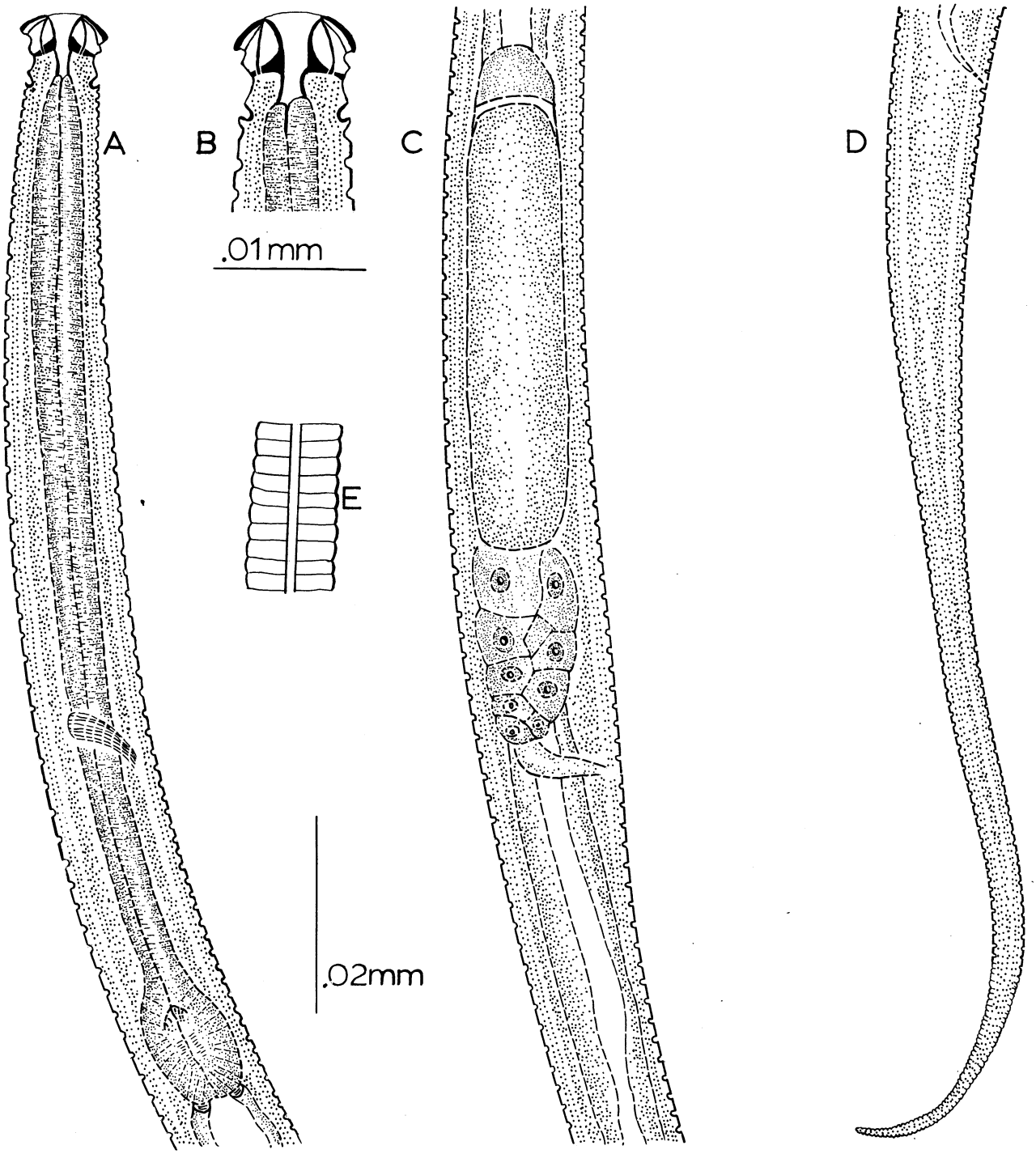


Figure 84.—*Teratocephalus angustus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* cuticular pattern.

sures. Lips flaplike, their perimeters heavily sclerotized especially when viewed under phase contrast illumination. Amphids porelike, their openings heavily sclerotized and occurring laterally at level of base of pharynx. Cheilostom and protostom distinct and of equal size. Rhabdions distinct. Meso, meta, and telorhabdions fused and forming entrance to esophagus. Esophagus cylindroid, transition between corpus and isthmus obscure, terminal bulb oblong, valvate. Nerve ring 2 body widths anterior to terminal bulb. Lips of vulva continuous with body wall, obscure. Vagina obscure. Ovary single, short, anterior. Postvulval sac absent. Anus and rectum obscure. Tail conoid, very long to an acute terminus.

Diagnosis.—Related to *T. terrestris* varies in its distinctive amphid apertures and its pharyngeal characters.

Type habitat.—Associated with *Leperisinus aculeatus* in green ash.

Type locality.—Chillicothe, Ohio.

Type specimens.—Collection No. 88.

Genus *Geraldius* Sanwal, 1971

Synonym: *Chambersiella bakeri* Sanwal, 1957.

Type species: *Geraldius bakeri* Sanwal, 1971.

Cuticle finely striated, with lateral incisures; lip region with 6 cephalic cirri and 6 large papillae; anterior-most rhabdions of stoma distinct from the rest and modified to form hooklike structures; posterior part of stoma forming a long, narrow, vaselike channel surrounded by esophageal tissue; amphids opening behind anterior broad chamber of stoma; esophagus without median bulb but with a valvulated terminal bulb; ovaries 2, opposed and reflexed; vulva median; testis single; male tail with several pair of caudal papillae; spicules paired and not joined; gubernaculum present; tail of each sex with a dorsally-hooked terminus.

Diagnosis.—The genus *Geraldius* is closely related to *Chambersiella, Santafea,* and *Diastolaimus.* It differs from *Chambersiella* in having 2 ovaries and from *Santafea* and *Diastolaimus* in having well-developed cephalic cirri.

Geraldius bakeri (Sanwal, 1957) Sanwal, 1971

Figure 85

Female: 0.8–1.3 mm; a=20–26; b=3.5–5.6; c=7.8–10; V=49.6–53%.

Male: 1.04–1.37 mm; a=21–35; b=4.3–5.9; c=10.4–11.

Body gradually attenuated toward both ends. Cuticle very finely striated and bearing two lateral incisures. Head not marked off from rest of body and without distinct lips. Cuticle of lip region with six branched cirri. Six large labial papillae on the head, one at base of each cephalic cirri. Amphids opening through elliptical aperture behind main chamber of stoma. Stoma broad, the walls heavily sclerotized and divided into 3 regions, anterior, middle, and posterior. Esophagus with cylindrical corpus and without median bulb. Narrow isthmus swelling into a terminal valvate bulb. Cardia well developed. Nerve ring at midisthmus. Excretory pore at level of nerve ring. Ovaries paired and reflexed, tips at times crossing each other. Oocytes arranged in single file. Two uteri running parallel to reflexed ovaries. Lips of vulva protuberant. Vagina transverse, short. Tail conoid to a dorsally hooked terminus.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate, cephalated, 45 to 52 μ in length. Gubernaculum roughly keel shaped. Caudal papillae vary from 12–15 pairs, both dorsal and ventral. Tail and terminus as in female.

Habitat.—This species has been recovered in association with *Leperisinus aculeatus* and *Phloeosinus dentatus* in green ash and eastern redcedar. Collections were made in the vicinity of Chillicothe, Ohio, and Keysville, Virginia. It was also found associated with *Chramesus hicoriae* Lec. in pignut hickory, *Carya glabra* (Mill.) Sweet, at the Ohio location.

Genus *Santafea* Massey, 1963

Type species: *Santafea croca* Massey, 1963.

Cuticle finely striate. Six prominent cephalic papillae. Stoma similar to *Chambersiella;* cheilorhabdions and protorhabdions distinct, the meso, meta, and telorhabdions fused into a glottoid apparatus which extends well back into the procorpus of the esophagus. Amphids opposite telostom. Corpus of the esophagus without

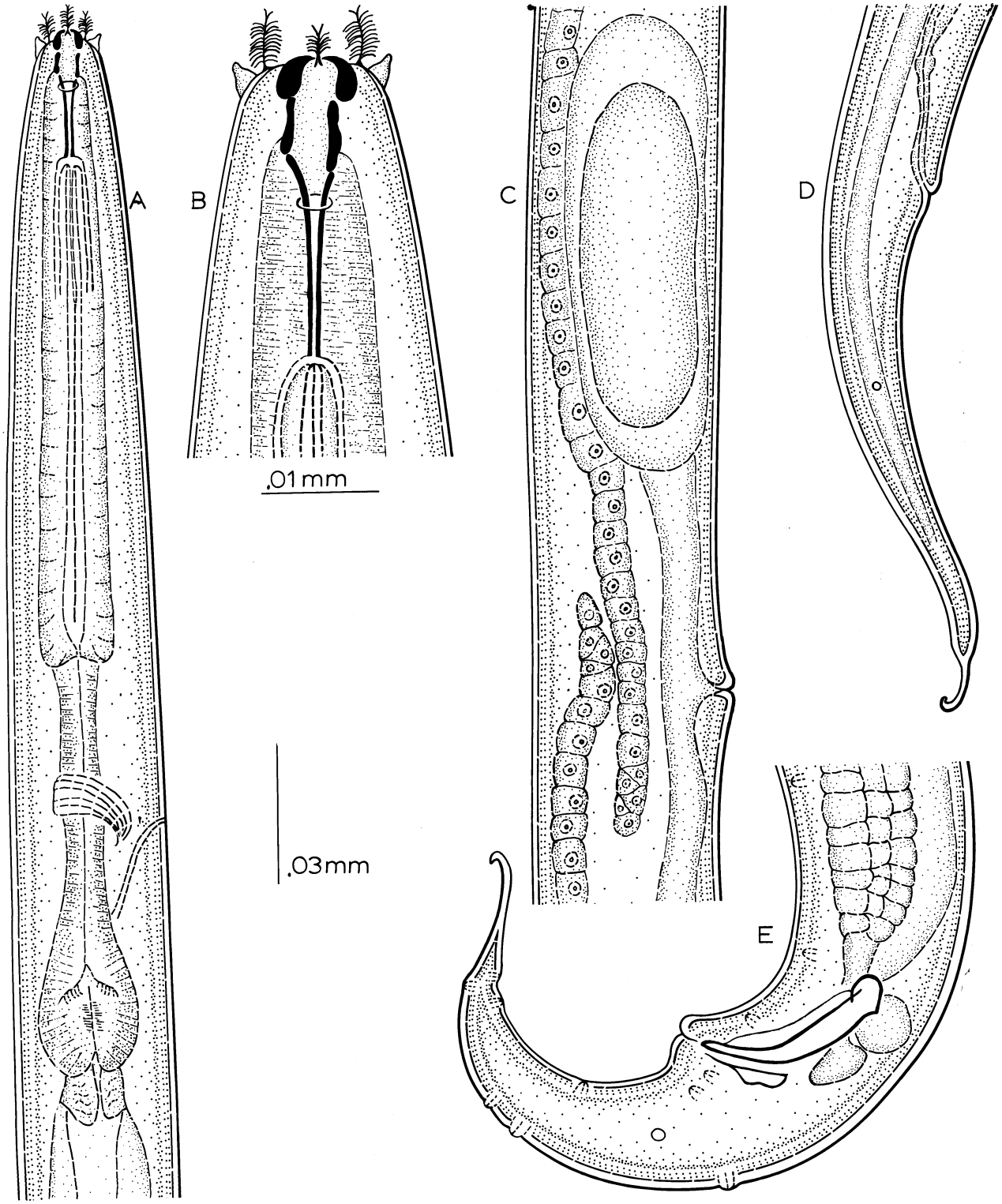


Figure 85—***Geraldius bakeri*** **(Sanwal, 1957) Sanwal, 1971:** ***A.*** **Head and neck;** ***B.*** **head;** ***C.*** **female, midbody;** ***D.*** **female, tail;** ***E.*** **male, tail.**

a bulb but set off by a slight swelling at its base; the isthmus expanding to a valvate terminal bulb. Ovaries paired; vulva at midbody. Testis single, spicules paired, gubernaculum present. Male tail with several pairs of caudal papillae. Tails of both sexes with a hooked terminus.

Diagnosis.—*Santafea* is immediately distinguished from *Chambersiella* by the absence of the cephalic cirri or hairlike setae and by the presence of 2 ovaries.

***Santafea croca* Massey, 1963** **Figure 86**

Female: 1.4–1.6 mm; a=32; b=6; c=11; V=54%.

Male: 1.2–1.5 mm; a=35; b=7; c=11.

Cuticle with very fine transverse striae and 2 lateral incisures. Body widest at the middle, tapering to a moderately broadly rounded head and a slender hooked terminus. Head with a circlet of 6 prominent papillae. Stoma much deeper than wide, consisting of a well defined cheilostom and protostom, the cheilorhabdions forming part of the cephalic arch. Meso, meta, and telorhabdions fused to form the telostom which extends well back into procorpus of esophagus. Amphids opening opposite anterior third of telostom. Esophagus with a cylindrical procorpus and corpus, without a median bulb, the isthmus expanding into a valvate terminal bulb. Nerve ring at middle of isthmus. Excretory pore slightly anterior to terminal bulb. Amphidelphic ovaries at times with reflexed termini, oocytes arranged in tandem. Vulva at midbody, lips protuberant, vagina transverse. Anal opening very prominent; rectal glands present. Terminus dorsally hooked as figured.

Male: Testis single, reflexed. Rectal glands present. Spicules paired, gubernaculum present. Terminus hooked. There are 13 pairs of caudal papillae, 4 pairs subventral and preanal, 1 pair lateral preanal, 1 pair postanal and lateral, 4 pairs postanal subventral, 3 pairs postanal and subdorsal.

Type habitat.—Associated with *Scolytus ventralis* in white fir. Also collected in association with *Phloeosinus neomexicanus* Blkm. in Utah juniper, *Juniperus osteosperma* (Torr.) Little, in central New Mexico.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 38-B.

***Santafea damalis* Massey, 1966** **Figure 87**

Female: 1.09–1.15 mm; a=36–41; b=4.8–5.2; c=11–14; V=51%.

Male: 1.23–1.40 mm; a=44–50; b=5.0–5.8; c=13–14.5.

Cuticle with moderately fine transverse striations, marked by 2 lateral incisures. Head without distinct lips, but bearing 6 prominent, hornlike setae. Stoma 2 times deeper than wide. Cheilostom 1½ times depth of protostom; cheilorhabdions and prorhabdions distinct. Meso, meta, and telorhabdions fused into a glottoid apparatus which extends well back into procorpus of esophagus. Amphids opposite base of telostom, 1¼ body widths from anterior end. Esophagus with a cylindrical corpus and procorpus without a median bulb, the isthmus joining a valvate terminal bulb. Nerve ring at middle of isthmus. Excretory pore slightly anterior to nerve ring. Ovaries paired, at times reflexed well beyond vulval opening, in some specimens reflexed more than once. Lips of vulva protuberant. Vagina transverse. Terminus dorsally hooked.

Male: Testis single, reflexed in some specimens. Spicules paired arcuate, cephalated. Gubernaculum slightly less than one-half length of spicules. Ten pairs of caudal papillae: 4 pairs preanal subventral, 6 pairs postanal, of which 4 pairs are subventral and 2 subdorsal, all situated as illustrated. Terminus dorsally hooked.

Diagnosis.—*S. damalis* differs from *S. croca* Massey, 1963 in the larger size of the cephalic papillae, the location of the amphidial openings, and shape of gubernaculum.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine. Also found with other bark beetle species, see list.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 38-M.

Genus *Macrolaimus* Maupas, 1900

Type species: *Macrolaimus crucis* Maupas, 1900.

Head broadly rounded, continuous with body contour, bearing 6 hornlike papillae. Lips arching over buccal cavity. Pharynx divided into a broad cheilostom and protostom. Cheilorhabdions and prorhabdions prominent. Meso, meta, and telorhabdions fused, obscure. Corpus of esophagus cylindroid, isthmus narrow to the

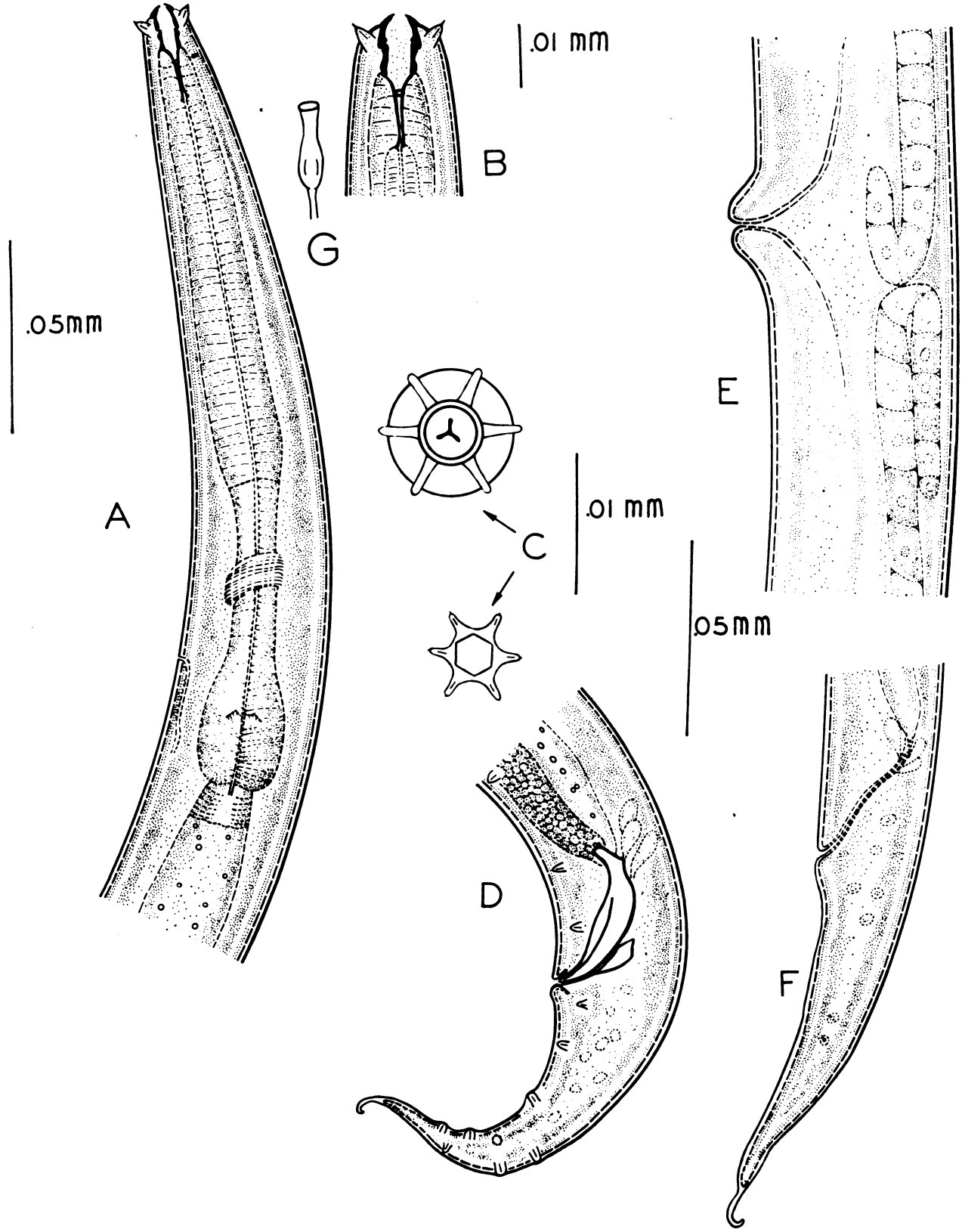


Figure 86.—*Santafea croca* Massey, 1963: *A.* Head and neck; *B.* head; *C.* face views; *D.* male, tail; *E.* female, midbody; *F.* female, tail; *G.* amphid structure.

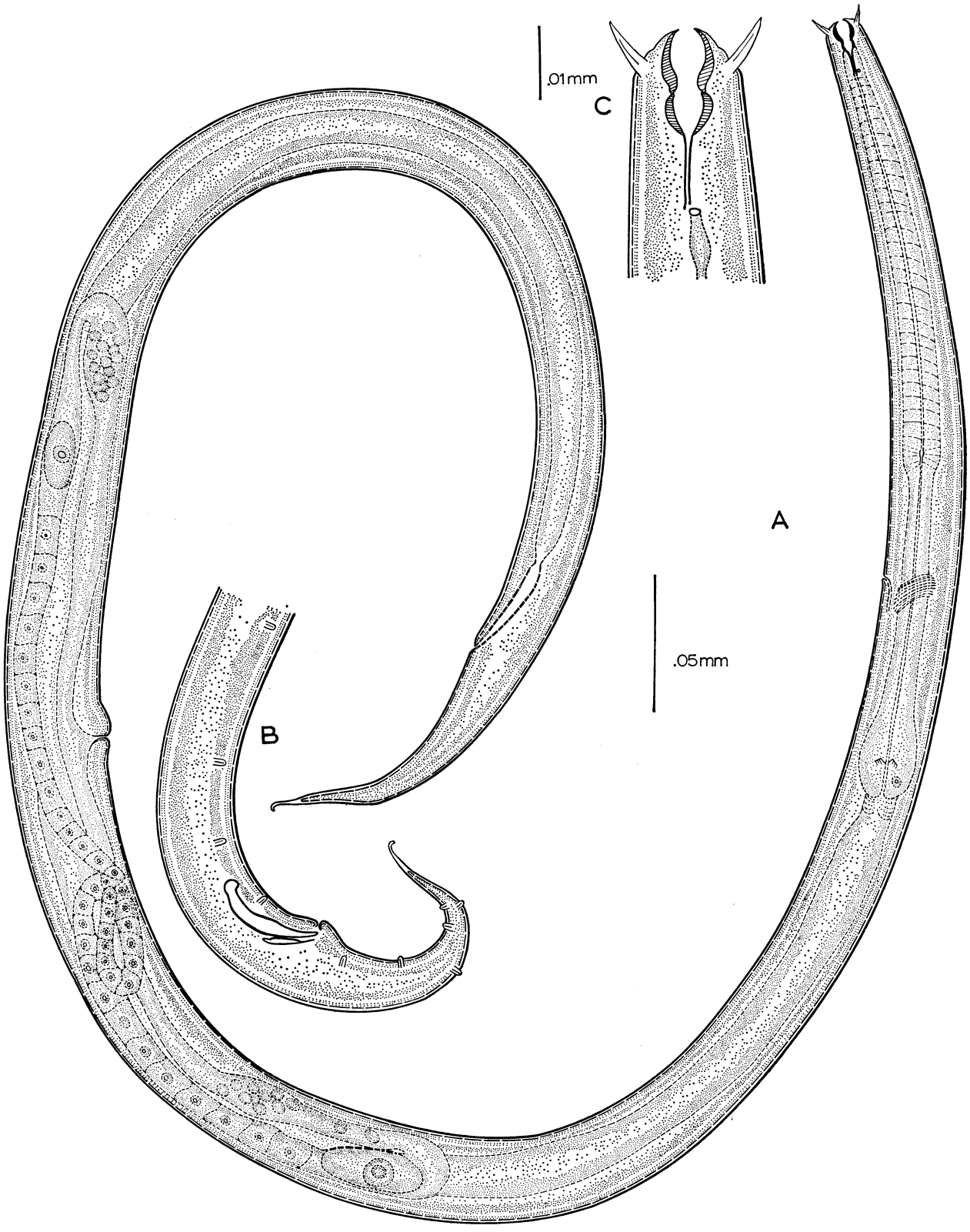


Figure 87.—*Santafea damalis* Massey, 1966: *A.* Female; *B.* male, tail; *C.* head.

valvate terminal bulb. Ovary single, reflexed, panagrolaimoid with or without postvulval sac. Tail conoid to a small acute terminus which may or may not be hooked. Male tail usually as in female. Testis single. Spicules paired, ventrally arcuate, cephalated. Gubernaculum variable in shape. Several pairs of caudal papillae.

Macrolaimus canadensis Sanwal, 1960 **Figure 88**

Female: 0.99–1.2 mm; a=34–36.6; b=4.5–4.9; c=13.5–14.8; V=55–57%.

Male: 0.95–1.07 mm; a=38.8–43; b=4.2–4.7; c=16.7–19.8.

Body narrowing abruptly behind vulva. Cuticle with fine transverse striations, two lateral incisures. Head continuous with body contour. Lips arched over mouth cavity. Six hornlike cephalic papillae. Buccal cavity spacious, divided into cheilostom and protostom. Cheilorhabdions and prorhabdions heavily sclerotized. Meso, meta, and telostom fused, obscure. Esophagus enveloping bases of prorhabions. Procorpus and corpus blended, almost cylindrical; no median esophageal bulb, isthmus narrow and broadening into a valvate terminal bulb. Cardia well developed. Nerve ring immediately posterior to corpus. Excretory pore a body width posterior to nerve ring, hemizonid immediately posterior to excretory pore. Lips of vulva protuberant, anterior lip most prominent. Vagina oblique. Ovary single, reflexed extending to within a few body widths of anal opening. Uterus distended to serve as a spermatheca. Postvulval uterine sac three-fourths body width in length. Anus and rectum conspicuous. Tail conoid to a small curved, acute terminus.

Male: Testis single, reflexed. Spicules paired, ventrally arcuate with a small thornlike ventral spine. Gubernaculum large, pyramid-shaped with a sclerotized process at each end. Caudal papillae variable in number. Sanwal lists 8 pairs, the author's specimens had only 6, as figured. Tail ventrally arcuate, conoid to a curved acute terminus.

Habitat.—Widespread throughout the western United States. The bark beetles with which this species was associated are indexed in the list of species.

Macrolaimus taurus Thorne, 1937 **Figure 89**

Female: 1.3 mm; a=30; b=5.9; c=18; V=60%.

Male: 1.1 mm; a=30; b=5.8; c=21.

Cuticle with moderately coarse transverse striations, marked by 2 lateral incisures. Head broadly rounded with 6 hornlike papillae. Lips arched over buccal cavity. Cheilorhabdions and prorhabdions heavily sclerotized. Cheilorhabdions hooklike in lateral view. Meso, meta, and telorhabdions funneling into esophagus, lightly sclerotized but distinct. Corpus of esophagus cylindroid, isthmus narrow, widening into an oval, valvate, muscular terminal bulb. Cardia prominent. Nerve ring at midisthmus. Excretory pore slightly posterior to nerve ring. Lips of vulva protuberant. Vagina slightly oblique. Ovary single, panagrolaimoid. Postuterine vulval sac approximately a body width in length. Anus and rectum conspicuous. Phasmid prominent. Tail conoid to a straight subacute terminus.

Male: Testis single. Spicules paired, ventrally arcuate, cephalated. Gubernaculum roughly keel shaped with a heavily sclerotized distal end. There are 5 pairs of caudal papillae, 2 preanal, 3 postanal, 2 of which are subventral, 1 subdorsal. Male tail ventrally arcuate, conoid to a subacute terminus.

Habitat.—Collected by Thorne in association with *Ips confusus* Lec. in pinyon near Tabiona, Utah. Specimens were also taken from green ash at Rugby, North Dakota, where they were associated with *Leperisinus californicus*.

Tylenchoidea (Örley, 1880) Chitwood and Chitwood, 1937

Tylenchidae Örley, 1880
- Tylenchinae (Örley, 1880) Marcinowski, 1909
  - *Aglenchus* (Andrassy, 1954) Meyl, 1961
    - *A. exiguus* Massey, 1969
- Sychnotylenchinae (Paramonov, 1967) Golden, 1971
  - *Neoditylenchus* Meyl, 1961
    - *N. corniculatus* n. sp.
    - *N. dendroctoni* n. sp.
    - *N. glandarius* n. sp.
    - *N. ovarius* n. sp.

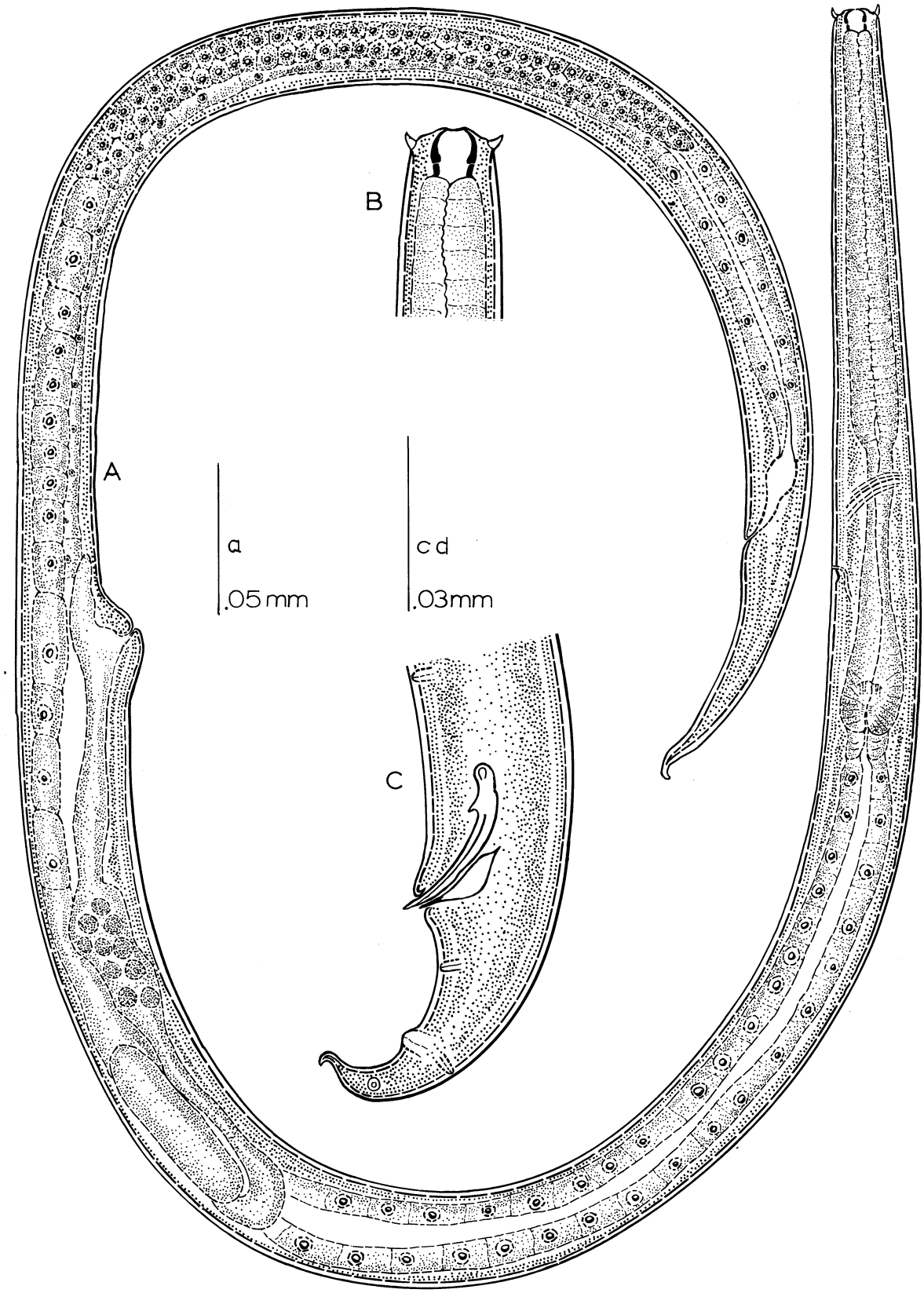


Figure 88.—*Macrolaimus canadensis* Sanwal, 1960: *A.* Female; *B.* head; *C.* male, tail.

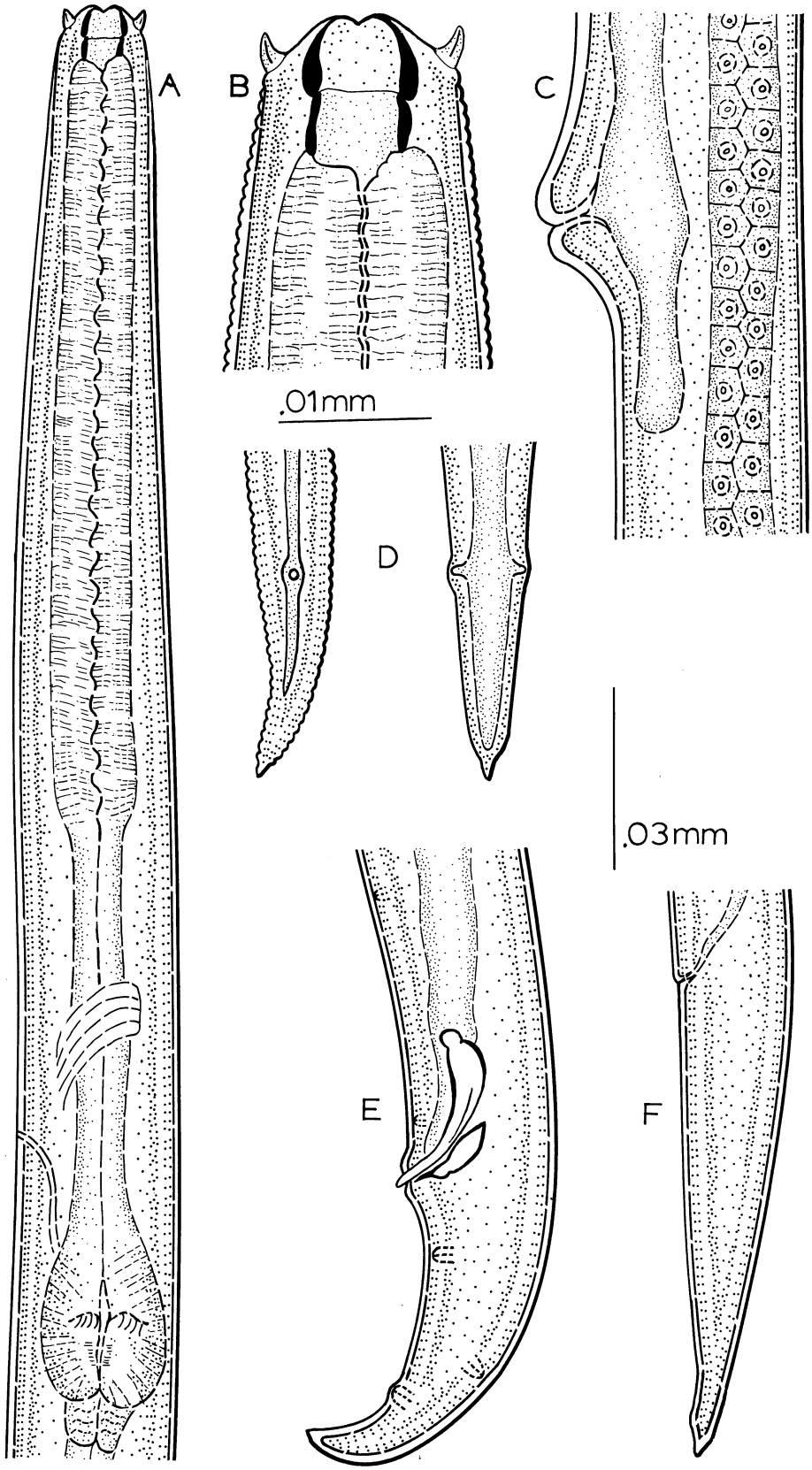


Figure 89—*Macrolaimus taurus* Thorne, 1937: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female tails show phasmids; *E.* male, tail; *F.* female, tail.

N. pinophilus (Thorne, 1935) J. B. Goodey, 1963
N. puniwopus Massey, 1969
N. yasinskii Massey, 1969
Sychnotylenchus Rühm, 1956
S. mutici n. sp.
S. phloeosini Massey, 1969
S. scolyti Massey, 1969
Ditylenchinae Golden, 1971
Pseudhalenchus Tarjan, 1958
P. damnatus Massey, 1966

Genus *Aglenchus* (Andrassy, 1954) Meyl, 1961

Synonym: *Tylenchus* (*Aglenchus*) Andrassy, 1954

Type species: *Aglenchus agricola* (deMan, 1884) Meyl, 1961

In general a small nematode (0.3–0.9 mm). Head well offset. Cuticle very markedly annulated. Stylet strong, with well developed knobs. Median bulb well rounded. Vagina muscular. Postuterine vulval sac present. Tail in both sexes long and slender. Spicules paired, tylenchoid. Gubernaculum small, lineate. Bursa leptoderan.

***Aglenchus exiguus* Massey, 1969** **Figure 90**

Female: 0.31 mm; a=19.7; b=4.6–4.9; c=?; V=64%.

Male: 0.31–0.34 mm; a=24.3–25; b=4.6; c=3.7.

Body slender, ending in an elongate tail. Cuticle coarsely annulated, the annules widest at midbody and interrupted by very prominent lateral fields formed by two bright lines. Lateral fields extending from two body widths posterior to anterior end to eight body widths anterior to terminus. Head slightly offset. Lips only faintly discernible in lateral view. Stylet slender with prominent basal knobs. Esophagus with valvate metacorpus, the procorpus and metacorpus equal in length to isthmus and terminal bulb. Excretory pore prominent, adjacent to center of terminal bulb of esophagus. Nerve ring at middle of isthmus. Ovary single, outstretched, very short in mature specimens; postuterine branch short, one-half body width in length. Vagina transverse. Lips covered by vulval flap. Anal opening not discernible. Tail elongate, terminus acute.

Male: With general body characters of female. Testis single, outstretched. Spicules typically tylenchoid. Gubernaculum and bursa as figured. Tail elongate, terminus acute.

Diagnosis.—Closely related to *Aglenchus bryophilus* (Steiner, 1914) Meyl, 1961; varies in the shape of the spicules and gubernaculum. Female without discernible anal opening.

Type habitat.—Taken from base of Engelmann spruce infested with *Dendroctonus rufipennis* (Mannerheim).

Type locality.—Mt. Taylor, New Mexico.

Type specimens.—Collection No. 49-A.

Genus *Neoditylenchus* Meyl, 1961

Type species: *Neoditylenchus dendrophilus* (Marcinowski, 1909) Meyl, 1961

Cephalic framework sclerotized. Stylet with or without knobs or basal swellings. Esophagus with muscular valvate metacorpus and distinct basal bulb. Ovary single; oocytes arranged in from one to several rows. Well developed postuterine sac. Vulva at approximately 90%. Spicules and gubernaculum tylenchoid. Bursa enveloping tail.

Key to species of *Neoditylenchus* in United States

1. Metacorpus of esophagus with valve plates in anterior one-half 2
   Metacorpus of esophagus with valve plates at center 3
2. Metacorpus spindle shaped 4
   Metacorpus ovoid ..... *ovarius* n. sp.
3. Tail of female cylindroid, terminus broadly rounded ..... *puniwopus*
   Tail of female conical, terminus narrowly rounded 5
4. Stylet with well developed basal knobs ... 6
   Stylet with base smooth, at best basal swellings ..... *dendroctoni* n. sp.

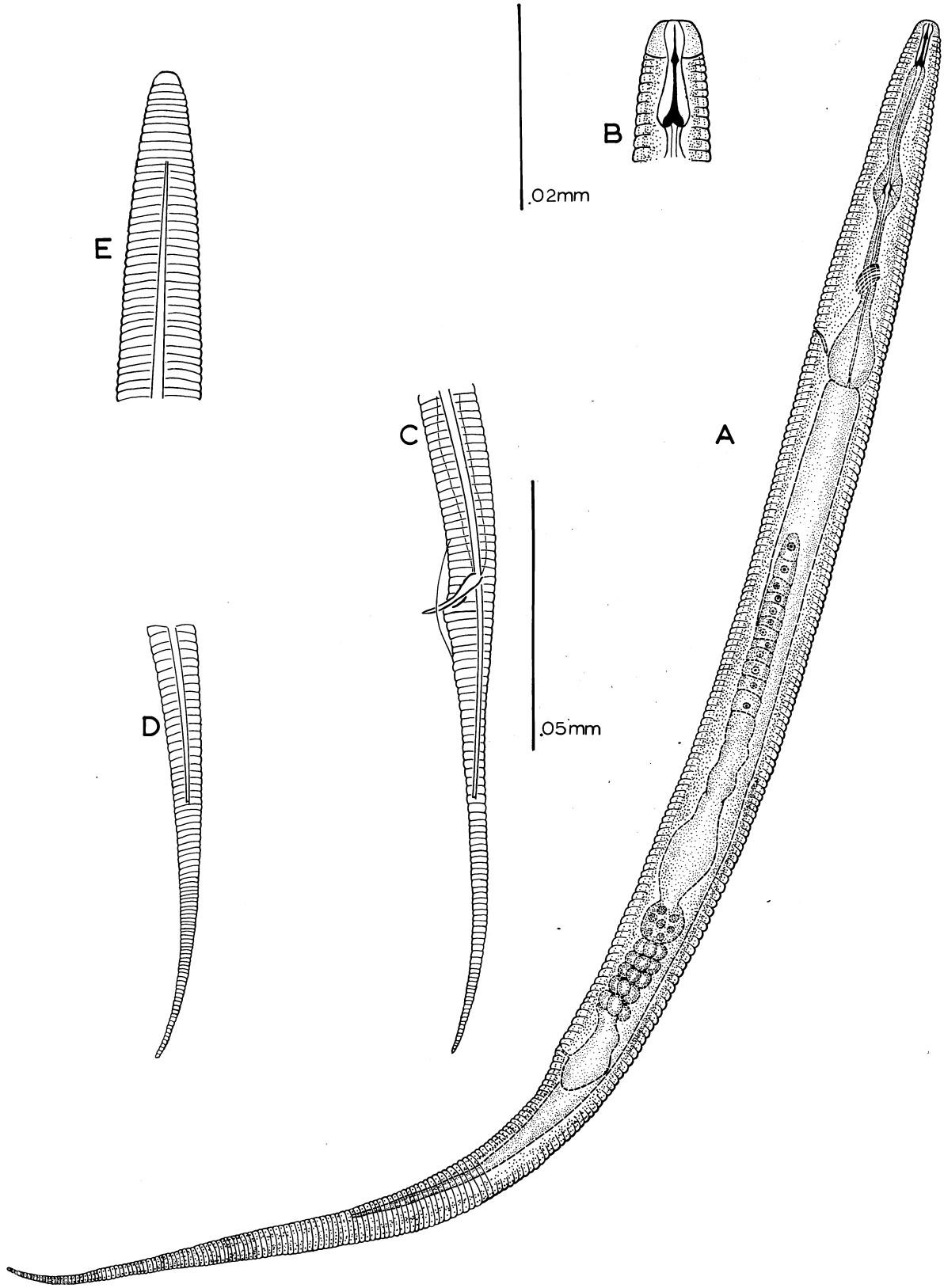


Figure 90.—*Aglenchus exiguus* Massey, 1969: *A.* Female; *B.* head; *C.* male, tail; *D.* female, tail; *E.* anterior portion of body showing lateral field.

5. Anal opening obscure ..... *yasinskii*
Anal opening not obscure ..... *pinophilus*
6. Female tail tapering only slightly from ca anal opening to terminus ..... *corniculatus* n. sp.
Female tail tapering sharply from ca anal opening to terminus ..... *glandarius* n. sp.

***Neoditylenchus corniculatus* n. sp.** **Figure 91**

Female: 1.0–1.12 mm; a=32.3–34.9; b=7.2; c=29.6–32; V=91%.

Male: 0.83 mm; a=36; b=6.1; c=25.

Body ventrally arcuate, cylindroid. Cuticle with moderately fine transverse striae at head and neck. Lateral incisures not observed. Lip region continuous with body contour. Cephalic framework sclerotized. Stylet 8 μ in length, with basal knobs; retractor muscles indistinct. Dorsal esophageal gland outlet distinct. Corpus of esophagus broad at distal end and narrowing immediately anterior to metacorpus. Metacorpus pear shaped, valve plates located in its anterior one-third. Anterior portion of dorsal side of basal bulb glandular, a distinct valvular apparatus present between basal bulb and intestine. Nerve ring a body width posterior to metacorpus. Excretory pore opposite nerve ring. Hemizonid a body width posterior to excretory pore. Vagina a transverse slit, lips protuberant. Ovary single, outstretched; oocytes arranged in a double row. Quadricolumella 1½ body widths in length. Posterior uterine branch 1–2 body widths in length. Anus indistinct. Rectum indistinct. Tail broadly conoid to a sharply rounded terminus.

Male: Testis single, outstretched. Spicules paired. Gubernaculum saucer shaped. Tail conoid to a mucronate terminus. Bursa enveloping tail and joining body wall immediately anterior to proximal end of spicules.

Diagnosis.—Related to *Neoditylenchus pityokteinophilus* (Rühm, 1956) Meyl, 1961; differs in esophageal characters and in the more slender stylet.

Type habitat.—Associated with *Scolytus ventralis* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Holotype and Allotype Collection No. 6-T.

***Neoditylenchus dendroctoni* n. sp.** **Figure 92**

Female: 1.28 mm; a=35; b=9.1; c=?; V=91%.

Male: 1.1 mm; a=41; b=7.5; c=25.6.

Body ventrally arcuate, cylindroid. Cuticle with moderately fine lateral striae, 2 widely spaced lateral incisures spanning one-fourth of body width, incisures especially prominent on males. Lip region set off, rounded. Cephalic framework sclerotized. Stylet with only small basal thickenings, 11 μ in length; retractor muscles obscure. Dorsal esophageal gland outlet discernible. Metacorpus pear shaped, small, only slightly wider than base of corpus, valve plates in anterior one-third. Basal bulb typical of genus, anterior dorsal side glandular. Deirids not observed. Nerve ring at anterior end of basal bulb. Excretory pore 1–2 body widths posterior to nerve ring. Hemizonid at posterior end of basal bulb. Valvular apparatus between basal bulb and intestine. Lips of vulva protuberant. Vagina transverse. Ovary single, at times reflexed; oocytes arranged in a double row. Quadricolumella short, at times less than a body width in length. Posterior uterine branch 1½ body widths in length. Anus and rectum obscure. Tail conoid to a narrowly rounded terminus.

Male: Testis single, outstretched. Spicules paired tylenchoid. Gubernaculum distinctive, as illustrated. Bursa enveloping tail and joining body wall at proximal end of spicules. Tail ventrally arcuate, terminus mucronate.

Diagnosis.—Differs from other species in the genus in the distinctive metacorpus and gubernaculum.

Type habitat.—Associated with *Dendroctonus frontalis* in loblolly pine.

Type locality.—Jonesville, Louisiana.

Type specimens.—Collections No. 83-C.

***Neoditylenchus glandarius* n. sp.** **Figure 93**

Female: 1.12 mm; a=35.5; b=7.6; c=?; V=89%.

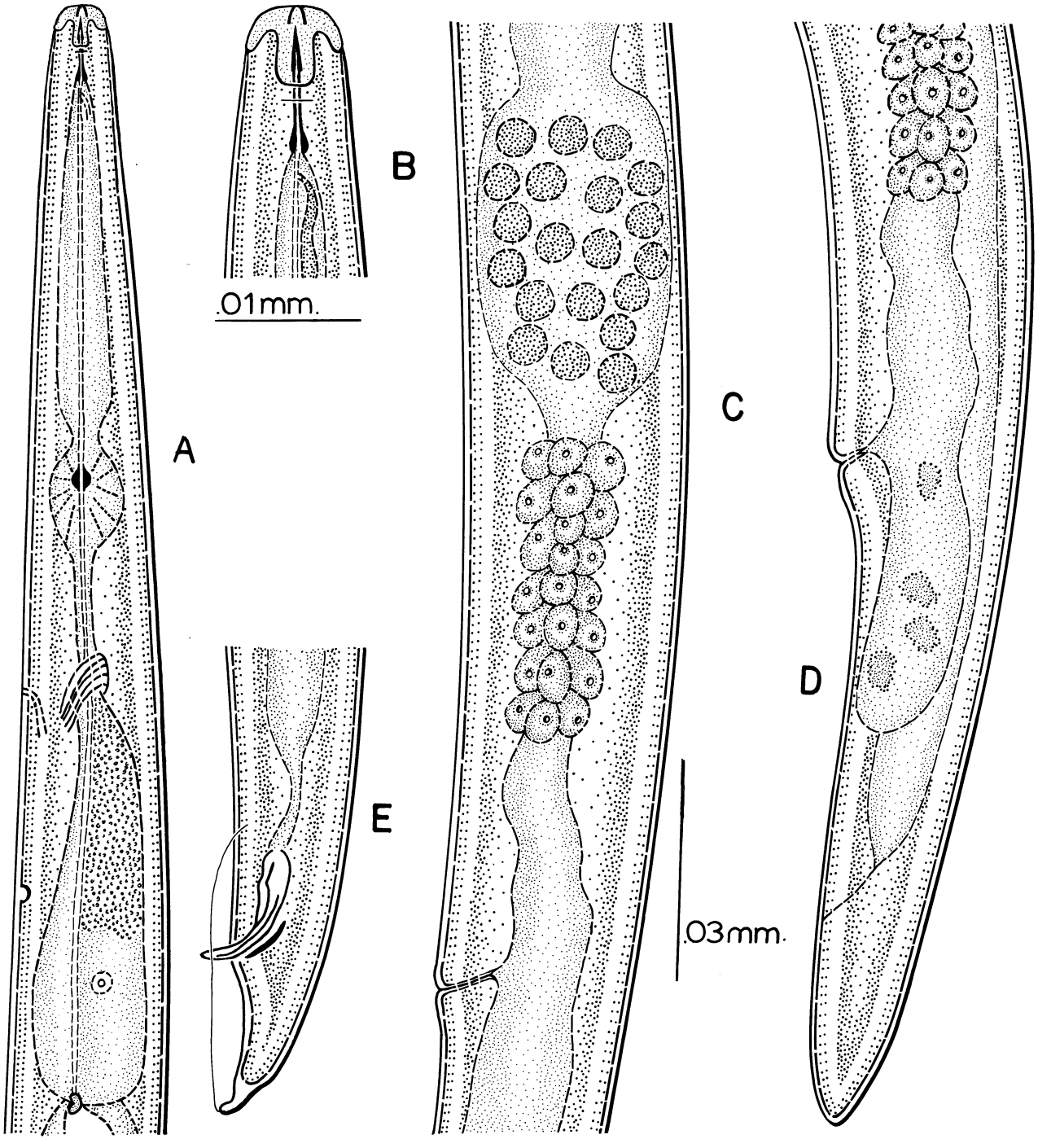


Figure 91.—*Neoditylenchus corniculatus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

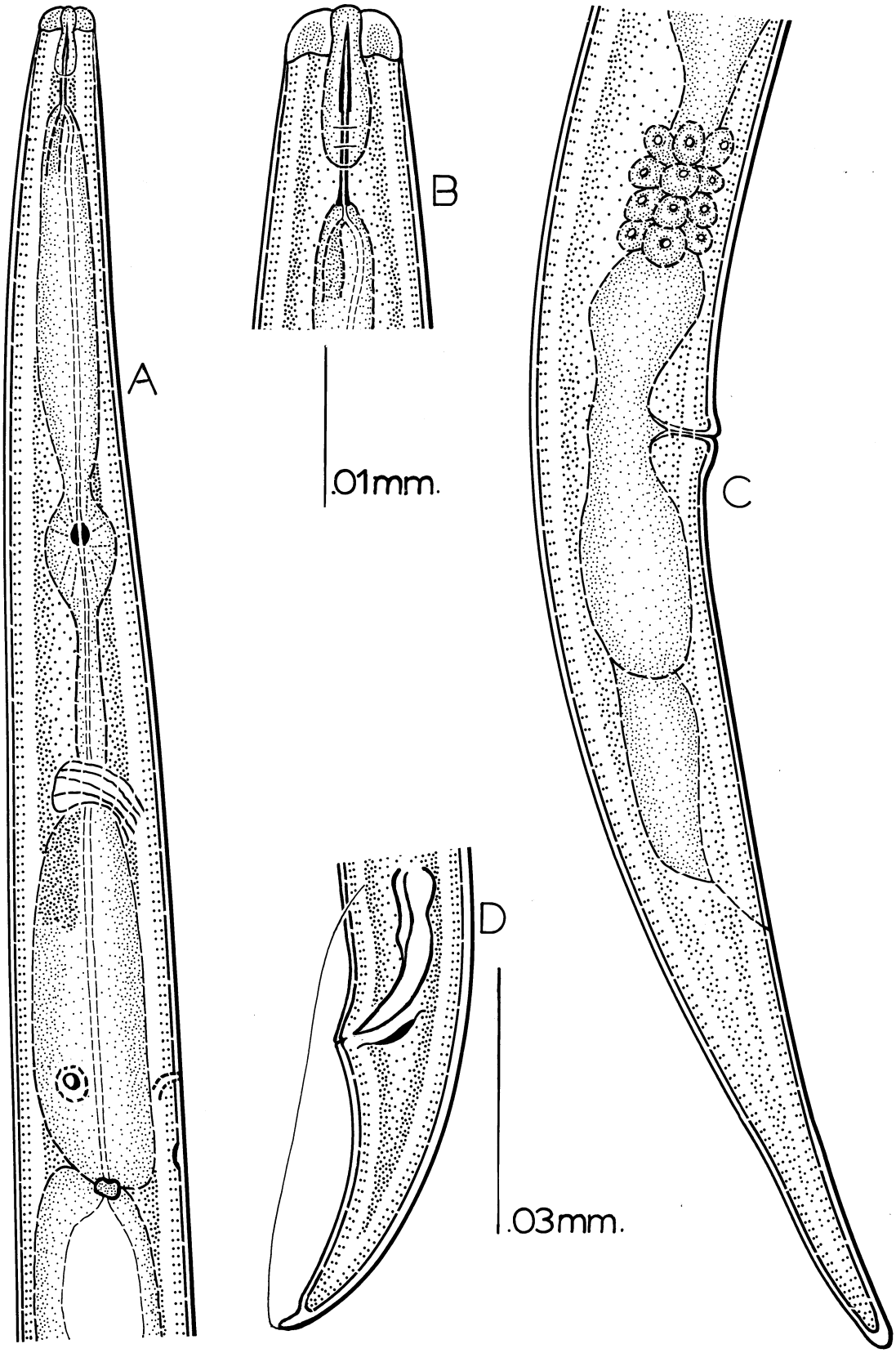


Figure 92.—*Neoditylenchus dendroctoni* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

Male: Unknown.

Body ventrally arcuate, cylindroid. Cuticle with very fine transverse striations. Lateral incisures not seen. Lip region rounded, continuous with body contour, over twice as wide as high. Cephalic framework sclerotized. Stylet slender, 10 μ in length, with small basal knobs; retractor muscles obscure. Dorsal esophageal gland outlet distinct, the gland visible throughout entire length of corpus. Corpus widest at the base. Metacorpus pear shaped, valve plates slightly anterior to its center. Basal bulb broad, its dorsal side glandular, muscular valvular apparatus between basal bulb and intestine. Deirids not seen. Nerve ring a body width posterior to metacorpus. Excretory pore a body width posterior to nerve ring. Hemizonid immediately anterior to excretory pore. Vagina transverse, lips continuous with body wall. Ovary with oocytes arranged in a single row. Quadricolumella 3 body widths in length. Posterior uterine branch 1–2 body widths in length. Anus and rectum obscure. Tail sharply narrowing from anus to small rounded terminus.

Diagnosis.—Related to *Neoditylenchus panurgus* (Rühm, 1956) Meyl, 1961; differs in dimensions of lip region, in apparent absence of lateral incisures, and in esophageal characters.

Type habitat.—Associated with *Dendroctonus brevicomis* Lec. in ponderosa pine.

Type locality.—Pena Blanca, New Mexico.

Type specimens.—Collection No. 58-I.

***Neoditylenchus ovarius* n. sp.** **Figure 94**

Female: 2.0 mm; a=43.7; b=6.6; c=?; V=91%.

Male: 1.0 mm; a=42; b=7.5; c=26.2.

Body ventrally arcuate, cylindroid. Cuticle with fine lateral striae, without apparent lateral incisures. Lip region set off, rounded. Cephalic framework sclerotized. Spear stout, 11 μ in length, with moderately coarse basal knobs; retractor muscles obscure. Dorsal esophageal gland outlet distinct. Metacorpus almost round, the valve plates well anterior to center. Basal bulb typical of genus. Deirids not visible. Nerve ring three-fourths body width posterior to metacorpus. Excretory pore over a body width posterior to nerve ring. Hemizonid immediately anterior to excretory pore. Vagina a depressed transverse slit. Ovary outstretched, massive; oocytes arranged in 2 rows. Quadricolumella approximately 4 body widths in length. Posterior uterine branch 1–2 body widths in length. Anus and rectum obscure. Tail conoid to a narrowly rounded terminus.

Male: Testis single, outstretched, massive, at times reaching beyond posterior end of basal bulb. Spicules and gubernaculum typically tylenchoid. Tail usually ventrally arcuate, some specimens straight, conoid to mucronate terminus. Bursa enveloping tail and joining body wall at proximal ends of spicules.

Diagnosis.—Related to *Neoditylenchus pinophilus* (Thorne, 1935) J. B. Goodey, 1963; differs in character of metacorpus and stylet.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Coconino National Forest, Arizona.

Type specimens.—Collection No. 58 (Holotype); 58-A (Allotype).

***Neoditylenchus pinophilus* (Thorne, 1935) J. B. Goodey, 1963** **Figure 95**

Female: 1.5–2.5 mm; a=36; b=11.1; c=33; V=91%.

Male: 1.0–1.5 mm; a=34; b=6.25; c=36.

Size rather variable, females usually considerably larger than males. Cuticle finely striated. Lateral field a refractive band. Lip region rather flat, almost twice as wide as high, set off by a slight constriction. Spear a little longer than width of lip region, with small, though distinct, basal swellings. Esophagus typical, median bulb one-half to two-thirds as wide as neck, valve plates at center. Vagina a deep transverse slit. Ovary outstretched, variable in length, sometimes reaching median bulb of esophagus. Posterior uterine branch reaching one-half to three-fourths the distance to anus. Females approaching senility occasionally oviparous. Testis outstretched. Spicula three-fourths as long as tail, most arcuate in distal half. Gubernaculum thin, flat, arcuate, about one-fourth as long as spicula. Female tail 2–3 times as long as anal body diameter, usually rather uniformly conoid to small rounded terminus. Phasmids a little posterior to middle of tail. Distance between vulva and anus variable. Male tail ventrally arcuate, uniformly conoid to pointed terminus. Bursa enveloping tail from

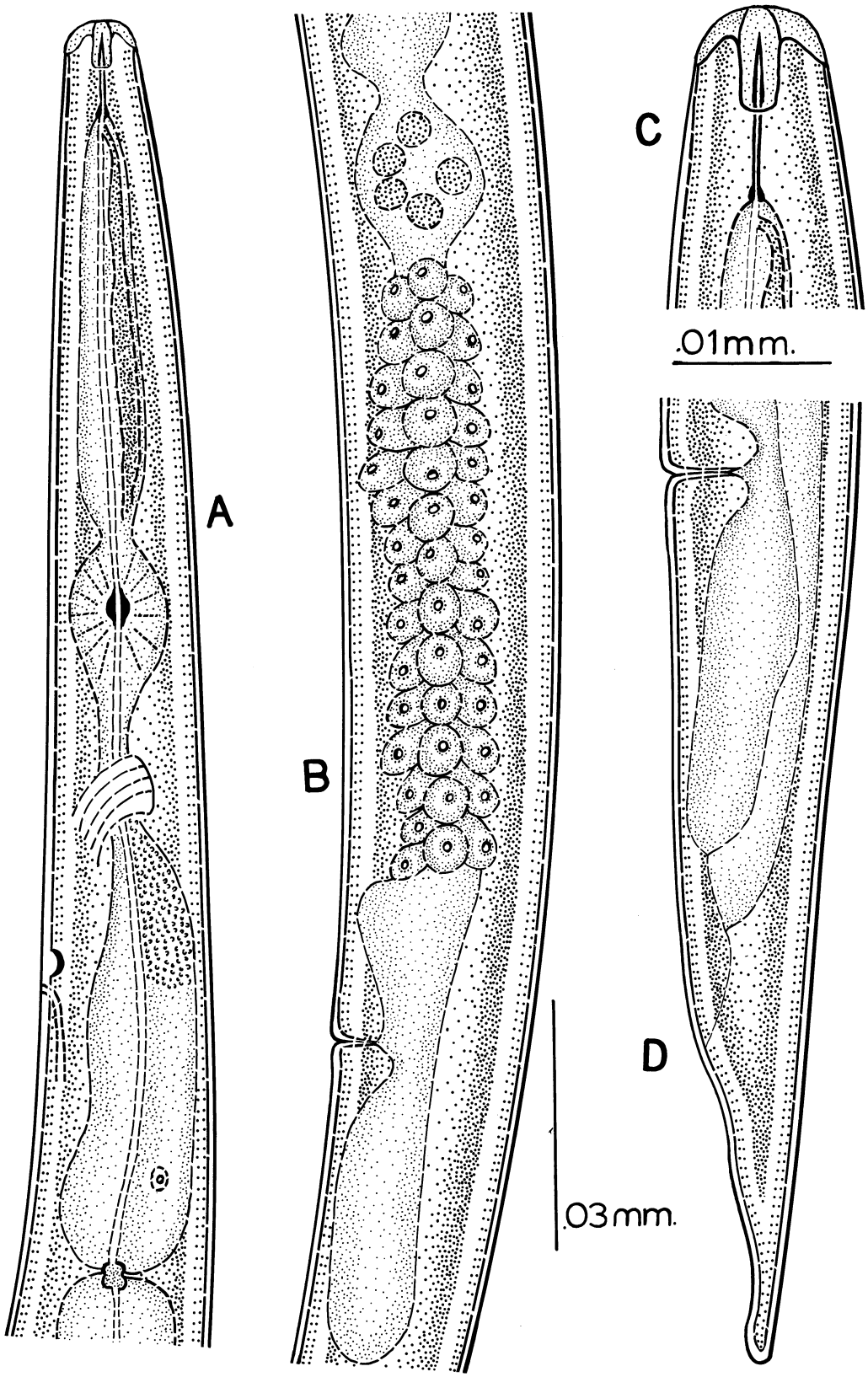


Figure 93.—*Neoditylenchus glandarius* n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* head; *D.* female, tail.

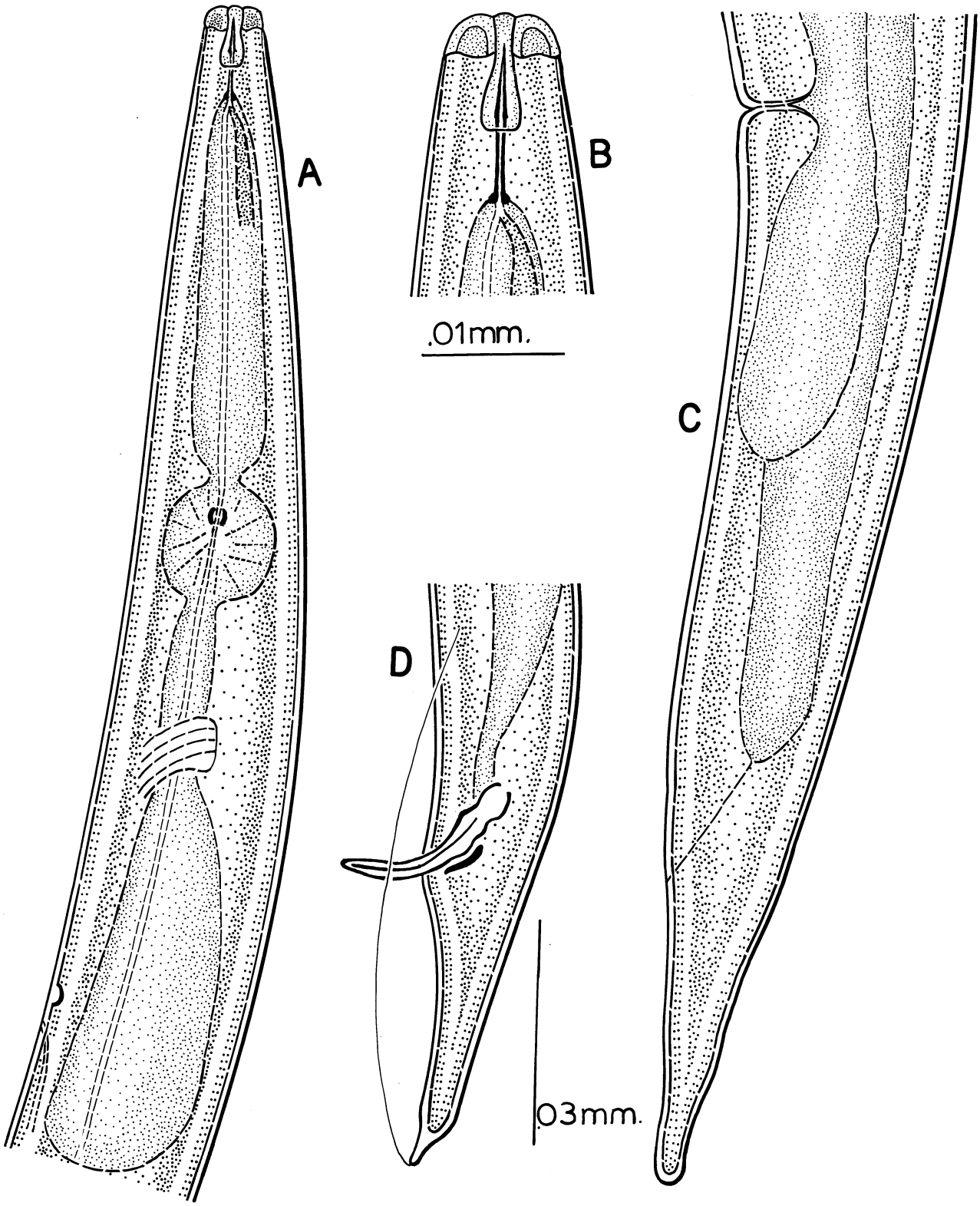


Figure 94.—*Neoditylenchus ovarius* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

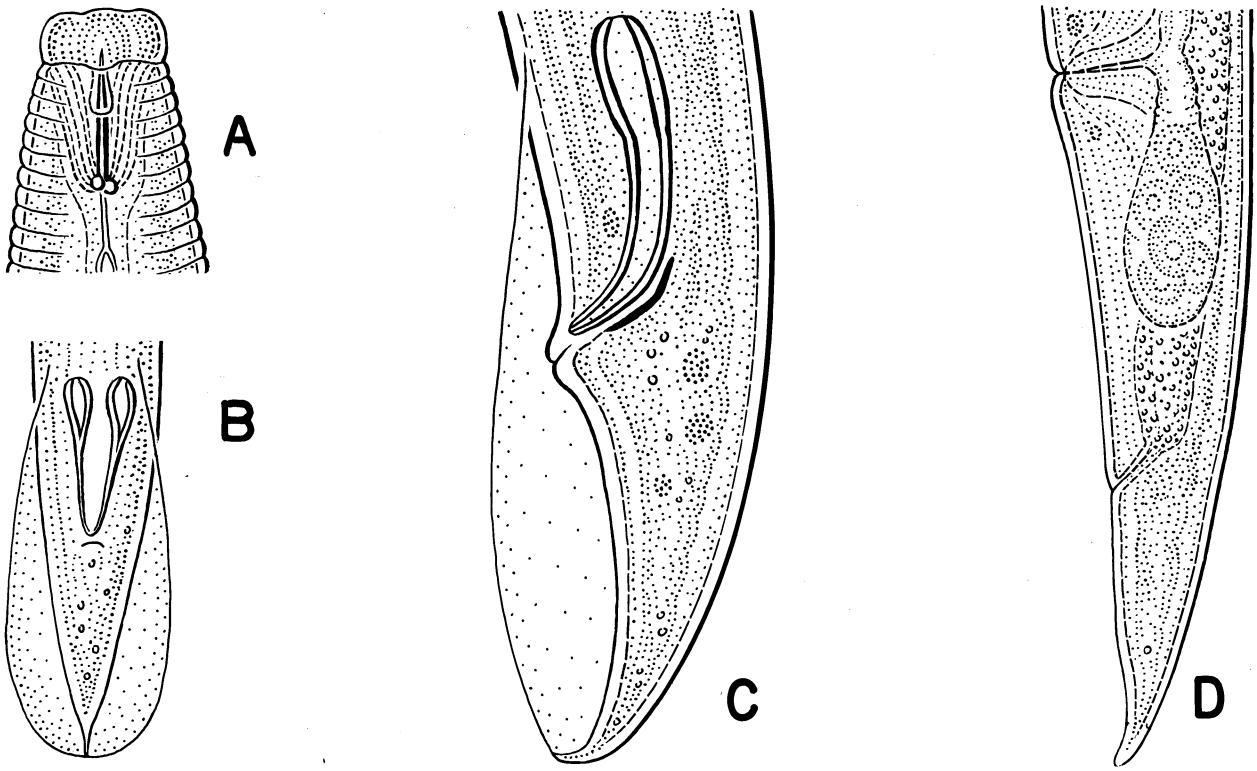


Figure 95.—*Neoditylenchus pinophilus* (Thorne, 1935) J. B. Goodey, 1963: *A.* Head; *B.* ventral view, male, tail; *C.* male, tail; *D.* female, tail. (After Thorne, 1935).

terminus to a point opposite proximal ends of spicula.

Diagnosis.—*Neoditylenchus* from tunnels of mountain pine beetle. Lip region truncated, almost twice as wide as high, set off by a slight constriction. Spear slightly longer than width of lip region, with small basal swellings. Spicula three-fourths as long as tail. Bursa completely enveloping tail. Measurements as given above.

Habitat.—Associated with *Dendroctonus ponderosae* in lodgepole pine.

***Neoditylenchus puniwopus* Massey, 1969** **Figure 96**

Female: 0.93–1.17 mm; a=34.0–44.0; b=6.2-7.4; c=31.1–35.2; V=90%.

Male: 0.59–0.71 mm; a=39.2–51.3; b=4.5–5.3; c=23.5–30.8.

Body slender. Cuticle nearly smooth, transverse striae faintly visible in younger specimens. Head continuous with body contour. Lip region twice as wide as deep. Stylet relatively slender with prominent basal knobs over one-third longer than width of head. Esophagus typical, metacorpus spindle shaped with large central valvular plates. Terminal bulb well developed. Nerve ring a body width posterior to metacorpus. Excretory pore adjacent to nerve ring. Hemizonid posterior to excretory pore. Ovary outstretched, quadricolumella two body widths in length. Postuterine branch a body width in length. Lips of vulva slightly protruding in some specimens. Vagina transverse. Anal opening barely discernible. Terminus broadly rounded.

Male: With anterior body characters of female. Testis single, outstretched. Spicules paired tylenchoid, gubernaculum one-fourth length of spicules. Bursa enveloping small rounded terminus.

Diagnosis.—Closely related to *Neoditylenchus abieticolus* (Rühm, 1956) Meyl, 1961; differs in body length and width, in its longer and more slender stylet and in the nearly smooth cuticle.

Type habitat.—Associated with *Dendroctonus pseudotsugae* in Douglas-fir.

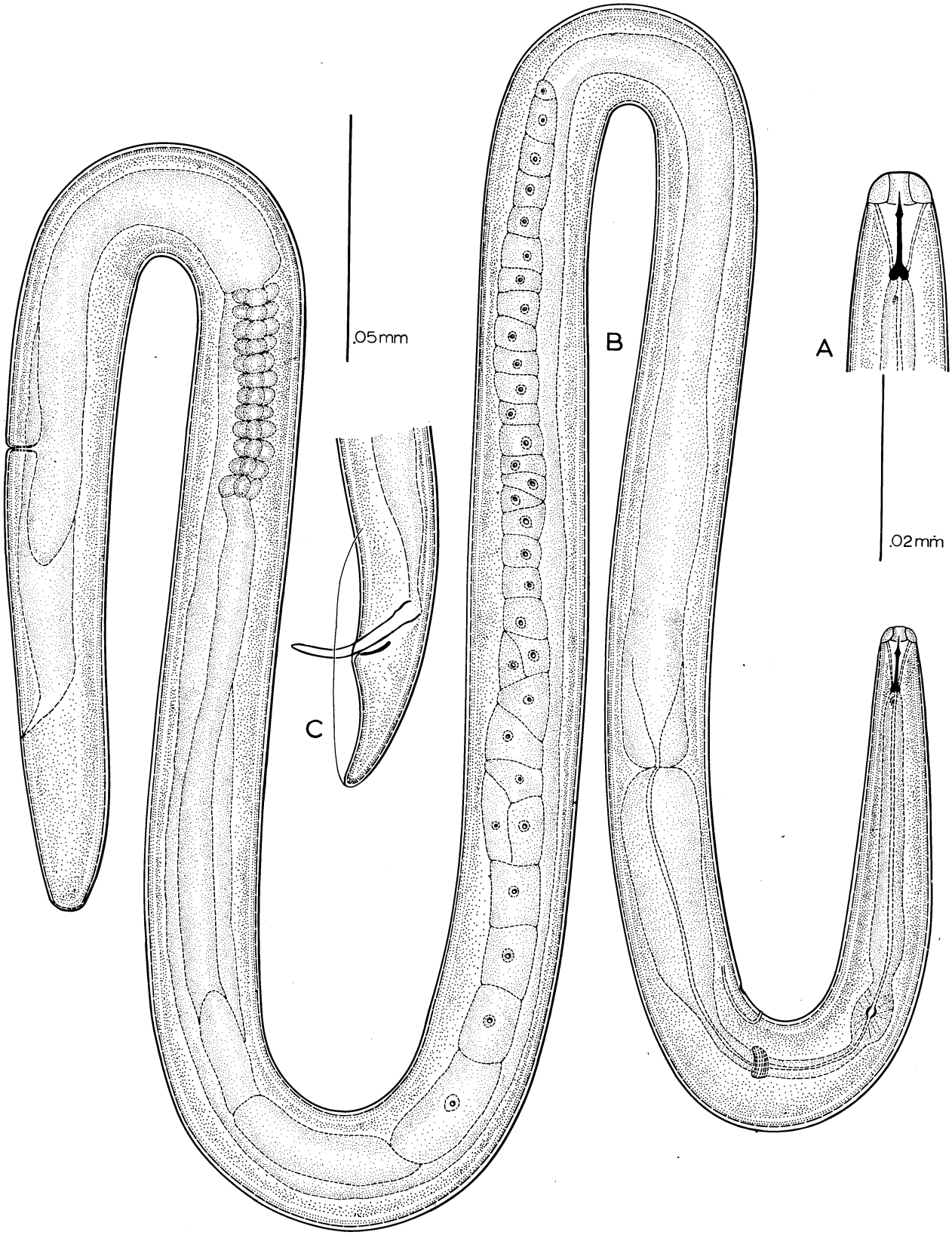


Figure 96.—*Neoditylenchus puniwopus* Massey, 1969: *A.* Head; *B.* female; *C.* male, tail.

Type locality.—Santa Fe National Forest, near Pecos, New Mexico.

Type specimens.—Collection No. 58-D.

***Neoditylenchus yasinskii* Massey, 1969** **Figure 97**

Female: 1.25–1.28 mm; a=32.60–38.60; b=8.54–8.62; c=20.77–22.82; V=89%.

Male: 0.94 mm; a=37.16; b=6.49; c=18.8.

Body nearly straight when relaxed, narrow at anterior end, widening rapidly near vulva. Cuticle with moderately fine transverse striations. Lip region twice as wide as deep. Head continuous with body contour. Stylet one-third longer than the width of the head, with distinct basal knobs. Esophagus typical of genus. Nerve ring two body widths posterior to metacorpus. Excretory pore three-fourths of a body width posterior to nerve ring. Hemizonid immediately posterior to excretory pore. Ovary single, outstretched on some specimens, reaching nearly to basal bulb of esophagus. Postuterine branch one body width in length. Vulvar lips protuberant. Vagina transverse. Anal opening obscure. Terminus subacute.

Male: Spicules tylenchoid. Gubernaculum as figured. Bursa enveloping tail, terminus narrowly rounded.

Diagnosis.—Closely related to *Neoditylenchus pinophilus* (Thorne, 1935) Goodey, 1963; differs from that species in shorter length, shape of tail, and gubernaculum. Stylet knobs considerably more prominent than *pinophilus*. Also related to *N. panurgus* (Rühm, 1956) Meyl, 1961; differing from that species in absence of a lateral field.

Type habitat.—Associated with *Dendroctonus rufipennis* in Engelmann spruce.

Type locality.—Mt. Taylor, New Mexico.

Type specimens.—Collection No. 58-F.

Genus *Sychnotylenchus* Rühm, 1956

Type species: *Sychnotylenchus intricati* (Rühm, 1955) Rühm, 1956

Lip region distinctly set off, sclerotized. Lateral lips essentially narrower than subventral or subdorsal. Stylet with strongly developed subulate shaft; basal knobs, when present, somewhat elongate. Corpus of esophagus gradually widening from base of spear to metacorpus. Metacorpus spindle shaped, isthmus narrow to elongate terminal bulb. Excretory pore opening at level or anterior to metacorpus. Vulva far posterior. Ovary single. Postuterine sac well developed. Tail relatively short. Terminus broadly rounded. Testis single. Spicules and gubernaculum typically tylenchoid. Bursa peloderan. Terminus acute to subacute.

***Sychnotylenchus mutici* n. sp.** **Figure 98**

Female: 0.94 mm; a=35.5; b=7.27; c=45.71; V=93%.

Male: 0.88 mm; a=59.6; b=6.47; c=49.6.

Body ventrally arcuate, strongly narrowed posterior to vulva. Cuticle marked with fine transverse striae. Lateral incisures absent. Lip region set off, rounded. Cephalic framework sclerotized. Spear slender, 9.5 μ in length, with elongate basal knobs or swellings, the dorsal knob at times deformed by dorsal esophageal gland outlet. Median bulb oblong ovate, basal bulb broad, anterior one-third glandular with muscular valvularlike organ between gut and bulb. Nerve ring at midisthmus. Excretory pore adjacent to metacorpus. Hemizonid at posterior end of basal bulb. Lips of vulva elevated. Vagina oblique. Ovary single; oocytes arranged in a single file and at times reaching posterior end of basal bulb. Quadricolumella over 2 body widths in length. Posterior uterine branch 1½ body widths in length, at times packed with sperm. Tail conoid to a broadly rounded terminus, in some specimens flattened.

Male: Testis outstretched. Spicules and gubernaculum typically tylenchoid. Tail conoid to mucronate terminus. Bursa arising at proximal end of spicules and enveloping tail.

Diagnosis.—Related to *Sychnotylenchus scolyti*. Differs in position of excretory pore and in presence of basal stylet knobs.

Type habitat.—Associated with *Scolytus muticus* Say in honey locust, *Gleditsia triacanthos* L.

Type locality.—Delaware, Ohio.

Type specimens.—Collection No. 29-B.

***Sychnotylenchus phloeosini* Massey, 1969** **Figure 99**

Female: 0.96–1.05 mm; a=21–24; b=9.3–9.5; c=?; V=92.6–93.6%.

Male: 0.66–0.89 mm; a=29–38; b=5.5–7.8; c=38–39.

Body stout, narrow at anterior end, becoming widest immediately preceding vulva. Cuti-

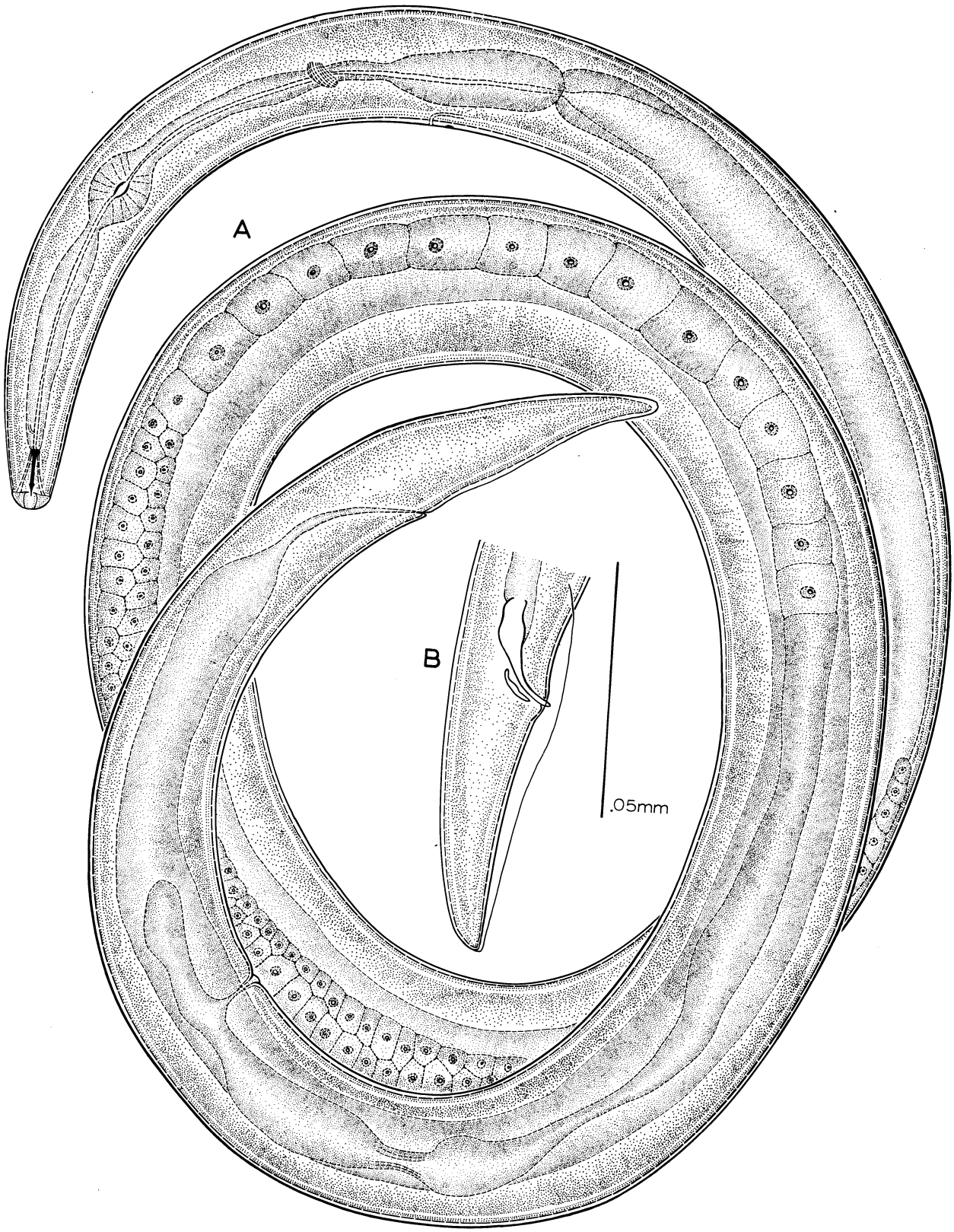


Figure 97.—*Neoditylenchus yasinskii* Massey, 1969: *A.* Female; *B.* male, tail.

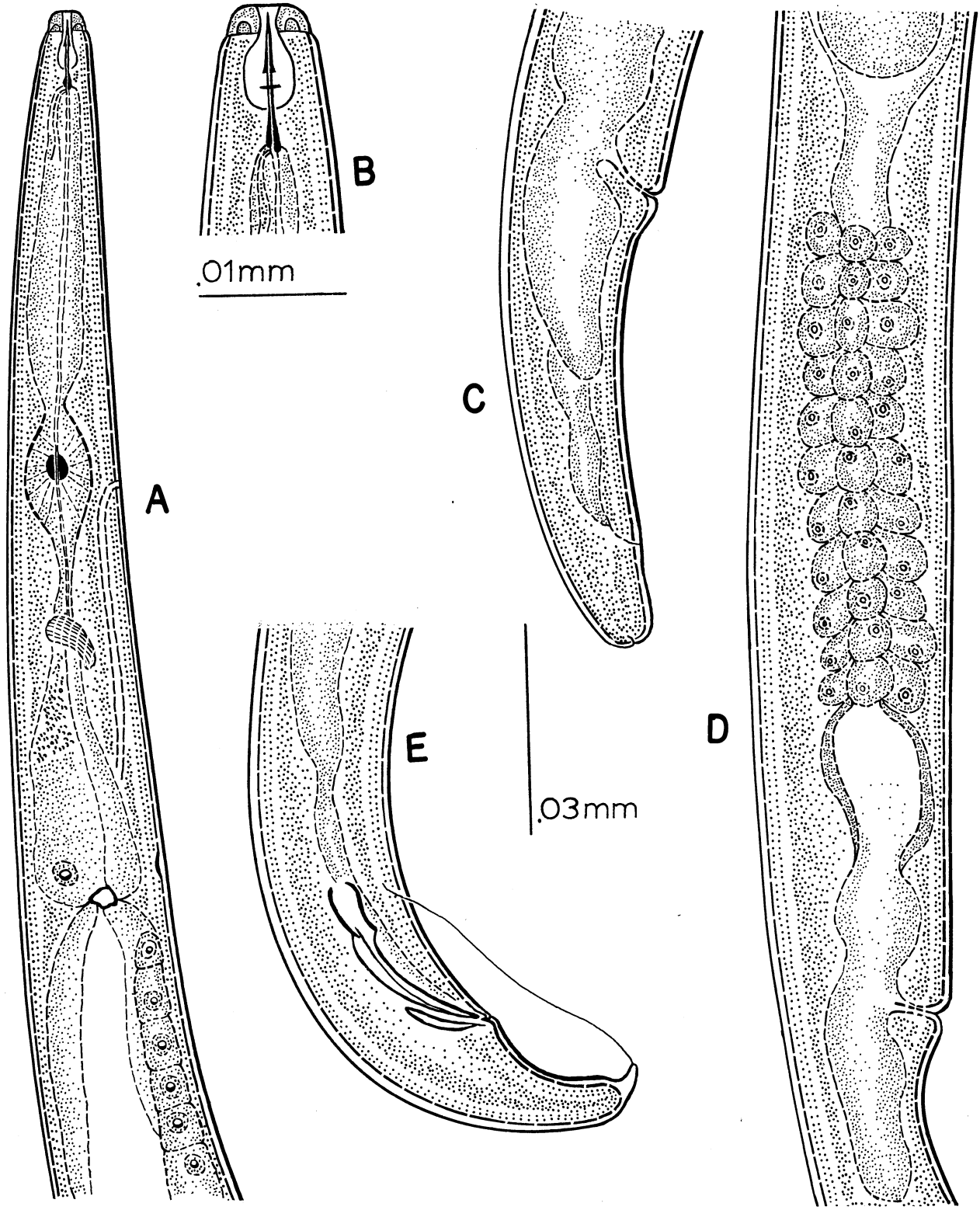


Figure 98.—*Sychnotylenchus mutici* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* female, midbody; *E.* male, tail.

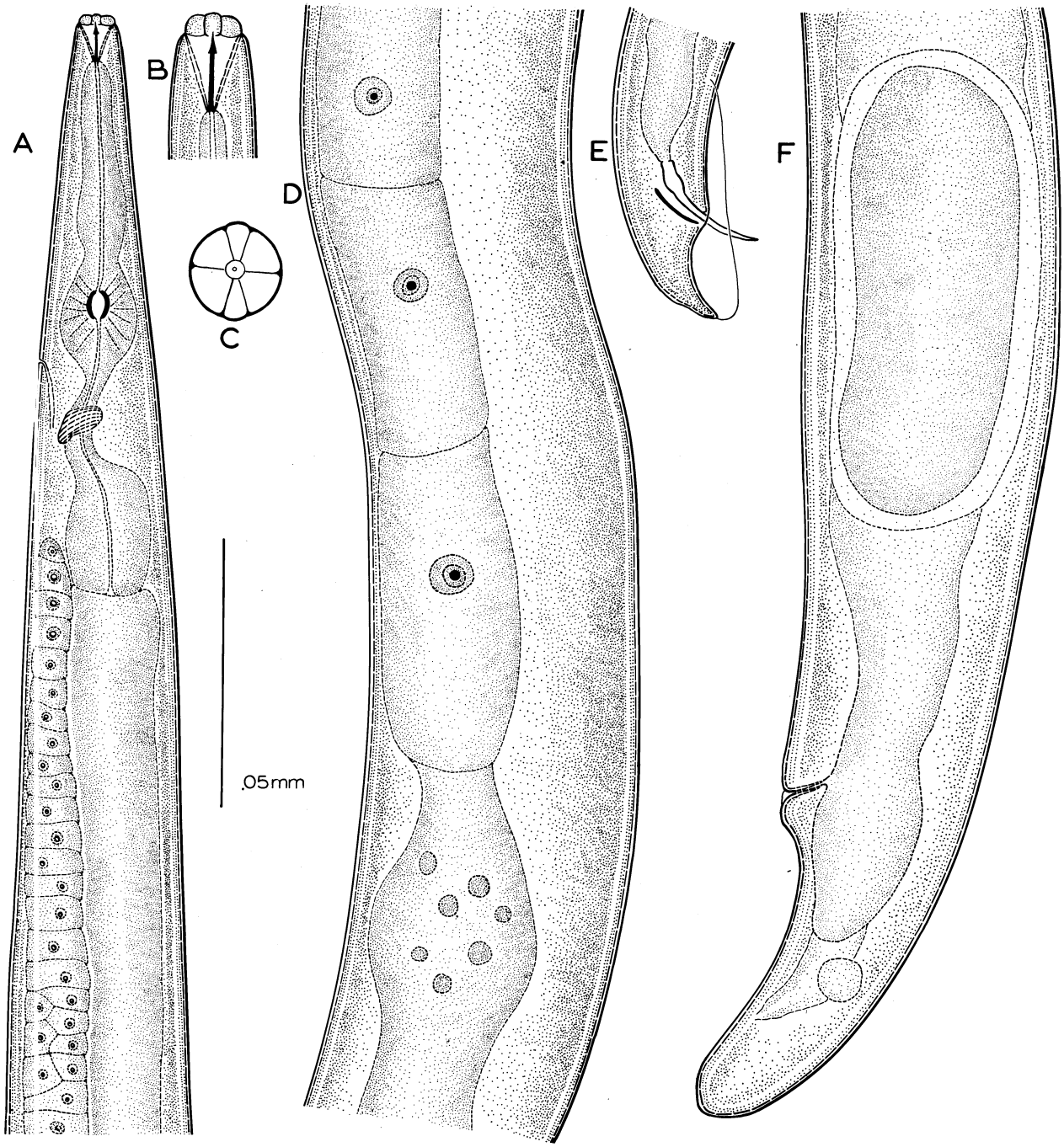


Figure 99.—*Sychnotylenchus phloeosini* Massey, 1969: *A.* Head and neck; *B.* head; *C.* face view; *D.* female, mid-body; *E.* male, tail; *F.* female, tail.

cle with faint longitudinal and transverse striations, most discernible in neck region, becoming very faint at midbody in mature specimens. Head slightly set off, flattened, lip region twice as wide as deep, the lateral lips much narrower, protruding beyond body contour in face view. Stylet moderately slender with obscure basal thickenings. Procorpus of esophagus stout, narrowing into a prominent ovate median bulb with distinct valvular apparatus. Terminal bulb as figured. Nerve ring at middle of isthmus. Excretory pore slightly posterior to median bulb. Hemizonid not discernible in specimens examined. Ovary reaching to the median bulb in mature specimens, posterior uterine branch as figured. Vulva lips protuberant. Vagina nearly transverse, anal opening not discernible. Terminus broadly rounded.

Male: Body relatively slender. Head and lips as in female. Testis outstretched, reaching nearly to basal bulb. Spicules paired, tylenchoid. Gubernaculum one-third to one-half length of spicules. Bursa enveloping tail. Terminus subacute.

Diagnosis.—Closely related to *Sychnotylenchus intricati* (Rühm, 1955) Rühm, 1956. Varies from that species in placement of excretory pore and nerve ring, absence of a lateral field, and discernible anal opening.

Type habitat.—Associated with *Phloeosinus* sp. in Rocky Mountain juniper, *Juniperus scopulorum* Sarg.

Type locality. Bandelier National Monument, New Mexico.

Type specimens.—Collection Nos. 6-S (Allotype); 6-U (Holotype).

***Sychnotylenchus scolyti* Massey, 1969** **Figure 100**

Female: 0.71–0.87 mm; a=30.6–33.8; b=5.5–6.2; c=?; V=89–90%.

Male: 0.70–0.72 mm; a=52–54; b=5.2–5.4; c=31–35.

Body narrowest at anterior end, widest immediately anterior to vulva. Cuticle almost smooth, transverse striations very faint. Head slightly set off. Lip region more than twice as wide as deep, lateral lips narrower than other four and protruding beyond body contour. Stylet slightly longer than width of head, stout, without basal knobs. Metacorpus spindle shaped, muscular, with prominent valvular apparatus. Isthmus slender, ending in a prominent elongate terminal bulb. Nerve ring one-half body width posterior to median bulb. Excretory pore one body width anterior to median bulb. Hemizonid about opposite anterior end of basal bulb. Ovary outstretched, relatively short. Quadricolumella prominent, approximately one-seventh ovary length. Posterior uterine branch 1⅓ body widths long. Lips of vulva protuberant. Vagina transverse. Anal opening not discernible. Terminus broadly rounded.

Male: With head and esophageal characters of female. Testis outstretched. Spicules paired, tylenchoid. Gubernaculum one-third length of spicules. Bursa enveloping tail. Terminus subacute.

Diagnosis.—Differs from *Sychnotylenchus ulmi* (Rühm, 1955) Rühm, 1956 in stylet length, absence of basal knobs on stylet, form of metacorpus, and absence of a discernible anal opening. *S. scolyti* is in general a smaller species than *S. ulmi.*

Type habitat.—Associated with *Scolytus multistriatus* in American elm.

Type locality.—Ft. Collins, Colorado.

Type specimens.—Collection No. 25-F.

Genus *Pseudhalenchus* Tarjan, 1958

Type species: *Pseudhalenchus minutus* Tarjan, 1958

Both sexes similar in appearance. Somatic annulations light to moderately heavy. Lip region annulation moderate to indistinct. Labial framework sclerotized. Stomatostyle well developed, usually with distinct knobs. Deirids (cervical papilla) observed on some specimens. Metacorpus bulb of esophagus valvate with distinct outline. Esophageal glands overlapping intestine. Ovary monodelphic and prodelphic. Vulva situated in posterior third of body. Rudimentary posterior uterus present. Male with well defined spicules and gubernaculum, with bursa (caudal alae) enveloping one-third to two-thirds of tail. Lateral fields present, phasmids not observed in either lateral or dorsoventral view. Tail of both sexes elongate-conoid, tapering, with minutely rounded to broadly rounded terminus.

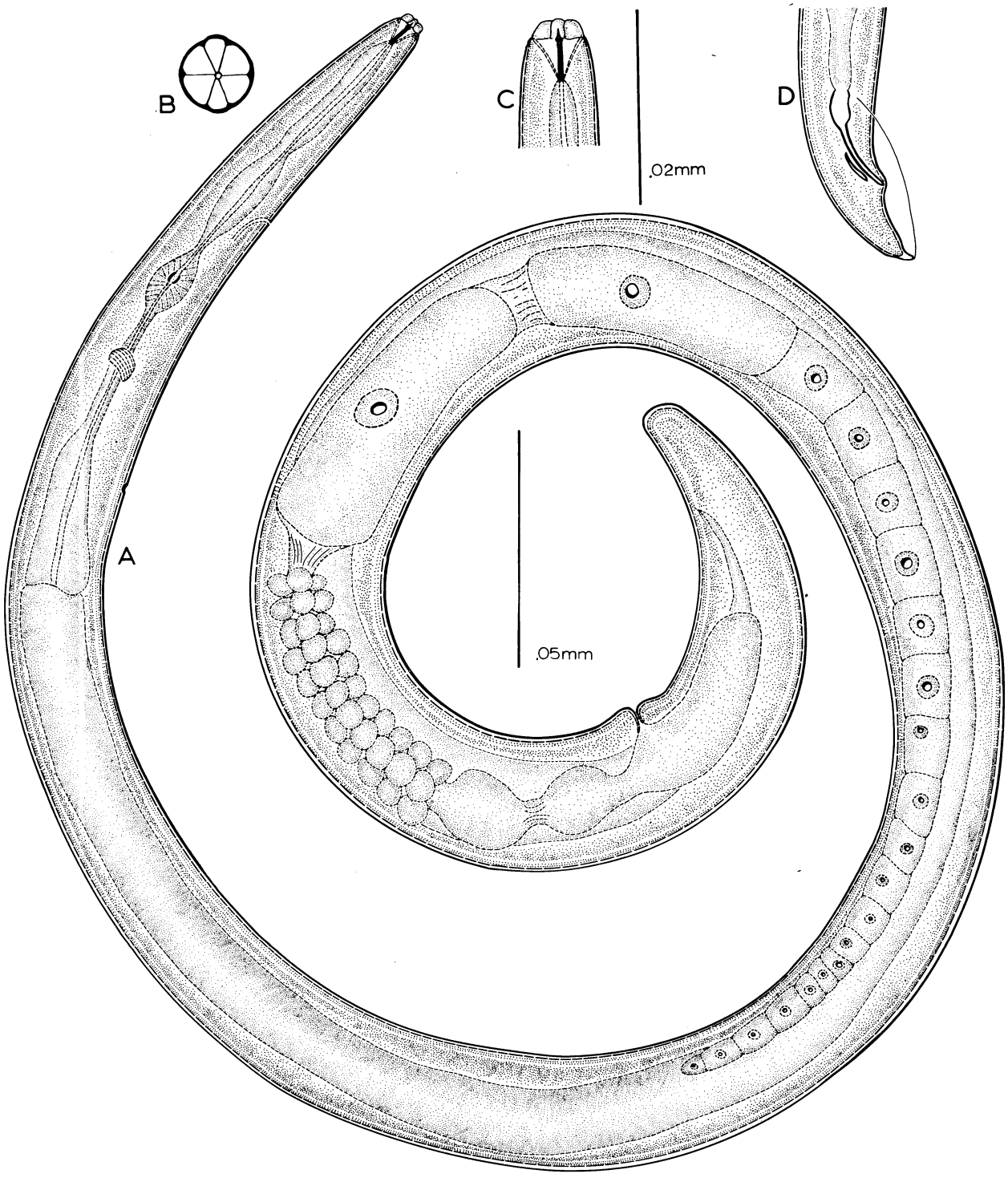


Figure 100.—*Sychnotylenchus scolyti* Massey, 1969: *A.* Female; *B.* face view; *C.* head; *D.* male, tail.

***Pseudhalenchus damnatus* Massey, 1966** **Figure 101**

Females: 0.93–1.1 mm; a=37–43; b=5.4–6.2; c=14–16; V=75%.

Males: 0.61 mm; a=36; b=6.1; c=14–16.

Cuticle with fine annulations which become quite coarse at tail. Lateral incisures absent. Lip region continuous with neck contour. Stylet short, stout, with well-developed basal knobs. Median bulb of esophagus much longer than wide, weakly muscular, slightly expanded in comparison to procorpus. Deirids observed in lateral field opposite nerve ring. Dorsal esophageal gland 6 body widths in length. Nerve ring 2 body widths posterior to median bulb. Hemizonid less than 1 body width behind nerve ring. Excretory pore immediately posterior to hemizonid. Ovary single, outstretched; posterior uterine branch less than 1 body width in length. Lips of vulva slightly protuberant. Vagina short, transverse. Tail tapering to a finely rounded terminus.

Male: Testis outstretched. Spicules arcuate, cephalated. Gubernaculum one-half length of spicules. Bursa begins anterior to spicule cephalation and ends at two-thirds distance from anus to terminus.

Diagnosis.—Differs from other species in the genus in its larger size and absence of lateral incisures; from *Pseudhalenchus minutus* Tarjan, 1958 in its shorter tail and placement of bursa; and from *P. anchilisposomus* Tarjan, 1958 in location of vulva and length of posterior uterine branch.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection Nos. 44-A (Holotype); 44-B (Allotype).

Neotylenchoidea (Thorne, 1941) Jairajpuri and Siddiqi, 1969

Neotylenchidae (Thorne, 1941) Thorne, 1949
- Neotylenchinae Thorne, 1941
  - *Neotylenchus* Steiner, 1931
    - *N. nitidus* Massey, 1969
  - *Deladenus* Thorne, 1941
    - *D. ipini* n. sp.
    - *D. paradurus* n. sp.
- Hexatylinae Skarbilovich, 1952
  - *Hexatylus* Goodey, 1926
    - *H. viviparus* Goodey, 1926
- Nothotylenchinae, 1941
  - *Nothotylenchus* Thorne, 1941
    - *N. compactus* n. sp.
    - *N. parasimilis* n. sp.
    - *N. petilus* n. sp.
  - *Anguillonema* Fuchs, 1938 [3]
    - *A. annamari* n. sp.
    - *A. leperisini* n. sp.
  - *Luella* n. gen.
    - *L. luculenta* n. sp.

Paurodontidae (Thorne, 1941) Massey, 1967
- Misticiinae Massey, 1967
  - *Misticius* Massey, 1967
    - *M. mustus* Massey, 1967
- Family and subfamily of uncertain position
  - *Dotylaphus* Andrassy, 1958
    - *D. lonchites* n. sp.
  - *Robleus* n. gen.
    - *R. cylindricus* n. sp.

Genus *Neotylenchus* Steiner, 1931

Type species: *Neotylenchus abulbosus* Steiner, 1931

Basal bulb of esophagus definitely set off from intestine, dorsal esophageal gland sometimes enlarged until it forms a lobe extending a short distance back over intestine. Lumen of esophagus continuous, not interrupted by a muscular valvular apparatus near base of corpus. Spear generally with three definite basal knobs. Ovary outstretched or reflexed; with or without postuterine branch. Spicula, gubernaculum, and bursa tylenchoid.

Diagnosis.—Neotylenchinae possessing a definitely set off basal esophageal bulb and a continuous lumen. Bursa, spicula, and gubernaculum tylenchoid.

***Neotylenchus nitidus* Massey, 1969** **Figure 102**

Female: 0.79–0.86 mm; a=31.6–37.3; b=5.7–6.8; c=11.1–13.3; V=83%.

Male: Unknown.

Body extended when relaxed. Cuticle with moderately fine transverse striations. Lip region continuous with body contour, twice as wide as deep. Stylet moderately coarse with prominent basal knobs. Corpus of esophagus cylindrical, somewhat widened at middle, then

[3] This genus was placed in the subfamily Misticiinae by Jairajpuri and Siddiqui, 1969. I do not agree with the placement.

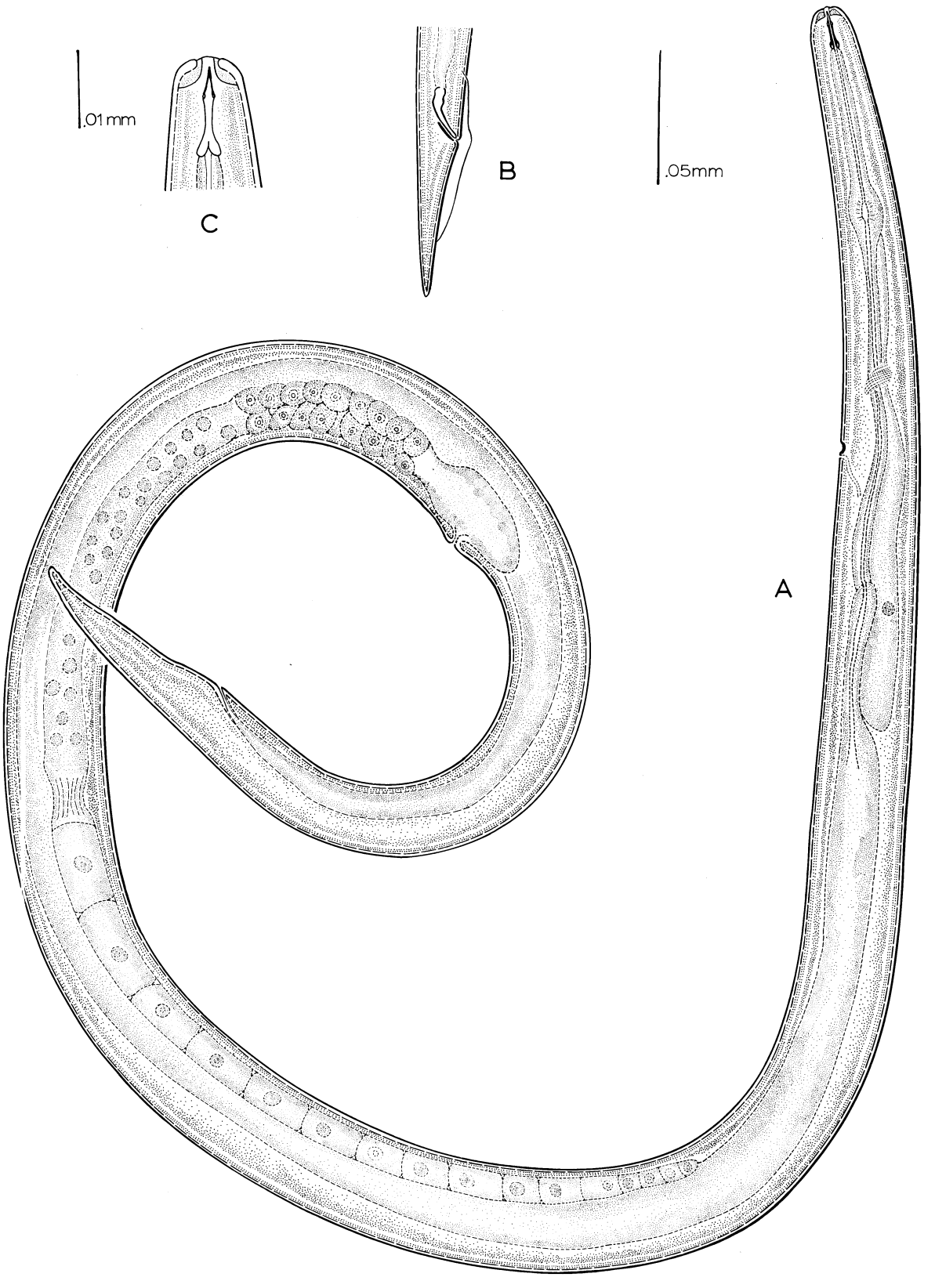


Figure 101.—*Pseudhalenchus damnatus* Massey, 1966: *A.* Female, *B.* male, tail; *C.* head.

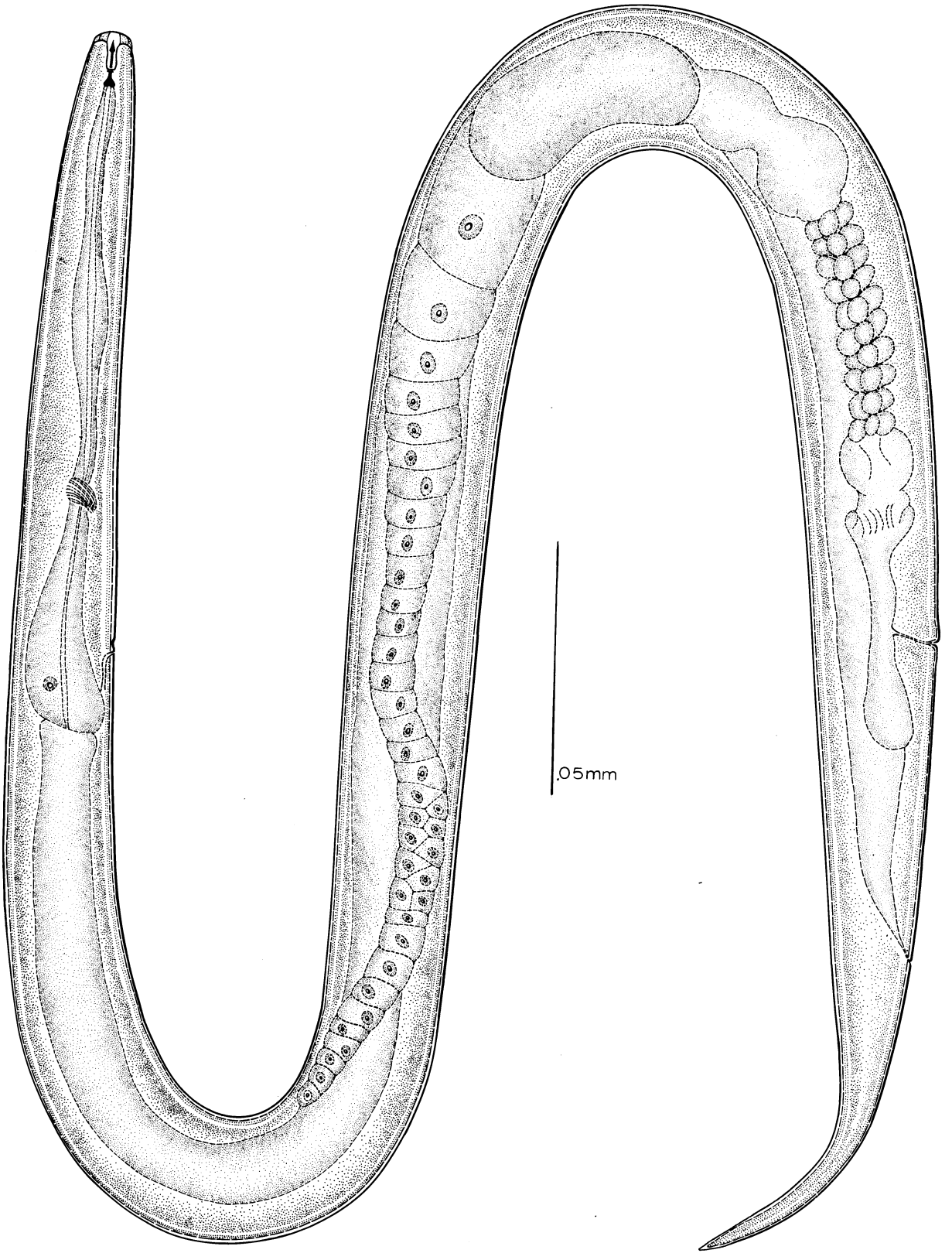


Figure 102.—*Neotylenchus nitidus* Massey, 1969.

narrowing as it passes through nerve ring, ending in a prominent basal bulb. Excretory pore immediately posterior to hemizonid, both approximately one-half body width anterior to junction of esophagus and gut. Ovary single, outstretched; quadricolumella occupying one-eighth of its total length. Posterior uterine branch approximately one body width in length. Vagina transverse. Anal opening only faintly discernible in some specimens. Terminus acute.

Diagnosis.—Closely related to *Neotylenchus acutus* Thorne, 1941; varies in prominence of stylet knobs, character of junction of esophagus and gut, and in presence of a posterior uterine branch. It also varies in the absence of a lateral field.

Type habitat.—Abandoned galleries of *Dendroctonus rufipennis* (Kby.) in Engelmann spruce.

Type locality.—Red Feather Lakes, Roosevelt National Forest, Colorado.

Type specimens.—Collection No. 55.

Genus *Deladenus* Thorne, 1941

Type species: *Deladenus durus* (Cobb, 1922) Thorne, 1941

Esophagus joining intestine immediately behind nerve ring, esophageal glands lying free in body. A chamberlike valvular apparatus sometimes present in corpus of esophagus. Vulva located less than 10% from terminus. Ovary prevulvar. Postuterine sac sometimes present. Spicula and gubernaculum tylenchoid. Bursa enveloping tail.

***Deladenus ipini* n. sp.** **Figure 103**

Female: 0.89 mm; a=30.3; b=4.9; c=43.3; V=93%.

Male: 0.66 mm; a=37.8; b=4.3; c=25.2.

Body straight, cylindroid. Cuticle with moderately fine transverse striations. Lateral incisures obscure. Lip region set off, rounded, twice as wide as high. Cephalic framework sclerotized. Spear 8 μ in length, stout; basal knobs very prominent, distinct. Protractor muscles conspicuous, attached to body wall. Dorsal esophageal gland outlet well defined in most specimens. Corpus spindle shaped, with valvelike chamber slightly anterior to its midpoint. Three distinct esophageal glands grouped around anterior end of intestine. Deirids not observed. Nerve ring 5 body widths posterior to lip region. Excretory pore opposite nerve ring. Hemizonid 2 body widths posterior to nerve ring. Vagina short, transverse, lips of vulva protuberant. Uterine pouch heavily sclerotized. Ovary single, outstretched; oocytes arranged in single row for two-thirds of ovary length, anterior one-third a double row. Quadricolumella 2½ body widths in length. Postuterine pouch less than body width in length. Anus and rectum obscure. Tail sharply narrowing from vulva to narrowly rounded terminus.

Male: Testis outstretched, reaching at times beyond posterior end of esophageal glands. Spicules and gubernaculum typically tylenchoid. Bursa enveloping terminus and joining body opposite proximal end of spicules.

Diagnosis.—Differs from any other species in the genus in presence of postuterine sac.

Type habitat.—Associated with *Dendroctonus frontalis* and *Ips calligraphus* in loblolly pine.

Type locality.—Oakdale, Louisiana.

Type specimens.—Collection No. 82-I.

***Deladenus paradurus* n. sp.** **Figure 104**

Female: 0.85–0.92 mm; a=30–36; b=8.4–11; c=21; V=91%.

Male: Unknown.

Body straight, cylindroid. Cuticle with moderately fine transverse striations and 4 lateral incisures arranged as figured. Lips continuous with neck region. Cephalic framework sclerotized. Stylet 8 μ in length, basal knobs prominent; protractor muscles obscure. Dorsal esophageal gland outlet distinct. Corpus of esophagus spindle shaped, its valvular chamber absent. Esophageal glands several body widths in length, only one gland nucleus visible. Deirids at level of excretory pore. Nerve ring 6–7 body widths posterior to head. Excretory pore a body width posterior to nerve ring, walls of tube heavily sclerotized and visible for several body widths as it extends posteriorly. Hemizonid immediately anterior to excretory pore. Hemizonion immediately posterior to excretory pore. Ovary outstretched, reaching at times to nerve ring. Lips of vulva protuberant. Vagina muscular, oblique, thick-walled. Muscular, pouchlike uterus. Quadricolumella ca 3 body widths in length. Postuterine sac absent. Anus

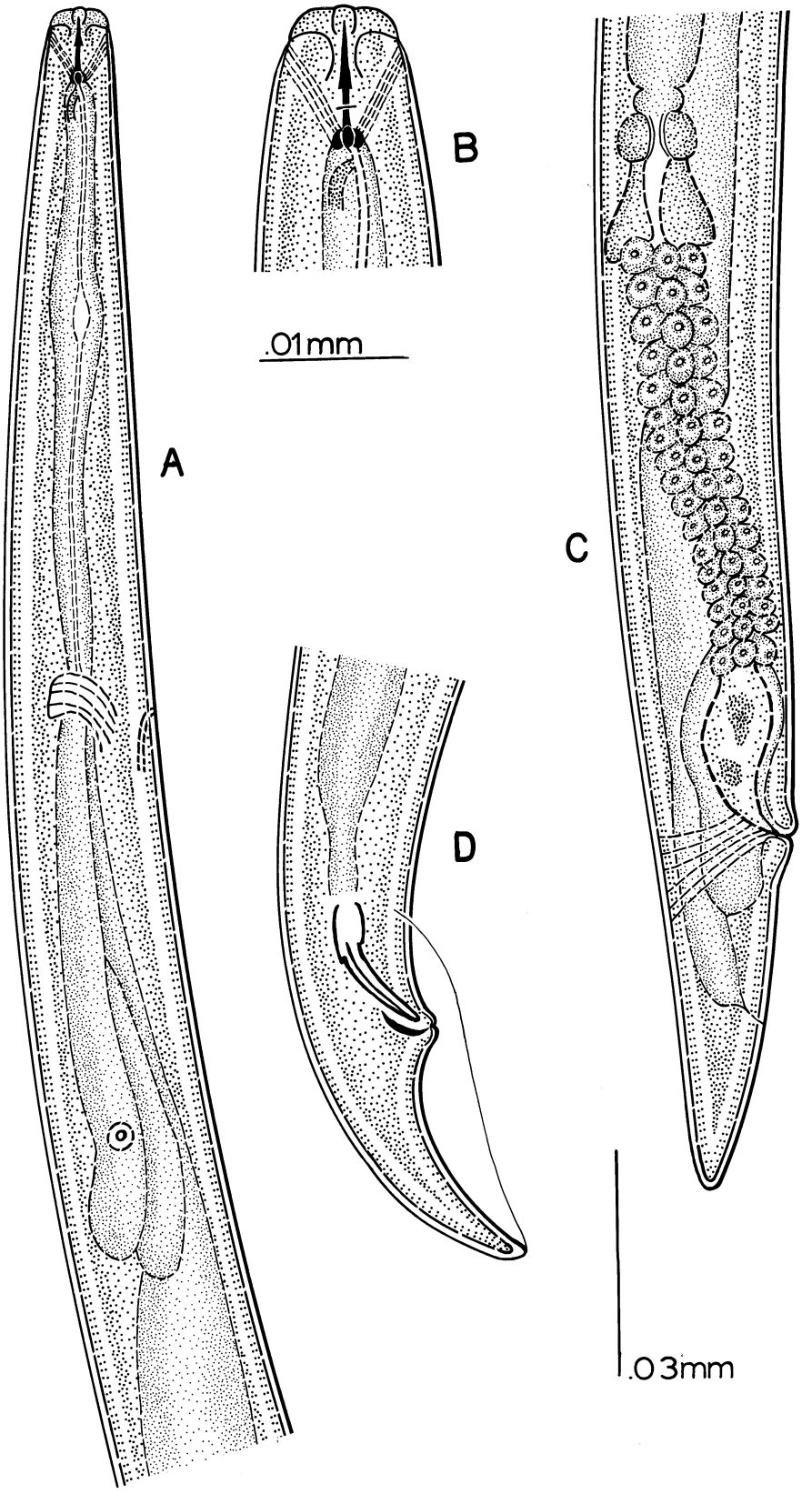
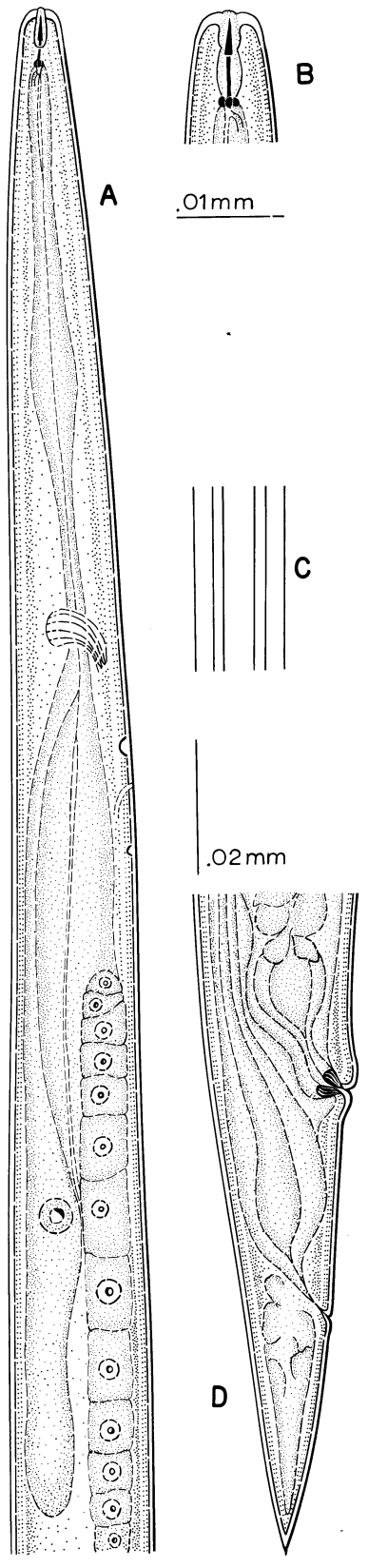


Figure 103.—*Deladenus ipini* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.



and rectum conspicuous. Tail narrowing sharply from vulva to an acute terminus.

Diagnosis.—Related to *Deladenus durus* (Cobb, 1922) Thorne, 1941; differs in the number and arrangement of lateral incisures, and in the coarseness of the lateral striae. *D. paradurus* does not possess the ovoid valvular chamber in the corpus of the esophagus.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 3-M.

Genus *Hexatylus* Goodey, 1926

Type species: *Hexatylus viviparus* Goodey, 1926

Esophagus base fused with intestine. Lumen of esophagus with a distinct break near the base of corpus where the lumen becomes much wider, the walls heavier and a muscular valvular apparatus apparently is present. Pharynx slightly sclerotized, forming several minute guiding rings for the spear. Spear with three well-developed basal knobs, each of which is somewhat duplex. The outer surface of these basal knobs is unusually refractive and conspicuous. *En face* the octagonal lip region is observed to be divided into 12 approximately equal sectors with four smaller triangular sectors at the submedial angles through which the circlet of four papillae emerge. The basal framework of the head retains the octagonal pattern of the genus.

Hexatylus viviparus Goodey, 1926 **Figure 105**

Female: 1.0–1.5 mm; a=15–35; b=5–7; c=17–20; V=89%.

With characters of the genus. Great variation in width is found between females which have reached their normal length but have not begun egg production, and those approaching senility. Senile specimens frequently somewhat shorter than the younger forms associated with them. Phasmids and deirids not observed. Lateral field marked by four refractive lines, the two outer ones being more prominent. Tissues of the basal portion of the esophagus are somewhat less dense in texture than those of the intestine to which they are fused. This basal

Figure 104.—*Deladenus paradurus* n. sp.: *A.* Head and neck; *B.* head; *C.* lateral field; *D.* female, tail.

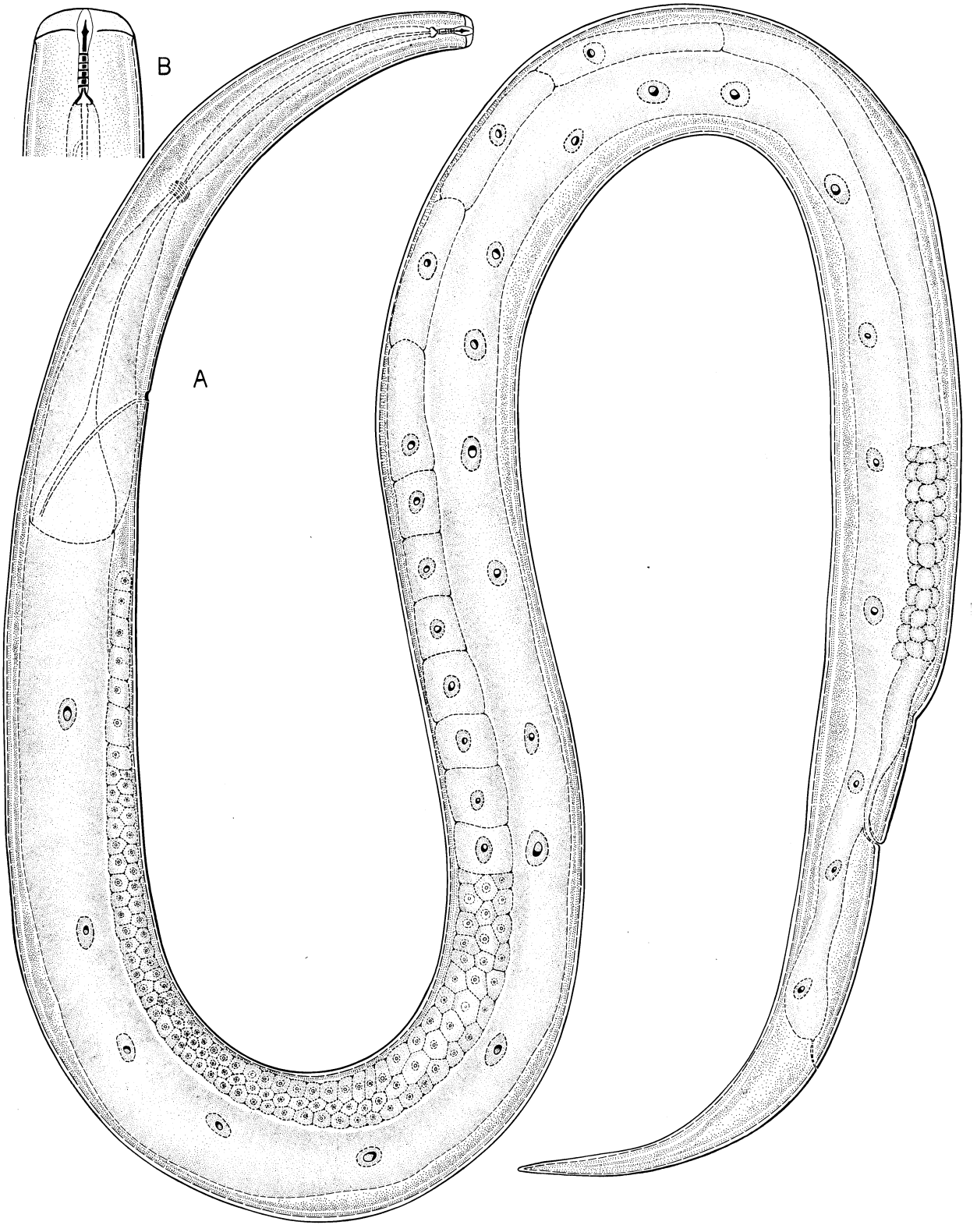


Figure 105.—*Hexatylus viviparus* Goodey, 1926: *A.* Female; *B.* head.

portion encloses a number of nuclei, some of which appear identical to those of the intestine while others are probably the nuclei of the esophageal glands. Nuclei of intestinal cells less than one body width apart. Intestine probably four cells to a circumference but this point was not definitely determined as cell walls were not visible.

Ovary of adults reaching as far forward as the nerve ring, the anterior portion made up of several hundred massed oocytes which, as they increase in size, are observed to be grouped about a prominent rachis. Only the anterior half of the ovary is occupied by the oocytes, the remainder being a long tube in which the ova develop. A short oviduct leads to a pouchlike uterus. Vagina a broad transverse slit.

Habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine, *Dendroctonus terebrans* in loblolly pine, and *Leperisinus aculeatus* in green ash.

Genus *Nothotylenchus* Thorne, 1941

Type species: *Nothotylenchus acris* Thorne, 1941

Cuticle thin, marked by fine transverse striae which are interrupted by the lateral fields, marked by 2 or more bright lines. Cephalic framework in six sectors. Spear with rounded basal knobs. Corpus of esophagus cylindroid, with or without a fusiform valveless bulb. Basal bulb of esophagus distinctly set off from intestine, sometimes slightly lobed. Ovary outstretched, with oocytes arranged in single file. Posterior uterine branch present. Spicules and gubernaculum tylenchoid. Bursa peloderan.

Nothotylenchus compactus n. sp. Figure 106

Female: 0.55 mm; a=21.1; b=4.9; c=17.3; V=84%.

Male: Unknown.

Body ventrally arcuate. Cuticle with moderately fine transverse striae. Lips rounded, continuous with body contour. Cephalic framework lightly sclerotized. Stylet 9 μ long, strongly knobbed, retractor muscles indistinct. Dorsal esophageal gland outlet obscure. Basal bulb cylindroid, elongate. Deirids not observed. Excretory pore one and one-half body widths posterior to nerve ring. Hemizonid immediately anterior to excretory pore. Vagina a transverse slit. Lips of vulva continuous with body contour. Ovary outstretched, oocytes tandem. Quadricolumella 1 body width long. Postuterine branch a body width in length. Anus and rectum obscure. Tail conoid to rounded knoblike terminus.

Diagnosis.—Differs from all other species in the genus in the short, stout body conformation and distinctly shaped tail.

Type habitat.—Associated with *Phloeosinus neomexicanus* Blkm. in Rocky Mountain juniper.

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 36.

Nothotylenchus parasimilis n. sp. Figure 107

Female: 0.61 mm; a=29; b=5.9; c=16; V=81%.

Male: 0.54 mm; a=37; b=7.4; c=14.2.

Body slightly ventrally arcuate. Cuticle with moderately coarse transverse striations, especially on neck and on tail. Lateral incisures obscure, 4 noted on some specimens. Lips rounded, continuous with neck contour. Cephalic framework sclerotized. Spear stout, 7.5 μ in length, with large basal knobs. Retractor muscles distinct. Dorsal esophageal gland outlet distinct. Basal bulb oblong, ellipsoid. Deirids not observed. Excretory pore varies in position from posterior portion of nerve ring to posterior portion of basal bulb. Hemizonid not observed. Lips of vulva slightly protuberant. Vagina oblique. Uterus serving as spermatheca. Ovary single, outstretched; oocytes tandem. Quadricolumella ca 2 body widths in length. Posterior uterine branch over a body width long. Anal opening inconspicuous, rectum obscure. Tail conoid to an acute terminus.

Male: Testis single, outstretched. Spicules and gubernaculum tylenchoid. Tail conoid to an acute terminus. Bursa extending from body at midspicules posteriorly two-thirds of distance from anus to terminus.

Diagnosis.—Related to *Nothotylenchus similis* Thorne and Malek, 1968. Varies in coarseness of transverse striae, number of lateral incisures, and size of stylet. *N. parasimilis* is a much smaller species.

Type habitat.—Associated with *Ips grandicollis* in loblolly pine.

Type locality.—Henderson, North Carolina.

Type specimens.—Collection No. 32-K.

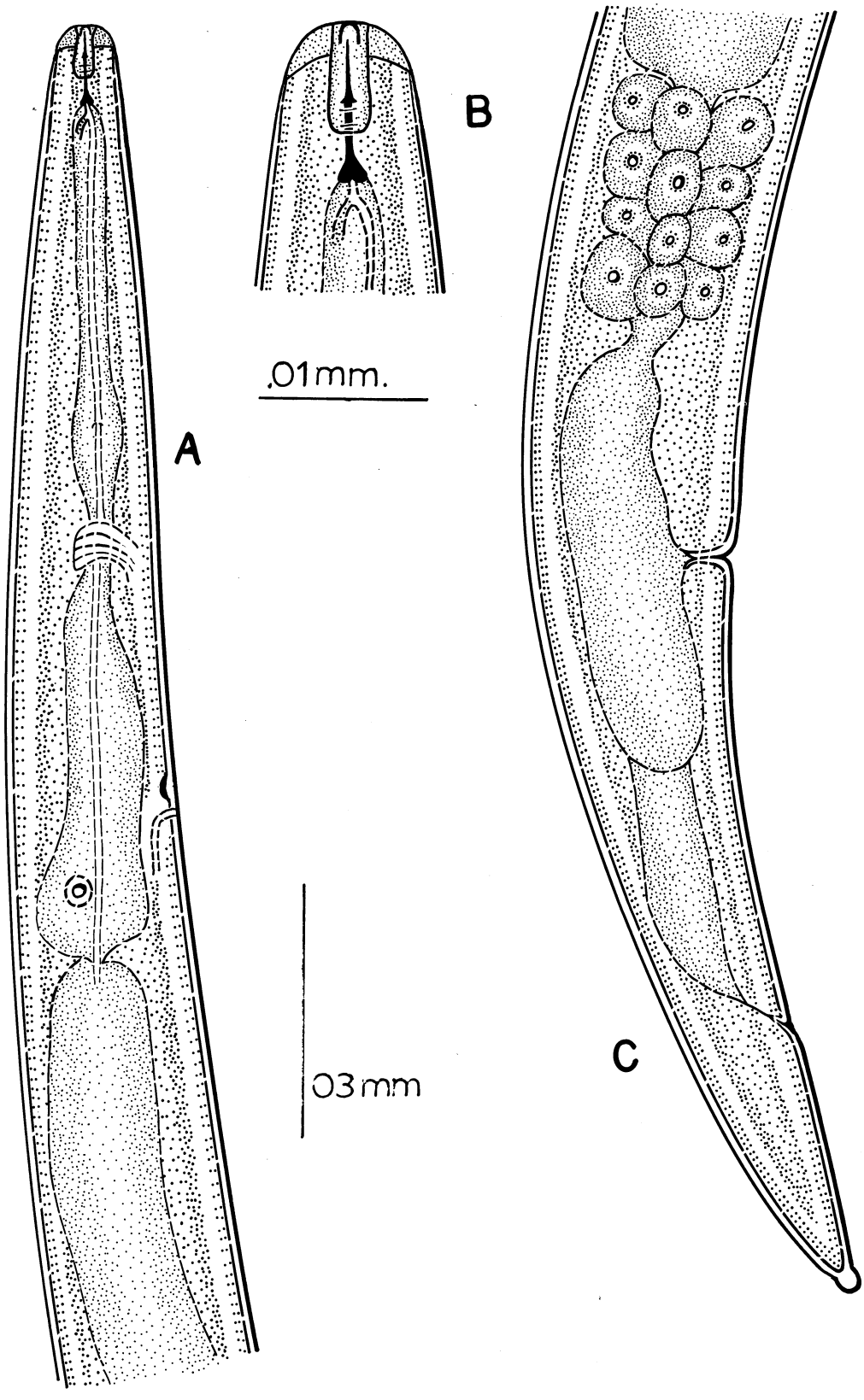


Figure 106.—*Nothotylenchus compactus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail.

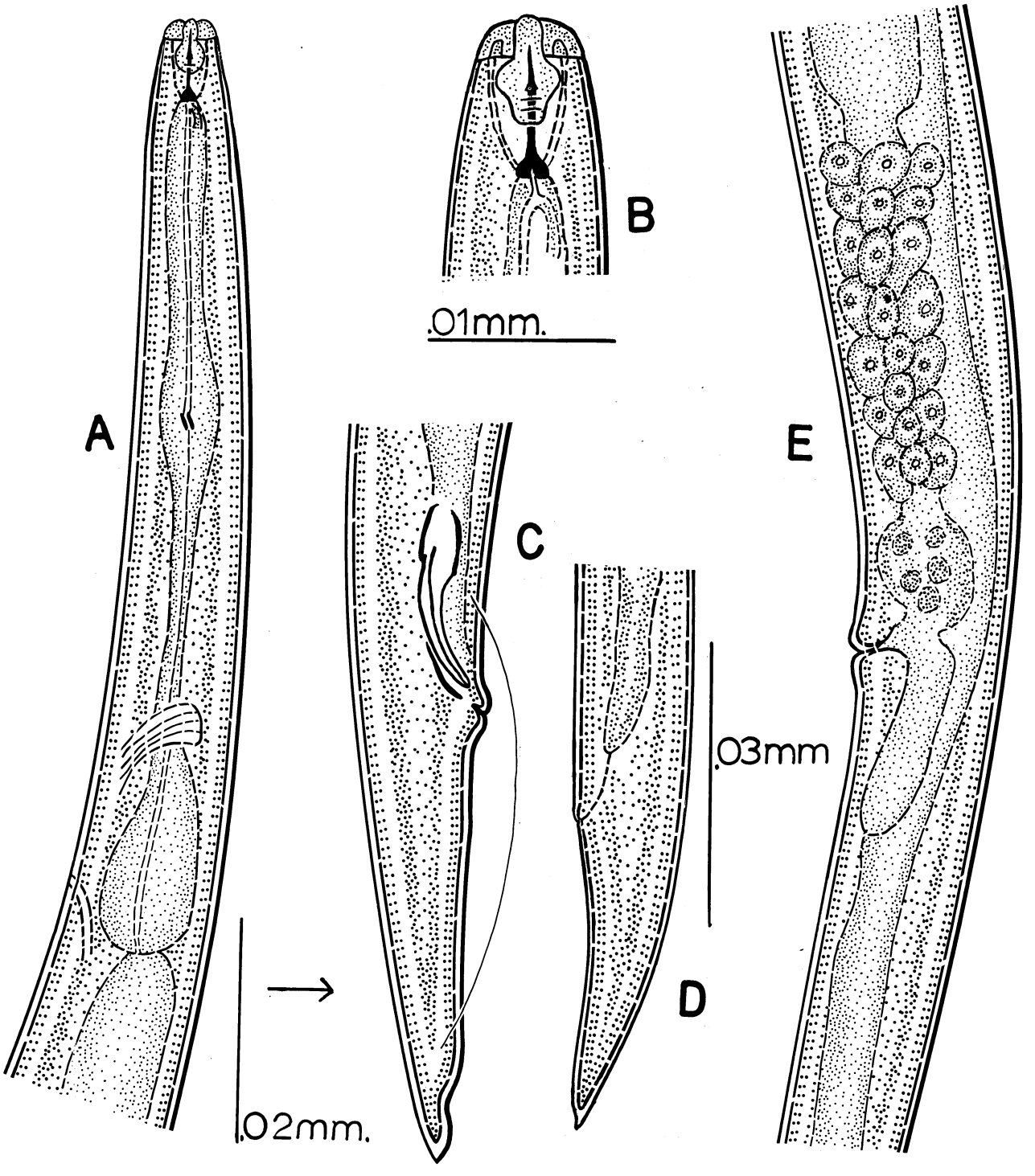


Figure 107.—*Nothotylenchus parasimilis* n. sp.: *A.* Head and neck; *B.* head; *C.* male, tail; *D.* female, tail; *E.* female, midbody.

Nothotylenchus petilus n. sp. **Figure 108**

Female: 0.57 mm; a=40.5; b=4.5; c=18.0; V=76%.

Male: 0.57 mm; a=48.5; b=5.0; c=15.0.

Body slender, slightly ventrally arcuate. Cuticle with moderately coarse transverse striae, especially prominent at neck and tail, 2 lateral incisures. Lips continuous with neck, angular. Cephalic framework sclerotized. Stylet relatively slender, strongly knobbed, 7.5 μ in length; retractor muscles conspicuous and attached to body wall. Dorsal esophageal gland outlet discernible. Basal bulb oblong. Deirids not observed. Excretory pore one-half body width posterior to nerve ring, its tube heavily sclerotized. Hemizonid immediately anterior to excretory pore. Vulva lips protruding or continuous with body contour. Vagina transverse. Ovary outstretched, oocytes tandem. Quadri-

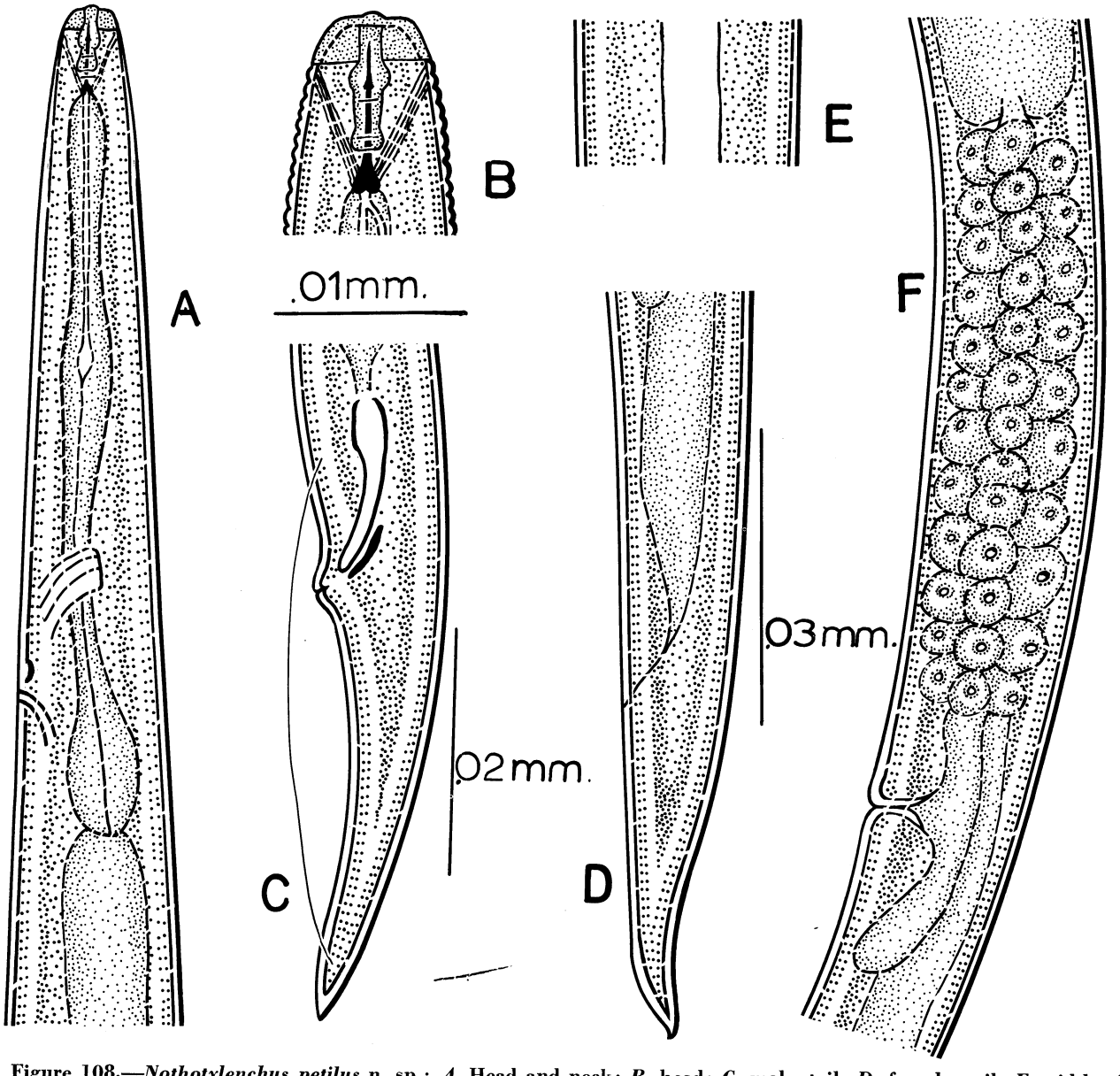


Figure 108.—*Nothotylenchus petilus* n. sp.: *A.* Head and neck; *B.* head; *C.* male, tail; *D.* female, tail; *E.* width of lateral field; *F.* female, midbody.

columella ca 4 body widths long. Posterior uterine branch over a body width in length. Anus and rectum obscure. Tail conoid to an acute terminus.

Male: Testis single, outstretched, short. Spicules and gubernaculum tylenchoid. Tail conoid to an acute terminus. Bursa arising at body wall opposite midpoint of spicules and extending posteriorly seven-eighths of distance between anus and terminus.

Diagnosis.—Related to *Nothotylenchus medians* Thorne and Malek, 1968; differs in number of incisures in lateral field, stylet muscles attached to body wall instead of cephalic framework, and in length and point of attachment of bursa.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Henderson, North Carolina.

Type specimens.—Collection No. 82-D.

Genus *Anguillonema* Fuchs, 1938, Emended [3]

Type species: *Anguillonema xylebori* (Roux, 1906) Rühm, 1955

Cuticle with transverse striae, with or without lateral incisures. Lips continuous with neck region. Cephalic framework distinct. Stylet relatively short, usually with distinct basal knobs, dorsal knob at times deformed by development of dorsal esophageal gland outlet. Corpus spindle shaped, isthmus slightly constricted by nerve ring. Basal bulb distinct, at times lobed on dorsal side. Ovary single, posterior uterine branch rudimentary. Anus and rectum at times obscure. Testis outstretched. Spicules and gubernaculum tylenchoid. Bursa enveloping tail.

The genus has been unobserved since originally described by Fuchs. Original description is herein amended to more adequately diagnose the genus.

Anguillonema annamari n. sp.[4] Figure 109

Female: 0.76 mm; a=32; b=4.2; c=?; V=89%.

Male: 0.60 mm; a=35; b=5.0; c=17.5.

Body straight, cylindroid except at extremities. Cuticle with moderately coarse transverse striae, 2 lateral incisures. Lips continuous with neck region, rounded, twice as wide as deep. Cephalic framework sclerotized. Stylet 8 μ in length, with small basal knobs, the dorsal knob at times deformed by the prominent dorsal esophageal gland outlet; retractor muscles obscure. Esophageal lumen can be traced to junction with intestine. Corpus spindle shaped, isthmus severely constricted by nerve ring, basal bulb distinctive, usually lobed on dorsal side; a valvelike structure between basal bulb and intestine. Deirids not observed. Excretory pore conspicuous, located over a body width posterior to nerve ring, wall of tube heavily sclerotized. Hemizonid immediately anterior to excretory pore. Lips of vulva elevated, vagina short and slanting anteriorly. Ovary outstretched or reflexed several times, sometimes extending to nerve ring. Oocytes arranged in a single row. Quadricolumella 1–2 body widths in length. Posterior uterine branch rudimentary. Anus and rectum obscure. Tail subcylindroid, terminus broadly rounded, obtuse.

Male: Testis outstretched, at times reaching posterior end of basal bulb. Sperm cells small, highly refractive. Spicules and gubernaculum highly refractive. Tail slightly ventrally arcuate. Terminus sharply rounded. Bursa enveloping tail and joining body wall one-half body width anterior to proximal end of spicules.

Diagnosis.—Distinctive because of glandular basal bulb and obtuse tail of female.

Type habitat.—Associated with *Dendroctonus frontalis* in loblolly pine.

Type locality.—Spurger, Texas.

Type specimens.—Collection No. 82-C, 82-E.

Anguillonema leperisini n. sp. Figure 110

Female: 0.70–0.83 mm; a=33–34; b=4.2–4.9; c=29.7; V=90%.

Male: 0.63 mm; a=36; b=4.3; c=21.6.

Body straight, cylindroid. Cuticle with moderately coarse transverse striations, lateral incisures absent. Lips continuous with neck region, rounded, twice as wide as high. Cephalic framework sclerotized. Spear 9-10 μ in length, stout, with basal knobs, dorsal knob usually deformed anteriorly by the prominent dorsal esophageal gland outlet; protractor muscles obscure. Corpus of esophagus spindle shaped, isthmus severely constricted by nerve ring, basal bulb massive, without dorsal lobe

[3] This genus was placed in the subfamily Misticiinae by Jairajpuri and Siddiqi, 1969. I do not agree with the placement.

[4] Named in honor of my granddaughter, Anna Marie Massey.

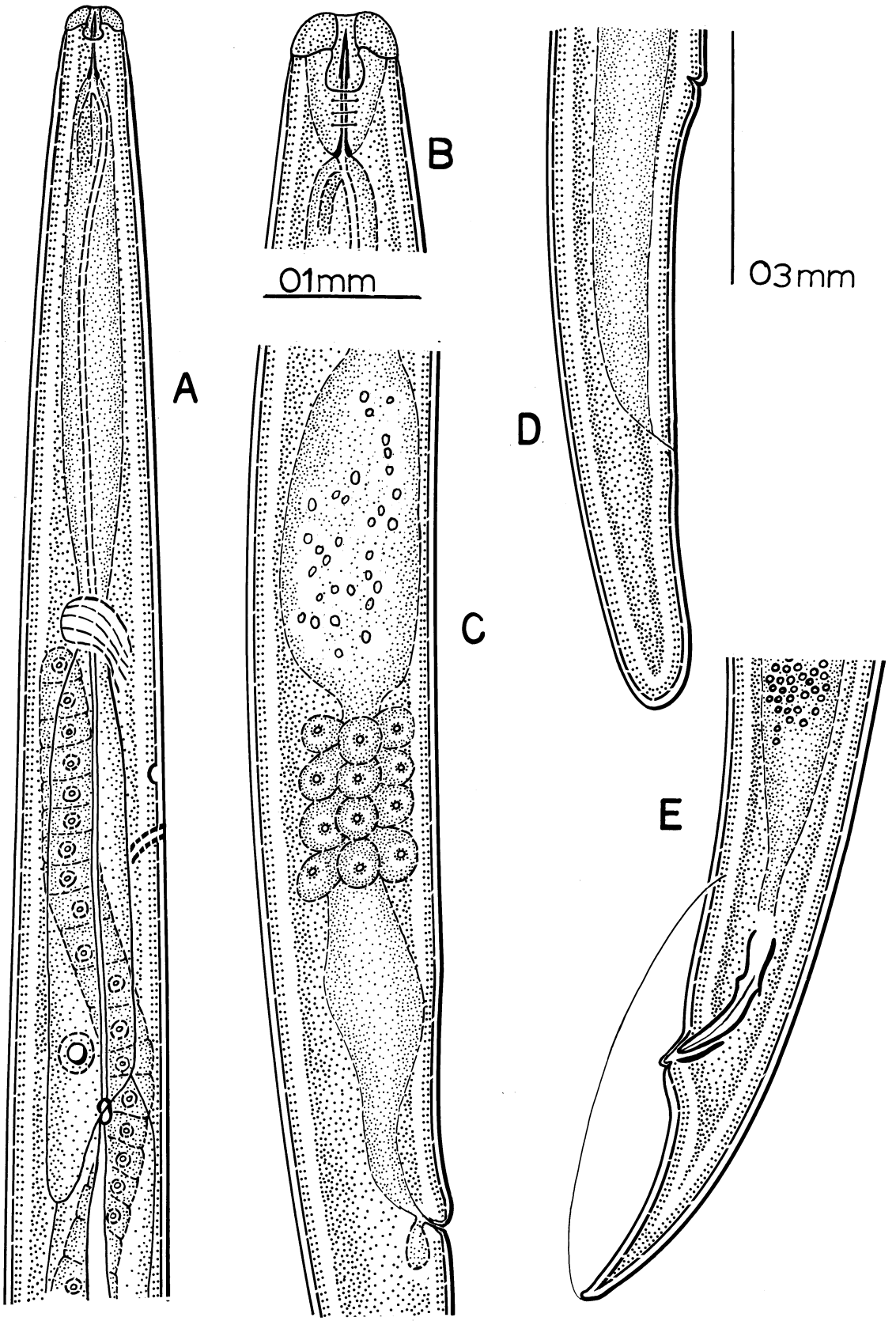


Figure 109.—*Anguillonema annamari* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

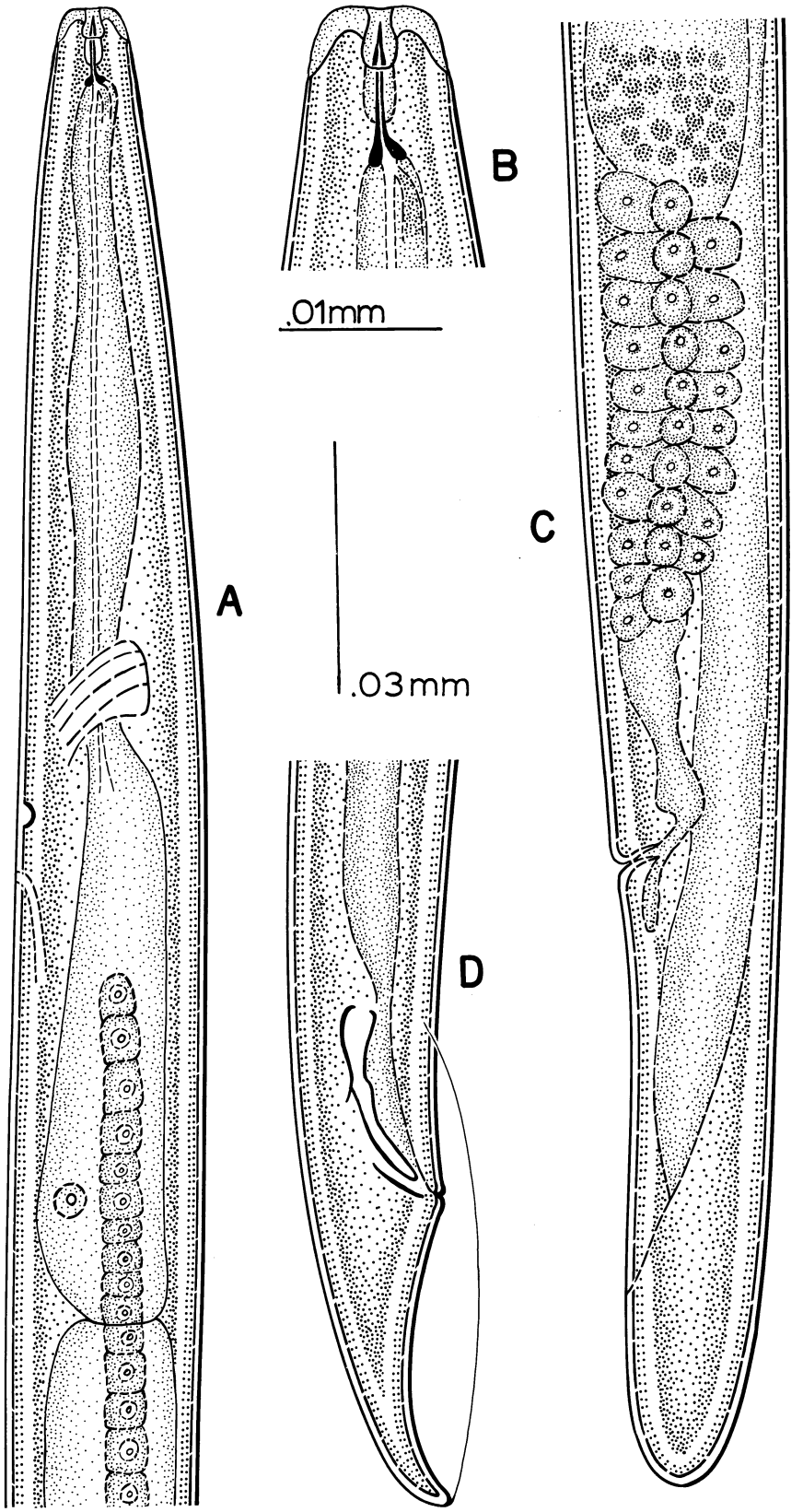


Figure 110.—*Anguillonema leperisini* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

and filling body cavity. Deirids not observed. Excretory pore prominent, ca 1 body width posterior to nerve ring, tube heavily sclerotized. Hemizonid immediately anterior to excretory pore. Lips of vulva slightly elevated. Vagina short, oblique. Ovary usually reflexed one to several times: oocytes tandem. Quadricolumella 1–2 body widths in length. Posterior uterine branch rudimentary. Anus and rectum obscure. Tail narrowing but little from vulva to terminus. Terminus broadly rounded, obtuse.

Male: Testis outstretched. Spicules and gubernaculum tylenchoid. Bursa enveloping tail and joining body wall at proximal end of spicules.

Diagnosis.—Related to *Anguillonema annamari;* differs in the shape and character of basal bulb, in the longer and stouter stylet, and in the shorter, more obtusely rounded tail.

Type habitat.—Associated with *Leperisinus aculeatus* in green ash.

Type locality.—Chillicothe, Ohio.

Type specimens.—Collection No. 82-P.

Luella n. gen.[5]

Nothotylenchinae: Cuticle finely striated, without lateral incisures. Stylet slender, smooth, without basal knobs or thickenings. Basal bulb of esophagus distinctly set off from intestine, junction unique and slightly overlapping intestine. Ovary single, reflexed; oocytes arranged in a single row. Posterior uterine branch rudimentary. Female anus and rectum obscure. Terminus filiform. Spicules and gubernaculum tylenchoid. Bursa arising one-half body width anterior to proximal end of spicules and extending one-third of the distance to terminus.

Diagnosis.—Immediately distinguished from *Nothotylenchus* by the smooth delicate stylet, absence of lateral striae, and junction of esophagus and intestine, and in the filiform tail in both sexes.

Luella luculenta n. gen., n. sp. Figure 111

Female: 0.69 mm; a=33.6; b=5.1; c=7.3; V=80%.

Male: 0.69 mm; a=33.6; b=4.8; c=8.1.

Body straight to slightly ventrally arcuate. Cuticle with fine transverse striae. Without lateral incisures. Lips continuous with neck region. Cephalic framework sclerotized. Stylet 8 μ in length, slender, without basal knobs; retractor muscles obscure. Dorsal esophageal gland outlet obscure to prominent. Corpus of esophagus cylindrical, basal bulb distinctly set off from intestine, at times lobed; lumen visible throughout entire length. Nerve ring massive. Excretory pore prominent, immediately posterior to nerve ring, its tube heavily sclerotized. Hemizonid very conspicuous and immediately anterior to excretory pore. Lips of vulva slightly elevated. Vagina short, transverse. Ovary reflexed; oocytes tandem. Quadricolumella 1–2 body widths in length. Posterior uterine branch rudimentary. Anus and rectum obscure. Tail constricted from vulva to a filiform terminus.

Male: Testis outstretched. Spicules and gubernaculum tylenchoid. Tail as in female. Bursa arising one-half body width anterior to proximal end of spicules and extending one-third of the distance to terminus.

Type habitat.—Associated with *Ips pini* in red pine.

Type locality.—Caroline Co., New York.

Type specimens.—Collection No. 82-O.

Genus *Misticius* Massey, 1967

Type species: *Misticius mustus* Massey, 1967

Lip region only slightly offset; labial framework lightly sclerotized. Knobs of stylet flattened at base. Metacorpus weakly developed without a valvular apparatus, but a thickening of the lumen walls; terminal bulb overlapped by intestine and emptying subventrally into gut. Excretory pore located far forward, at times nearly opposite base of spear. Hemizonid located near nerve ring. Ovary single, prodelphic. Spicules cephalated. Gubernaculum tylenchoid. Bursa rising at proximal end of spicula and extending four-fifths length of tail.

Misticius mustus Massey, 1967 Figure 112

Female: 2.7 mm (2.4–2.9); a=68 (66–79); b=11.5 (9.6–13.0); c=27 (23–32); V=89% (87–91).

Male: 1.83 mm (1.59–2.4); a=64.7 (61.1–68.7); b=10.5 (10.4–10.7); c=27.0 (21.8–30.5).

Cuticle with moderately fine annulations consistent throughout body length. Lateral inci-

[5] Named in honor of Mrs. Luella Kramer, Principal Clerk, Albuquerque, New Mexico Unit, Rocky Mountain Forest and Range Experiment Station.

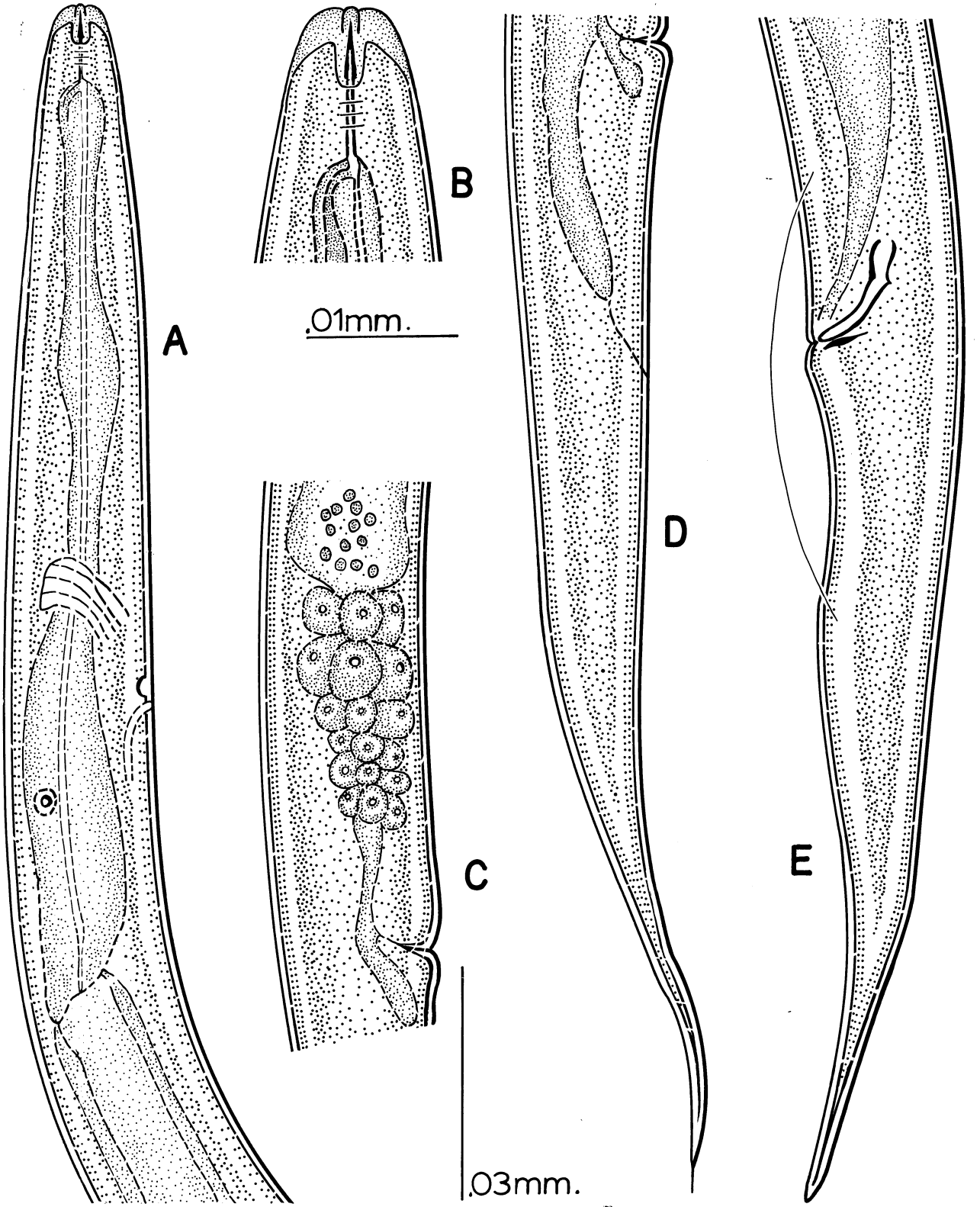


Figure 111.—*Luella luculenta* n. gen., n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* female, tail; *E.* male, tail.

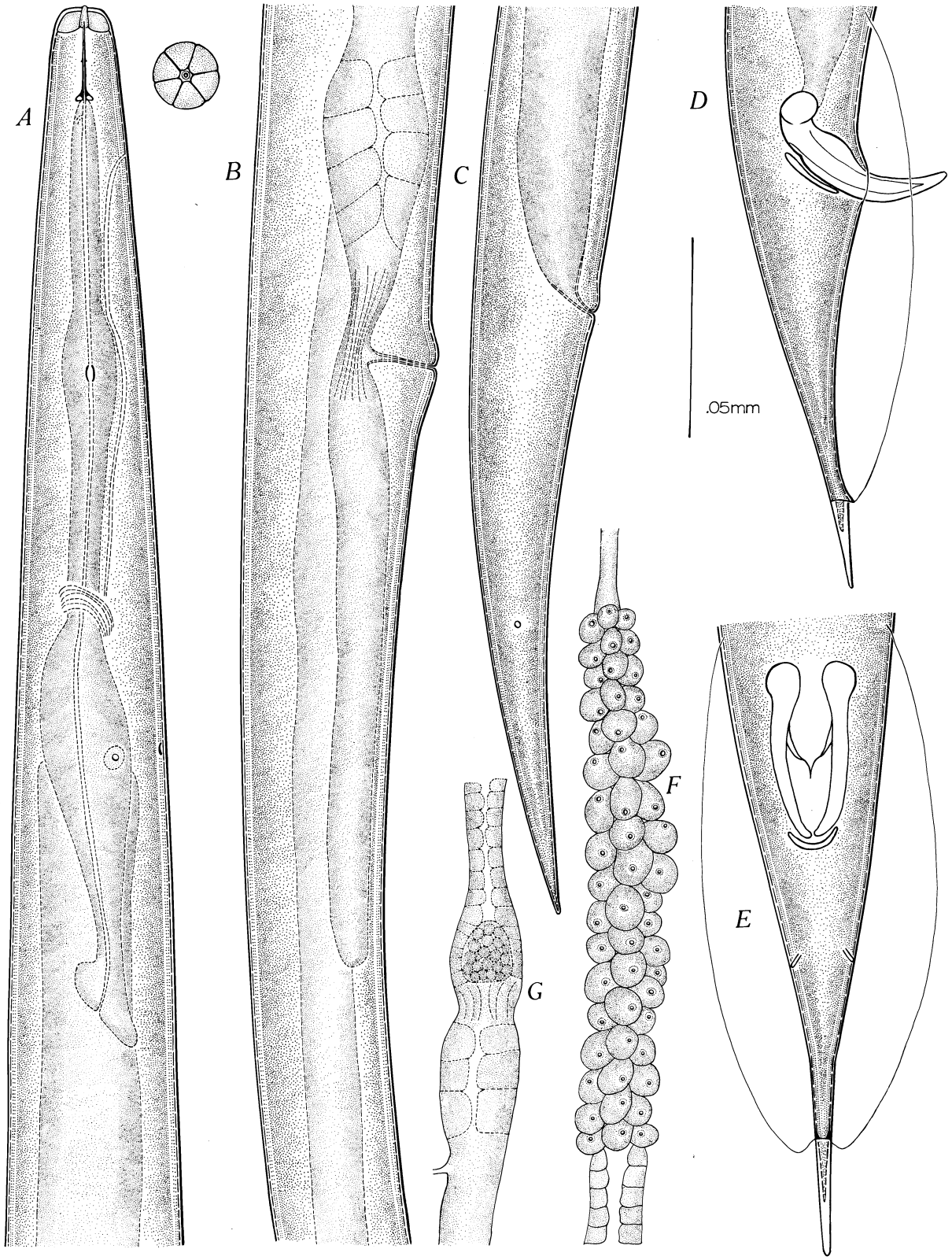


Figure 112.—***Misticius mustus*** **Massey, 1967: *A.* Head and neck; *B.* female, midbody; *C.* female, tail; *D.* male, tail; *E.* male, tail, ventral view; *F.* quadricolumella; *G.* portion of ovary showing spermatheca.**

sures absent. Lip region very slightly sclerotized. Stylet moderately stout, length 13 μ (13 μ-14 μ), with prominent basal knobs appearing flattened at the base in lateral view. Orifice of the dorsal esophageal gland immediately behind base of spear. Metacorpus weakly developed, spindle shaped, without a valvular apparatus, but a thickening of the walls forming the lumen of the esophagus at the metacorpus. Terminal bulb of esophagus elongated and extending into intestine up to two body widths and emptying subventrally into gut. Excretory pore far forward, at times within 2 μ of base of spear, ranging from 2–15 μ from base of that organ. Hemizonid located slightly more than one body width posterior to nerve ring. Ovary prodelphic, in some specimens slightly reflexed. Quadricolumella very elongated, several body widths in length in mature specimens. Spermatheca as figured. Posterior uterine branch elongate, up to four body widths in length. Tail terminus minutely rounded.

Male: With cuticular, head, and neck characteristics of female. Testis outstretched; spicules paired, stout, arcuate, and cephalated. Gubernaculum troughlike in lateral view, approximately one-third length of spicules. Phasmids as figured. Bursa joining body slightly anterior to proximal end of spicules and extending to within 16 μ of spicate terminus.

Type habitat.—Galleries of *Dendroctonus pseudotsugae* in Douglas-fir.

Type locality.—Pecos, New Mexico.

Type specimens.—Collection No. 46.

Genus *Dotylaphus* Andrássy, 1958 Emended

Type species: *Dotylaphus ruehmi* Andrássy, 1958

Females: Cuticle thick, with several lateral incisures. Head rounded. Lips indistinct. Stylet dorsally arcuate, with or without basal knobs. Dorsal and ventral shafts appearing to be separate. Esophagus unique, terminating in two large glands lying free in body cavity, each gland with a distinctive outlet, appearing fingerlike, their walls heavily sclerotized, an outlet in each gland. Esophageal-intestinal juncture indefinite. Vulva posterior. Ovary development indistinct.

Males: Head rounded. Cuticle as in female. Stylet straight, slender, with oblique basal thickenings. Esophagus as in female, except for glandular outlets which are not apparent. Testis outstretched. Spicules and gubernaculum tylenchoid. Bursa peloderan.

The genus is dimorphic in that males and females bear distinctively different stylets; the male stylet is straight with a normal subulate shaft and shaft; however, the basal thickenings are oblique. Female spear is coarse and long, dorsally arcuate, the shafts appearing separate.

***Dotylaphus lonchites* n. sp.** **Figure 113**

Females: 1.36–1.5 mm; a=58.1–64.6; b=?; c=?; V=?.

Males: 1.09–1.15 mm; a=46.5–49.1; b=?; c=19.6–20.7.

Cylindroid. Cuticle thick, with fine transverse striae and 6 lateral incisures. Lip region round, indistinct, continuous with body contour. Cephalic framework indistinct. Stylet 22 μ in length, with prominent oblong basal knobs, dorsally arcuate, dorsal and ventral shaft appearing separate, dorsal shaft more coarse than ventral. Subulate portion of dorsal shaft spearlike, heavily sclerotized. Musculature unusual and apparently attached from shafts of spear to walls of vestibule. Esophagus distinctive, terminating in two large glands, dorsal and ventral, each with a distinctive finger-like outlet, the walls of the tubular outlet heavily sclerotized. Nerve ring 5 body widths from anterior end. Excretory pore and hemizonid a body width posterior to nerve ring. Ovary, vulva, and anus indistinct. Tail cylindroid to an obtuse terminus.

Male: Cuticle as in female. Head rounded, lips indistinct. Stylet slender, straight, 12 μ in length, with oblique basal thickenings. Esophagus as in female, but without the fingerlike esophageal gland outlets. Testis outstretched. Spicules and gubernaculum tylenchoid. Bursa peloderan, joining body wall one-half body width anterior to proximal end of spicules. Tail conoid to a subacute terminus.

Diagnosis.—Differs from *Dotylaphus ruehmi* Andrássy, 1958 in stylet characteristics, in the number of lateral incisures, and in size.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine; also associated with *Dendroctonus adjunctus* in ponderosa pine at Oak Creek Canyon, Arizona.

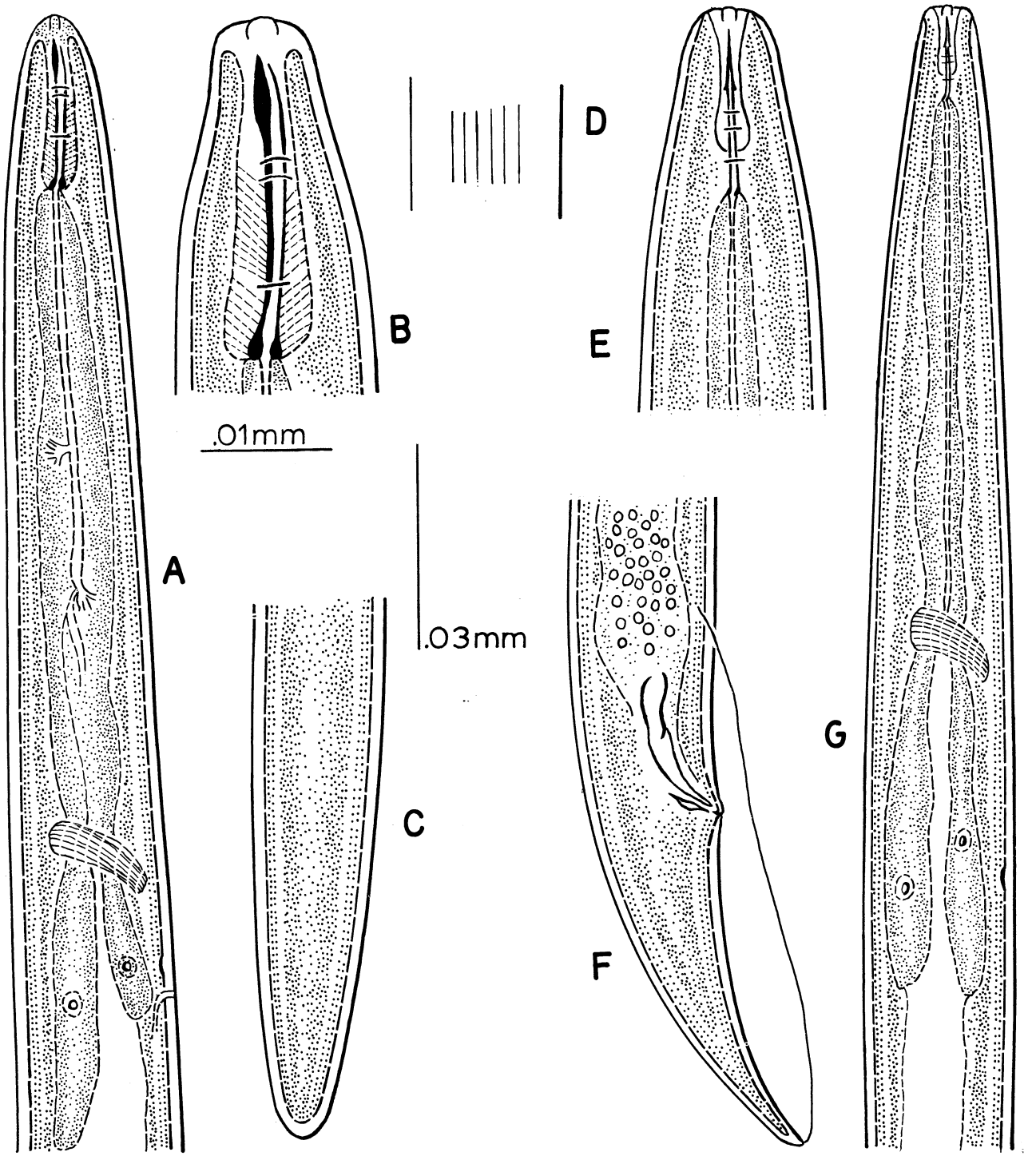


Figure 113.—*Dotylaphus lonchites* n. sp.: *A.* Female, head and neck; *B.* female, head; *C.* female, tail; *D.* cuticle illustrating lateral incisures; *E.* male, head; *F.* male, tail; *G.* male, head and neck.

Type locality.—Oakdale, Louisiana.
Type specimens.—Collection No. 82-F.

***Robleus* n. gen.**[6]

Cuticle with fine transverse striations. Head broadly rounded, lips indistinct. Stylet with heavily sclerotized subulate shaft, ventrally bent at anterior end, prominently knobbed. Basal lobe of esophagus elongate, cylindrical, glandular throughout its entire length. Ovary short, oocytes arranged in a single row. Oviduct long and serving as a spermatheca. Uterus conspicuously muscular. Anus and rectum obscure. Tail cylindroid to obtuse terminus.

Diagnosis.—Distinctive because of its unique stylet and esophagus, short ovary, and prominent uterus.

***Robleus cylindricus* n. gen., n. sp.** **Figure 114**

Females: 0.62–0.68 mm; a=28.1–31.8; b=2.8–3.0; c=?; V=87%.

Males: Unknown.

Cylindroid. Cuticle with fine transverse striae, lateral incisures not discernible. Lip region broadly rounded, indistinctly set off, hardly discernible. Cephalic framework indistinct. Amphids not observed. Stylet 19 μ in length, subulate shaft ventrally bent at anterior end and exceedingly heavily sclerotized, two-thirds total spear length, knobs very conspicuous, musculature prominent. Dorsal esophageal gland outlet not discernible. Procorpus short, basal bulb cylindrical, exceedingly long and glandular. Lumen visible throughout its entire length, anterior portion of basal bulb with indistinct radial muscles and several fingerlike ducts protruding from lumen. Cardia-like organ at base of esophagus with 3 prominent nuclei. Nerve ring severely constricting anterior portion of basal lobe imparting the appearance of a median bulb. Excretory pore one-half body width posterior to nerve ring. Hemizonid immediately anterior to excretory pore. Ovary single, oocytes arranged in a single row. Oviduct packed with exceedingly minute sperm cells. Quadricolumella 2 body widths in length. Lips of vulva only slightly protuberant. Vagina a very short, transverse slit. Uterus prominent, muscular, shaped as illustrated. Anus and rectum obscure. Phasmids obscure. Tail cylindroid to an obtuse terminus.

Type habitat.—Associated with *Dendroctonus frontalis* in loblolly pine.
Type locality.—Spurger, Texas.
Type specimens.—Collection No. 83-E.
Robleus cylindricus appears to be the free-living stage of an insect parasite, in all probability a parasite of an insect associate of the southern pine beetle.

Aphelenchoidea (Fuchs, 1937) Thorne, 1949

Aphelenchoididae (Skarbilovich, 1947) Paramonov, 1953
- Aphelenchoidinae Skarbilovich, 1947
  - *Aphelenchoides* Fischer, 1894
    - *A. conophthori* n. sp.
    - *A. hylurgi* n. sp.
    - *A. pityokteini* n. sp.
    - *A. polygraphi* n. sp.
    - *A. rhytium* Massey, 1971
    - *A. tenuidens* Thorne, 1935
  - *Bursaphelenchus* Fuchs, 1937
    - *B. bestiolus* n. sp.
    - *B. corneolus* Massey, 1966
    - *B. elytrus* Massey, 1970
    - *B. newmexicanus* n. sp.
    - *B. pityogeni* n. sp.
    - *B. scolyti* n. sp.
    - *B. talonus* (Thorne, 1935) J. B. Goodey, 1960
    - *B. tritrunculus* n. sp.
    - *B. wilfordi* Massey, 1964
  - *Laimaphelenchus* Fuchs, 1937
    - *L. pannocaudus* Massey, 1966
    - *L. penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941
    - *L. pensobrinus* Massey, 1966
    - *L. phloeosini* n. sp.
  - *Ektaphelenchus* (Fuchs, 1937) Skrjabin et al, 1954
    - *E. josephi* n. sp.
    - *E. obtusus* Massey, 1956
    - *E. prolobos* Massey, 1964
    - *E. sandiaensis* Massey, 1964
    - *E. smaelus* n. sp.
    - *E. terebranus* n. sp.
  - *Cryptaphelenchus* (Fuchs, 1937) Rühm, 1954
    - *C. cirrus* n. sp.
    - *C. ipinius* n. sp.

[6] Named in honor of my grandson, Robert Lee Verzino.

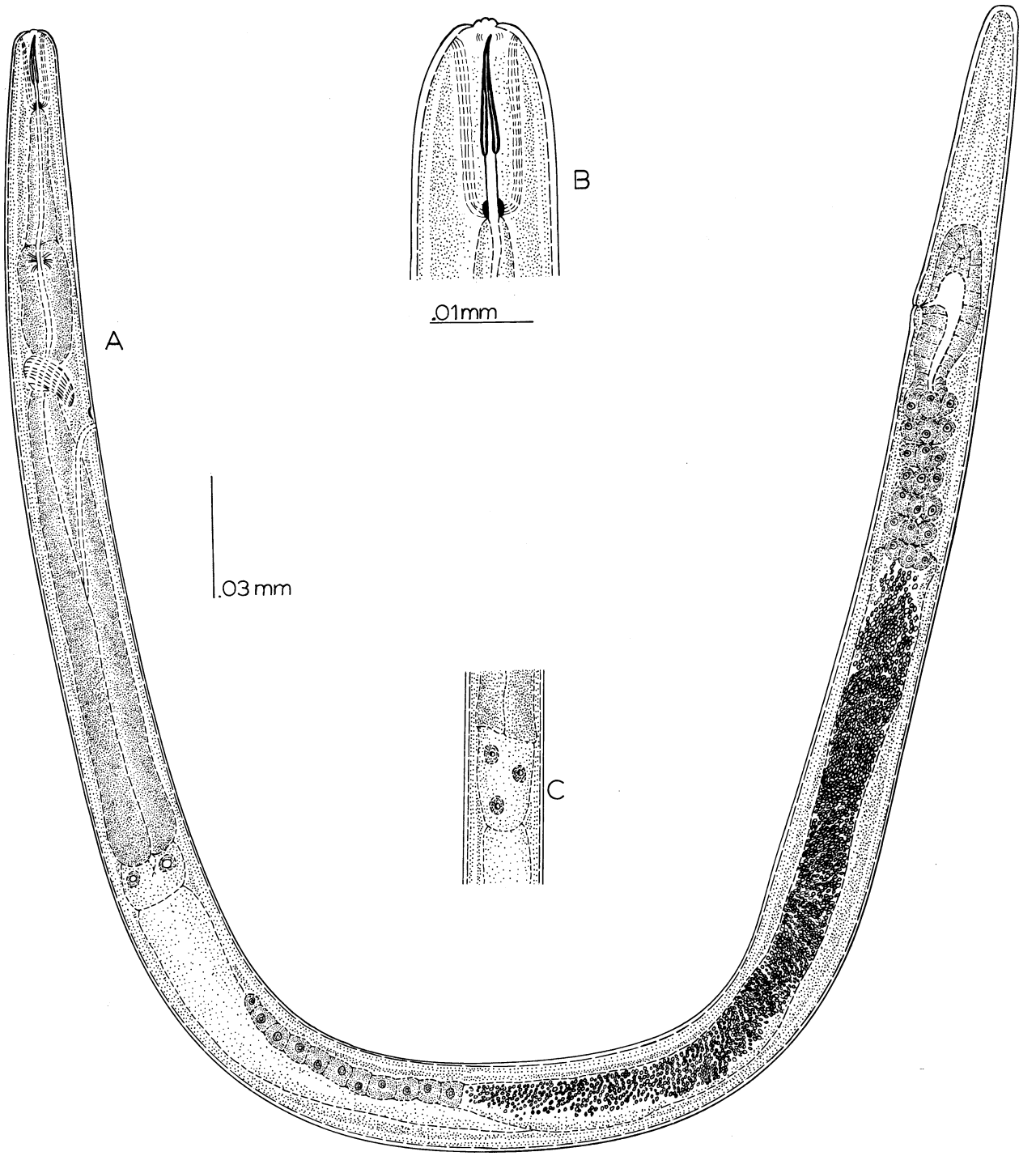


Figure 114.—*Robleus cylindricus* n. sp.: *A.* Female; *B.* head; *C.* dorsal view, posterior end of esophagus.

C. latus (Thorne, 1935) Rühm, 1956
Omemeea Massey, 1971
O. maxbassiensis Massey, 1971
Teragramia n. gen.
T. willi n. sp.
Berntsenus n. gen.
B. brachycephalus (Thorne, 1935) n. comb.
B. labiosus n. sp.
Seinurinae Husain and Khan, 1967
Seinura Fuchs, 1931
S. arizonensis n. sp.
S. attenuata n. sp.
S. pini Massey, 1966

Genus *Aphelenchoides* Fischer, 1894

Body usually long and slender. Cuticle with fine transverse striae, with or without lateral incisures. Lip region offset, the six nonannulated lips supported by hexaradial internal sclerotizations. Stylet with or without basal knobs. Esophagus distinguished by a prominent metacorpus containing well developed crescentic valve plates. Dorsal esophageal glands lobelike and lying free in the body cavity, its orifice in metacorpus. Ovary prodelphic, oocytes arranged in one or more rows. Postuterine branch present or absent. Vulva posterior. Spicules paired. Bursa and gubernaculum absent. Male tail usually ventrally arcuate, with a variable number of papillae.

***Aphelenchoides conophthori* n. sp.** **Figure 115**

Female: 0.48 mm; a=23; b=8.3; c=13.1; V=70%.

Male: 0.55 mm; a=26; b=8.7; c=15.

Body cylindroid. Cuticle marked by 2 lateral incisures, indistinct in many specimens. Transverse striae very faint. Lip region set off, rounded. Cephalic framework sclerotized. Lips distinct. Stylet with prominent triangular basal knobs, 12 μ in length, its retractor muscles indistinct. Metacorpus ovate, valve plates at center, dorsal esophageal gland outlet indistinct. Dorsal esophageal gland long, slender, 5 body widths in length. Nerve ring slightly less than a body width posterior to metacorpus. Excretory pore opposite or slightly anterior to nerve ring. Hemizonid not observed. Lips of vulva slightly elevated. Vagina oblique. Ovary short, oocytes tandem. Postuterine branch 4 body widths in length. Anal opening distinct. Rectum obscure. Tail conoid to a bluntly rounded mucronate terminus.

Male: Body straight. Head, neck and cuticular characteristics similar to female. Testis single, outstretched. Sperm cells exceedingly large. Spicules paired, the dorsal limbs bent near distal end, ventral limb not closing with dorsal limb. Apex high, ventral rostrum short. Tail ventrally arcuate. Two pair of postanal papillae. Terminus mucronate, sharply pointed.

Diagnosis.—Related to *Aphelenchoides sinodendroni* Rühm, 1957; differs in the presence and shape of knobs of stylet and in the shape and character of the male and female terminus. Spicules distinctive.

Type habitat.—Associated with *Conophthorus coniperda* in the cones of eastern white pine.

Type locality.—Hamden, Connecticut.

Type specimens.—Collection No. 78-P.

***Aphelenchoides hylurgi* n. sp.** **Figure 116**

Female: 0.57 mm; a=26.6; b=10.2; c=14.7; V=66%.

Male: Unknown.

Body ventrally arcuate, cylindroid. Without lateral incisures. Transverse striae absent or very faint, only discernible on neck region in some specimens, otherwise cuticle smooth. Lip region set off, rounded. Cephalic framework sclerotized. Lips distinct. Stylet 13 μ in length. Retractor muscles indistinct. Metacorpus almost round, anterior portion glandular, valve plates located posteriorly. Esophageal gland outlet indistinct. Dorsal esophageal gland 4 times body width in length. Nerve ring one-half body width posterior to metacorpus. Excretory pore slightly posterior to nerve ring. Hemizonid not observed. Lips of vulva protuberant, the posterior lip more than anterior. Ovary at times reflexed and reaching to the nerve ring, single, oocytes arranged in a single row. Posterior uterine branch one and one-half body widths in length. Anal opening distinct, rectum obscure. Tail conoid. Terminus 3-pronged, the prongs in various shapes as figured.

Diagnosis.—Related to *Aphelenchoides aligarhensis* Siddiqui, Husain, and Khan, 1957; differs from that species in size and conformation of lateral striae; similar to *A. astero-*

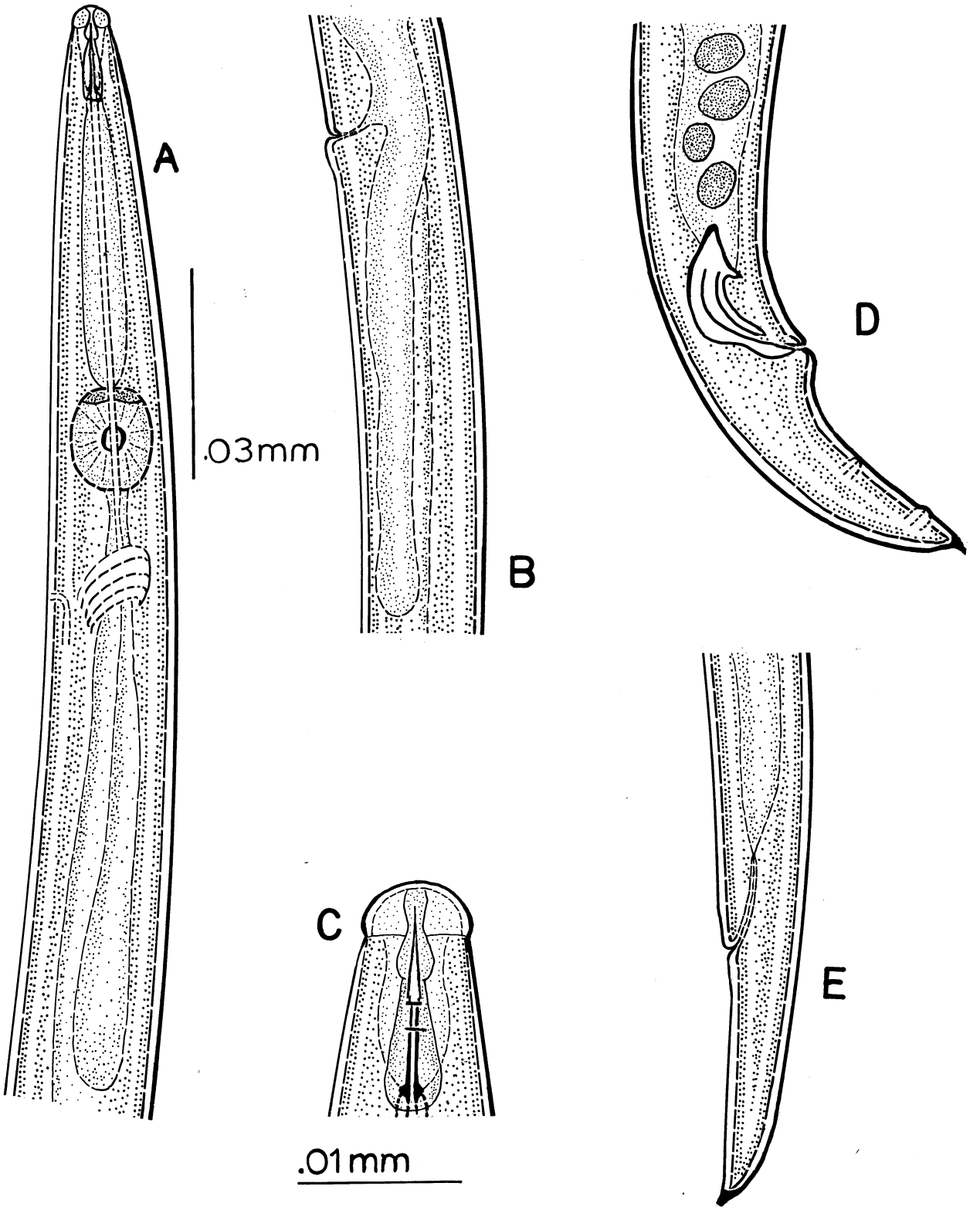


Figure 115.—*Aphelenchoides conophthori* n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* head; *D.* male, tail; *E.* female, tail.

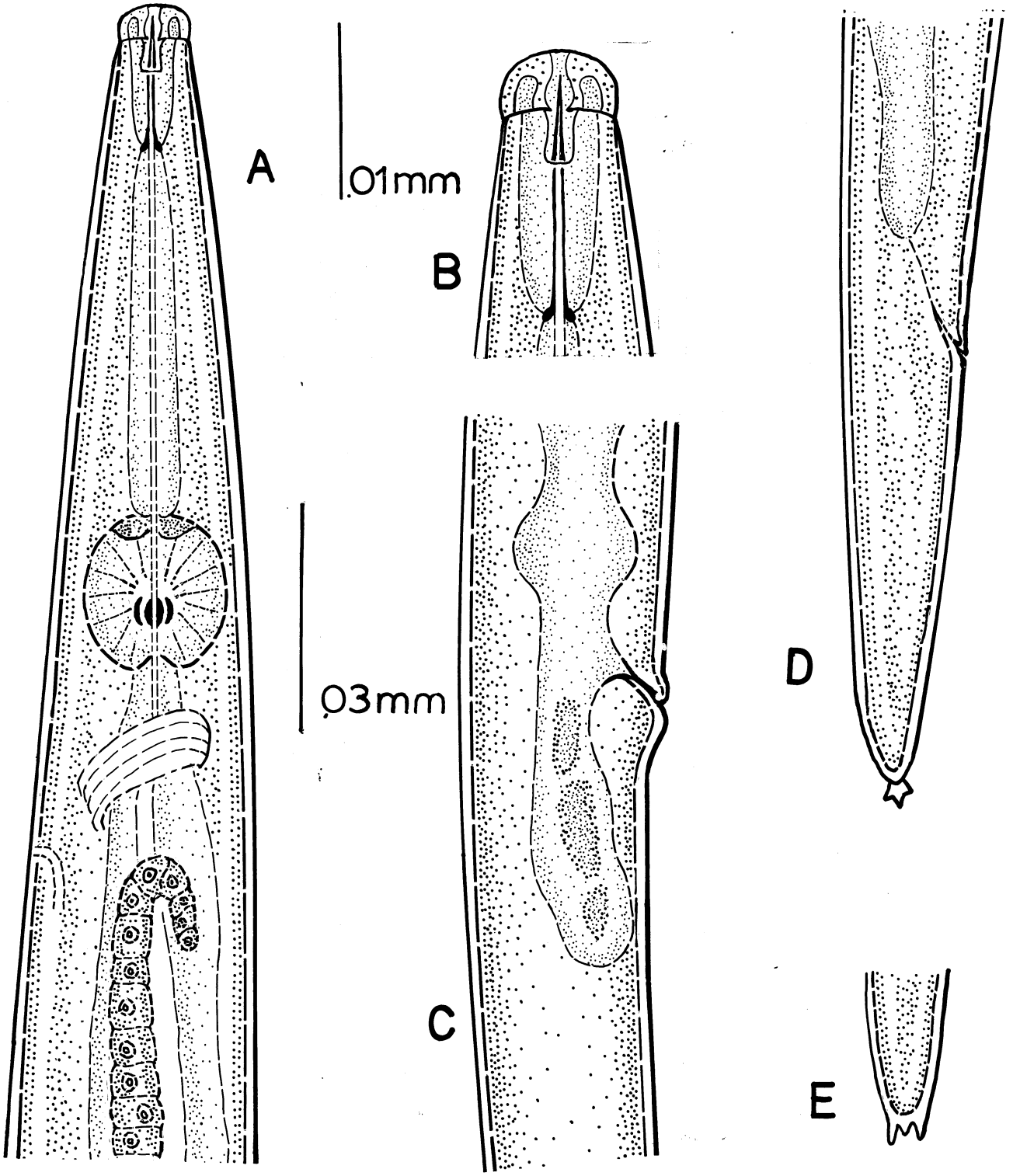


Figure 116.—*Aphelenchoides hylurgi* n. sp.: *A*. Head and neck; *B*. head; *C*. female, midbody; *D-E*. female, tails.

caudatus Das, 1960; differs in absence of lateral incisures. Differs from both species in placement of valve plates in metacorpus.

Type habitat.—Associated with *Hylurgops pinifex* in eastern white pine.

Type locality.—Gorham, Maine.

Type specimens.—Collection No. 78-G.

***Aphelenchoides pityokteini* n. sp.** **Figure 117**

Female: 0.54–0.74 mm; a=28.5–29.6; b=9.5–11.3; c=22.8–24.6; V=72–75%.

Male: 0.54 mm; a=27.2; b=9.1; c=21.8.

Body ventrally arcuate, cylindroid. Lateral incisures absent. Cuticle with moderately fine transverse striae. Lip region set off, rounded. Cephalic framework sclerotized. Lips distinct. Stylet 12 μ in length, with small basal knobs or thickenings, retractor muscles distinct. Metacorpus oblong, ovate; dorsal esophageal gland outlet obscure. Valve plates median. Dorsal esophageal gland slender, 4 body widths in length. Nerve ring one-half body width posterior to metacorpus. Excretory pore opposite nerve ring. Hemizonid not observed. Lips of vulva protuberant, posterior lip protruding more than anterior. Vagina oblique. Ovary outstretched. Oocytes arranged in a double row. Postuterine branch 6 body widths in length, anterior end with a heavily sclerotized pluglike body which may act as a valve for sperm cells stored in postuterine branch. Anal opening and rectum obscure. Tail conoid to a rather sharply rounded terminus.

Male: With cuticular, head, and neck characteristics of female. Testis outstretched. Spicules paired, very heavily sclerotized. Apex low, ventral rostrum short. Tail ventrally arcuate, with a variably shaped terminus, from bluntly rounded to mucronate to sharply pointed. There are 2 pairs of postanal papillae.

Diagnosis.—Closely related to *Aphelenchoides tenuidens* Thorne, 1935. Differs in the absence of lateral incisures and in character of lateral striations.

Rühm, 1956 erred in placing *A. tenuidens* in the genus *Ektaphelenchus*. The shape of the spicules, the presence of a visible anal opening, the fine stylet conformation, and lip shape all preclude its placement in the genus *Ektaphelenchus*.

Type habitat.—Associated with *Pityokteines* sp. infesting corkbark fir.

Type locality.—Sandia Mts., Cibola National Forest, New Mexico.

Type specimens.—Collection No. 78-O (Holotype); 78-N (Allotype).

***Aphelenchoides polygraphi* n. sp.** **Figure 118**

Female: 1.18–1.30 mm; a=41.16–48.33; b=12.6–14.0; c=16.1–21.7; V=69%.

Male: 1.04–1.26 mm; a=39.4–48.2; b=11.8–12.6; c=16.6–19.7.

Body cylindroid. Cuticle finely annulated with 2 lateral incisures. Lip region rounded, set off. Cephalic framework sclerotized. Lips distinct. Stylet 15–16 μ in length, with small basal knobs. Retractor muscles distinct, but weak. Metacorpus spheroid with anterior section glandular. Dorsal esophageal gland distinct, 5–6 body widths in length. Nerve ring ca 1 body width posterior to metacorpus. Excretory pore opposite nerve ring. Lower lip of vulva protuberant. Ovary with oocytes in a single row. Posterior uterine branch 4–5 body widths in length. Sclerotized valvelike organ at juncture of ovary and postuterine branch. Anus and rectum as illustrated. Tail conoid to an acute terminus.

Male: Testis single, outstretched. Spicules massive, with short ventral, obtuse rostrum. One pair of preanal papillae, two pairs of postanal papillae. Tail ventrally arcuate, terminus as in female.

Diagnosis.—Distinctive because of massive spicules and their conformation.

Type habitat.—Associated with *Polygraphus hoppingi* in Engelmann spruce.

Type locality.—Flagstaff, Arizona.

Type specimens.—Collection No. 78-Q.

***Aphelenchoides rhytium* Massey, 1971** **Figure 119**

Females: 0.78–0.94 mm; a=43–48; b=11.7–13.4; c=16–21; V=67%.

Males: 0.70–0.78 mm; a=47–54; b=10.6–13.0; c=19–22.

Cuticle with fine transverse striations. Head broadly rounded, set off by constriction. Stylet 11 μ long, with prominent basal thickenings, muscles well defined under dark field illumination. Metacorpus ovate to oblong ovate. Dorsal esophageal gland slender, ca 6 body widths long. Nerve ring slightly over a body width behind metacorpus. Excretory pore adjacent and

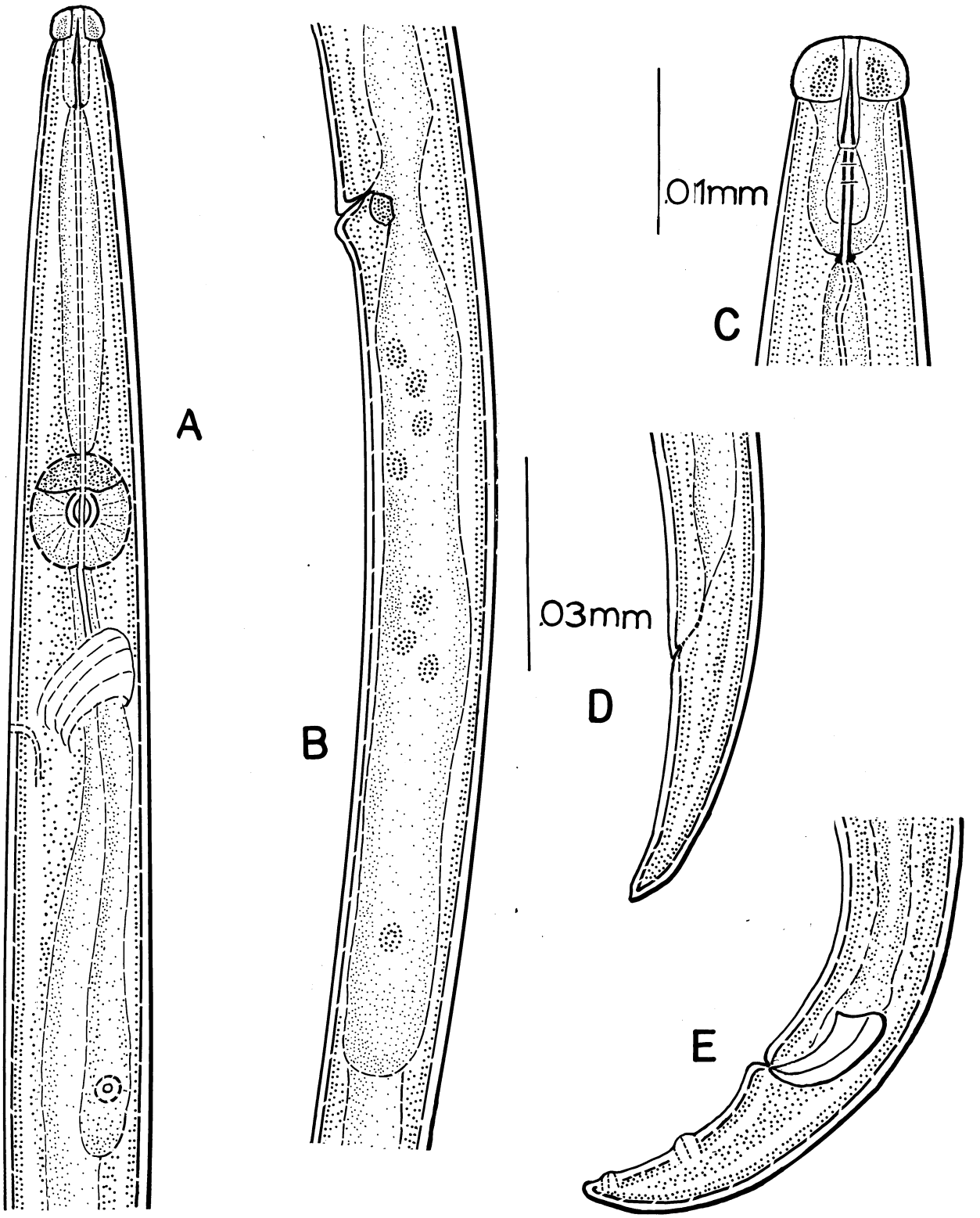


Figure 117.—*Aphelenchoides pityokteini* n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* head; *D.* female, tail; *E.* male, tail.

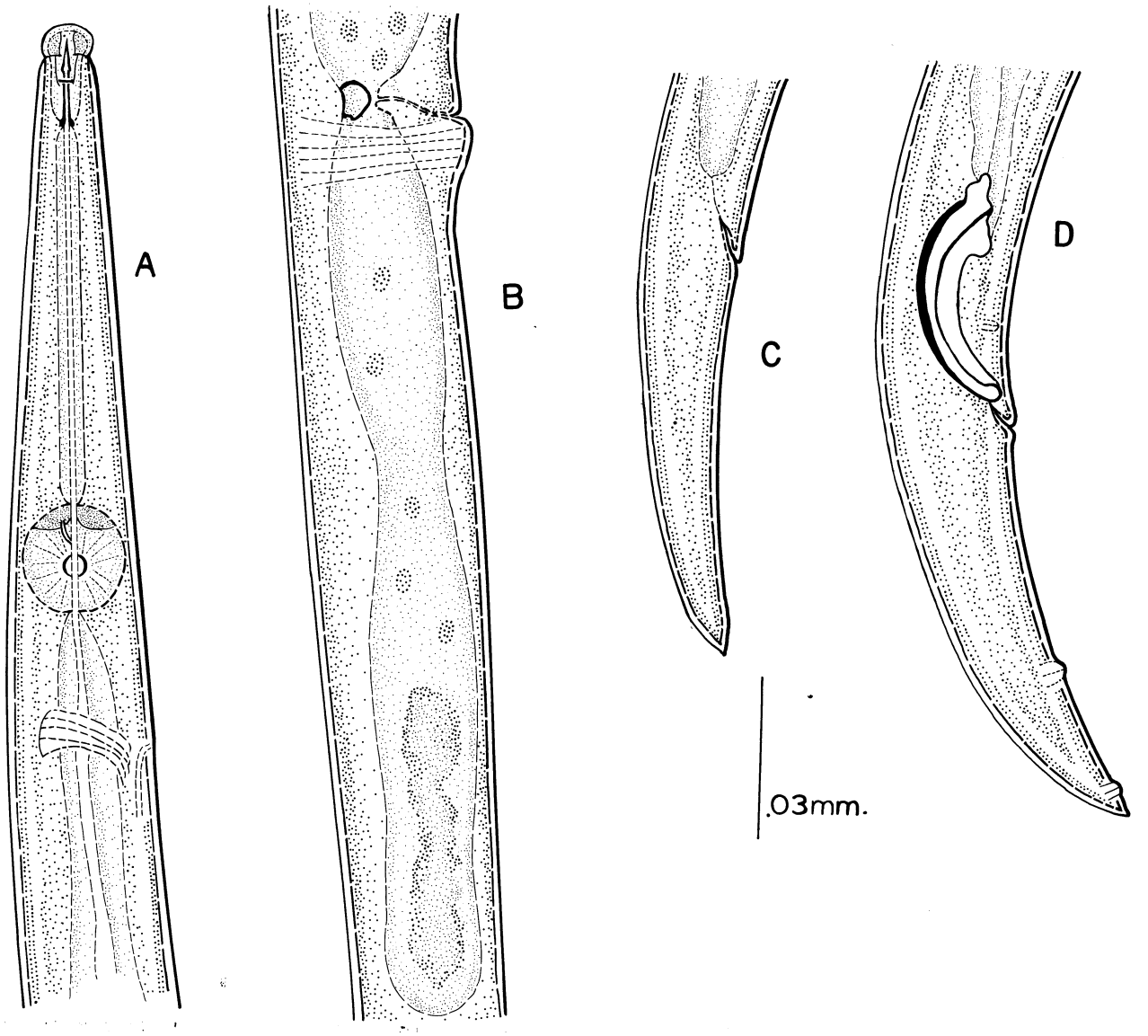


Figure 118.—*Aphelenchoides polygraphi* **n. sp.:** *A.* **Head and neck;** *B.* **female, midbody;** *C.* **female, tail;** *D.* **male, tail.**

slightly posterior to nerve ring. Hemizonid one-half body width posterior to excretory pore. Lips of vulva protuberant. Ovary single, outstretched. Walls of uterus strongly thickened as it enters vagina. Posterior uterine branch 4–6 body widths long. Tail conoid to a unique digitate terminus.

Male: Testis single, outstretched; spicules as figured. Two pair of caudal papillae located as figured. Tail conoid then digitate.

Diagnosis.—Related to *Aphelenchoides hamatus* Thorne and Malek (1968). Differs in general body proportions, absence of lateral incisures, and in the outstretched ovary.

Habitat.—Associated with *Ips calligraphus* in loblolly pine, and with *Chramesus hicoriae* in pignut hickory.

Type locality.—Baker Mills, New York.

Type specimens.—Collection No. 56-T.

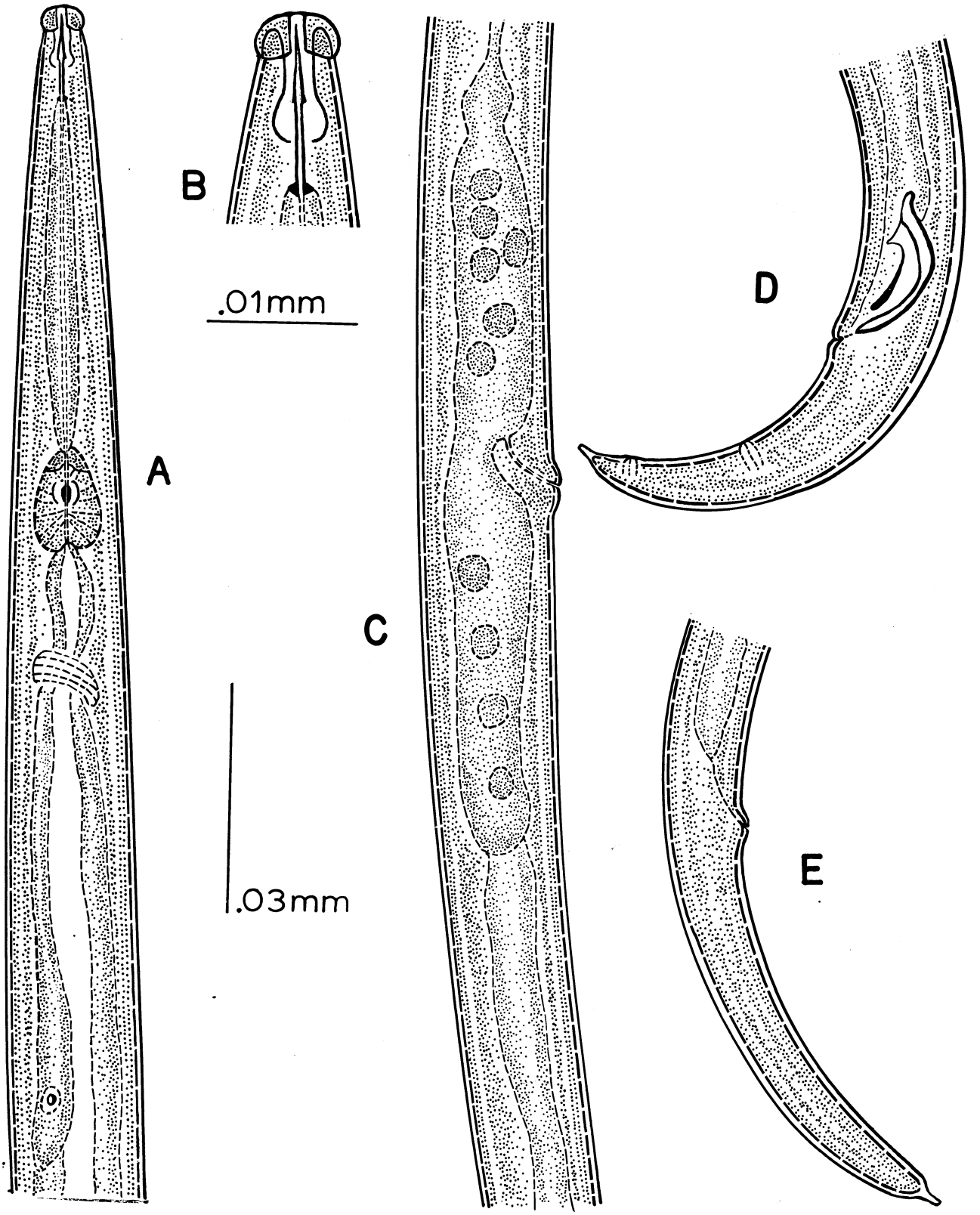


Figure 119.—*Aphelenchoides rhytium* Massey, 1971: *A.* Head and neck; *B. h*ead; *C.* female, midbody; *D.* male, tail; *E.* female, tail.

Aphelenchoides tenuidens Thorne, 1935 Figure 120

Female: 0.8 mm; a=37; b=7.7; c=20; V=75%.

Male: 0.75 mm; a=39; b=7.1; c=15.

Body tapering rapidly anteriorly, the widest at esophageal bulb being 2½ times that of lip region. Female tail 3 times as long as anal body diameter, slightly convex-conoid to the abruptly conoid terminus, which does not bear a distinct mucro. Male tail slightly bent ventrally, terminus mucronate. Four pair of submedian papillae present, 2 pairs preanal and 2 caudal. Spicula about two-fifths as wide as body, arcuate in distal half, proximally almost straight on dorsal side; ventral side flexible when spicula are extruded.

Distinct striations of the cuticle interrupted by a wing area, which near middle of nema is about one-eighth as wide as body. Lip region amalgamated, caplike, set off by constriction. Vestibule well cuticularized. Spear very slender, its length almost twice width of lip region, with obscure basal swellings. In living specimens distinct joint observed near middle of spear. Esophageal bulb ovate, with strong musculature, a little more than half as wide as neck; nerve ring one bulb length behind bulb. Excretory pore slightly back of nerve ring. Intestines densely granular. Ovary outstretched, sometimes almost reaching esophagus. Posterior uterine branch reaching one-half to three-fourths the distance to anus. Eggs half as wide as body; 2½ times as long as wide. Testis usually outstretched, occasionally reflexed a short distance.

Diagnosis.—Aphelenchoides. Spear twice as long as width of lip region, with obscure basal swellings. Male terminus with mucro, female terminus without mucro. Spicula two-fifths as wide as body, proximally almost straight on dorsal side, ventrally slender, flexible. Male caudal papillae arranged as shown in figure.

Associate of *Dendroctonus ponderosae.*

Genus *Bursaphelenchus* Fuchs, 1937

Synonym: *Aphelenchoides* (*Bursaphelenchus*) (Fuchs, 1937) Rühm, 1956

Type species: *Bursaphelenchus piniperdae* Fuchs, 1937

Male tail with thin sclerotized terminal extension forming a spadelike clasping organ, at times multi-pronged. Spicules variable in shape. Lip region well set off, with well sclerotized framework. Stylet plain or with moderately developed basal thickenings. Metacorpus ovate, with crescentic valve plates at or near center, the anterior portion glandular. Ovary outstretched or reflexed, with oocytes arranged in one to several rows. Posterior uterine branch usually elongate and acting as a store for spermatozoa.

Bursaphelenchus bestiolus n. sp. Figure 121

Female: 0.83 mm; a=31.8; b=12.2; c=17; V=74%.

Male: 0.67 mm; a=32; b=10.7; c=18.3.

Body cylindroid, ventrally arcuate. Cuticle with fine transverse striae, without lateral incisures. Lip region set off, rounded. Cephalic framework sclerotized. Stylet 13–14 μ, slender, without basal knobs, retractor muscles distinct. Metacorpus elongate, ovate, the anterior one-third glandular. Dorsal esophageal gland 3–5 body widths in length. Nerve ring two-thirds body width posterior to metacorpus. Excretory pore and hemizonid not observed. Ovary outstretched, the oocytes arranged in 3 rows. Anterior lip of vulva modified into protective flap. Posterior uterine branch 8–9 body widths in length. Anus and rectum visible, but indistinct. Tail conoid to a sharply rounded terminus.

Male: Testis outstretched. Spicules paired, shaped as figured, reaching almost to dorsal body wall, ventral rostrum relatively short. There are 3 pairs of ventrosubmedian papillae, 1 pair preanal, 2 pairs postanal. Tail ventrally arcuate to a claw-shaped terminus.

Diagnosis.—Closely related to *Bursaphelenchus talonus* (Thorne, 1935) J. B. Goodey, 1960; varies in the shape of the spicules and in the presence of the vulva flap.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 28-R.

Bursaphelenchus corneolus Massey, 1966 Figure 122

Female: 0.65–0.70 mm; a=29; b=10.5; c=18.5; V=73%.

Male: 0.57–0.70 mm; a=35; b=10.5; c=18.5.

Cuticle nearly smooth, transverse striations very faint. Head caplike, lips distinct. Stylet

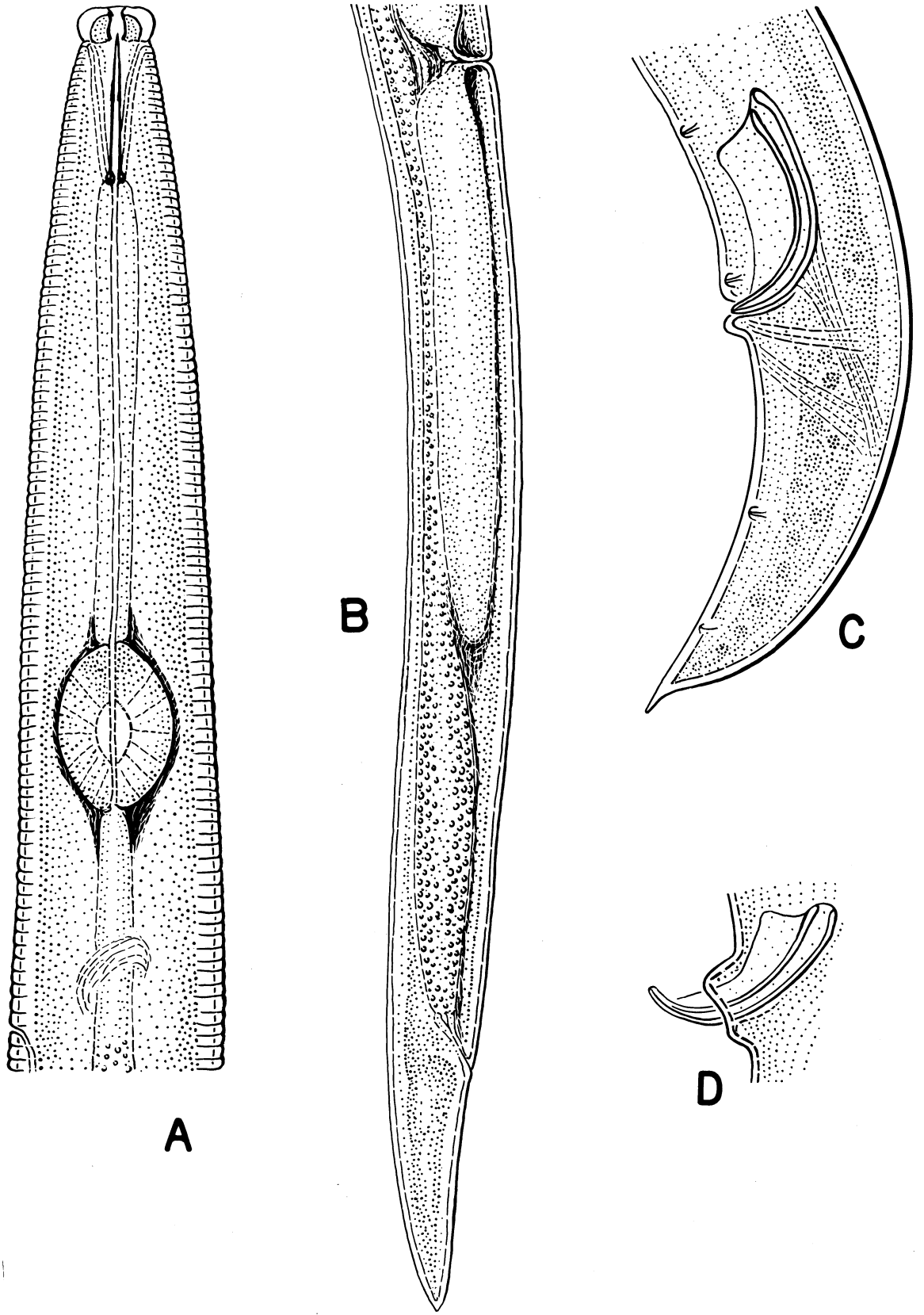


Figure 120.—*Aphelenchoides tenuidens* Thorne, 1935: *A.* Head and neck; *B.* female, tail; *C.* male, tail; *D.* spicule. (After Thorne, 1935).

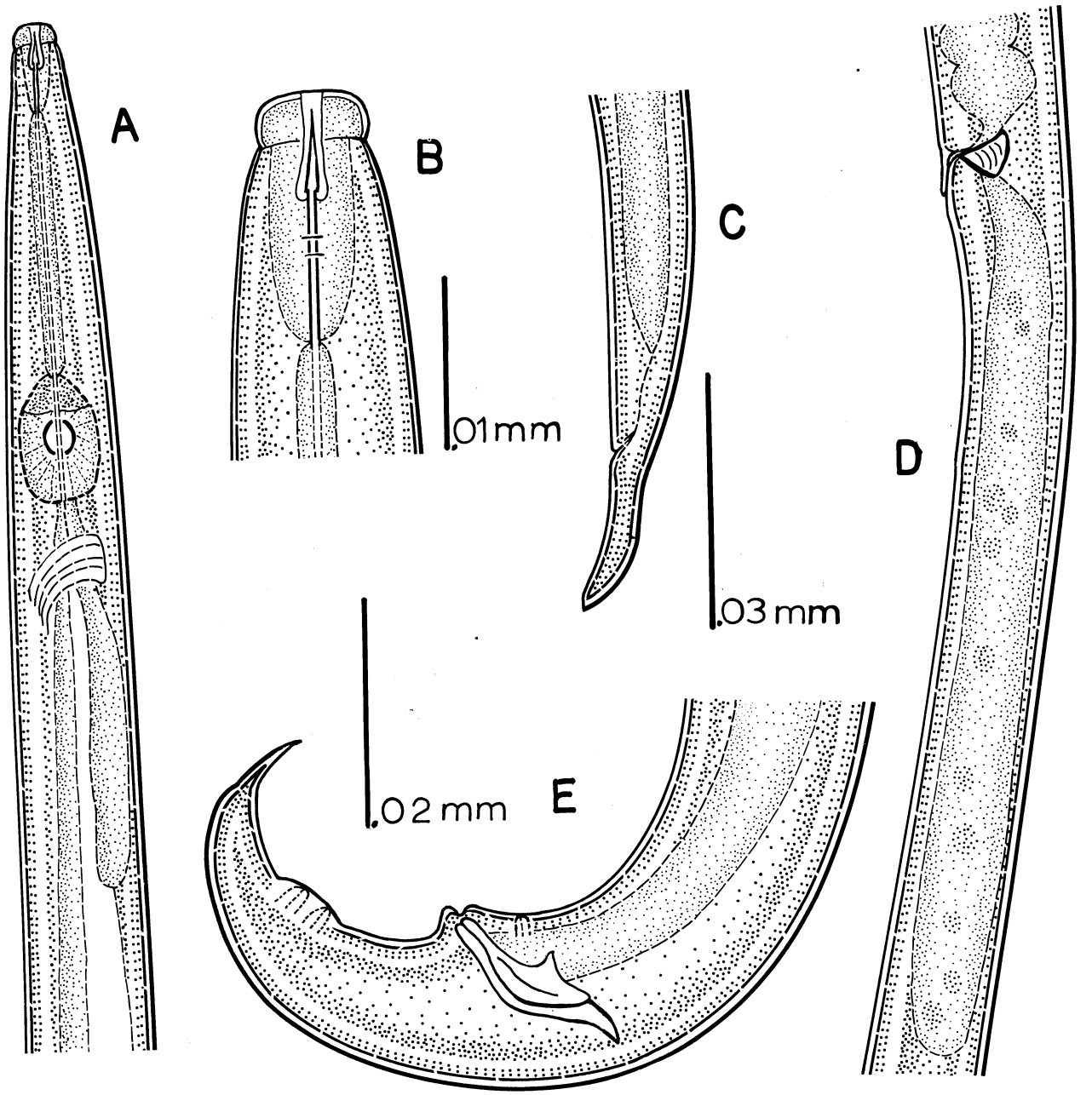


Figure 121.—*Bursaphelenchus bestiolus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* female, midbody; *E.* male, tail.

without basal knobs or thickenings. Median bulb of esophagus slightly longer than wide in lateral view; esophageal gland length over 3 times body width. Nerve ring immediately posterior to median bulb. Excretory pore 1 body width posterior to nerve ring. Hemizonid immediately posterior to excretory pore. Ovary outstretched, reaching beyond posterior end of esophageal glands. Sperm duct packed with spermatozoa; posterior uterine branch reaching to within 2 body widths of anal opening, packed with spermatozoa. Vulva covered by a cuticular flap. Tail hooked as figured.

Male: Testis single, reflexed at times as much as 3 body widths. Spicula relatively short.

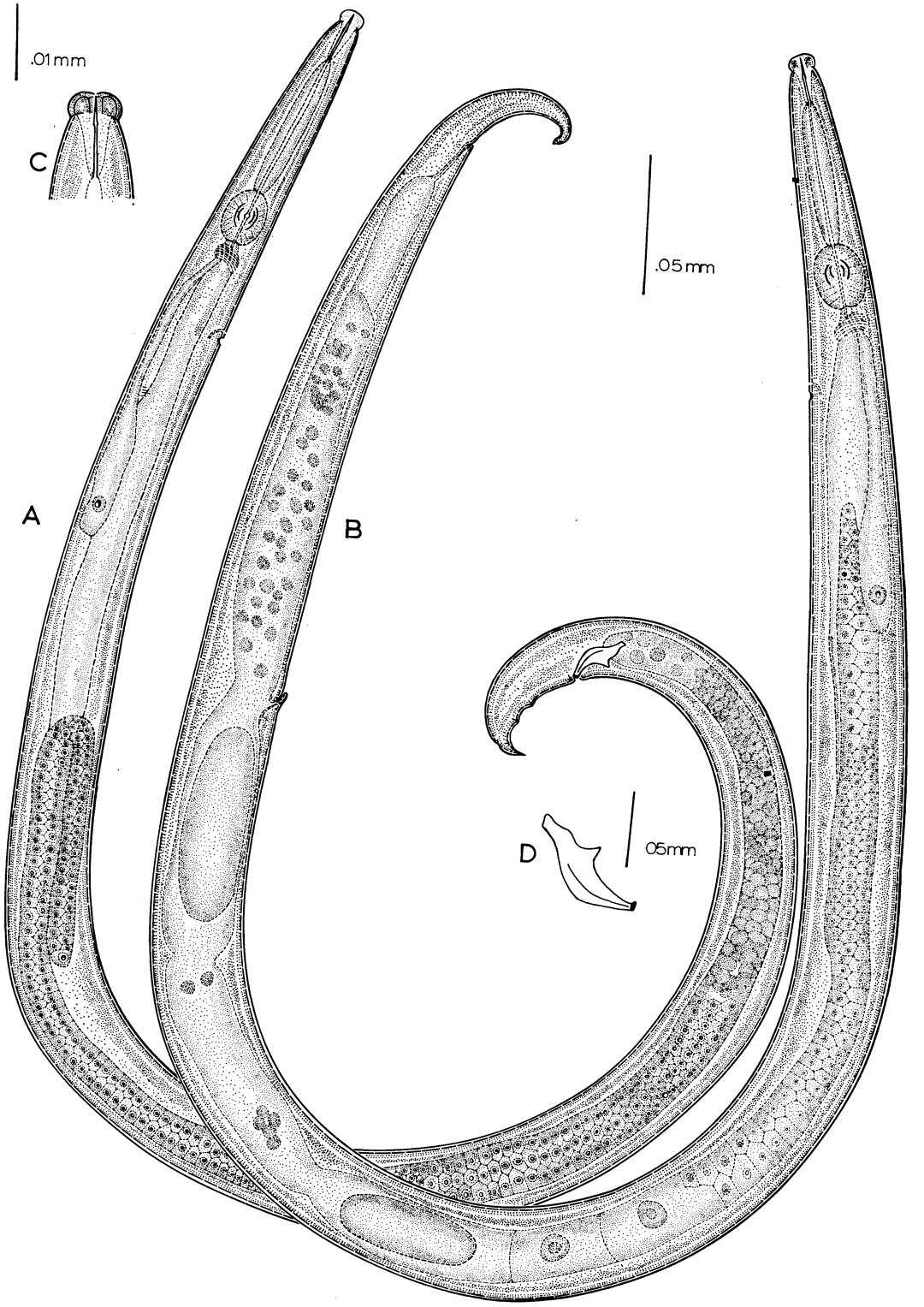


Figure 122.—***Bursaphelenchus corneolus*** **Massey, 1966: *A.* Male; *B.* female; *C.* head; *D.* spicula.**

Three pairs of postanal ventrosubmedian papillae. Tail hooked; with spadelike terminus.

Diagnosis.—Closely related to *Bursaphelenchus eggersi* (Rühm, 1956) Goodey, 1960. *B. corneolus* differs in smaller size of female, presence of vulval flap, and size and shape of spicula.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 37-L.

***Bursaphelenchus elytrus* Massey, 1971** **Figure 123**

Female: 0.89–0.96 mm; a=35–41; b=9.6–11.6; c=17–21; V=73%.

Male: 0.83–1.04 mm; a=41–52; b=10.4–14.2; c=21–26.

Cuticle with very faint transverse striations. Lip region set off by constriction, lips distinct. Stylet 15 μ long, with basal thickenings. Metacorpus oblong ovate. Dorsal esophageal gland 4–5 body widths long. Excretory pore opposite metacorpus. Nerve ring slightly over one-half body width posterior to metacorpus. Hemizonid opposite nerve ring. Lips of vulva only slightly elevated. Ovary relatively short, outstretched. Posterior uterine branch 7–8 body widths long. Tail conoid to a narrowly rounded or acute terminus, sclerotized.

Male: Testis outstretched, spicules uniquely shaped for genus, with sharply pointed ventral rostrum, tip of dorsal limb obscure, with a short rounded projection as it joins transverse bar. Three pairs of caudal papillae located as figured. Terminus acute.

Diagnosis.—Differs from other species in genus in shape and conformation of spicules.

Habitat.—Associated with *Hylurgops pinifex* in red pine and in eastern white pine.

Type locality.—Hamden, Connecticut.

Type specimens.—Collection No. 56-W.

***Bursaphelenchus newmexicanus* n. sp.** **Figure 124**

Female: 1.5 mm; a=40.4; b=14.2; c=28.1; V=73%.

Male: 1.25 mm; a=47.4; b=13.2; c=26.3.

Body cylindroid. Cuticle with very fine transverse striae, no lateral incisures. Lip region set off, rounded. Cephalic framework sclerotized. Stylet fine, without basal knobs, 15 μ in length; retractor muscles distinct. Median bulb elongate-spheroid, anterior one-fifth glandular. Dorsal esophageal gland outlet obscure. Dorsal esophageal gland 4 body widths in length. Nerve ring two-thirds body width posterior to median bulb. Excretory pore immediately posterior to median bulb. Ovary outstretched. Oocytes arranged in 3 rows. Anterior lip of vulva modified into flap. Posterior uterine branch massive, 6–7 body widths in length and usually packed with sperm cells. Anal opening distinct. Rectum appearing as a thin line in lateral view. Tail conoid to a narrowly rounded terminus.

Male: Testis outstretched, Spicules paired, with short ventral rostrum, the apices modified into a knob. Tail ventrally arcuate with 2 pairs of papillae, 1 pair immediately preanal, 1 pair postanal. Terminus 3-pronged, the outer prongs acute, the center prong somewhat shorter and less acute.

Diagnosis.—Related to *Bursaphelenchus elytrus*. Differs in the shape of spicules and in the form and conformation of male terminus.

Type habitat.—Associated with *Hylurgops* sp. in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 37-U.

***Bursaphelenchus pityogeni* n. sp.** **Figure 125**

Female: 0.94 mm; a=30; b=13.8; c=25.7; V=73%.

Male: 0.82 mm; a=31; b=12.1; c=22.4.

Body cylindroid. Cuticle with 2 lateral incisures, transverse striae fine. Lip region rounded, lips distinct. Cephalic framework sclerotized. Stylet 14–15 μ in length, with small basal knobs or thickenings; retractor muscles distinct. Dorsal esophageal gland outlet obscure. Median bulb oblong, anterior one-eighth glandular. Dorsal esophageal gland approximately 3 body widths in length. Nerve ring two-thirds body width posterior to metacorpus. Excretory pore immediately posterior to metacorpus. Hemizonid not observed. Vulva with distinct flap, lips slightly elevated. Ovary outstretched with oocytes arranged in 3 rows. Posterior uterine branch massive, filling body cavity, 5–6 body widths in length. Anal opening distinct. Rectum appearing as a fine line. Tail conoid to a small rounded terminus.

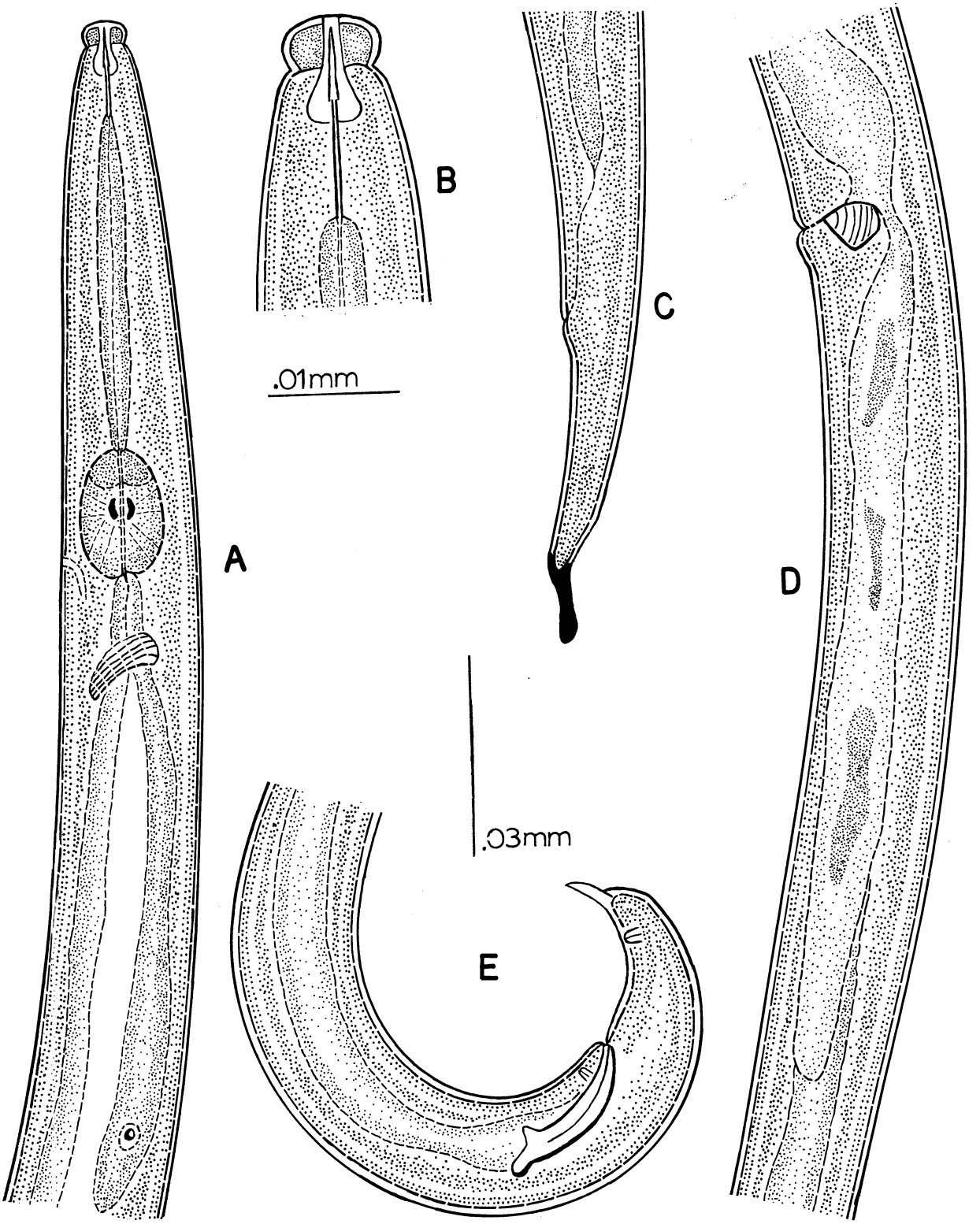


Figure 123.—*Bursaphelenchus elytrus* Massey, 1971: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* female, mid-body; *E.* male, tail.

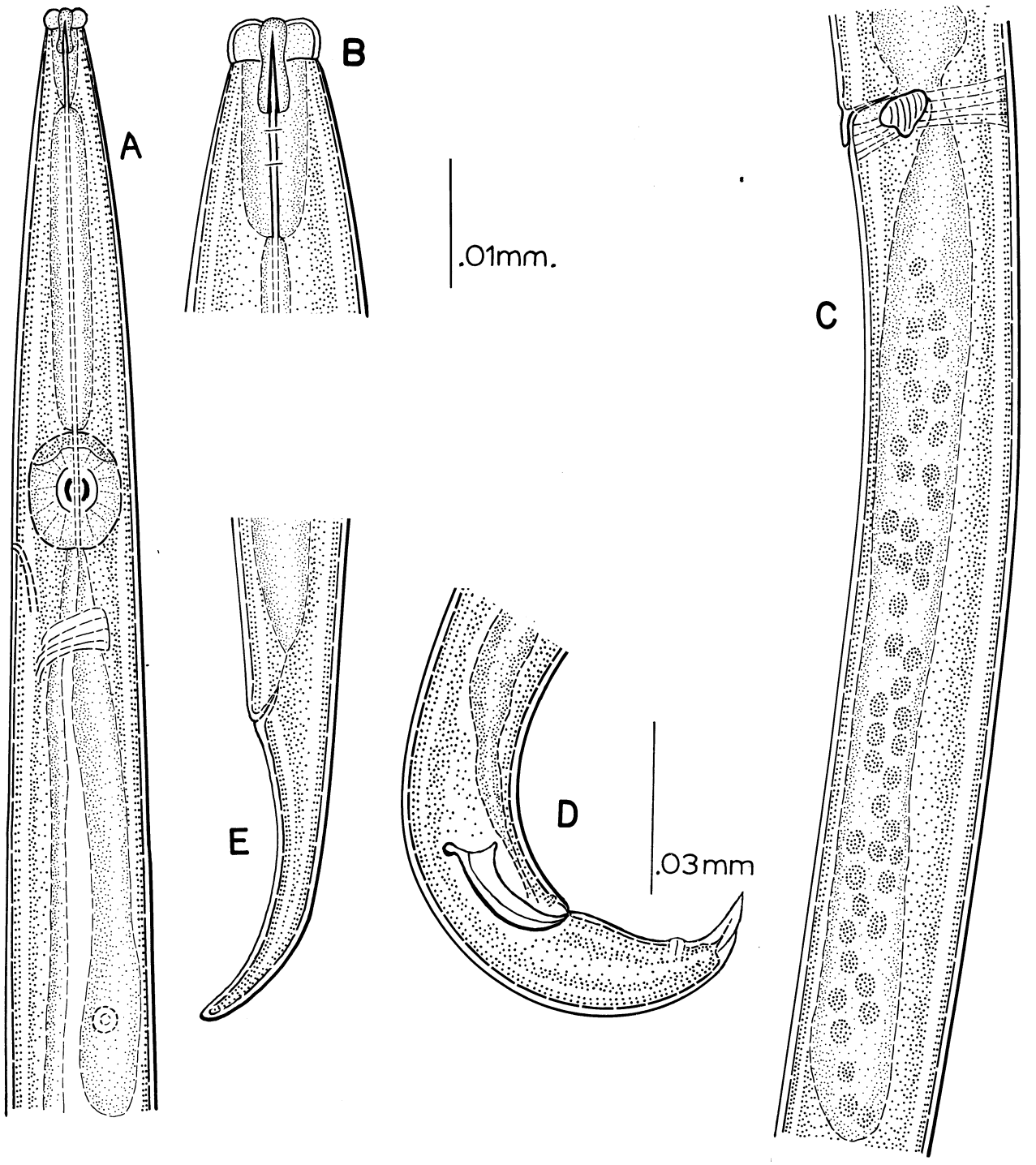


Figure 124.—*Bursaphelenchus newmexicanus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, midbody; *D.* male, tail *E.* female, tail.

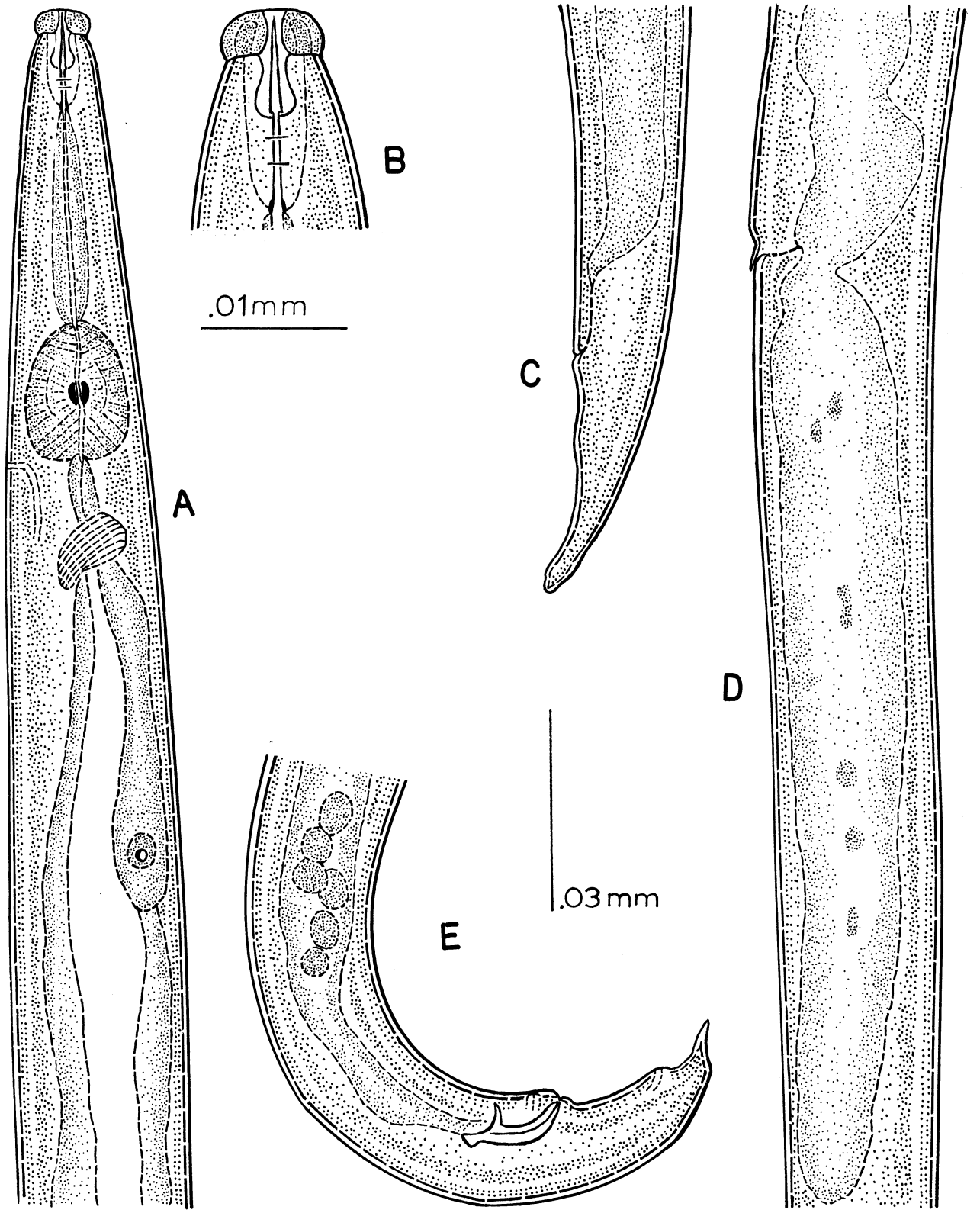


Figure 125.—*Bursaphelenchus pityogeni* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* female, midbody; *E.* male, tail.

Male: Testis outstretched. Sperm cells relatively large. Spicules paired, ventral rostrum elongate, sharply pointed. Apex squared, hammerlike in lateral view. Two pairs of ventral papillae, 1 pair preanal, 1 pair postanal. Terminus sharply pointed.

Diagnosis.—Differs from other species in presence of lateral incisures.

Type habitat.—Associated with *Pityogenes carinulatus* (Lec.) in ponderosa pine.

Type locality.—Mt. Taylor, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 56-J.

***Bursaphelenchus scolyti* n. sp.** **Figure 126**

Female: 0.84 mm; a=40; b=12.3; c=20; V=72%.

Male: 0.80 mm; a=38; b=11.7; c=25.3.

Body cylindroid. Cuticle relatively smooth, with faint transverse striae. No lateral incisures. Lip region set off, rounded. Lips and cephalic framework distinct. Stylet slender, 11.5 μ in length, with small basal knobs or swellings, retractor muscles indistinct. Metacorpus oblong ovate, anterior one-eighth to one-fourth glandular. Dorsal esophageal gland outlet indistinct. Dorsal esophageal gland over 5 body widths in length. Nerve ring three-fourths body width posterior to metacorpus. Excretory pore opposite nerve ring. Hemizonid not observed. Lips of vulva protuberant. Ovary outstretched; oocytes arranged in a single row. Posterior uterine branch large, up to 7 body widths in length, filling entire body cavity and acting as a storage compartment for relatively large sperm. Anus and rectum indistinct. Tail conoid, elongate, to a finely rounded terminus.

Male: With head and neck characteristics of female. Testis single, outstretched, relatively short. Spicules paired with thornlike apex extending toward dorsal body wall, ventral rostrum slender, elongate. Two pair of postanal ventrosubmedian papillae. Tail extremely ventrally arcuate. Terminus 3-pronged, center prong bluntly rounded, outer prongs to an acute point, claw-like in lateral view.

Diagnosis.—Distinctive because of comparatively short stylet, long slender tail of female, and shape and conformation of spicules.

Type habitat.—Associated with *Scolytus multistriatus* in American elm.

Type locality.—Ft. Collins, Colorado.

Type specimens.—Collection No. 19-E.

***Bursaphelenchus talonus* (Thorne, 1935) J. B. Goodey, 1960** **Figure 127**

Female: 0.8 mm; a=33; b=8.3; c=25; V=73%.

Male: 0.8 mm; a=47; b=10; c=25.

Anteriorly body is slightly convex-conoid to the amalgamated, truncate, definitely set off lip region, which is one-third as wide as the neck at the bulb. Female tail convex-conoid to the blunt, rounded terminus, which bears no mucro. Male tail ventrally arcuate, ending in cuticular, talonlike terminus. Spear slender, without basal knobs, its length equal to twice the width of the lip region. Vulva with slightly elevated labia. Ovary extending forward, then reflexed a short distance. Posterior uterine branch reaching three-fourths the way to the anus. Eggs 2 to 2½ times as long as body width. Testis reflexed a short distance.

Diagnosis.—*Bursaphelenchus* with above measurements. Male with "mitten-shaped" spicula and cuticular talonlike terminus. Female tail conoid to the blunt rounded terminus, which bears no mucro. Lip region amalgamated, definitely set off. Spear without basal knobs, its length equal to twice width of lip region.

Associate of *Dendroctonus ponderosae.*

***Bursaphelenchus tritrunculus* n. sp.** **Figure 128**

Female: 0.65 mm; a=29.2; b=9; c=11.4; V=71%.

Male: 0.65 mm; a=29; b=9; c=23.4.

Body cylindroid. Cuticle with moderately prominent transverse striae, especially visible at neck region and between anus and terminus. No lateral incisures. Lip region barely set off, rounded. Cephalic framework sclerotized. Stylet fine, 13 μ in length, without basal knobs, retractor muscles distinct. Metacorpus ovate, anterior one-third glandular. Dorsal esophageal gland outlet obscure. Dorsal esophageal gland 3–4 body widths in length. Nerve ring immediately posterior to metacorpus. Excretory pore opposite nerve ring. Hemizonid not observed. Ovary at times reflexed, oocytes arranged in a double row. Posterior uterine branch 3–4 body widths in length and usually containing numer-

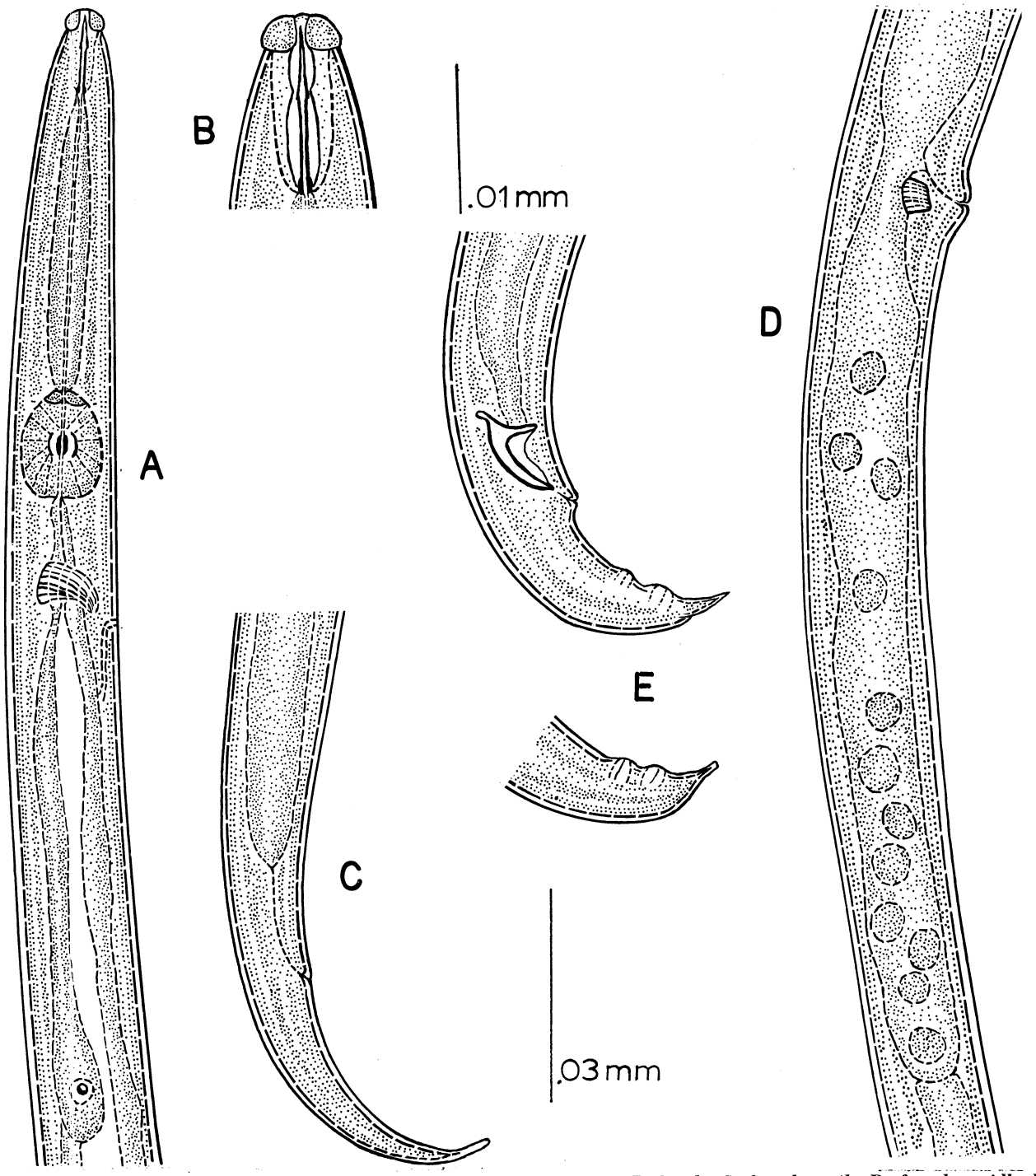


Figure 126.—***Bursaphelenchus scolyti*** **n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* female, midbody; *E.* male, tails.**

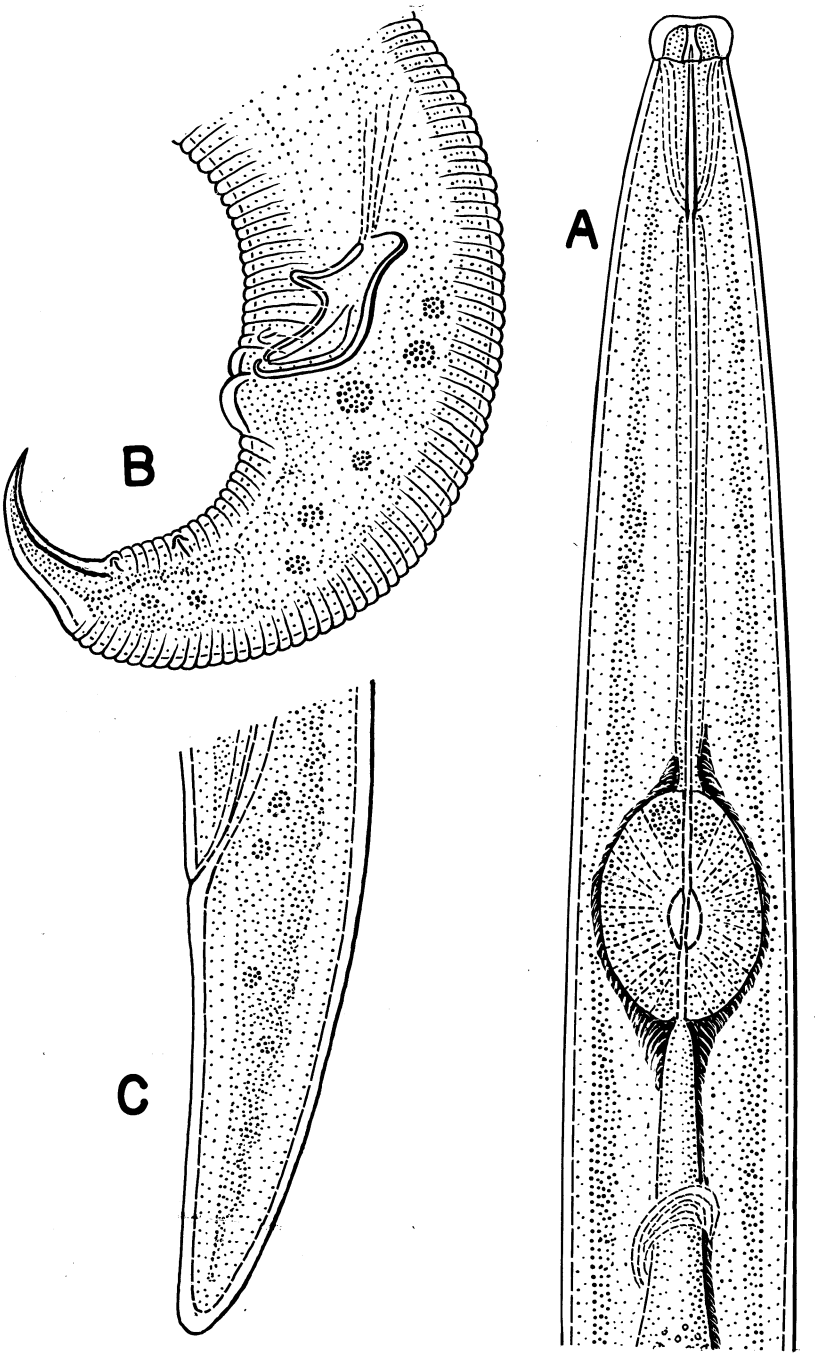


Figure 127.—*Bursaphelenchus talonus* (Thorne, 1935) J. B. Goodey, 1960: *A.* Head and neck; *B.* male, tail; *C.* female, tail. (After Thorne, 1935).

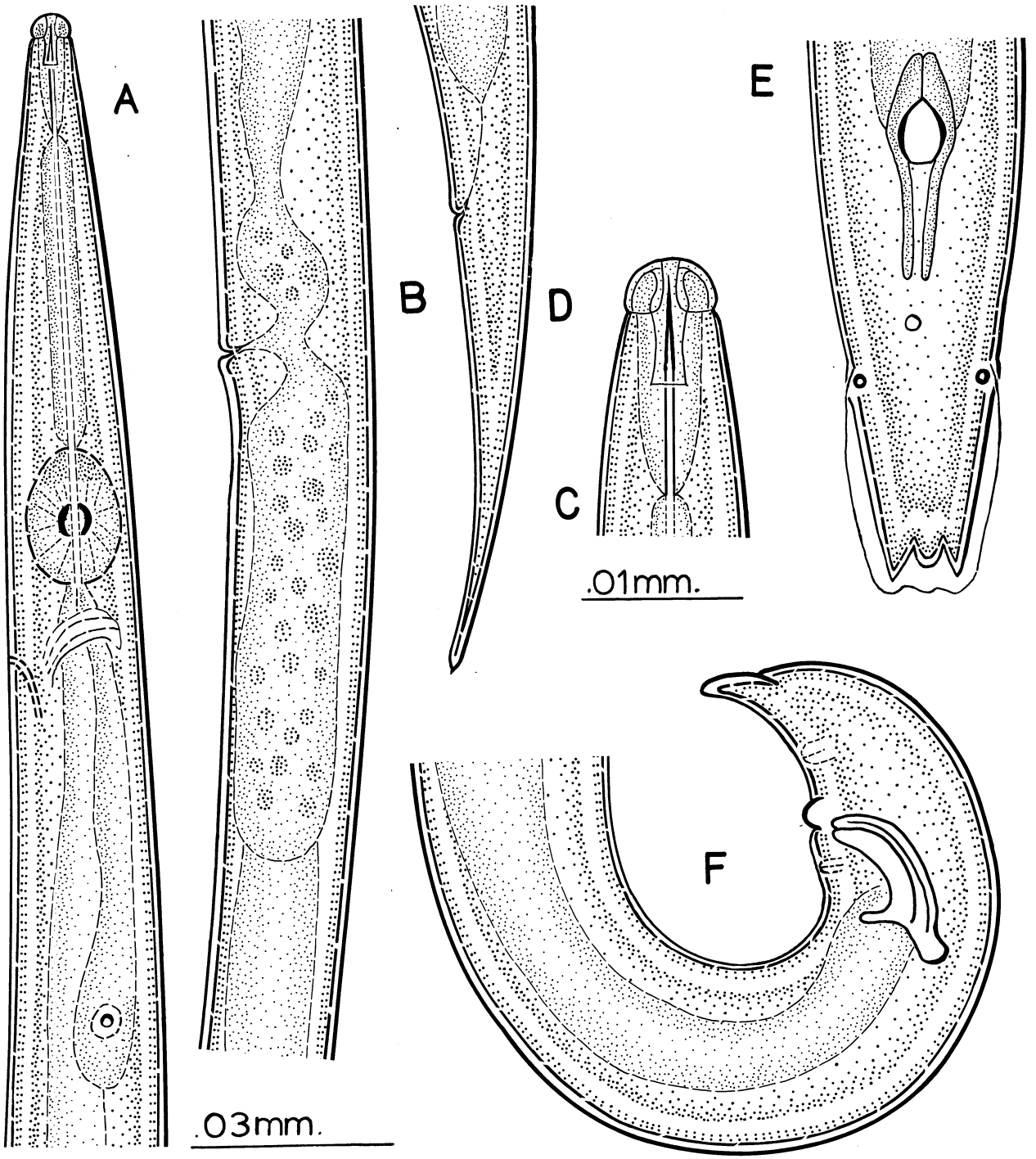


Figure 128.—***Bursaphelenchus tritrunculus*** **n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* head; *D.* female, tail; *E.* ventral view, male, tail; *F.* lateral view, male, tail.**

ous sperm cells. Anus and rectum indistinct. Tail attenuated to an acute terminus.

Male: Testis single, outstretched, relatively short. Spicules with apices broadly rounded, and a prominent, obtuse ventral rostrum. There are two pairs of caudal papillae, 1 pair preanal, 1 pair postanal. Tail ventrally arcuate. Terminus spadelike, the outer edges semiacute, the inner core obtuse.

Diagnosis.—Especially distinctive as it bears characteristics commonly found in the genus *Cryptaphelenchus* as they relate to the head and to the spicula.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Nacogdoches, Texas.

Type specimens.—Collection No. 79-C.

***Bursaphelenchus wilfordi* Massey, 1964** **Figure 129**

Female: 0.9 mm; a=60; b=15; c=27; V=70%.

Male: 0.67–0.75 mm; a=61; b=10; c=26.

Cuticle smooth. Lip region expanded, caplike. Spear slender, without basal knobs, obscure in many specimens. Median bulb of esophagus symmetrically oval. Dorsal esophageal glands prominent, approximately 4 body widths in length. Nerve ring conspicuous, one-half body width posterior to median bulb. Excretory pore and hemizonid not observed. Ovary outstretched, at times nearly reaching to esophageal gland. Postuterine branch elongate, extending nearly to the anal opening, sperm cells present in both uterus and postuterine branch. Tail conoid to a subacute terminus as figured.

Male: Testis reflexed. Spicula mitten shaped, the distal end almost square in lateral view. Three pairs of ventrosubmedian caudal papillae: 1 preanal; 2 postanal, 3 postanal immediately posterior to number 2. Terminus spadelike, sclerotized.

Diagnosis.—*Bursaphelenchus wilfordi* is closely related to *B. cryphali* (Fuchs, 1930) J. B. Goodey, 1960, and *B. crenati* (Rühm, 1956) J. B. Goodey, 1960. It differs in its smaller size, shape of spicula, and length of the postuterine branch.

Type habitat.—Associated with *Scolytus ventralis* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 37-F.

Genus *Laimaphelenchus* Fuchs, 1937 Emended

Type species: *Laimaphelenchus moro* Fuchs, 1937

Aphelenchoidinae: Terminus in both sexes stalked, bearing suckerlike tubercles or irregular projections. Ovary single, with oocytes arranged in a single row. Postuterine branch rudimentary to several body widths in length. Vulva with or without vulval flap. Stylet plain or with well developed basal knobs. Metacorpus ovate, the dorsal esophageal glands well developed.

Key to the *Laimaphelenchus* associated with bark beetles in the United States

1. Terminus stalked, bearing suckerlike tubercles in both sexes	2
Terminus stalked, bearing irregular projections in both sexes	*pannocaudus*
2. Vulva with flap	3
Vulva without flap	*phloeosini* n. sp.
3. Spicules strongly ventrally arcuate, ventral rostrum distinct, spicules less than 30 μ	*penardi*
Manubrium of spicules projected into indistinct ventral rostrum, spicules more than 30 μ	*pensobrinus*

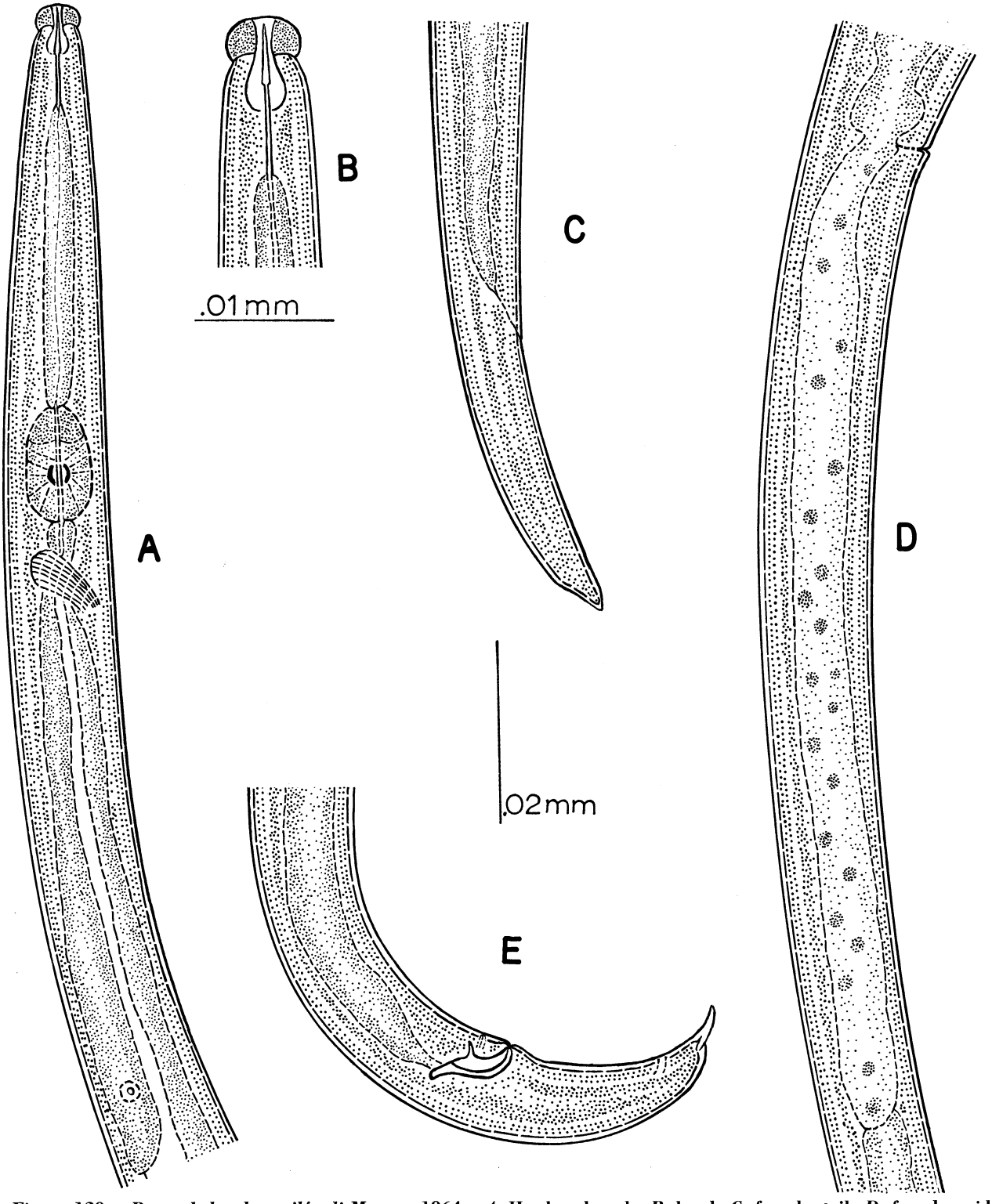


Figure 129.—*Bursaphelenchus wilfordi* Massey, 1964.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* female, mid-body; *E.* male, tail.

***Laimaphelenchus pannocaudus* Massey, 1966 Figure 130**

Female: 0.79–0.86 mm; a=50; b=13; c=23; V=70%.

Male: 0.65–0.78 mm; a=50; b=13; c=22.

Body slender. Cuticle with very faint transverse striations. Head rounded, set off, lips approximately twice as wide as deep. Stylet with prominent basal knobs. Median bulb of esophagus ovate, nearly spheroid. Nerve ring a body width posterior to median bulb. Excretory pore anterior to nerve ring. Hemizonid not observed. Dorsal esophageal gland 6 times body width in length. Ovary outstretched, reaching nearly to distal ends of esophageal glands, posterior uterine branch 3–6 body widths in length, uterus filled with granular, circular spermatozoa. Vulva slightly elevated. Terminus ragged in appearance with bristlelike protuberances.

Male: Testis outstretched, almost reaching posterior end of esophageal glands. Spicula arcuate with low rostrum. Tail semicircular, with 1 pair of postanal caudal papillae. Terminus as in the female.

Diagnosis.—This species is closely related to *Laimaphelenchus lignophilus* (Korner, 1954) J. B. Goodey, 1960. It differs in its smaller size, number of male caudal papillae, and absence of a bursa.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 37-K.

***Laimaphelenchus penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941 Figure 131**

Synonyms: *Aphelenchus penardi* Steiner, 1914
Aphelenchoides penardi (Steiner, 1914) Filipjev, 1934

Specimens of *Laimaphelenchus* very similar to *L. penardi* have been collected in association with several species of bark beetles throughout the United States. Steiner's original description of the species is quite meager. Type specimens are not available for study; it may be that the species being designated as *penardi* in collections throughout the country may be something quite different. Only by a monographic study of the genus can correct speciation be determined. The following description is based on a translation of Steiner's original description.

Only the female is known.

Body small anteriorly. Cuticle finely annulated, without setae. Head and neck annulated; with 3 lips. Esophagus with a typical aphelenchoid bulb. Nerve ring not broader than wide; excretory pore ventral to the nerve ring.

Vulva two-thirds of the length from the front end. Female ovary developed anteriorly. Postuterine branch rudimentary. Tail proportionately short, gradually attentuated to a terminus with 4 papillaelike appendages resembling one another.

Measurements:	Length	0.573 mm	a=30
	Esophagus	0.054 mm	b=10.6
	Tail	0.029 mm	c=20
	Width	0.019 mm	

The following description is of specimens taken in association with *Scolytus ventralis* from white fir, and in the author's opinion is *Laimaphelenchus penardi.*

Female: 0.70–0.80 mm; a=30; b=8.8–9.2; c=18.4–20; V=68–70%.

Male: 0.70–0.80 mm; a=39.2–41; b=11.1–11.9; c=15.2–17.

Body cylindroid, ventrally arcuate, at times almost a spiral. Cuticle with 2 lateral incisures, appearing as a broad band in lateral view, annulations moderately coarse. Lip region set off, rounded. Cephalic framework sclerotized, lips distinct. Stylet 14–15 μ in length, with well developed basal knobs; retractor muscles discernible but not well developed. Metacorpus ovate, the dorsal esophageal gland outlet not discernible, the gland approximately 5 body widths in length. Nerve ring one-half body width posterior to metacorpus. Excretory pore one-half body width posterior to nerve ring. Hemizonid not discernible. Vulva with a prominent vulval flap. Ovary single, reaching beyond distal end of dorsal esophageal gland; oocytes arranged in a single row. Postuterine branch up to 4 body widths in length. Anus and rectum as illustrated. Tail conoid to a stalked terminus bearing four suckerlike tubercles.

Male: With head and neck characteristics of female. Testis outstretched. Tail ventrally arcuate; there is one pair of postanal caudal pa-

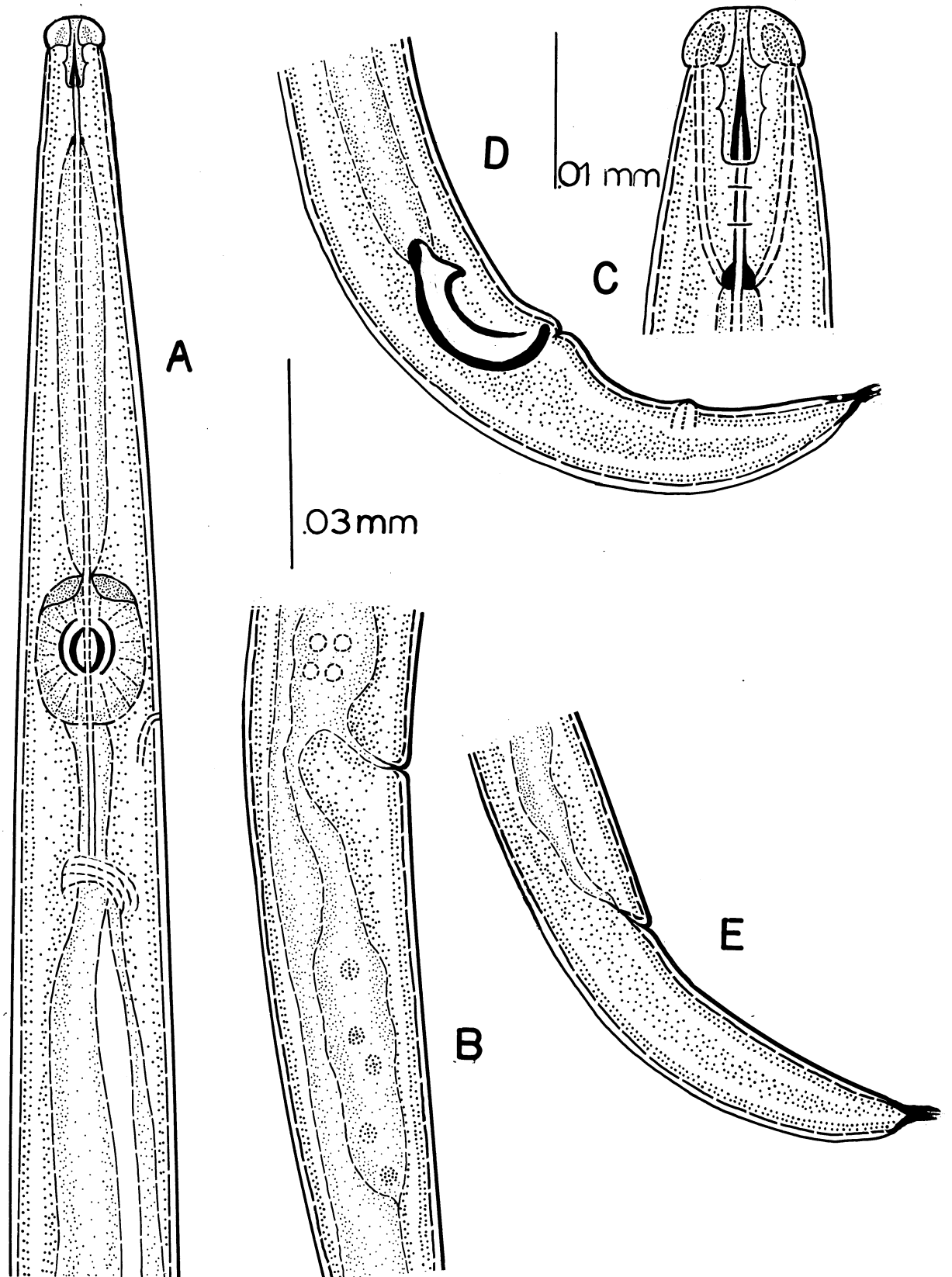


Figure 130.—*Laimaphelenchus pannocaudus* Massey, 1966: *A.* Head and neck; *B.* female, midbody; *C.* head; *D.* male, tail; *E.* female, tail.

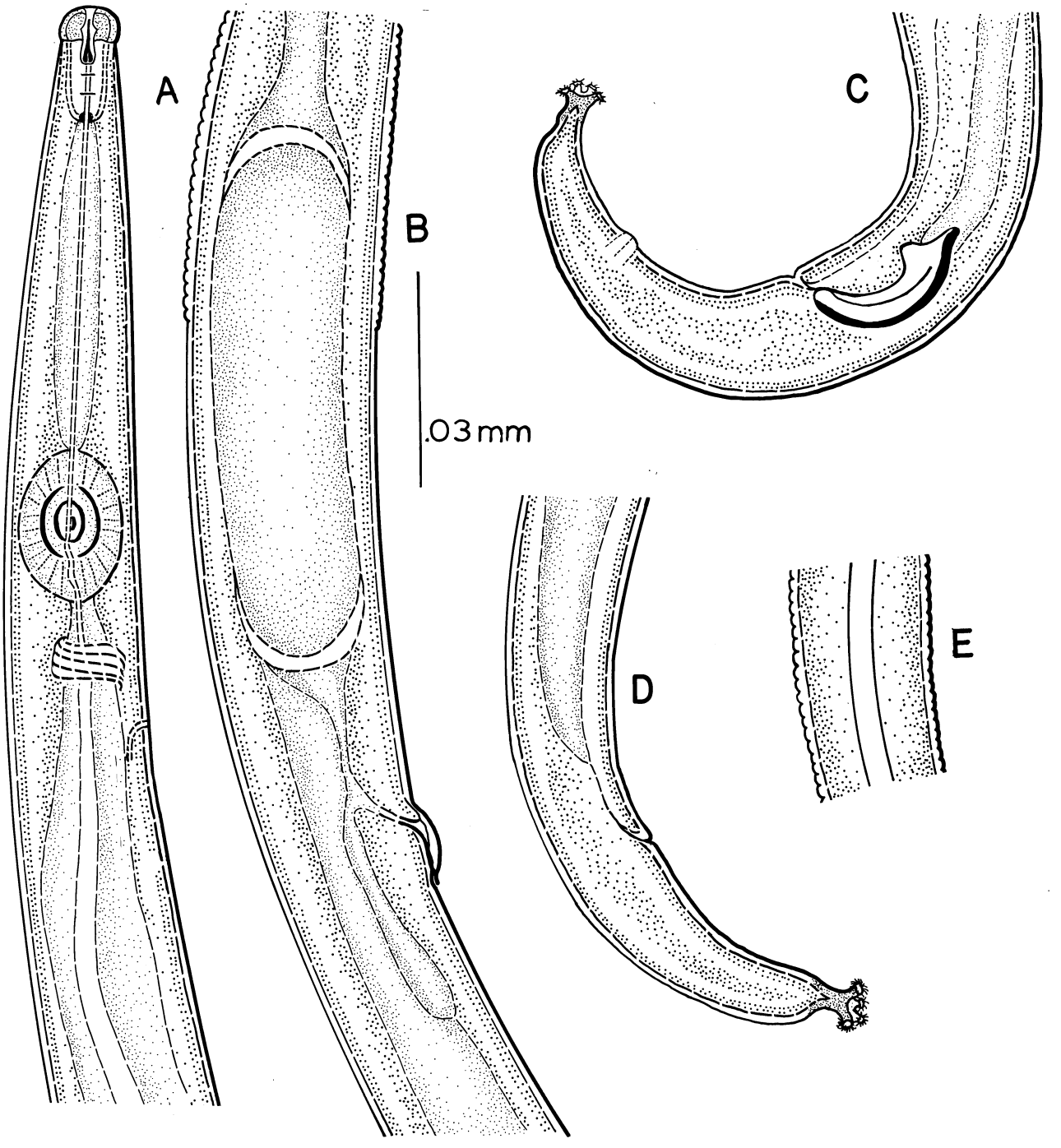


Figure 131.—*Laimaphelenchus penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941: *A.* Head and neck; *B.* female, midbody; *C.* male, tail; *D.* female, tail; *E.* lateral field.

pillae. Spicules strongly ventrally arcuate, with a low distinct rostrum. Terminus as in female.

Laimaphelenchus pensobrinus **Massey, 1966 Figure 132**

Female: 0.46–0.53 mm; a=30; b=10; c=21; V=70%.

Male: 0.51 mm; a=33; b=10.5; c=17.

Cuticle finely annulated. Lateral field interrupted by 2 incisures. Lip region set off, lips distinct. Stylet with prominent basal knobs. Median bulb of esophagus ovate; dorsal esophageal gland over 4 body diameters in length. Nerve ring 1 body width behind median bulb. Excretory pore less than 1 body width posterior to nerve ring. Hemizonid not apparent. Ovary outstretched, at times reaching well beyond distal end of dorsal esophageal gland; postuterine branch up to 2½ body diameters in length. Vulva with cuticular flap. Tail dorsally convex, conoid, terminating in 4 sucker-like tubercules.

Male: Testis single, outstretched, reaching to within 4 body diameters of dorsal esophageal gland. Spicula arcuate. Anal opening covered by a cuticular flap. Two pairs of ventrosubmedian papillae. Tail semicircular. Terminus as in the female.

Diagnosis.—Closely related to *Laimaphelenchus penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941. It differs in its generally smaller size, number and location of caudal papillae, and in size and shape of spicula and presence of anal flap on male.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 37-J.

Laimaphelenchus phloeosini **n. sp. Figure 133**

Female: 0.51 mm; a=23.3; b=8.45; c=15.50; V=72%.

Male: 0.50 mm; a=30; b=8.18; c=12.8.

Cylindroid, ventrally arcuate. Cuticle with 2 lateral incisures and moderately fine annulations. Cephalic framework sclerotized, lips distinct. Stylet 12–13 μ with well developed basal knobs, retractor muscles obscure. Metacorpus ca circular, anterior sector glandular; dorsal esophageal glands 5 body widths in length. Nerve ring slightly less than a body width posterior to metacorpus. Excretory pore at nerve ring. Vulva lips slightly elevated without flap. Ovary single, outstretched, at times reaching beyond the distal end of esophageal glands. Posterior uterine branch 3–4 body widths in length. Anus and rectum as illustrated. Tail conoid to 4 very small stalked tubercles.

Male: With head and neck characteristics of female. Testis single, outstretched. Spicules paired, ventral rostrum pointed, reduced in size. One pair of postanal ventrosubmedian papillae. Tail ventrally arcuate to terminus as in female.

Diagnosis.—Differs from *Laimaphelenchus pensobrinus* and *L. penardi* in the smaller size of the terminal tubercles, in size and shape of spicules, and absence of a vulval flap.

Type habitat.—Associated with *Phloeosinus dentatus* in eastern redcedar.

Type locality.—Keysville, Virginia.

Type specimens.—Collection No. 79-E.

Genus *Ektaphelenchus* (Fuchs, 1937) Skrjabin et al, 1954 Emended

Synonym: *Parasitaphelenchus* (*Ektaphelenchus*) Fuchs, 1937
Cryptaphelenchoides J. B. Goodey, 1960

The type species *Ektaphelenchus hylastophilus* (Fuchs, 1930) Skrjabin et al, 1954, was originally described in the genus *Parasitaphelenchus* by Skrjabin and others in 1954, who presented *Parasitaphelenchus hylastophilus* forma *ateri* Fuchs, 1930 as the type *species.*

Body cylindroid. Head offset, angular in lateral view. Lips distinct and separate, the lateral lips narrower than the other four. Lateral fields obscure or absent. Stylet with a wide lumen with or without basal knobs. Metacorpus ovate, with the anterior one-third to one-half glandular in composition. Prominent valve plates at or posterior to middle of bulb. Dorsal esophageal glands well developed and elongate, usually 7–8 body widths in length. Vulva posterior, lips usually not elevated. Postuterine branch occasionally several body widths in length. Anus and rectum usually not visible, the gut ending as blind diverticulum. Spicules ventrally curved with a prominent ventral rostrum. Caudal papillae usually present.

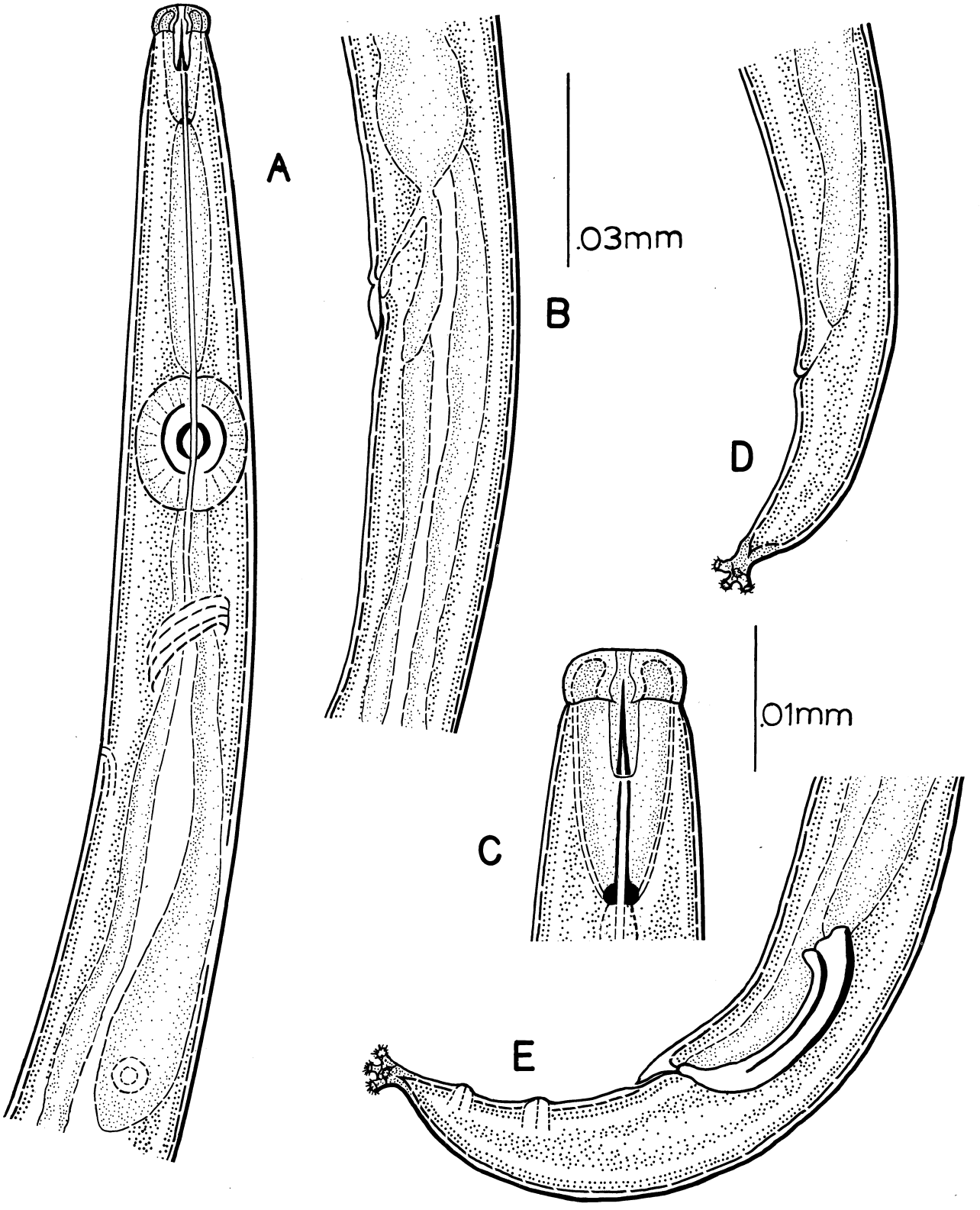


Figure 132.—*Laimaphelenchus pensobrinus* Massey, 1966: *A.* Head and neck; *B.* female, midbody; *C.* head; *D.* female, tail; *E.* male, tail.

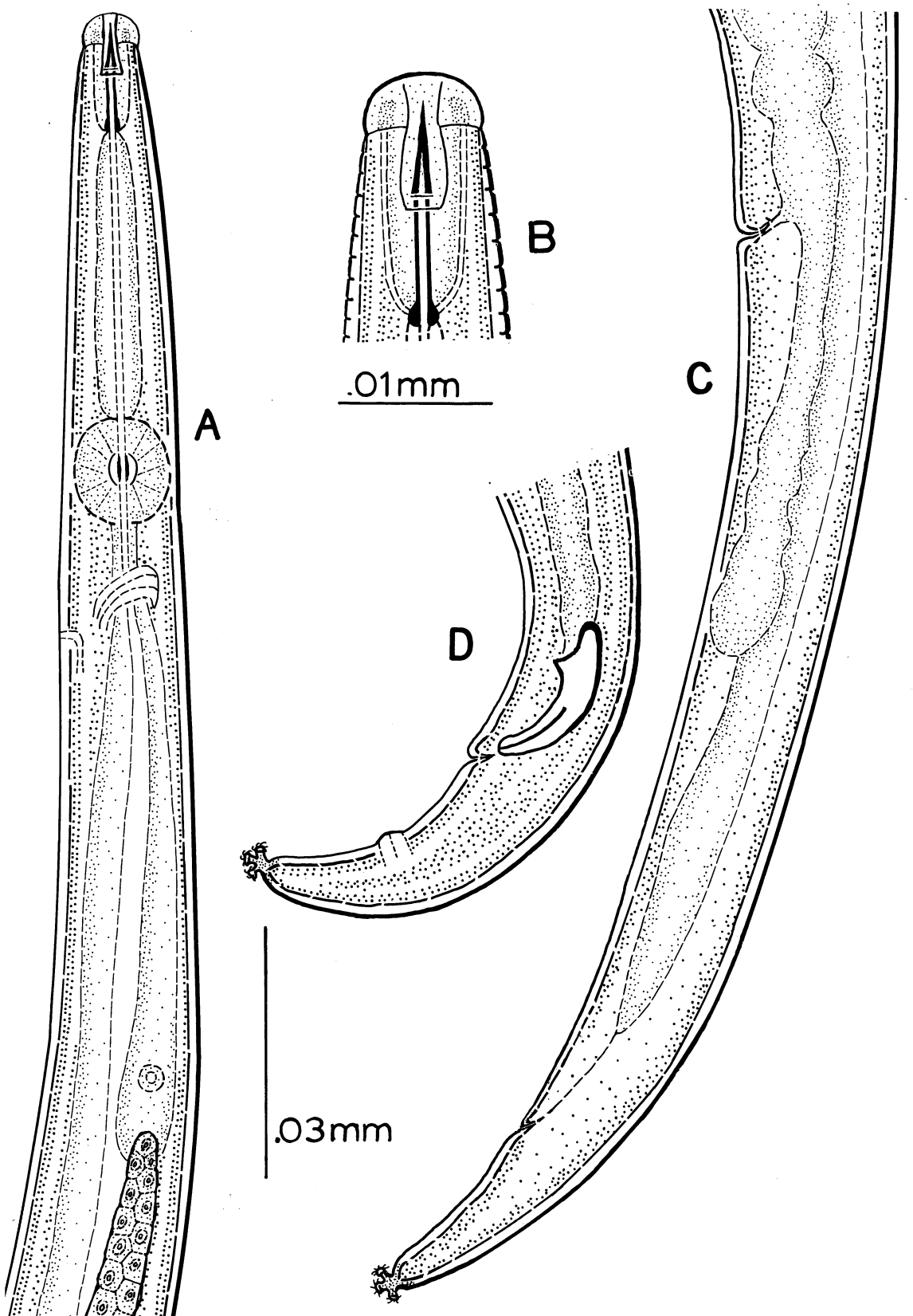


Figure 133.—*Laimaphelenchus phloeosini* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

Key to the female species of *Ektaphelenchus* associated with bark beetles in the United States

1. Postuterine branch several body widths in length ..... *sandiaensis*
   Postuterine branch rudimentary or not over a body width long 2
2. Stylet 25 μ or less 3
   Stylet over 30 μ ..... *terebranus* n. sp.
3. Terminus obtuse ..... *obtusus*
   Terminus acute or subacute 4
4. Stylet with basal swelling 21 μ in length .. *prolobos*
   Stylet with prominent basal knobs ..... *josephi* n. sp.
   Stylet without knobs 16 μ in length ..... *smaelus* n. sp.

***Ektaphelenchus josephi* n. sp.**[7] **Figure 134**

Female: 0.83–0.92 mm; a=29.5–33; b=8–9, c=?; V=75–77%.

Male: 0.71 mm; a=32; b=7; c=12.

Body cylindroid, ventrally arcuate. Cuticle without lateral incisures, with very fine transverse striae. Lip region flat, set off. Lips distinct. Cephalic framework strongly sclerotized. Stylet 22 μ in length with prominent basal knobs which are angular in lateral view. Subulate shaft more strongly sclerotized than shaft. Retractor muscles distinct. Dorsal esophageal gland outlet conspicuous in anterior third of metacorpus. Median bulb oblong, much longer than wide, anterior third glandular. Dorsal esophageal gland relatively slender, 5 body widths in length. Nerve ring slightly less than a body width posterior to metacorpus. Excretory pore a body width posterior to nerve ring. Hemizonid immediately posterior to excretory pore. Lips of vulva only slightly protuberant. Vagina oblique. Ovary single, outstretched, comparatively short. Oocytes arranged in a double row, in some specimens three rows for a very small portion of its length as figured. Quadricolumella prominent, approximately a body width in length. Postuterine branch short, less than a body width in length. Anus and rectum not visible. Tail conoid to a narrowly rounded terminus.

Male: Testis single, outstretched, Spicules mitten shaped, apex high, dorsal arm heavily sclerotized. Ventral rostrum prominent and sharply pointed. Three pairs of caudal papillae, 1 pair immediately preanal ventrosubmedian, 1 pair immediately postanal ventrosubmedian, and 1 pair postanal ventral, ca 2 body widths anterior to terminus. Tail conoid, extremely ventrally arcuate. Terminus a short rigid hair-like filament.

Diagnosis.—Allied to *E. prolobos;* differs from that species in the prominent triangular knobs of stylet and in the terminus of the male.

Type habitat.—Associated with *Dendroctonus ponderosae* in limber pine, *Pinus flexilis* James.

Type locality.—Capillo Peak, Manzano Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 37.

***Ektaphelenchus obtusus* Massey, 1956** **Figure 135**

Female: 0.8 mm; a=30; b=8; c=?; V=78%.

Male: 0.7 mm; a=23; b=7; c=14.4.

Body cylindroid, ventrally arcuate. Cuticle with moderately fine annulations. Lip region set off, angular. Cephalic framework sclerotized. Lips distinct. Stylet 24 μ in length, without basal knobs or thickenings; retractor muscles distinct and prominent. Metacorpus oblong ovate, the anterior one-third to one-half glandular. Dorsal esophageal gland outlet prominent. Dorsal esophageal gland 7–8 body widths in length. Nerve ring ca 1 body width posterior to metacorpus. Excretory pore ca two-thirds body width posterior to nerve ring. Hemizonid not observed. Lumen of intestine distinct for entire length. Ovary single, outstretched. Postuterine branch rudimentary, less than a body width in length. Rectum and anus absent. Tail conoid to an obtuse terminus.

Male: With head and neck characteristics of female. Testis outstretched. Spicules with a

[7] Named in honor of my son, Joseph.

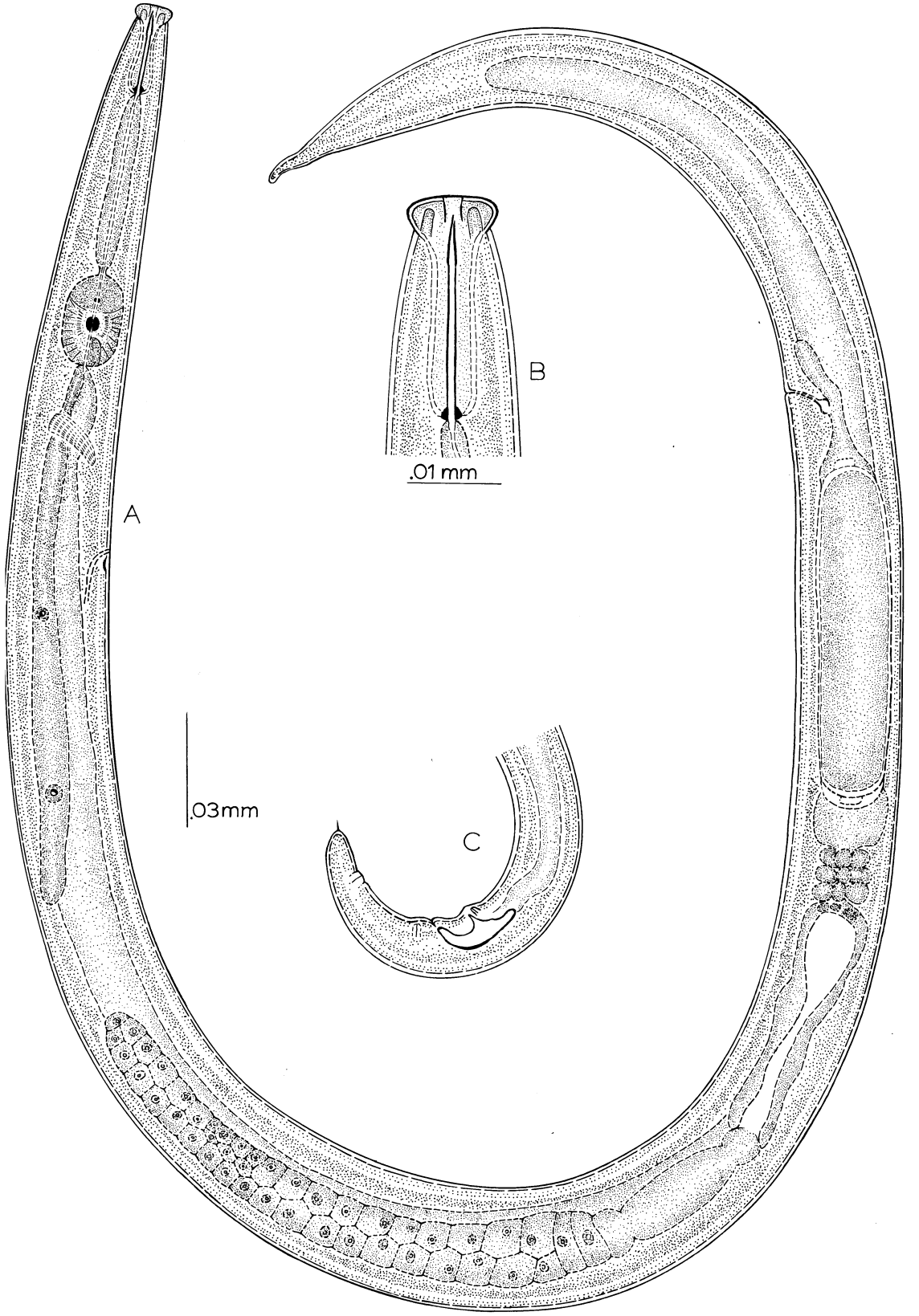


Figure 134.—*Ektaphelenchus josephi* n. sp.: *A.* Female; *B.* head; *C.* male, tail.

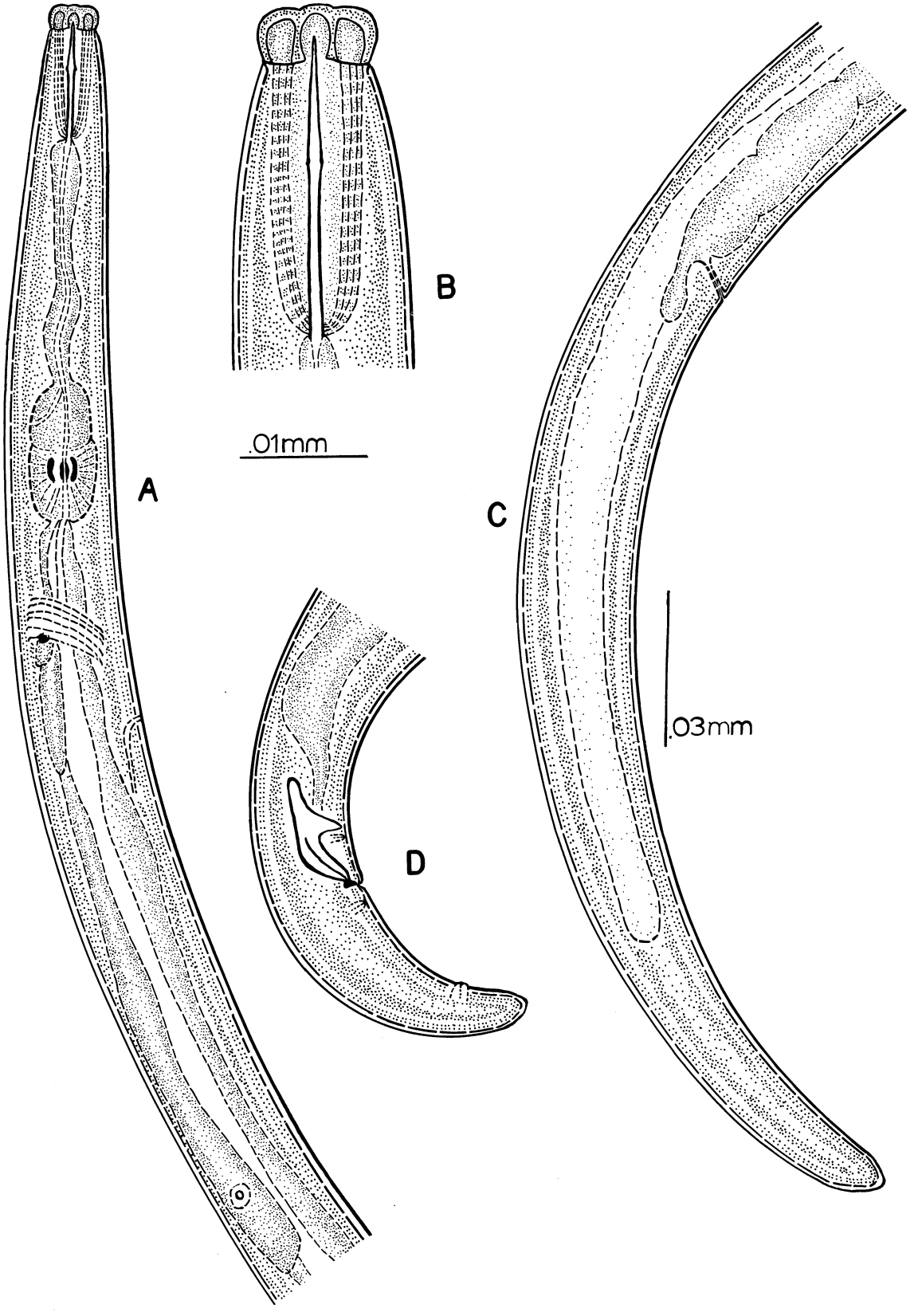


Figure 135.—*Ektaphelenchus obtusus* Massey, 1956: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

distal strongly sclerotized footlike projection. There are 3 pairs of caudal papillae, 1 pair preanal ventrosubmedian, 2 pairs postanal ventrosubmedian. Tail ventrally arcuate, conoid to an obtuse terminus.

Diagnosis.—Differs from other members of the genus in the obtuse terminus in both sexes and in the footlike projection at the distal end of the spicules.

Type habitat.—Found in galleries and beneath wing covers of *Dendroctonus rufipennis.*

Type locality.—Red Table Mountain, White River National Forest, Colorado.

Type specimens.—Collection No. 22.

Ektaphelenchus prolobos **Massey, 1964 Emended**
Figure 136

Female: 0.70–0.81 mm; a=0.35; b=8.5; c=?; V=79%.

Male: 0.61 mm; a=35; b=7.0; c=14.0.

Body cylindroid, ventrally arcuate. Cuticle without lateral incisures, marked by fine lateral striae or annulations. Lip region angular, set off. Cephalic framework sclerotized. Lips distinct. Stylet 12 μ in length, with small basal swellings. Retractor muscles at best indistinct. Metacorpus oblong ovate, anterior one-third glandular, its duct indistinct. Dorsal esophageal gland 7–8 body widths in length. Nerve ring two-thirds of a body width posterior to metacorpus. Excretory pore one-third body width posterior to nerve ring. Hemizonid immediately posterior to excretory pore. Ovary single, outstretched. Posterior uterine branch ca 1 body width in length, containing sperm cells. Anus and rectum absent. Tail conoid to sharp terminus.

Male: With head and neck characteristics of female. Testis outstretched. Spicules mitten shaped as figured. Tail ventrally arcuate, with three pairs of papillae, one pair immediately preanal, two pair postanal and located as figured. Terminus acute.

Diagnosis.—Differs from *Ektaphelenchus sandiaensis* Massey, 1964 in the presence of basal knobs on the spear and in its shorter posterior uterine branch.

Type habitat.—Associated with *Dryocoetes confusus* in corkbark fir.

Type locality.—Rio Grande Grant, Carson National Forest, New Mexico.

Type specimens.—Collection No. 28-T.

Ektaphelenchus sandiaensis **Massey, 1964 Emended**
Figure 137

Female: 0.63–0.64 mm; a=28–31; b=8.0–8.5; c=?; V=81%.

Male: 0.62–0.64 mm; a=32; b=8.0–8.5; c=16.

Body cylindroid, ventrally arcuate. Cuticle with moderately coarse transverse striae, without lateral incisures. Lip region almost continuous with body contour. Cephalic framework lightly sclerotized, lips distinct. Stylet 25 μ in length, without knobs or basal thickenings, retractor muscles distinct, appearing as twisted bundles. Metacorpus ovate, the anterior one-fourth glandular, but hardly set off from basal portion, its duct indistinct. Dorsal esophageal gland approximately 8 body widths in length. Nerve ring two-thirds body width posterior to metacorpus. Excretory pore a body width posterior to nerve ring and immediately posterior to hemizonid. Ovary single, outstretched, at times beyond the posterior tip of dorsal esophageal gland. Posterior uterine branch 4–5 body widths in length and containing sperm cells. Anus and rectum absent. Terminus obtuse.

Male: With head and neck characteristics of female. Testis single, outstretched. There are 3 pairs of ventrosubmedian caudal papillae, 1 pair preanal, 2 pairs postanal, located as figured. Spicules mitten shaped. Tail ventrally arcuate to a strongly sclerotized acute terminus.

Diagnosis.—Varies from other species in the genus in the length of the posterior uterine branch, in the shape of the lips, and sclerotized terminus of male.

Type habitat.—Associated with *Scolytus ventralis* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 22-F.

Ektaphelenchus smaelus **n. sp.** **Figure 138**

Female: 0.63–0.65 mm; a=38–39; b=7.3–7.6; c=?; V=76–77%.

Male: Unknown.

Body cylindroid, ventrally arcuate. Cuticle with moderately fine lateral striae, without lateral incisures. Lip region slightly set off, angular. Cephalic framework sclerotized. Lips distinct. Stylet with or without slight basal

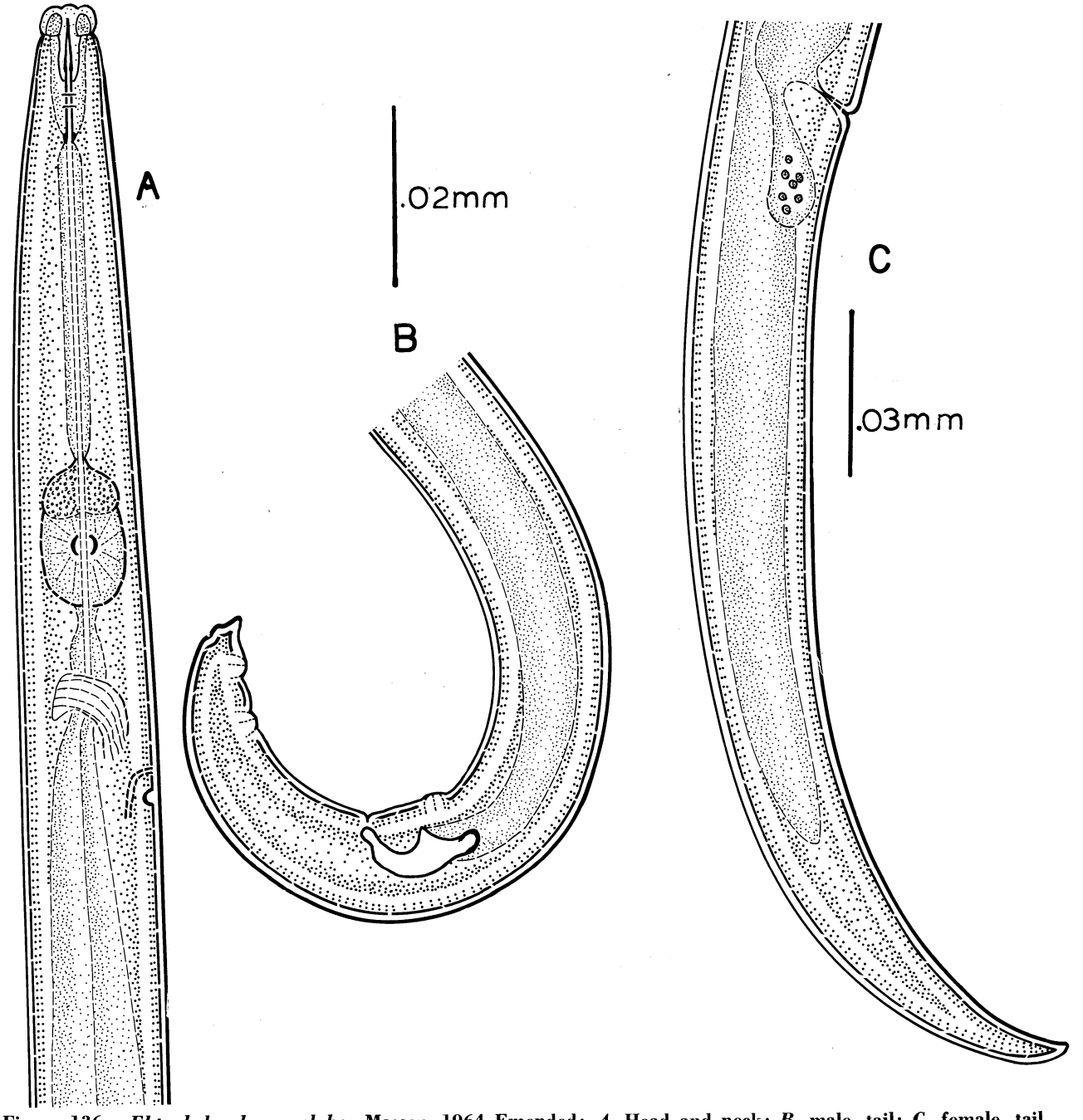


Figure 136.—***Ektaphelenchus prolobos*** **Massey, 1964 Emended:** ***A.*** **Head and neck;** ***B.*** **male, tail;** ***C.*** **female, tail.**

swellings, 16 μ in length; retractor muscles indistinct. Metacorpus oblong ovate, anterior one-third glandular, the glandular duct indistinct. Dorsal esophageal gland 8 body widths in length. Nerve ring a body width posterior to metacorpus. Excretory pore immediately posterior to nerve ring. Hemizonid not observed. Ovary outstretched. Posterior uterine branch rudimentary. Rectum and anal opening absent. Tail conoid to an acute terminus.

Diagnosis.—Differs from all other species in genus in general tail conformation.

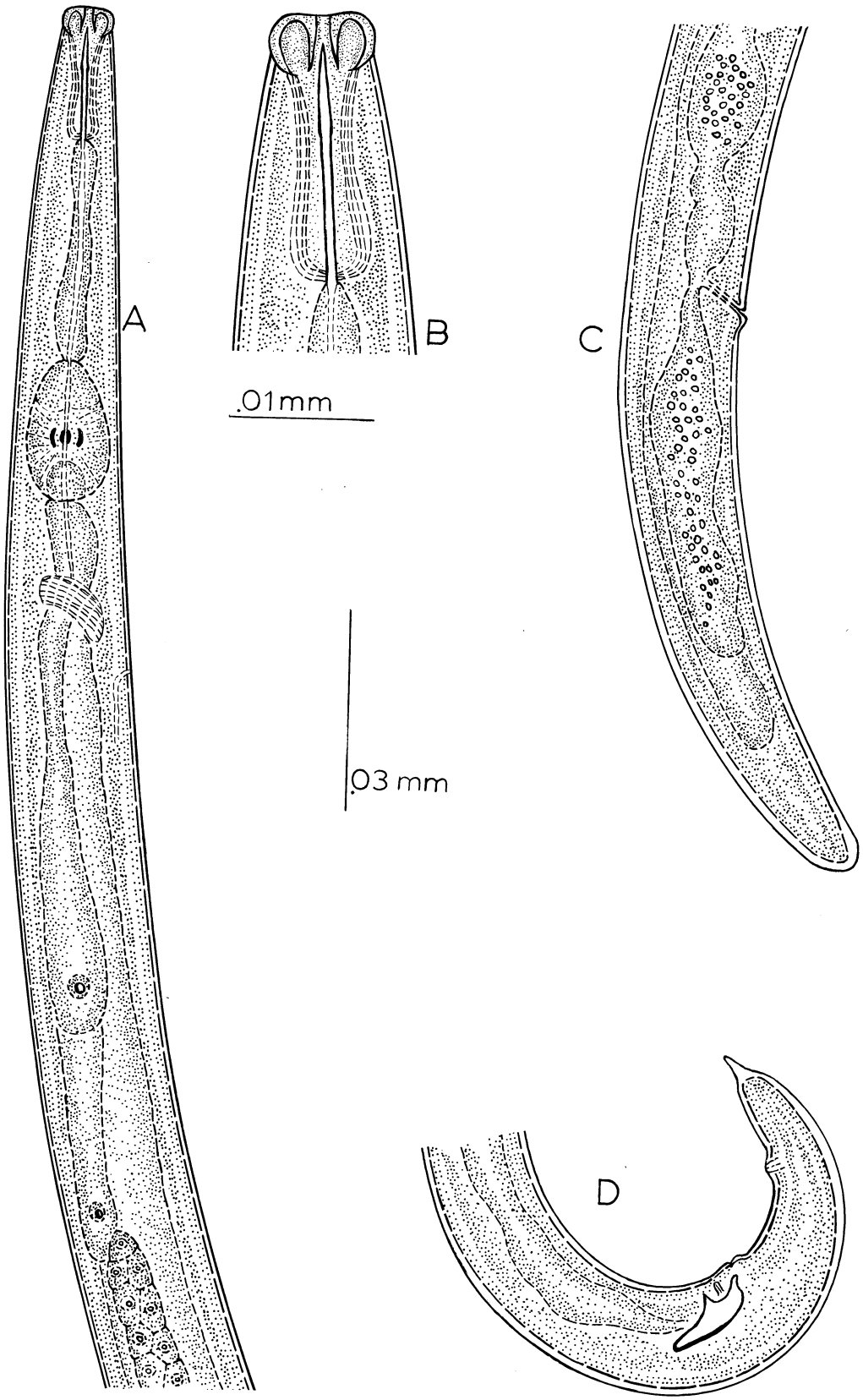


Figure 137.—*Ektaphelenchus sandiaensis* Massey, 1964 Emended: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

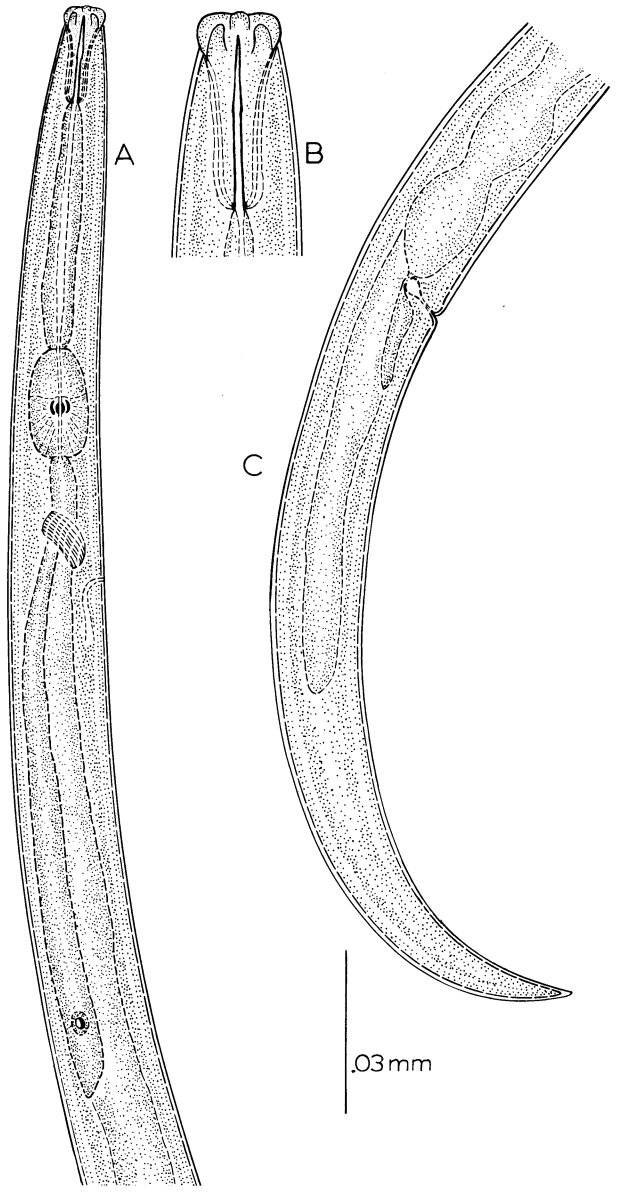


Figure 138.—*Ektaphelenchus smaelus* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail.

Type habitat.—Associated with *Dryocoetes confusus* in subalpine fir, *Abies lasiocarpa* (Hook.) Nutt; also found associated with *Ips pini* and *Pityophthorus* sp. in eastern white pine at Neola, West Virginia.

Type locality.—Rabbit Ears Pass, Routt National Forest, Colorado.

Type specimens.—Collection No. 11-V-1.

***Ektaphelenchus terebranus* n. sp.** **Figure 139**

Female: 0.84 mm; a=30.4; b=7.6; c=?; V=80%.

Male: Unknown.

Body cylindroid. Cuticle with very coarse transverse striae and no visible lateral incisures. Lip region well set off. Cephalic framework strongly sclerotized. Stylet 35 μ in length, without knobs, musculature very prominent, appearing as twisted rope. Median bulb massive, the anterior one-third glandular, its duct and tube strongly sclerotized. Dorsal esophageal gland 8–9 body widths in length. Nerve ring slightly less than a body width posterior to metacorpus. Excretory pore which opens through hemizonid slightly less than a body width posterior to nerve ring. Ovary single, outstretched. Posterior uterine branch rudimentary. Rectum and anal opening absent. Tail conoid to narrowly rounded terminus.

Diagnosis.—Closely related to *Ektaphelenchus obtusus* Massey, 1956. Varies in its more coarse transverse striations, its longer spear, more prominent spear muscles, visible duct to the glandular anterior portion of metacorpus, and in its narrowly rounded terminus.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine stumps.

Type locality.—Nacogdoches, Texas.

Type specimens.—Collection No. 79-D.

Genus *Cryptaphelenchus* (Fuchs, 1937) Rühm, 1954

Synonyms: *Parasitaphelenchus* (*Cryptaphelenchus*) Fuchs, 1937
Parasitaphelenchus (*Steineria*) Fuchs, 1937 (nec *Steineria* Mikoletzky, 1922)

Type species: *Crytaphelenchus macrogaster* (Fuchs, 1915) Rühm, 1956

Length usually less than one-half mm. Lips rounded, usually continuous with body contour. Cephalic framework sclerotized. Cuticle with or without lateral incisures. Stylet less than 10 μ. Metacorpus ca spheroid, muscular. Dorsal esophageal gland well developed. Ovary single, short, Posterior uterine branch absent. Anus and rectum absent. Spicules paired, mit-

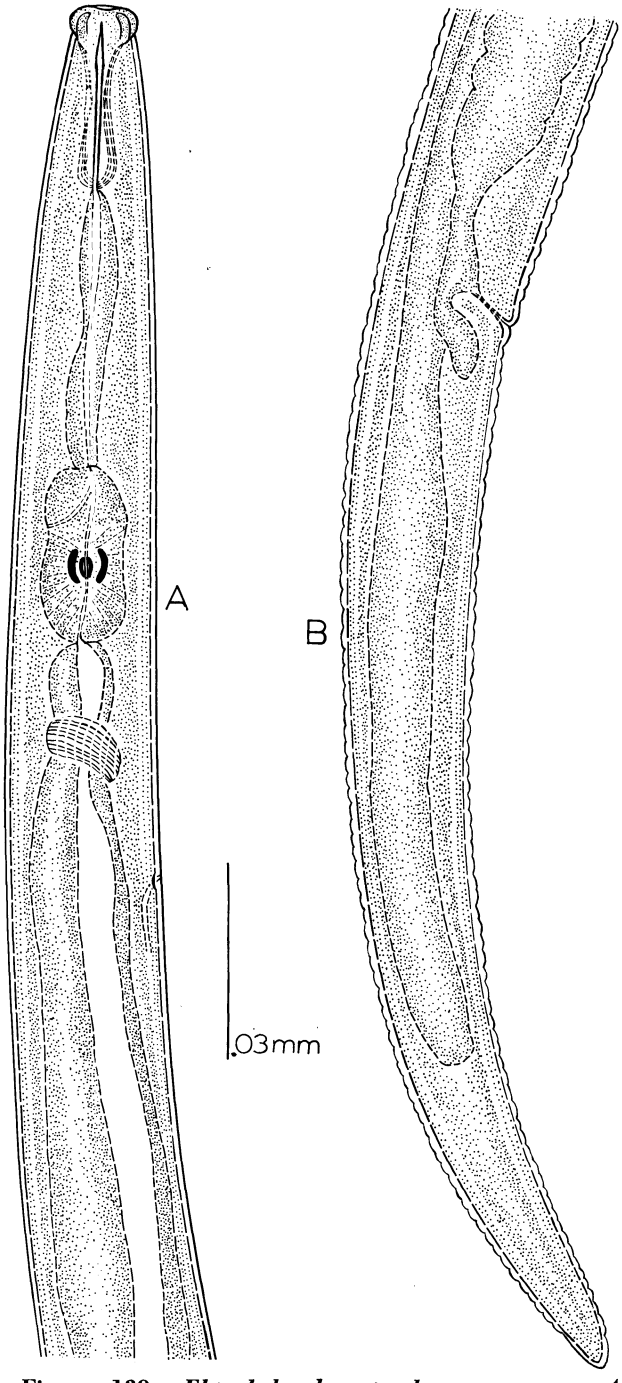


Figure 139.—*Ektaphelenchus terebranus* n. sp.: *A.* Head and neck; *B.* female, midbody and tail.

ten shaped, the apex high and at times distinctly developed. Ventral rostrum usually elongate, acute. Posterior anal lip heavily sclerotized. There are 2 pairs of caudal papillae.

***Cryptaphelenchus cirrus* n. sp.** **Figure 140**

Female: 0.30 mm; a=25; b=6.25; c=?; V=78%.

Male: 0.27 mm; a=22.5; b=5.92; c=12.5.

Body ventrally arcuate, cylindroid. Cuticle with moderately coarse transverse striae, lateral incisures not observed. Lip region continuous with body contour, wider than long. Cephalic framework sclerotized. Stylet 8 μ in length, slender, without basal knobs or thickenings, retractor muscles indistinct. Metacorpus ovate, filling body cavity, its width greater than its length in many individuals, anterior portion glandular, crescentic valve plates at or near the center. Dorsal esophageal gland outlet indistinct. Dorsal esophageal gland extends ca 3 body widths posterior to metacorpus. Excretory pore opening through hemizonid and located opposite nerve ring. Lips of vulva indistinct in many specimens. Ovary short; oocytes arranged in a double row. Posterior uterine branch absent. Anal opening and rectum absent. Tail ventrally arcuate, conoid, elongate to a subacute terminus.

Male: Testis outstretched. Spicules with ventral rostrum sharply pointed and turning downward in lateral view. Apex prominent, elongate. Posterior anal lip heavily sclerotized. There are two pair of ventrosubmedian papillae, 1 pair immediately anterior to anal opening, the other pair immediately anterior to terminus. Tail ventrally arcuate, terminus acute.

Diagnosis.—Differs from other species in the genus in tail characteristics of the female.

Type habitat.—Associated with *Ips confusus* in pinyon.

Type locality.—Bandelier National Monument, New Mexico.

Type specimens.—Collection No. 8-Z.

***Cryptaphelenchus ipinius* n. sp.** **Figure 141**

Female: 0.43 mm; a=23.2; b=6.3; c=?; V=79%.

Male: 0.26 mm; a=19.4; b=7.0; c=11.1.

Body ventrally arcuate, cylindroid. Cuticle with fine lateral striae. Lateral incisures not observed. Lip region continuous with body contour, rounded. Cephalic framework sclerotized. Stylet 8.5 μ in length, with distinct basal knobs, retractor muscles indistinct. Median bulb al-

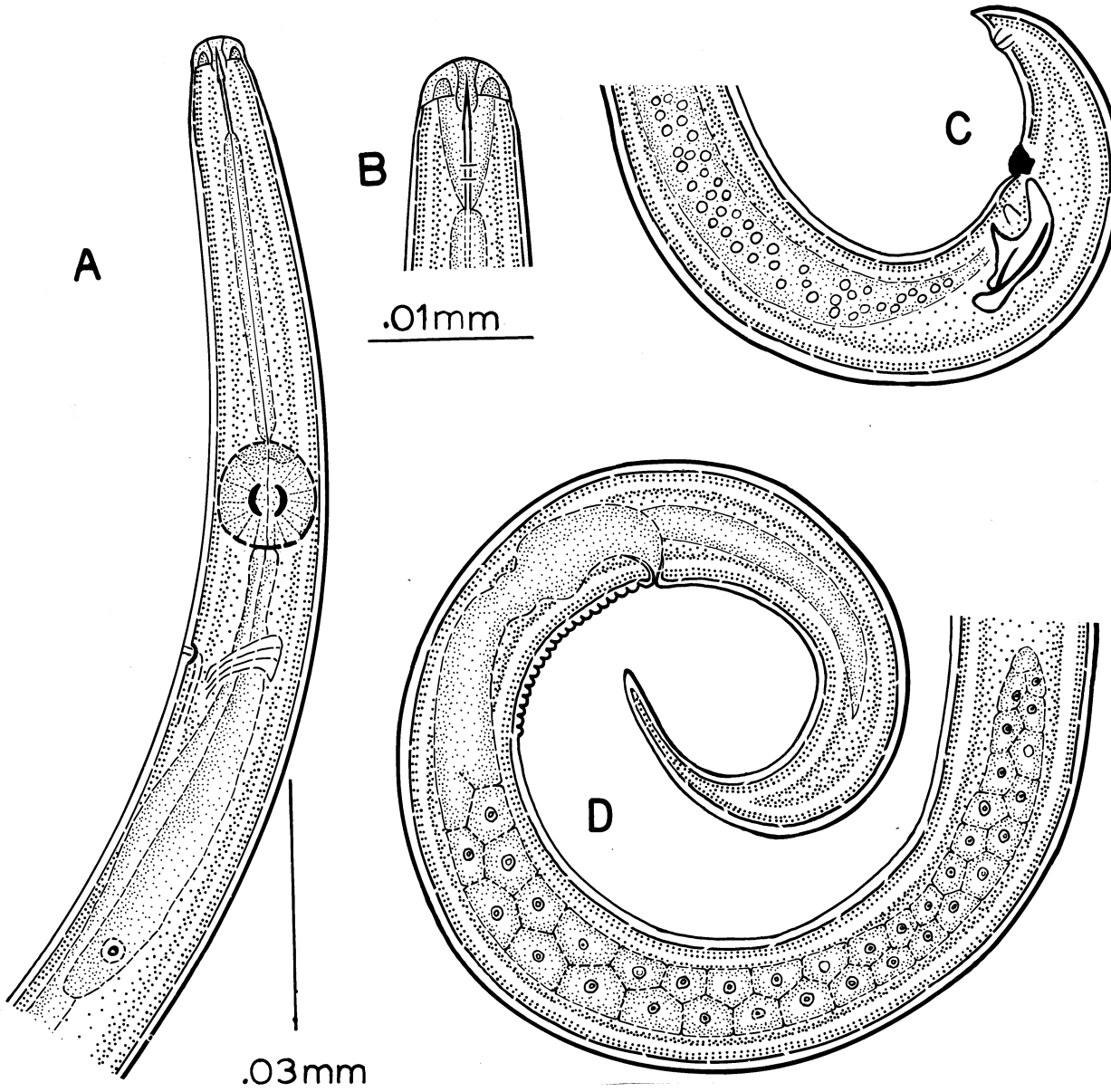


Figure 140.—*Cryptaphelenchus cirrus* n. sp.: *A.* Head and neck; *B.* head; *C.* male, tail; *D.* female, tail.

most round, anterior portion glandular. Dorsal esophageal gland outlet indistinct. Dorsal esophageal gland ca 3 body widths in length. Nerve ring a body width posterior to median bulb. Excretory pore opening through hemizonid and located opposite nerve ring. Lips of vulva slightly protuberant. Ovary outstretched, at times reaching almost to median bulb; oocytes arranged in 3 rows. Posterior uterine branch absent. Tail thickly conoid to an acute terminus.

Male: Testis single, outstretched, short. Spicules with prominent ventral rostrum, apex extremely high. There are 2 pairs of ventrosubmedian caudal papillae, 1 pair located immediately anterior to the anal opening, the other immediately anterior to terminus. Tail ventrally arcuate, terminus acute.

Diagnosis.—Related to *Cryptaphelenchus latus* (Thorne, 1935) Rühm, 1956; differs in finer striations of cuticle and in shape of spicules.

Type habitat.—Associated with *Ips pini* and *Pityophthorus* sp. in eastern white pine.

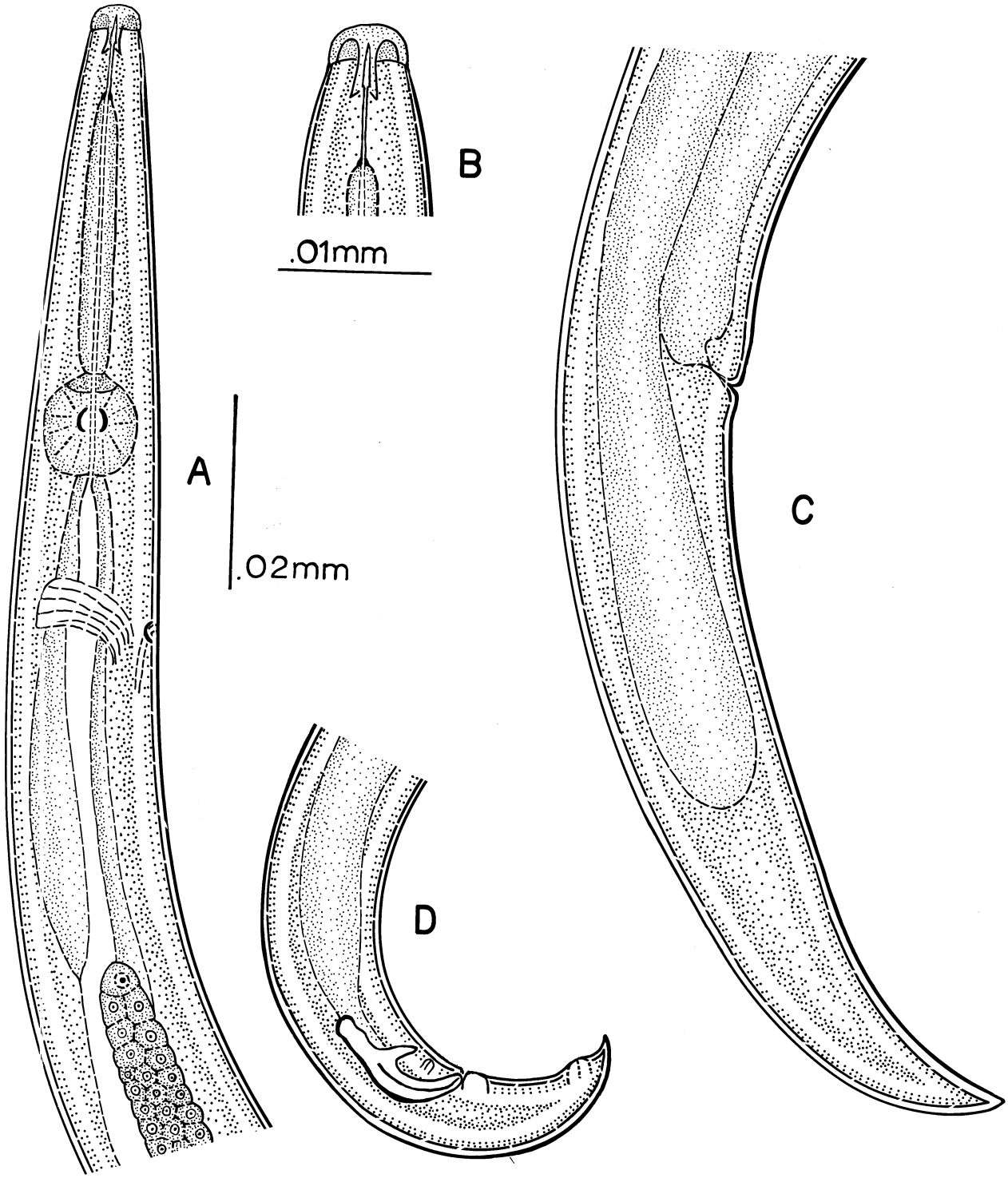


Figure 141.—*Cryptaphelenchus ipinius* n. sp.: *A.* Head and neck; *B.* head; *C.* female, tail; *D.* male, tail.

Type locality.—Caroline County, New York.
Type specimens.—Collection Nos. 81-H (Holotype); 81-K (Allotype).

***Cryptaphelenchus latus* (Thorne, 1935) Rühm, 1956**
Figure 142

Female: 0.4 mm; a=20; b=5.2; c=13.5; V=80%.

Male: 0.4 mm; a=20; b=4.7; c=13.

Body straight, unusually broad for a *Cryptaphelenchus,* tapering anteriorly until lip region is about two-fifths as wide as the neck at the bulb. Lateral field marked by four lines. Annulation broad, obscure. Body slightly narrowed ventrally at vulva. Female tail slightly arcuate, conoid to pointed terminus. Male tail ventrally arcuate, conoid to pointed terminus. Lip region set off by slight depression, lips obscure. Spear with well developed basal knobs. Esophageal bulb very large. Hyaline esophagus extends back from bulb unusually long distance before merging with intestine. Excretory pore located about opposite first granules of intestine. Granules of intestine and body generally large. Vulva a depressed transverse slit, anterior lip overlapping. Vagina at first extending in and forward, then bent to nearly right angles with body axis. Ovary outstretched. Female rectum and anus inconspicuous. Two pairs of conspicuous, conical male papillae, one slightly preanal and other at beginning of distal third of tail. Spicula elongate, mitten-shaped, cephalated. Sex ratio about eight females to each male.

Diagnosis.—*Cryptaphelenchus* of small size, and broad body with above measurements. Spear with basal knobs. Esophageal bulb comparatively massive. Intestinal granules beginning almost 2 body widths behind bulb. Excretory pore about opposite anterior end of intestine. Body slightly contracted at vulva. Spicula elongate, mitten-shaped. Tail of female slightly

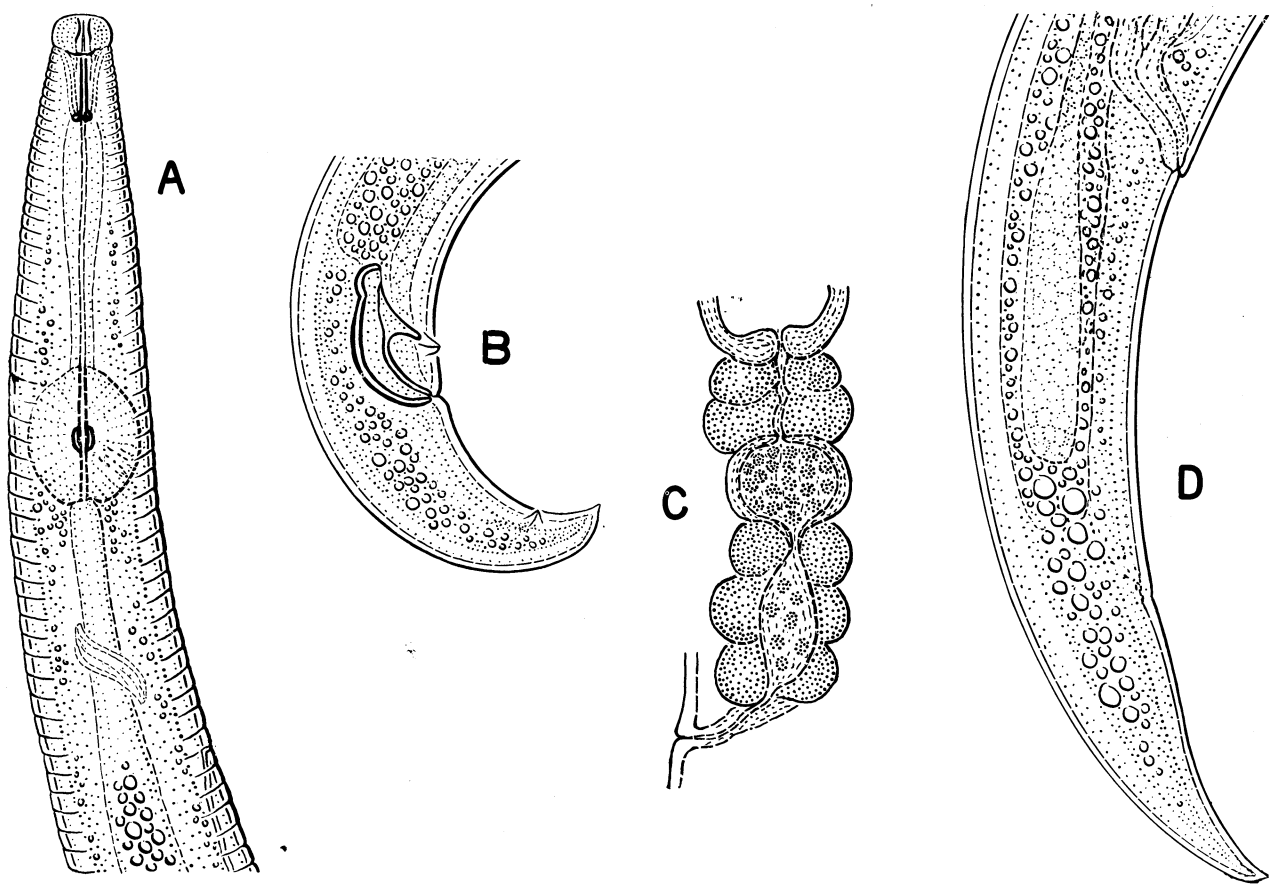


Figure 142.—*Cryptaphelenchus latus* (Thorne, 1935) Rühm, 1956. *A.* Head and neck; *B.* male, tail; *C.* uterine tract; *D.* female, tail. (After Thorne, 1935).

arcuate, that of male conspicuously arcuate. Terminus acute.

Beneath elytra and in tunnels of *Dendroctonus ponderosae*.

Genus *Omemeea* Massey, 1971

Type species: *Omemeea maxbassiensis* Massey, 1971

Aphelenchoidinae: Lip region heavily sclerotized, umbrellalike in a lateral view. Cephalic framework refractive, distinct. Stylet exceedingly long with very prominent basal knobs, subulate shaft longer than the shaft. Metacorpus oblong, ovate, the anterior portion glandular. Dorsal esophageal gland robust, relatively short. Excretory pore obscure, anterior to metacorpus. Ovary outstretched, postuterine branch several body widths in length. Female anal opening obscure. Male tail usually arcuate with sclerotized terminal membrane. Spicules paired with prominent ventral rostra.

Omemeea maxbassiensis Massey, 1971 Figure 143

Female: 0.64–0.77 mm; a=31.4–34.6; b=8.8–9.7; c=22.6–23; V=77–79%.

Male: 0.63–0.75 mm; a=32.0–35.8; b=8.6–9.0; c=19.5–19.7.

Body straight, cylindroid. Cuticle with faint transverse striae and marked with 3 lateral incisures. Lip region sclerotized, set off with angular overhang in some specimens, appearing umbrellalike in lateral view. Cephalic framework with six heavily sclerotized sectors. Amphids not discerned. Spear exceedingly long, 23–26 μ, the subulate shaft longer than the shaft, the knobs prominent and strongly sclerotized at point of muscle attachment. Vestibule and its extension very distinct and geometrically formed. Metacorpus oblong ovate, the anterior portion glandular. Dorsal esophageal gland 2–3 body widths in length. Nerve ring two-thirds of a body width posterior to metacorpus. Excretory pore obscure, located anterior to metacorpus, more readily visible on immature specimens. Hemizonid two body widths posterior to metacorpus. Ovary single, outstretched. Posterior uterine branch 4–5 body widths in length, usually containing sperm. Prominent vulval flap present. Anal opening obscure. Tail conoid to a sharp, heavily sclerotized terminus.

Male: With head and neck characteristics similar to females. Testis outstretched or reflexed, spicules paired with a prominent sharply pointed ventral rostrum. Tail arcuate with terminal flap. There are 3 pairs of caudal papillae, 1 pair preanal, obscure, 2 pairs slightly anterior to the terminus.

Type habitat.—From galleries of *Leperisinus californicus* infecting green ash.

Type locality.—Omemee, North Dakota.

Type specimens.—Collection No. 78-X.

Teragramia n. gen.[8]

Lip region set off, rounded. Cephalic framework sclerotized. Stylet slender, subulate shaft only slightly wider than shaft. Vagina extending anteriorly from vulval opening. Posterior uterine branch prominent, several body widths in length. Female tail obtuse, clublike in lateral view. Spicules massive, distinctive. Male tail with membranous flap, distinctively reflexed on preserved specimens.

Diagnosis.—Differs from other members of the subfamily in shape and size of the spicules, in the distinctive vulva and in the shape of the tails of both sexes.

Teragramia willi n. gen., n. sp.[9] Figure 144

Female: 0.57–0.63 mm; a=23.4–29.8; b=7.9–8.6; c=13–13.6; V=75%.

Male: 0.52–0.60 mm; a=28.4–28.8; b=8.2–8.6; c=19.2–20.

Ventrally arcuate, cylindroid. Cuticle with fine transverse striae, 2 lateral incisures. Lip region set off, rounded. Cephalic framework sclerotized. Spear fine, 11 μ in length, subulate shaft only slightly wider than shaft, without basal knobs; retractor muscles distinct. Metacorpus oblong ovate, crescent-shaped valves at or near center, anterior one-third glandular. Dorsal esophageal gland outlet indistinct. Dorsal esophageal gland stout, approximately 4 body widths in length. Nerve ring approximately 1 body width posterior to metacorpus. Excretory pore at or slightly below base of metacorpus. Hemizonid slightly posterior to nerve ring. Lips of vulva slightly elevated. Vagina extending anteriorly, ca one-half body width. Ovary outstretched; oocytes arranged in

[8] Named in honor of my wife, Margaret (reverse spelling).

[9] Named in honor of my grandson, Will Verzino.

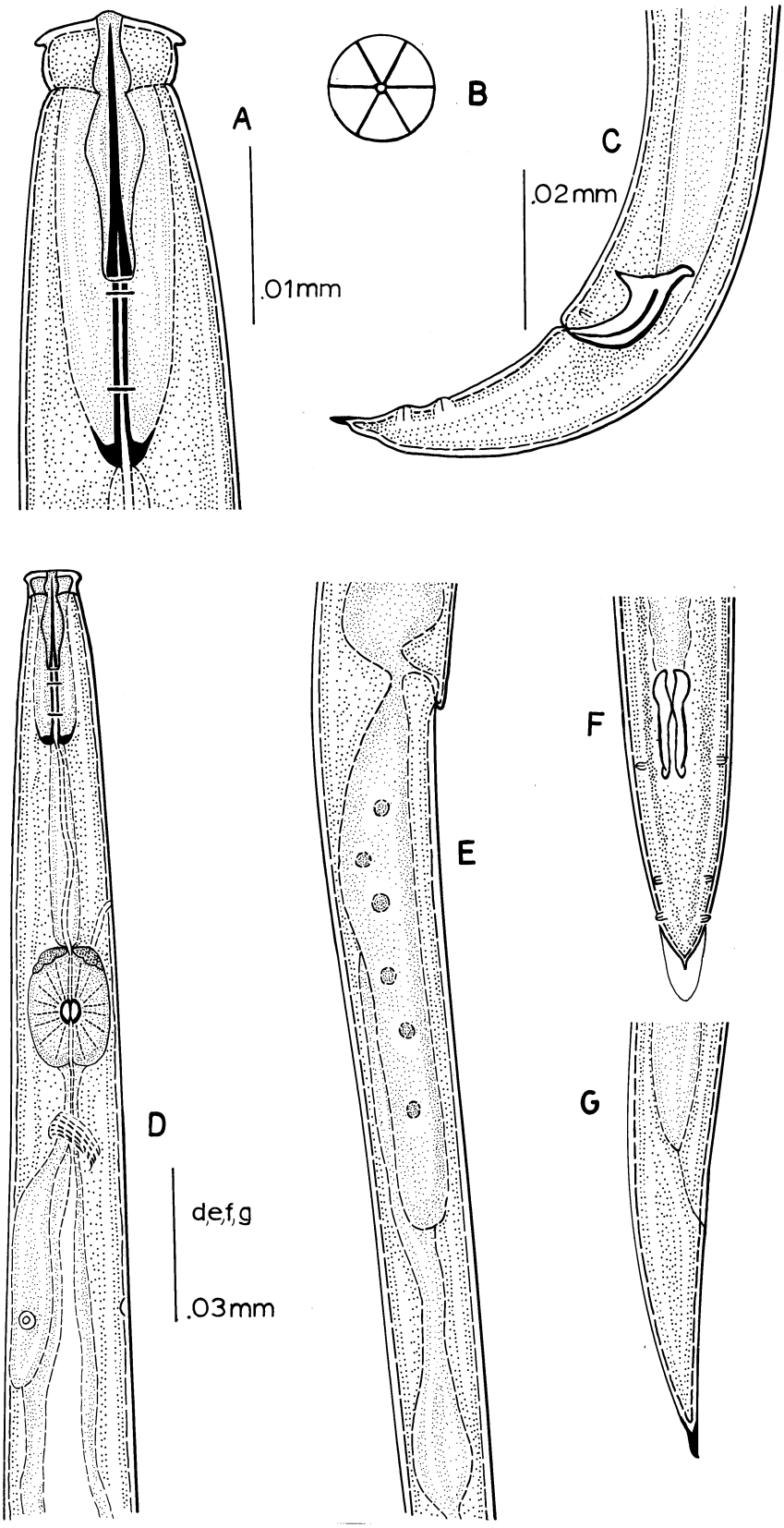


Figure 143.—*Omemeea maxbassiensis* Massey, 1971: *A.* Head; *B.* face view; *C.* lateral view, male, tail; *D.* head and neck; *E.* female, midbody; *F.* ventral view, male, tail; *G.* female, tail.

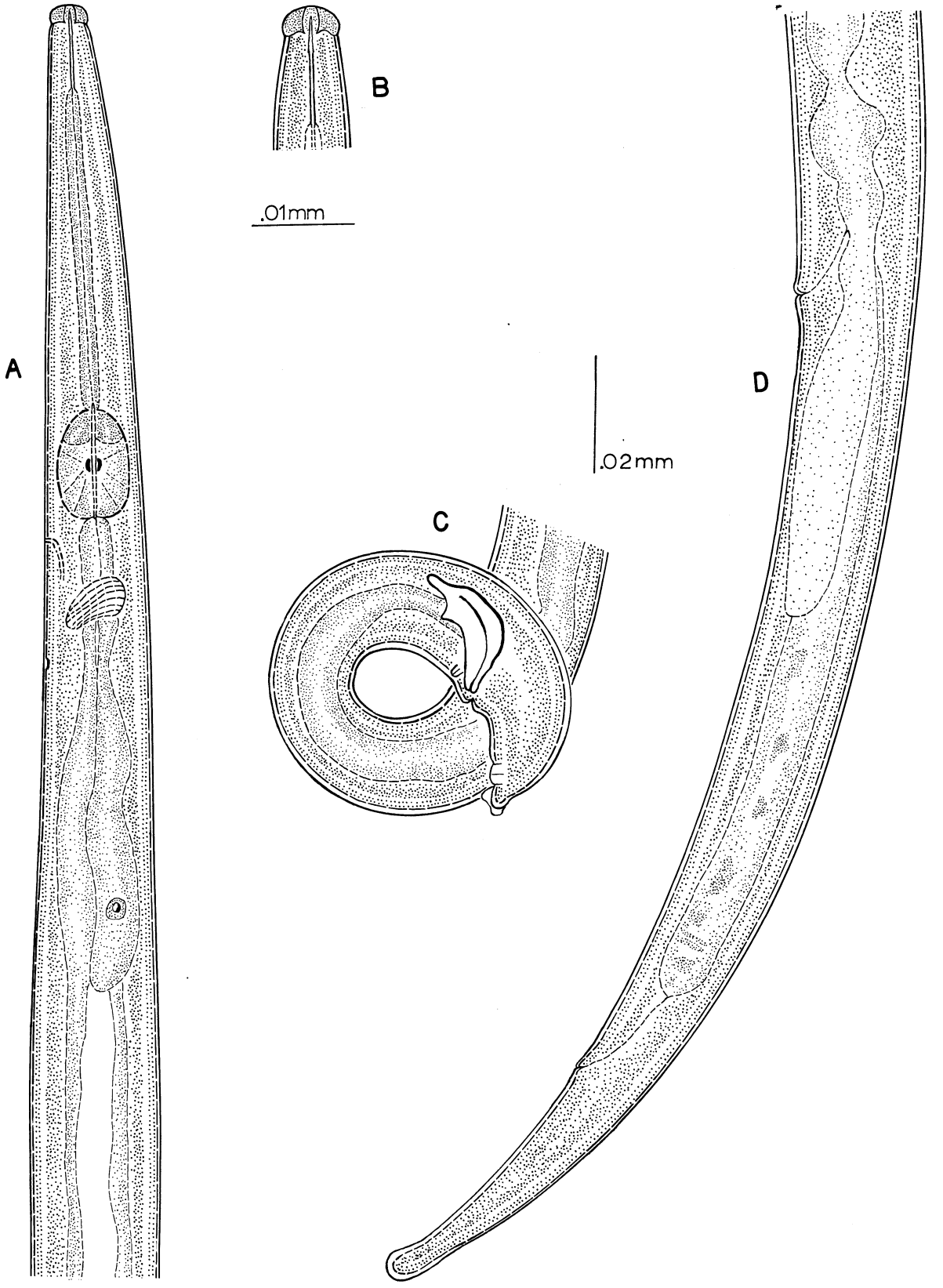


Figure 144.—*Teragramia willi* n. gen., n. sp.: *A.* Head and neck; *B.* head; *C.* male, tail; *D.* female, tail.

3 rows. Posterior uterine branch stout, ca 3 body widths in length. Anal opening and rectum indistinct. Tail conoid to an obtuse terminus, club shaped in lateral view.

Cuticle of male with distinct annulations in the region of the tail. Testis single, outstretched. Spicules massive, the apices high, the ventral rostra short. Two pair of caudal papillae, 1 pair preanal, 1 pair near terminus. Terminus obtuse, with a membranous flap. Tail extremely ventrally coiled on the majority of preserved specimens as illustrated.

Type habitat.—Associated with *Dendroctonus valens* in ponderosa pine.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 21-B.

Berntsenus n. gen.[10]

Type species: *Berntsenus brachycephalus* (Thorne, 1935) n. comb.

Cuticle with faint transverse striae, with or without lateral incisures. Lips expanded, 3 times wider than deep, petiolate. Stylet, under phase illumination, with heavily sclerotized subulate shaft, lightly sclerotized ventral aperture visible. Esophagus short. Metacorpus massive, filling body cavity in some specimens, round to oblong. Dorsal esophageal gland stout. Lips of vulva continuous with body wall. Vagina short. Posterior uterine branch 2–3 body widths in length. Ovary single. Anus and rectum conspicuous. Terminus subacute. Spicules paired, dorsal shaft lightly sclerotized, ventral segment less sclerotized than dorsal shaft. Apex low. One pair of postanal and ventrosubmedian papillae. Tail ventrally arcuate, conoid; subacute to acute terminus.

Diagnosis.—Related to *Ektaphelenchus* but easily distinguished by its narrower lip region, shape of metacorpus, its longer postuterine sac, and the presence of a conspicuous anus and rectum. Male spicules much less refractive with a low apex and delicate rostrum.

Berntsenus brachycephalus (Thorne, 1935) n. comb. Figure 145

Female: 0.95–0.96 mm; a=25.6–27.3; b=11; c=21.8–21.9; V=75%.

[10] Named in honor of Dr. Carl Berntsen, Assistant Director, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Male: 0.82–0.84 mm; a=37.3–41.1; b=10.3–10.5; c=22.3–27.9.

Form cylindroid. Cuticle with fine transverse striae, lateral incisures not discernible. Lip region set off, broadly expanded, 3 times wider than deep. Lips petiolate, distinct. Stylet unique, subulate shaft heavily sclerotized, ventral aperture distinct, shaft lightly sclerotized and faintly visible under phase contrast illumination, without basal knobs, 17–18 μ in length. Musculature conspicuous, running from base of spear to base of lips. Esophagus short. Metacorpus round to ovate, anterior one-fifth glandular. Crescentic valves at center. Dorsal esophageal gland stout, approximately 4 body widths in length. Excretory pore located midway between metacorpus and nerve ring. Lips of vulva continuous with body wall. Vagina short, slightly oblique. Ovary single, outstretched; oocytes arranged in double row. Posterior uterine branch 2–3 body widths in length. Anus and rectum conspicuous. Tail conoid to a subacute terminus.

Male: Testis single, outstretched. Spicules with apex low, with ventral segment forming a slight ventral rostrum. Spicules unrefractive, ventral rostrum difficulty visible under both bright field and phase contrast illumination. Only one pair of caudal papillae visible, they are postanal ventrosubmedian. Tail ventrally arcuate, conoid to a subacute to acute terminus.

Type habitat.—Associated with *Dendroctonus ponderosae* in lodgepole pine.

Type locality.—Provo Basin, Utah.

Type specimens.—Thorne Collection—USDA, Beltsville, Maryland. Slides No. 10-C and 10-D.

Berntsenus labiosus n. sp. Figure 146

Female: 0.71–0.82 mm; a=28–33; b=8–12; c=23–24; V=71–72%.

Male: Unknown.

Cylindroid. Cuticle with fine transverse striae, lateral incisures not observed. Lip region set off, flat; lips rounded laterally. Cephalic framework sclerotized. Stylet uniquely shaped for subfamily, with distinct basal thickenings, subulate shaft heavily sclerotized, retractor muscles distinct. Median bulb ovate. Dorsal esophageal gland outlet obscure. Dorsal esophageal gland relatively robust, 4–5 body widths in length. Nerve ring one-half body width posterior to metacorpus. Excretory pore

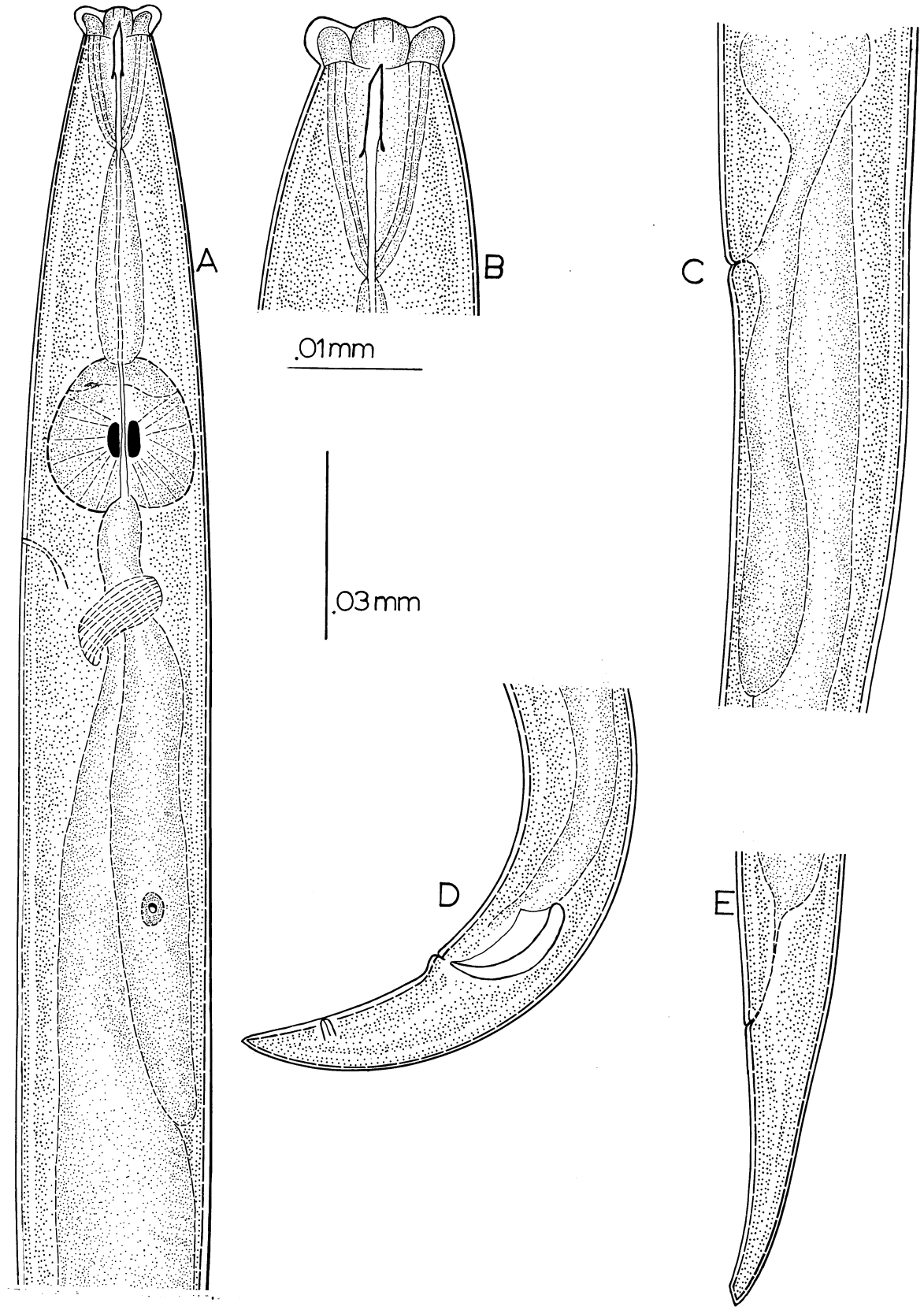


Figure 145.—***Berntsenus brachycephalus*** **(Thorne, 1935) n. comb.:** ***A.*** **Head and neck;** ***B.*** **head;** ***C.*** **female, midbody;** ***D.*** **male, tail;** ***E.*** **female, tail.**

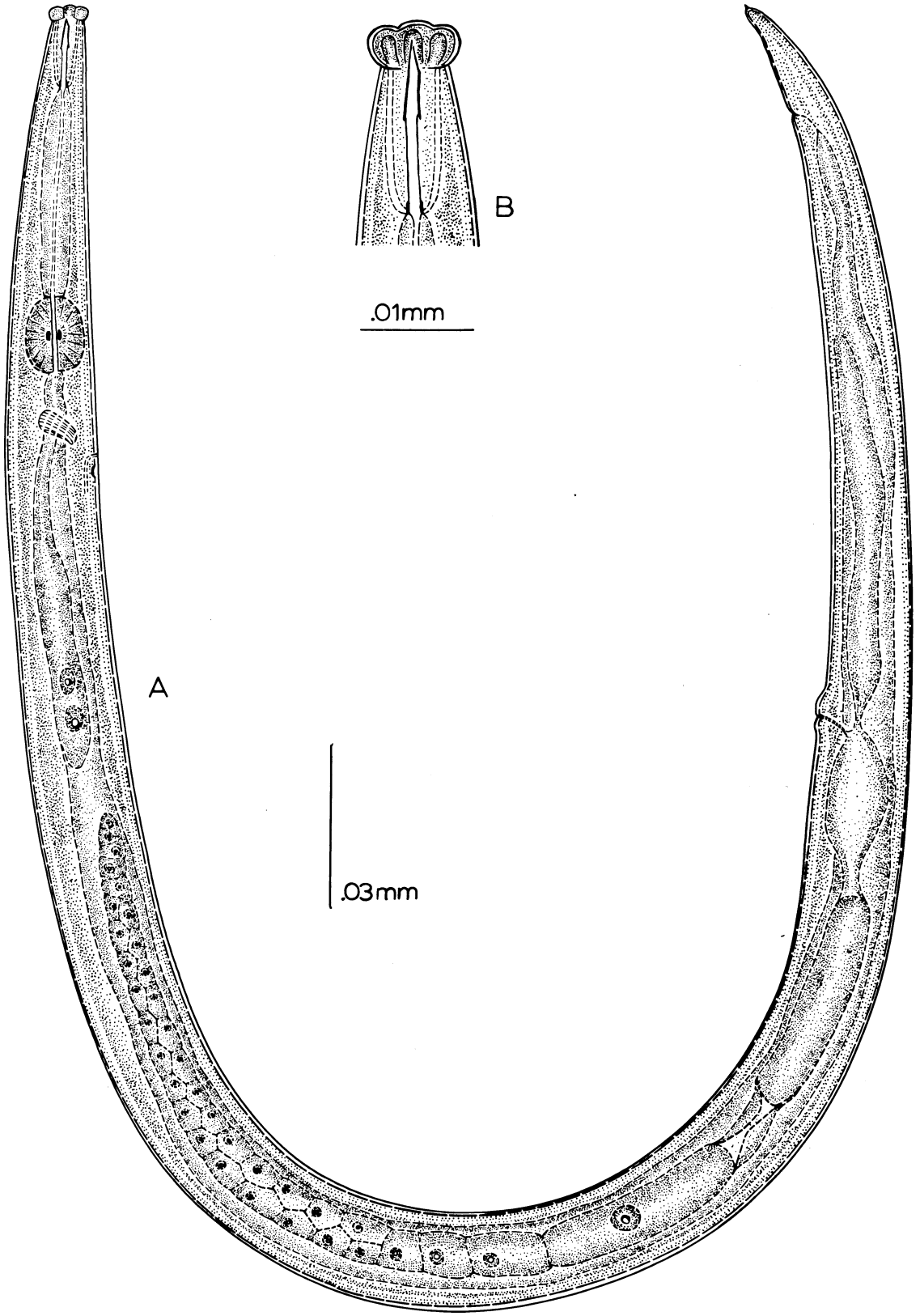


Figure 146.—*Berntsenus labiosus* n. sp.: *A.* Female; *B.* head.

slightly posterior to nerve ring. Hemizonid immediately posterior to excretory pore. Lips of vulva slightly protuberant. Vagina oblique. Ovary outstretched. Oocytes arranged in a double row. Posterior uterine branch 4–5 body widths in length. Anus distinct, rectum obscure. Tail conoid to an acute mucronate-like terminus.

Diagnosis.—Differs from *B. brachycephalus* in its smaller size, in the presence of distinct basal thickenings on stylet, and in the elongate postuterine branch.

Type habitat.—Associated with *Pityokteines elegans* in white fir.

Type locality.—Sandia Mountains, Cibola National Forest, New Mexico.

Type specimens.—Collection No. 78-L.

Genus *Seinura* Fuchs, 1931

Type species: *Seinura mali* Fuchs, 1931

Labial framework lightly sclerotized, no hexoradiate star surrounding oral aperture. Stylet plain, with or without basal swellings or small knobs. Hemizonid surrounding or behind excretory pore. Metacorpus longer than wide, crescentic valve plates usually located behind middle. Ovary single, outstretched, with oogonia in one to five rows, with or without postvulvar sac. Female tails elongate, conoid to filiform. Male tail ventrally arcuate, elongate conoid to filiform or tapering to spicate terminus. Spicules paired with knoblike apex and beaklike ventral rostrum. Caudal papillae vary from one to four pairs.

Key to the species of *Seinura* associated with bark beetles in the United States

1. Females with vulval flap 2
   Females without vulval flap ..... *attentuata* n. sp.
2. Lip region definitely set off ..... *arizonensis* n. sp.
   Lip region more or less continuous with body contour ..... *pini*

***Seinura arizonensis* n. sp.** **Figure 147**

Female: 1.12 mm; a=40.4; b=13.5; c=12.6; V=73%.

Male: Unknown.

Cylindroid. Cuticle with very fine annulations, lateral incisures not discernible. Lip region set off, rounded. Cephalic framework lightly sclerotized. Lips indistinct. Stylet 20 μ in length, without basal knobs or thickenings. Retractor muscles indistinct. Metacorpus ovate, the anterior one-third glandular. Dorsal esophageal gland outlet not visible. Dorsal esophageal gland 4–5 body widths in length. Nerve ring three-fourths body width posterior to metacorpus. Excretory pore through hemizonid and ca 1 body width posterior to the nerve ring. Lips of vulva continuous with body contour, anterior lip forming a distinct flap. Ovary outstretched, at times reaching beyond the distal end of the dorsal esophageal gland, the oogonia in 4 rows. Postuterine branch broad, filling most of body cavity in some specimens, 3–4 body widths in length. Anus and rectum as illustrated. Tail filiform to an acute terminus.

Diagnosis.—*Seinura* with lip region set off and with elongate tail, not filiform.

Type habitat.—Associated with *Ips integer* (Eichh.) in ponderosa pine.

Type locality.—Prescott, Arizona.

Type specimens.—Collection No. 56-F.

***Seinura attenuata* n. sp.** **Figure 148**

Female: 0.95 mm; a=42.7; b=13.1; c=?; V=60%.

Male: 0.70 mm; a=31.7; b=8.46; c=9.

Body cylindroid. Cuticle with no discernible lateral incisures, annulations very fine. Lip region hardly set off. Cephalic framework sclerotized. Lips distinct. Stylet 20 μ in length, without basal knobs or thickenings, the retractor muscles indistinct. Dorsal esophageal gland outlet indistinct. Metacorpus oblong ovate, approximately one-half the anterior portion glandular, valvular plates below the center. Nerve ring a body width posterior to metacorpus. Dorsal esophageal gland 6–7 body widths in length. Excretory pore opposite nerve ring and running through hemizonid. Ovary outstretched, reaching in some specimens be-

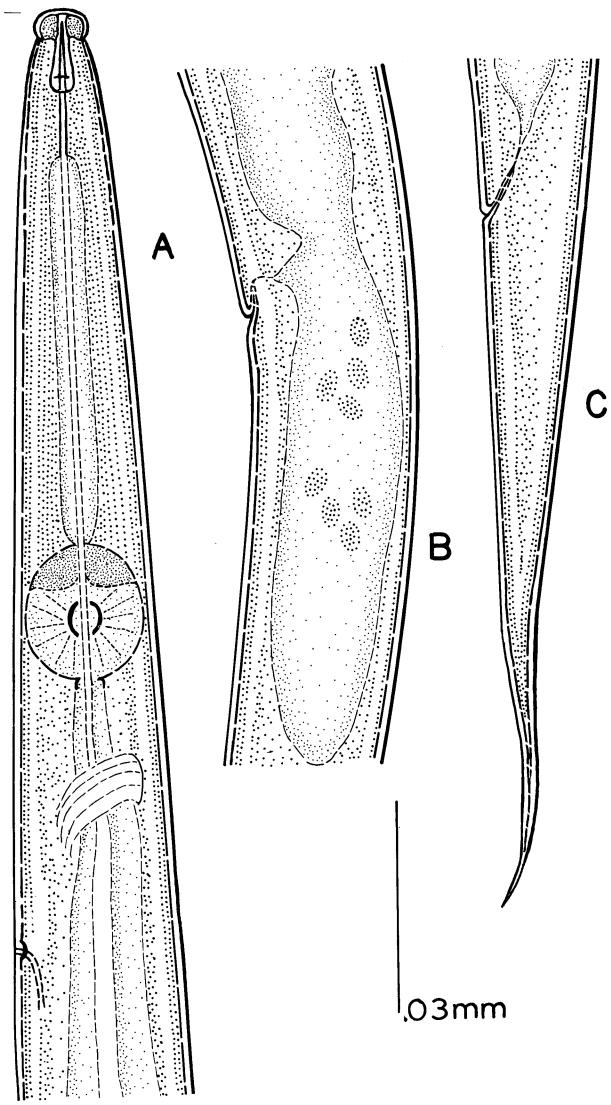


Figure 147.—*Seinura arizonensis* n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* female, tail.

yond the distal end of the dorsal esophageal gland. Lips of vulva continuous with body contour. Postuterine branch ca 1½ body widths in length. Anal opening and rectum obscure. Tail conoid to a filamentous terminus.

Male: With head and neck characteristics of female. Testis short, outstretched. Spicules with low rounded prominent ventral rostrum. There is one pair of postanal ventral papillae. Tail ventrally arcuate, conoid to a filamentous terminus.

Diagnosis.—Related to *Seinura pini* Massey, 1966; differs in the spear length and in the more attenuated tail of both sexes.

Type habitat.—Associated with *Dendroctonus terebrans* in loblolly pine.

Type locality.—Oakdale, Louisiana.

Type specimens.—Collection No. 67-A.

***Seinura pini* Massey, 1966** **Figure 149**

Female: 0.81–0.83 mm; a=32–34; b=7.2–9.5; c=?; V=71–75%.

Male: 0.78 mm; a=31; b=8.9; c=12.4.

Head continuous with body contour, lips distinct. Spear 26 μ long, without basal knobs or thickenings. Median bulb of esophagus oblong ovate, anterior and posterior portions very glandular. Excretory pore one and one-third body widths posterior to median bulb. Hemizonid immediately posterior to excretory pore. Dorsal esophageal glands prominent, 4–5 times body width. Ovary outstretched, at times overlapping distal end of esophageal glands. Anterior lip of vulva forming a flap. Vagina transverse, posterior uterine branch 1 body width in length. Anal opening not observed. Terminus spicate.

Male: Testis single, outstretched, occupying approximately two-thirds of body length. Spicules paired, with prominent ventral rostrum. One pair postanal caudal papillae. Terminus spicate.

Diagnosis.—Closely related to *Seinura mali* Fuchs, 1931 but differs in the shorter length of female tail and absence of a discernible anal opening.

Type habitat.—Associated with *Dendroctonus adjunctus* in ponderosa pine.

Type locality.—Ruidoso, New Mexico.

Type specimens.—Collection No. 37-D.

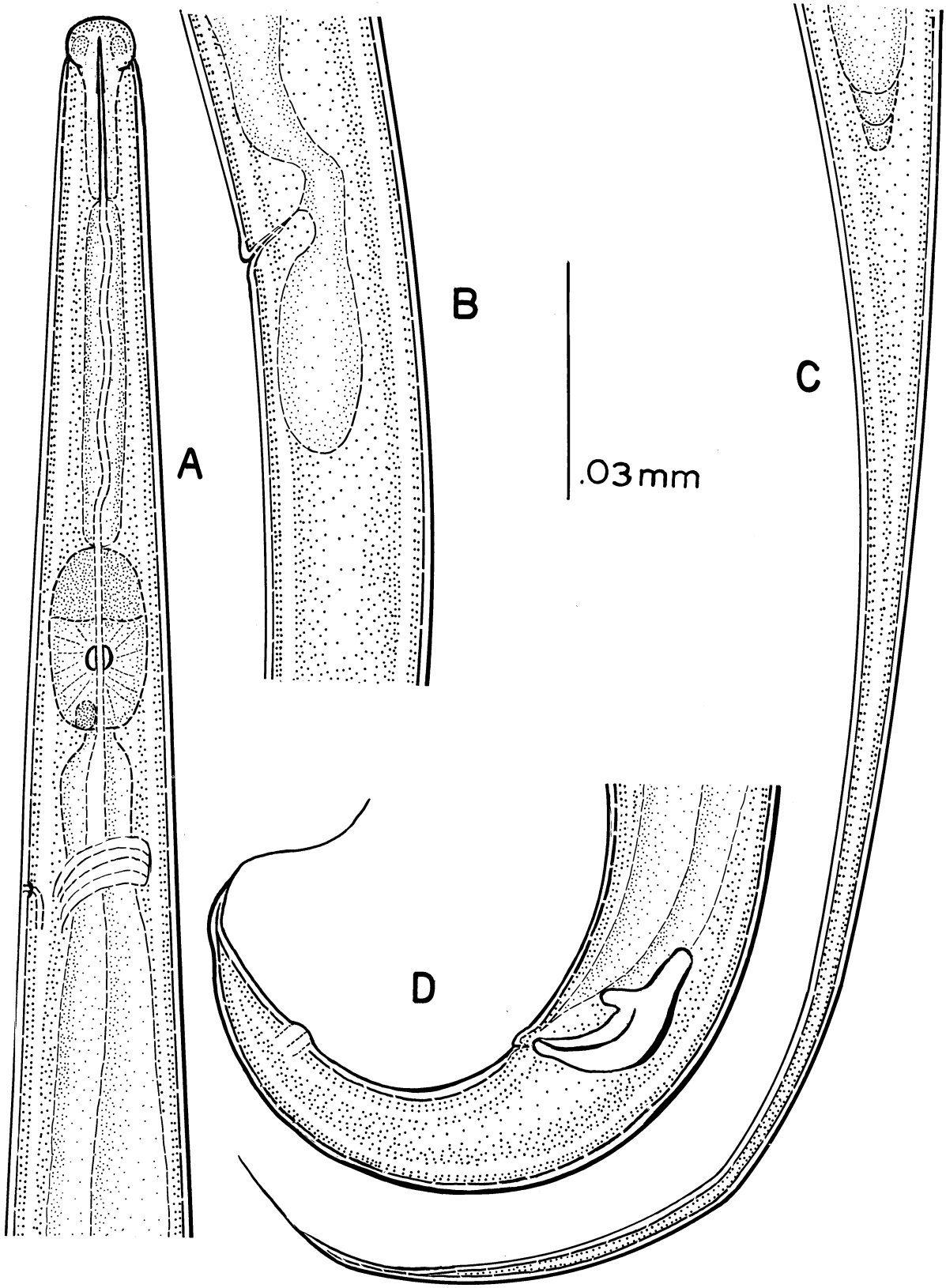


Figure 148.—*Seinura attenuata* n. sp.: *A.* Head and neck; *B.* female, midbody; *C.* female, tail; *D.* male, tail.

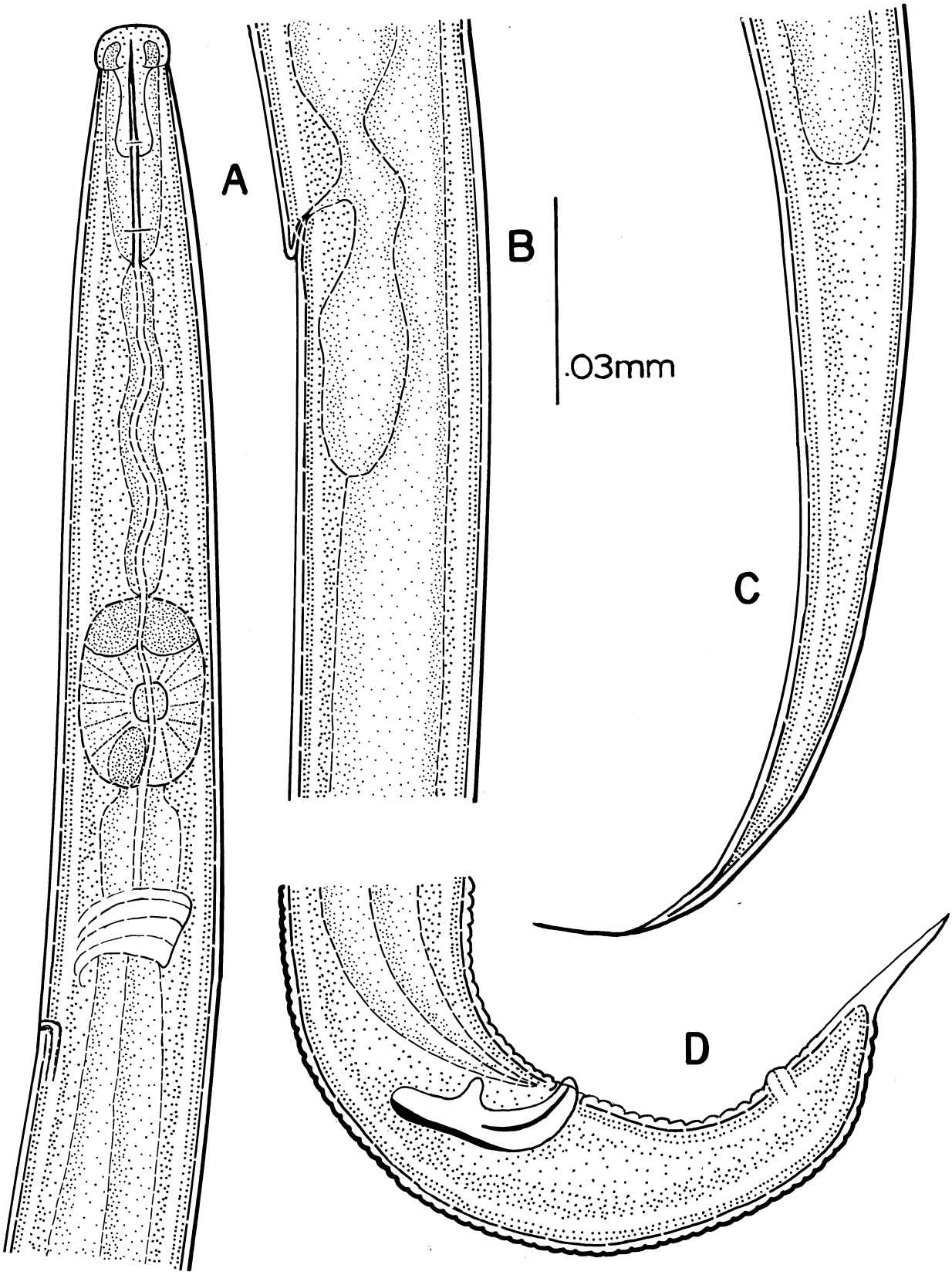


Figure 149.—*Seinura pini* Massey, 1966: *A.* Head and neck; *B.* female, midbody; *C.* female, tail; *D.* male, tail.

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APPENDIX

Nematode Parasites and Associates by Bark Beetle Species

Chramesus hicoriae Leconte
- *Aphelenchoides rhytium* Massey, 1970
- *Laimaphelenchus penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941
- *Santafea damalis* Massey, 1966

Conophthorus coniperda Schwarz
- *Aphelenchoides conophthori* n. sp.
- *Panagrolaimus conophthori* n. sp.

Dendroctonus adjunctus Blandford
- *Acrostichus ponderosus* Massey, 1962
- *Bunonema* sp.
- *Bursaphelenchus bestiolus* n. sp.
- *Bursaphelenchus corneolus* Massey, 1966
- *Cephaloboides rotundus* n. rank n. sp.
- *Deladenus paradurus* n. sp.
- *Diplogasteroides marshalli* Massey, 1962
- *Dotylaphus lonchites* n. sp.
- *Ektaphelenchus obtusus* Massey, 1956
- *Gerthornus balaenus* Massey, 1966
- *Hexatylus* sp.
- *Laimaphelenchus pannocaudus* Massey, 1966
- *Laimaphelenchus pensobrinus* Massey, 1966
- *Macrolaimus canadensis* Sanwal, 1960
- *Mikoletzkya cervicula* Massey, 1966
- *Mononchoides adjunctus* Massey, 1966
- *Neocephalobus judithae* Massey, 1964 n. comb.
- *Neoditylenchus ovarius* n. sp.
- *Panagrobelus scolyti* Massey, 1964
- *Parasitaphelenchus dendroctoni* Massey, 1966
- *Parasitorhabditis* sp.
- *Parasitylenchus stipatus* Massey, 1966
- *Plectus acuminatus* Bastian, 1865
- *Plectus annulatus* Maggenti, 1961
- *Plectus parietinus* Bastian, 1865
- *Pseudhalenchus damnatus* Massey, 1966
- *Rhabdontolaimus* sp.
- *Santafea damalis* Massey, 1966
- *Seinura pini* Massey, 1966
- *Teregramia willi* n. gen. n. sp.

Dendroctonus brevicomis LeConte
- *Aphelenchoides* sp.
- *Bursaphelenchus bestiolus* n. sp.
- *Bursaphelenchus wilfordi* Massey, 1966
- *Contortylenchus brevicomi* (Massey, 1957) Rühm 1960
- *Ektaphelenchus obtusus*
- *Neoditylenchus glandarius* n. sp.
- *Parasitorhadbitis* sp.
- *Rhabdontolaimus* sp.
- *Seinura* sp.

Dendroctonus frontalis Zimmerman
- *Anguillonema annamari* n. sp.
- *Aphelenchoides rhytium* Massey, 1970
- *Aphelenchoides* sp.
- *Bursaphelenchus* sp.
- *Deladenus ipini* n. sp.
- *Hexatylus viviparus* Goodey, 1926
- *Luella luculenta* n. gen. n. sp.
- *Mikoletzkya bandelieri* (Massey, 1960) Massey, 1966
- *Monohystera* sp.
- *Neoditylenchus dendroctoni* n. sp.
- *Neoditylenchus* sp.
- *Nothotylenchus* sp.
- *Parasitaphelenchus gallagheri* (Massey, 1960) J. B. Goodey, 1960
- *Parasitorhabditis* sp.
- *Rhabdontolaimus adephagus* n. sp.
- *Rhabdontolaimus frontali* n. sp.
- *Robleus cylindricus* n. gen., n. sp.
- *Santafea damalis*

Dendroctonus ponderosae Hopkins
- *Aphelenchoides tenuidens* Thorne, 1935
- *Berntsenus brachycephalus* (Thorne, 1935) n. gen., n. comb.
- *Bursaphelenchus conurus* (Steiner, 1932) J. B. Goodey, 1960
- *Bursaphelenchus talonus* (Thorne, 1935) J. B. Goodey, 1960
- *Contortylenchus reversus* (Thorne, 1935) Rühm, 1956

Dendroctonus ponderosae Hopkins (Continued)
- *Cryptaphelenchus latus* (Thorne, 1935) Rühm, 1956
- *Ektaphelenchus josephi* n. sp.
- *Ektaphelenchus obtusus* Massey, 1956
- *Laimaphelenchus penardi* (Steiner, 1914) Filipjev and Schuurmans Stekhoven, 1941
- *Laimaphelenchus pensobrinus*
- *Macrolaimus canadensis*
- *Mikoletzkya inedia* Massey, 1966
- *Mikoletzkya pinicola* (Thorne, 1935) Baker, 1962
- *Neocephalobus judithae*
- *Neoditylenchus pinophilus* (Thorne, 1935) J. B. Goodey, 1963
- *Nothotylenchus* sp.
- *Panagrodontus dentatus* Thorne, 1935
- *Parasitaphelenchus acroposthion* (Steiner, 1932) Rühm, 1956
- *Parasitorhabditis* sp.

Dendroctonus pseudotsugae Hopkins
- *Aphelenchoides* sp.
- *Bursaphelenchus* sp.
- *Contortylenchus reversus*
- *Ektaphelenchus obtusus*
- *Mikoletzkya diluta* Massey, 1966
- *Misticius mustus* Massey, 1967
- *Neocephalobus judithae*
- *Neoditylenchus puniwopus* Massey, 1969
- *Neoditylenchus* sp.
- *Parasitaphelenchus beccus* n. sp.
- *Parasitorhabditis* sp.
- *Santafea damalis*
- *Seinura* sp.
- *Sphaerularia dendroctoni* Massey, 1956

Dendroctonus rufipennis Kirby
- *Acrostichus gubernatus* n. sp.
- *Aglenchus exiguus* Massey, 1969
- *Anaplectus granulosus* (Bastian, 1865) deConick and Schuurmans Stekhoven, 1933
- *Bunonema* sp.
- *Bursaphelenchus talonus* (Thorne, 1935) J. B. Goodey, 1960
- *Contortylenchus reversus* (Thorne, 1935) Rühm, 1956
- *Diplogasteroides bibrochus* n. sp.
- *Ektaphelenchus obtusus*
- *Ereptonema fimbriatum* Anderson, 1966
- *Mesorhabditis longistomis* n. sp.
- *Mikoletzkya ruminis* Massey, 1966
- *Monohystera* sp.
- *Mononchoides adjunctus* Massey, 1966
- *Neocephalobus judithae*
- *Neoditylenchus pinophilus*
- *Neoditylenchus yasinskii* Massey, 1969
- *Neotylenchus nitidus* Massey, 1969
- *Panagrolaimus concolor* Massey, 1964
- *Panagromacra margaretae* Massey, 1964
- *Parasitaphelenchus gallagheri* (Massey, 1960) J. B. Goodey, 1960
- *Parasitaphelenchus* sp.
- *Parasitorhabditis* sp.
- *Plectus assimilis* Bütschli, 1873
- *Plectus parietinus* Bastian, 1865
- *Prionchulus punctatus* (Cobb, 1917) Clark, 1960
- *Santafea croca* Massey, 1963
- *Sphaerularia dendroctoni*

Dendroctonus simplex Leconte
- *Aphelenchoides* sp.
- *Ektaphelenchus obtusus*
- *Laimaphelenchus pensobrinus*
- *Neocephalobus* sp.
- *Neoditylenchus* sp.

Dendroctonus terebrans (Oliver)
- *Acrostichus ponderosus*
- *Acrostichus taedus* Massey, 1962
- *Aphelenchoides rhytium*
- *Bursaphelenchus tritrunculus* n. sp.
- *Contortylenchus terebranus* n. sp.
- *Dirhabdilaimus nacogdochensis* n. sp.
- *Dotylaphus lonchites* n. sp.
- *Ektaphelenchus smaelus* n. sp.
- *Ektaphelenchus terebranus* n. sp.
- *Hexatylus* sp.
- *Laimaphelenchus penardi*
- *Mikoletzkya tomea* Massey, 1966
- *Neocephalobus judithae* n. comb.
- *Neodiplogaster pinicola* Steiner, 1930
- *Nothotylenchus petilus* n. sp.
- *Parasitorhabditis terebranus* n. sp.
- *Rhabdontolaimus janae* (Massey, 1962) n. comb.
- *Santafea damalis*
- *Seinura attenuata* n. sp.

Dendroctonus valens Leconte
- *Aphelenchoides* sp.
- *Ektaphelenchus obtusus*
- *Parasitorhabditis terebranus* n. sp.
- *Plectus parietinus*
- *Poikilolaimus* sp.
- *Prionchulus* sp.
- *Teragramia willi* n. gen. n. sp.

Dryocoetes affaber (Mannerheim)
- *Ektaphelenchus smaelus* n. sp.

Dryocoetes confusus Swaine
- *Acrostichus concolor* Massey, 1962
- *Aphelenchoides* sp.
- *Bursaphelenchus wilfordi* Massey, 1964
- *Ektaphelenchus prolobos* Massey, 1964
- *Laimaphelenchus penardi*
- *Laimaphelenchus pensobrinus* Massey, 1966
- *Macrolaimus canadensis*
- *Mikoletzkya langcaudus* n. sp.
- *Neocephalobus judithae*
- *Neoditylenchus* sp.
- *Panagromacra margaretae*
- *Parasitorhabditis* sp.
- *Plectonchus wyganti* Massey, 1964
- *Plectus makrodemas* Massey, 1964
- *Plectus parietinus*

Dryocoetes sp.
- *Acrobeloides* sp.
- *Aphelenchoides* sp.
- *Eucephalobus* sp.
- *Thada* sp.
- *Tylenchus* sp.

Hylurgops pinifex (Fitch)
- *Aphelenchoides hylurgi* n. sp.
- *Aphelenchoides polygraphi* n. sp.
- *Aphelenchoides* sp.
- *Bursaphelenchus elytrus* Massey, 1971
- *Bursaphelenchus* sp.
- *Contortylenchus bullus* n. sp.
- *Gerthornus* sp.
- *Mikoletzkya pugnea* Massey, 1971
- *Mikoletzkya* sp.
- *Neocephalobus judithae*
- *Panagrolaimus* sp.
- *Parasitorhabditis hylurgi* n. sp.
- *Parasitorhabditis ipini* n. sp.
- *Parasitylenchus coronatus* n. sp.

Hylurgops subcostulatus (Mannerheim)
- *Aphelenchoides* sp.
- *Bursaphelenchus newmexicanus* n. sp.
- *Gerthornus balaenus* Massey, 1966
- *Mikoletzkya pugnea* Massey, 1971
- *Neocephalobus judithae*
- *Panagrolaimus concolor*
- *Parasitaphelenchus* sp.
- *Plectonchus molgos* n. sp.

Ips avulsus (Eichhoff)
- *Anguillonema annamari* n. sp.
- *Aphelenchoides rhytium*
- *Aphelenchoides* sp.
- *Hexatylus viviparus*
- *Laimaphelenchus penardi*
- *Mikoletzkya bandelieri*
- *Mikoletzkya* sp.
- *Nothotylenchus similis* Thorne and Malek, 1968
- *Parasitorhabditis* sp.
- *Parasitorhabditis* sp.
- *Parasitylenchus avulsi* Massey, 1958
- *Rhabdontolaimus frontali* n. sp.
- *Santafea damalis*
- *Tylenchus* sp.

Ips calligraphus German
- *Aphelenchoides rhytium* Massey, 1971
- *Bursaphelenchus tritrunculus*
- *Contortylenchus grandicolli* (Massey, 1957) Rühm, 1960
- *Deladenus ipini* n. sp.
- *Diplogasteroides marshalli*
- *Ektaphelenchus obtusus*
- *Laimaphelenchus penardi*
- *Luella luculenta* n. sp.
- *Mikoletzkya calligraphi* n. sp.
- *Monohystera* sp.
- *Parasitaphelenchus procerus* n. sp.
- *Parasitorhabditis* sp.
- *Rhabdontolaimus janae*
- *Seinura pini*

Ips confusus Leconte
- *Acrostichus ponderosus*
- *Aphelenchoides* sp.
- *Contortylenchus elongatus* (Massey, 1957) Nickle, 1963
- *Cryptaphelenchus latus* (Thorne, 1935) Rühm, 1956
- *Laimaphelenchus penardi*
- *Laimaphelenchus pensobrinus*
- *Macrolaimus canadensis*
- *Mikoletzkya bandelieri*
- *Parasitaphelenchus gallagheri*
- *Parasitorhabditis* sp.
- *Parasitylenchus pilifronus* Massey, 1958
- *Plectus* sp.
- *Santafea croca*

Ips cribicollis (Eichhoff)
- *Contortylenchus cribicolli* n. sp.
- *Diplogasteroides marshalli*
- *Mikoletzkya bandelieri*
- *Parasitorhabditis* sp.

Ips grandicollis (Eichhoff)
- *Anguillonema* sp.
- *Aphelenchoides rhytium*
- *Contortylenchus grandicolli* (Massey, 1957) Rühm, 1960
- *Laimaphelenchus penardi*
- *Nothotylenchus similis*
- *Parasitorhabditis hastulus* n. sp.

Ips integer (Eichhoff)
Aphelenchoides polygraphi n. sp.
Diplogasteroides marshalli
Ektaphelenchus obtusus
Laimaphelenchus pannocaudus
Laimaphelenchus penardi
Mikoletzkya bandelieri
Neoditylenchus sp.
Parasitaphelenchus gallagheri
Plectus sp.
Seinura arizonensis n. sp.
Ips knausi Swaine
Laimaphelenchus penardi
Macrolaimus canadensis
Mikoletzkya inedia Massey, 1966
Parasitaphelenchus sp.
Parasitorhabditis sp.
Ips lecontei Swaine
Acrostichus ponderosus
Aphelenchoides sp.
Contortylenchus elongatus
Cryptaphelenchus sp.
Diplogasteroides marshalli
Ektaphelenchus obtusus
Laimaphelenchus pensobrinus
Macrolaimus canadensis
Mikoletzkya inedia
Parasitaphelenchus gallagheri
Parasitorhabditis sp.
Parasitylenchus sp.
Seinura pini
Ips pilifrons Swaine
Parasitylenchus ovarius Massey, 1958
Parasitylenchus pilifrons Massey, 1958
Ips pini (Say)
Contortylenchus sp.
Contortylenchus spirus (Massey, 1957) Rühm, 1960
Diplogasteroides ipini n. sp.
Ektaphelenchus obtusus
Ektaphelenchus smaelus
Luella luculenta n. gen. n. sp.
Macrolaimus canadensis
Neoditylenchus sp.
Parasitorhabditis ipini n. sp.
Parasitylenchus ipinius n. sp.
Parasitylenchus ovarius
Parasitylenchus sp.
Ips ponderosae Swaine = *Ips calligraphus* (German)
Acrostichus ponderosus
Aphelenchoides sp.
Contortylenchus grandicolli
Diplogasteroides marshalli
Ektaphelenchus obtusus
Laimaphelenchus pensobrinus
Macrolaimus canadensis
Mikoletzkya bandelieri
Parasitaphelenchus gallagheri
Parasitorhabditis sp.
Ips sulcifrons Wood
Contortylenchus spirus
Parasitylenchus elongatus Massey, 1964
Ips yohoensis Swaine
Parasitylenchus ovarius
Leperisinus aculeatus (Say)
Anguillonema leperisini n. sp.
Geraldius bakeri
Hexatylus viviparus
Laimaphelenchus penardi
Omemeea maxbassiensis
Panagrobelus scolyti
Panagrolaimus leperisini n. sp.
Parasitylenchus sp.
Plectus sp.
Teratocephalus angustus n. sp.
Leperisinus californicus Swaine
Aphelenchoides sp.
Laimaphelenchus sp.
Macrolaimus taurus
Omemeea maxbassiensis Massey, 1971
Panagrellus leperisini n. sp.
Orthotomicus caelatus (Eichhoff)
Contortylenchus orthotomici n. sp.
Parasitylenchus oriundus n. sp.
Orthotomicus ornatus Swaine
Allantonema orthotomici n. sp.
Phloeosinus dentatus (Say)
Geraldius bakeri
Laimaphelenchus phloeosini n. sp.
Panagrobelus phloeosini n. sp.
Phloeosinus neomexicanus Blackman
Laimaphelenchus pensobrinus
Nothotylenchus compactus n. sp.
Parasitorhabditis sp.
Santafea croca
Sychnotylenchus phloeosini Massey, 1969
Pityogenes carinulatus (Leconte)
Bursaphelenchus pityogeni n. sp.
Parasitaphelenchus sp.
Pityokteines elegans Swaine
Aphelenchoides pityokteini n. sp.
Berntsenus labiosus n. sp.
Ektaphelenchus prolobos
Macrolaimus canadensis
Neoditylenchus sp.
Parasitorhabditis sp.
Rhabdontolainus adephagus n. sp.
Santafea croca

Pityophthorus sp.
Bursaphelenchus sp.
Contortylenchus tomici (Bovien, 1937) Rühm, 1956
Neoditylenchus sp.
Parasitaphelenchus sp.
Parasitorhabditis hastulus n. sp.
Parasitylenchus senicus n. sp.
Polygraphus hoppingi Swaine
Aphelenchoides polygraphi n. sp.
Macrolaimus canadensis
Neoditylenchus yasinskii Massey, 1969
Panagromacra margaretae
Parasitorhabditis cluniculus n. sp.
Parasitylenchus parasitus n. sp.
Pseudohylesinus grandis Swaine
Parasitorhabditis gracilis n. sp.
Pseudohylesinus nebulosus (Leconte)
Bursaphelenchus sp.
Neoditylenchus sp.
Parasitylenchus undulatus n. sp.
Scolytus multistriatus Marsham
Aphelenchoides sp.
Bursaphelenchus scolyti n. sp.
Cylindrocorpus erectus Massey, 1960
Geraldius bakeri
Laimaphelenchus penardi
Panagrobelus scolyti
Panagrolaimus leperisini
Parasitaphelenchus oldhami Rühm, 1956
Santafea damalis
Sychnotylenchus scolyti Massey, 1969
Scolytus muticus (Say)
Sychnotylenchus mutici n. sp.
Scolytus ventralis Leconte
Acrostichus concolor
Aphelenchoides sp.
Bunonema newmexicana Massey, 1964
Bursaphelenchus wilfordi
Ektaphelenchus sandiaensis Massey, 1964
Laimaphelenchus penardi
Laimaphelenchus pensobrinus
Macrolaimus canadensis
Mesorhabditis longistomis n. sp.
Mikoletzkya diluta Massey, 1964
Neocephalobus judithae
Neoditylenchus sp.
Panagrolaimus concolor Massey, 1964
Panagromacra margaretae
Parasitaphelenchus sp.
Parasitorhabditis sp.
Parasitylenchus elongatus Massey, 1958
Parasitylenchus scrutillus Massey, 1964
Plectonchus wyganti
Plectus eurycerus Massey, 1964
Plectus parietinus
Santafea croca
Tylenchus sp.

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