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Mononchida (Nematoda) of West Bengal, India : Taxonomy and Ecology

TIASI JANA
AMALENDU CHATTERJEE
BUDDHADEB MANNA

ZOOLOGICAL SURVEY OF INDIA

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Mononchida (Nematoda) of West Bengal, India: Taxonomy and Ecology

TIASI JANA
AMALENDU CHATTERJEE
BUDDHADEV MANNA*

Zoological Survey of India, M-Block, New Alipore, Kolkata - 700 053

**Department of Zoology, Parasitology Laboratory, University of Calcutta, Kolkata - 700 019*

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FOREWORD

The book on the mononchids of West Bengal, written by Tiasi Jana, Amalendu Chatterjee and Buddhadeb Manna, would be of great help to the students of Agriculture, Zoology, Ecology and more particularly, Nematology. Taxonomy, although one of the basic fields of biology, is largely neglected by among researchers in our country.

Nematodes are widespread and very populous metazoans in the soil environment and offer interesting avenues of research in taxonomy, biodiversity and ecology. Plant-parasitic nematodes have attracted greater attention, as compared to their free-living counterparts, among the researchers because of their economic importance. Mononchids play an important role in the biological control of plant nematodes. Although they can not match the chemical control, they help in keeping the population of noxious nematodes as a reasonably lower level and would never allow them to reach plague proportions. This they do without polluting the environment. Earlier work in this respect focused mainly on the number of plant parasitic nematodes a mononchid devours in a fixed period. But, I think it is the presence of the predators, rather than their devouring capacity, which is important in keeping the phytonematode population at bay. A domestic cat may not capture many mice in a house but its very presence would keep the mice away-viewed from this perspective. Mononchids hold promise in the management of plant nematodes in the rhizosphere of perennial plants like guava, mango, tea etc.

In 1968, during my survey of soil nematodes at Santiniketan, I was attracted to a good number of mononchids belonging to the genus *Mylonchulus* in the rhizosphere of a very old rose garden of Uttarayana, the home of Rabindranath Tagore. I noticed that this rose garden maintained a rich community of nematodes including some plant parasites. It was because of this mixed community structure providing a steady supply of preys that the mononchid population thrived and helped in the natural management of phytonematodes. The book begins with an 'Introduction' followed by 'Materials and Methods' and 'Observations' which is divided into 'Taxonomy' and 'Ecology' Methodology includes soil sampling for the collection of nematodes, their fixation and mounting on slides and estimation of abiotic factors. A beginner can easily learn the basic techniques from this section and start work on soil nematodes. Both Dr. Chatterjee and Dr. Manna are competent nematologists and Ms. Jana, a devoted worker in this field. They have nicely described different species of mononchids collected from West Bengal, their ecology, community dynamics along with dorylaimids and tylenchids in relation to abiotic factors. Descriptions of morphology together with appropriate illustrations help in rapid identification of mononchids. The book is an important contribution to Nematology and would be appreciated by students and researchers in this field.

Prof. N. C. Sukul
Formerly, Head, Department of Zoology and Dean (Adhyaksha)
Faculty of Science (Siksha-Bhavana)
Viswa-Bharati University, Santiniketan, West Bengal, India

PREFACE

This book is intended to include the taxonomic work and ecology of soil dwelling, exclusively predatory nematode of order Mononchida from West Bengal, India. It is a small group of nematodes which consists more than 400 species (global) under order Mononchida, only about 19% of them were recorded from India.

In India, majority of the taxonomic, ecological and control work on nematodes have been done in Aligarh Muslim University, Aligarh. Apart from these, Indian Agricultural Research Institute, Delhi; Zoological Survey of India, Kolkata (formerly, Calcutta) and Jodhpur; Chowdhury Charan Singh Haryana Agricultural University, Hissar; Assam Agricultural University, Jorhat; Tamilnadu Agricultural University, Coimbatore; University Agricultural Sciences, GKVK, Bangalore; Bidhan Chandra Krishi Viswavidyalay, Kalyani; Gujrat Agricultural University, Anand; Punjub Agricultural University, Ludhiana; Orissa University of Agriculture and Technology, Bhubaneswar, Orissa; different research Institute under ICAR and few other Universities are also involved in nematology research. However, majority of the taxonomic works on mononchid were done in Aligarh Muslim University and Indian Agricultural Research Institute. In addition, a good few works have been done in Zoological Survey of India and Assam Agricultural University.

Since it is known that predaceous nematodes may be used as biological control agents as they predates on plant-parasitic nematodes which are recognized as serious limiting factor in crop production, so, their assessment is necessary.

In West Bengal, though significant amount of work were done on Dorylaimida and Tylenchida (by N.C. Sukul during nineteen sixties; Q.H. Baqri, S. Khera and Y. Chaturvedi during 1970s; Q.H. Baqri and A. Jana during 1980s; and A. Chatterjee during 1990s) but very little work was available on the order Mononchida. Most of the taxonomic part and all the ecological part in the present book are the cumulative study of survey in the district South-24-Parganas through out the period from 2004-2008. About 600 soil samples were processed but only twenty seven mononchid species from different blocks of the district South 24-Parganas were available.

Earlier to 2004, thirteen mononch species were reported, two from southern part and eleven from northern part of West Bengal. These have also been included here with diagrams and brief descriptions as illustrated by the respective workers. General descriptions are provided where authors only mentioned the species name. Reports of few of these species that do not include illustrations by the reporting authors have also been included from original description of the respective for the benefit of the readers.

So, the taxonomic part of this present work of mononchids includes systematic positions of thirty five mononchid species; their descriptions; morphometrics and variations, if any; associated plants; localities; diagrams etc.

Till date, no reports are available addressing ecology of this particular group from West Bengal. Diversity, distribution, community analyses and population fluctuations of mononchid species is incorporated here.

We have experienced several difficulties and impediments during collection and compilation of the articles and papers due to non-availability of these literatures neither in the libraries of different institutes in this part of the country nor in the web sources. A treatise on the order Mononchida itself thus hopefully help prospective researchers.

Till date, most of the areas in India are unexplored due to scanty survey work and lack of trained person in nematode systematics. The attempt of doing taxonomy and ecology of this particular predatory group is also taken for this purpose. This will be of immense satisfaction if this book is found worthy to the subsequent workers in this field and treated as a ready reference for their initial taxonomic work.

TIASI JANA
AMALENDU CHATTERJEE
BUDDHADEB MANNA

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INTRODUCTION

Studies on nematode started before middle of the eighteenth century. Needham first 'discovered' *Anguina tritici,* the first reported nematode, long back in 1743. Dujardin (1845) first reported predatory mononchs, but the type genus *Mononchus* was proposed a few years later by Bastian (1865). However, studies on different aspects of order Mononchida, a small predatory group, substantially started in 1969 from India, when Jairajpuri made notable changes in the classification scheme of Mononchida. He gave it the status of a separate order, previously, Mononchida was regarded as a superfamily under order Dorylaimida. His authentic publications (during 1969-82) drew attention of several nematologists world wide. During 1970s and subsequent years, mononchid taxonomy progressed rapidly through some valuable works from eminent nematologist communities around the world. Few workers became interested on this group due to its characteristic morphological features, speciality in buccal cavity consisting buccal teeth or teeth-like apparatus which help them to grasp or eat other soil nematodes and other meiofauna. However, availability of this particular group among all the nematodes is poor, as they are predatory and exist on the top of the soil food pyramid. Therefore, works on predatory mononchs is very limited throughout the world. Mononchida may be used as biological control agent as they consume the population of plant-parasitic nematodes in field. Few scientists also took interest on prey-predator relationships in field as well as in laboratory.

Mononchida are mostly soil dwellers, a smaller proportion (25%) inhabit freshwater biotopes (Zullini and Peneva, 2006). They are small group of active predator, live mainly on other nematodes, protozoans, rotifers, small oligochaetes etc. Among mononchids, about 22% shows cannibalism in nature (Small, 1987). Mononchids, most interestingly, prey on plant-parasitic nematodes, and their ability in this regards varies (Small, 1987). Mononchids are not directly associated with particular plant species; their distribution is less likely to reflect human influence, although in a given area the composition of the mononchid fauna may reflect management practices (Winiszewska-Slipinska and Skwiercz, 1987; Yeates, 1987). Yeates *et al.* (1994) showed distribution of Mononchida from 12 different geographical areas, the greatest numbers of mononch species were found from India which is geologically old with a great diversity of soil and climate and presumably with a corresponding diverse range of niches or habitats for mononchs. Mononchs are not considered primary candidates for exploitation as biological control agents, they may be important in naturally depressing pest numbers (Boag *et al.*, 1992). Withdrawal of some nematicides from commercial use and increasing interest in integrated control of crop pests supports the importance of investigating the biology of such natural control agents (Kerry, 1987). Predators contribute about 19% of nitrogen mineralization directly to the soil

ecosystem (Beare, 1997). Predators regulate microbial biomass and nitrogen mineralization by killing and feeding on nematodes and other microorganisms that pass from bottom to top trophic levels (Wardle and Yeates, 1993). Larger species of *Anatonchus* sp. Cobb, 1916 tend to ingest their prey completely, which increases their range of potential prey compared to smaller species that rely on penetration of the prey cuticle (Small and Grootaert, 1983). In mononchids, the flexible buccal cavity walls and the strong pharyngeal sucking action enable the rasping and cutting action of the teeth to penetrate nematode cuticle and permit removal of the body contents (Webster, 1972).

Populations of predaceous nematodes vary greatly with soil type (Webster, 1972). The survival of mononchids in cultivated soils has not been studied in detail. However, Szczygiel (1971) and Yeates and Hughes (1990) described the occurrence of predatory nematodes and effect of cultivation on them in soils from Poland and New Zealand respectively. Boag (1979, 1980) found five mononchid species in carrot, bean and pea fields. Arpin (1979) demonstrated that the mononchid assemblage varied between semi-natural habitats. Arpin *et al.* (1984) suggested that mononchids could be used as pedological indicators. Thorne (1927) was doubtful about the economic importance of mononchids in the control of sugar-beet nematodes from his limited study. Although ample evidences are availble suggesting their potential role as biological control agents (Ahmad, 1990; Bilgrami and Brey, 2005; Khan and Kim, 2007). However, works on the feeding habit of mononchids are meagre.

About 440 species have so far been described globally and categorized under 40 genera. Among these, about 83 species under 19 genera were from India till date. In West Bengal, very few works have been done on predatory mononchs. Prior to the work of current authors (2004 through 2010) on Mononchida, 13 species under 7 genera were described from West Bengal by Baqri and Khera (1977), Chaturvedi and Khera (1979), Baqri *et al.* (1981), Sinha *et al.* (1989) and Baqri and Dey (1991). Among those few species, only two were reported from southern part of West Bengal (one from North 24-Parganas and the other from South 24-Parganas).

Recently, Jana *et al.* (2006, 2007a, 2007b, 2008a, 2008b, 2008c, 2009 and 2010) described eight new mononchid species from the district South 24-Parganas, West Bengal, India.

MATERIALS AND METHODS

Site selection

For the purpose of taxonomic study the district South 24-Parganas (29 blocks under 5 subdivisions) (Latitude: 21°26′ to 22°38′; Longitude: 87°57′ to 89°09′), West Bengal, India was chosen.

For ecological study, two separate guava orchards were chosen at Baruipur subdivision in the district South 24-Parganas, one at Shalipur (Fig. 65A), consisting about 55 guava trees in its 1500 yard^2 area and another one at Balarampur (Fig. 65B), consisting of about 68 guava trees in its 1600 yard^2 area. These two places are situated

on either side of Baruipur railway station, about 25 km apart from Kolkata Metropolis. From each field 10 trees were selected randomly for sampling to cover the entire area from the two orchards. Soil of these areas is deep fine loamy with salinity ranging within 0.11-0.93 m.mhos and pH range of 5.0-6.8.

Soil sampling

For taxonomic study, composite soil samples were collected randomly from about 1 ft away from respective tree trunk at a depth of 0-15 cm. Soil samples were collected from each block through out the year on monthly interval.

For ecological study, soil samples were collected from a distance of about 1 ft from guava tree trunk. Ten soil samples per field were collected randomly in every third week of each month. For each soil sample, 5 soil 'sub-samples' from the circumference of each tree were taken and mixed to make a composite sample. From the composite soil sample 250 gm of soil was taken for further processing, thus 10 composite soil samples of 250 gm each were made from each field in every month from a depth of 0-15 cm.

Processing of soil samples

Soil samples were processed by modified Baermann funnel technique (Christie and Perry, 1951). The soil sample of 250 gm was placed in a bucket (10 L capacity) and thoroughly mixed with small amount of water. The grits, debris and stones were removed and soil lumps, if any, were broken and suspended by hand, then the bucket was filled with water to about $3/4^{th}$ of its volume and the suspension was stirred to make it homogeneous. After allowing the agitated muddy suspension to settle for 30 seconds, it was poured into another bucket through 50-mesh sieve (2 mm pore size) which was repeated thrice for a good recovery. The suspension in the second bucket was stirred and kept undisturbed for about 30 seconds to allow heavier soil particles to settle down at the bottom. The suspension was then poured into third and fourth bucket successively through 100-mesh sieve (833 µm aperture) and 325-mesh sieve (43 µm aperture). Nematodes and fine soil particles retained on the finest sieve used (43 µm aperture) were collected in a beaker. Then the material was placed on moist double-folded tissue paper, supported with an aluminium net (pore size 2 mm). After draining out excess water, it was kept on the petri dish filled with water that touched the bottom surface of the aluminium net. Special care was taken to avoid trapping of air bubbles between the bottom of sieve and water. Majority of the nematodes migrated through the tissue paper towards fresh water in petri dish between 24 (minimum) to 48 (maximum) hours. This water with nematodes were collected and kept for downstream processes.

Counting of nematodes

Population of nematodes were counted using Syracuse counting dish. Water from petridish alongwith collected specimens was poured in 100 ml measuring cylinder and the volume was made upto 100 ml by addition of water. Then it was made homogeneous by bubbling with pipette thoroughly before taking 10 ml of that water in the counting dish. Counting of each sample was done three times and the mean was recorded.

Fixation and Preservation

Nematodes were fixed following Seinhorst's (1966) method of fixation, in hot (90°-100°C), diluted FA (formalin: acetic acid 4 : 1, i.e, 10 parts 40% formalin, one part acetic acid and 89 parts distilled water) solution. Then fixed specimens were picked (under binocular microscope) into cavity block containing glycerin-alcohol solution (5 parts 1.5% glycerin in 95 parts of 30% alcohol) and kept into desiccator chamber at 25-30°C for about 4-8 weeks, or until the water was fully absorbed by anhydrous calcium chloride ($CaCl_2$) present at the lower chamber of the desiccator. A drop of copper sulfate ($CuSO_4$) was added to the solution before dehydration and desiccation in order to prevent the growth of moulds (Thorne, 1961).

Slide preparation

In 4-8 weeks, nematodes would be ready for slide preparation. Each slide was prepared by taking a droplet of anhydrous glycerin at the center of slide. Then, 3 or 4 nematodes (which were already dehydrated) were picked up and put in the middle of the glycerin drop and were then oriented parallely. Before mounting it with round (19 mm diameter) cover glass, 3 or 4 minute glass wool pieces (chosen approximately of simailar thickness as that of nematodes) were placed in the glycerin drop. This support would prevent the cover glass to press against the nematodes. Finally, cover glass was sealed at the margin by good quality nail paint. Another type of sealing procedure was also used which is much quicker than the process described earlier. After placing the glycerin droplet and nematodes at the center of the slide 3 or 4 lumps of paraffin wax were placed around the glycerin droplet. Each lump was about the size of the droplet or little larger. Cover slip was placed on the paraffin wax lumps. The slide was then placed on the hot plate with the temperature set at 60°C (the melting point of paraffin wax).

Identification

Nematodes were identified up to genus and species level following Jairajpuri and Khan (1982), Andrássy (1992, 1993, 1994), Vinciguerra and Orselli (2006) and other available literatures. Body dimensions were calculated following de Man's formulae (de Man, 1880), vaginal dimensions were calculated according to De Ley *et al.* (1993) and position of pharyngeal glands were calculated according to Andrássy (1998).

Abbreviations used in the tables for measurements of specimens of particular species :

L = total body length

a = total body length/maximum body diameter

b = total body length/pharyngeal length

c = total body length/tail length

c′ = tail length/anal body diameter

V% = distance from anterior end to vulva X 100/total body length

T% = length of testes X 100/total body length

G_1 = length of anterior gonad X 100/total body length

G_2 = length of posterior gonad X 100/total body length

cw = width of *pars refringens vagina*

Glandularium = distance from dorsal gland to pharyngo-intestine junction which contains two pairs of subventral pharyngeal glands

D = position of dorsal gland from anterior end X 100/pharyngeal length

AS1 = distance from dorsal gland to first anterior subventral gland X 100/ glandularium

AS2 = distance from dorsal gland to second anterior subventral gland X 100/ glandularium

PS1 = distance from dorsal gland to first posterior subventral gland X 100/ Glandularium

PS2 = distance from dorsal gland to second posterior subventral gland X 100/ glandularium

ABD = Anal Body Diameter

Estimation of abiotic factors

Soil temperature : Soil temperature was measured by 'Soil thermometer' that was set within a steel case and was penetrated into the soil up to the depth of 7.5 cm (average depth from surface, from where soil samples were taken) to get an average temperature.

Soil pH : Soil sample amounting 20 gm was suspended in 50 ml distilled water and mixed for about 30 minutes. pH meter was connected with electricity source and was initialized for appropriate duration. A known standard buffer solution (pH 7.0) was taken in 50 ml beaker to calibrate the instrument. Electrode of the calibrated instrument was submersed into the soil suspension and the readings were taken (Jackson, 1967).

Soil Moisture : Moisture were determined using 'Torson Balance Infra-red Moisture Meter' (Blue Star, Mumbai, India). Initially, 5 gm of moist soil was taken on the balance pan and the weight was calibrated to '0' scale. Soil was covered by infra-red lamp shed. After putting on the infra-red lamp, temperature in the thermometer was maintained at 105°C. Ten minute exposure was allowed and weight loss of the soil was further measured from the balance scale. The moisture indicating knob rotated against the weight loss of the soil and percentage reading of moisture was taken from the moisture meter.

Soil conductivity : For estimation of soil conductivity 20 gm of soil sample was mixed with 40 ml distilled water and stirred for about 30 minutes and allowed to stand the suspension till the soil particle settled down. Supernated liquid was taken to measure the soil conductivity by 'Digital Conductivity Meter with cell' (SYSTRONICS, Ahmedabad, India; Type-304).

Organic carbon content of soil : Organic carbon of soil was determined by wet oxidation method of Walkley and Black (1934). Soil sample of 1gm, 10ml potassium dichromate [$K_2Cr_2O_7$] solution and 20 ml concentrated sulfuric acid [H_2SO_4] were taken, mixed and kept for 30 minutes. 10 ml phosphoric acid [H_3PO_4] and 200 ml distilled water were mixed, 1.5 ml diphenylamine was also added, thus, appeared dull green color. Immediately after addition of diphenylamine, titration was started by addition of ferrous iron solution. Then the turbid blue color appeared. Then ferrous iron solution was added drop by drop till a brilliant green color appeared indicating the end point of the titration. The same procedure carried out without sample (blank titration) to find out the correct strength of ferrous iron solution at that moment. The oxidizable carbon content was calculated by comparing the volume and the strength of ferrous iron solution consumed during titration both with soil and without soil.

Nitrogen content of soil : Nitrogen content of soil was determined by 'Alkaline permanganate method' (Subbiah and Asija, 1956). Soil sample of 20 gm, 20 ml distilled water, 100 ml 0.32% potassium permanganet [$KMnO_4$] solution and 100 ml 2.5% sodium hydroxide [NaOH] solution were taken in a distillation flask. Another 250 ml conical flask connected with a 20ml bulb type pipette was taken. 20 ml N/50 H_2SO_4 was taken in 250 ml conical flask, 2-3 drops of methyl red indicator was added in it (red color appeared). After connecting the distillation flask with the distillation apparatus, the tip of the delivery tube was dipped in the N/50 H_2SO_4- indicator in the conical flask. Distillation flask was heated resulting in release of ammonia that was subsequently absorbed in N/50 H_2SO_4. The quantity of nitrogen was estimated which was absorbed as NH_3.

Phosphorus content of soil : Phosphorus content of the soil was estimated by sodium bicarbonate [$NaHCO_3$] method (Olsen *et al.*, 1954). Soil sample of 2.5 gm and 50 ml of 0.5 M $NaHCO_3$ (pH 8.5) solution were mixed and shaked for 30 minutes in presence of 1-2 gm phosphorus-free charcoal. The mixture was filtered through Whatman No. 42 filter paper and filtrate was collected for estimation of phosphorus concentration.

Potassium content of soil : For estimation of available potassium, 5gm of soil sample was mixed with 1N ammonium acetate [CH_3COONH_4] (pH 7.0). The solution was taken in a bulb type pipette in 1 : 5 ratio and shaked for 30 minutes on the mechanical shaker and filtered through Whatman No. 42 filter paper. Filtrate was collected for estimation of K_2O concentration. The concentration of K^+ ions in the solution was measured using flame photometer (Jackson, 1967).

Community analysis

Following parameters were used for community analysis of mononchid species of district South 24-Parganas using methods described by Norton (1978).

Frequency (N) : Number of soil sample containing particular species

Absolute Frequency (AF%) : (Number of samples containing a species) X 100/ (Total number of soil samples collected)

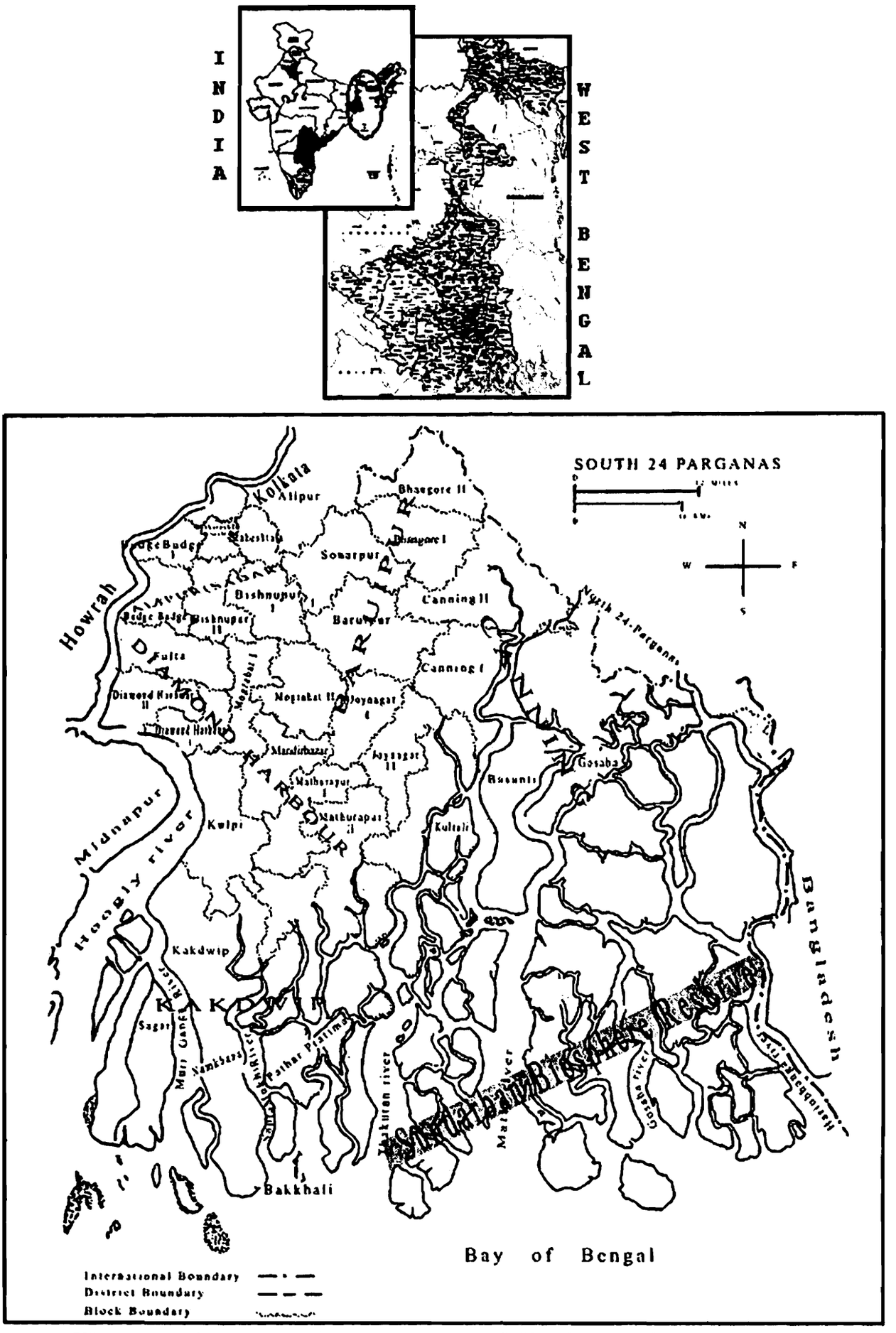

Figure 1. Survey localities and map of district South 24-Parganas.

Relative Frequency (RF%) : (Absolute frequency of the species) X 100/(Sum of absolute frequency of all species)

Density (D) : (Number of nematode specimens of the species counted in all samples)/(Total number of samples collected)

Prominence value (PV) : Density $\sqrt{\text{(Absolute frequency)}}$

Biomass (G) µg : $(a^2 \text{ X } b)/(16 \text{ X } 100{,}000)$; where, a = body width; b = body length; 16 X 100,000 = Empirical value

Total biomass (TG) µg : (Number of nematode specimens of the species present in the sample) X (Biomass of individuals of respective species)

I. TAXONOMY

List of mononchid species recorded from West Bengal and their systematic positions:

Order MONONCHIDA Jairajpuri, 1969

Suborder MONONCHINA Kirjanova and Krall, 1969

Superfamily MONONCHOIDEA Chitwood, 1937

Family ANATONCHIDAE Jairajpuri, 1969

Subfamily **Iotonchinae** Jairajpuri, 1969

Genus ***Nullonchus*** Siddiqi, 1984

1. *Nullonchus rafiqi* Jana, Chatterje & Manna, 2006

Genus ***Iotonchus*** (Cobb, 1916) Altherr, 1950

2. *Iotonchus trichurus* (Cobb, 1917) Andrássy, 1958
3. *I. rotundicaudatus* Peña-Santiago and Jimēnez-Guirado, 1991
4. *I. cuticaudatus* Jana, Chatterje & Manna, 2007
5. *I. indicus* Jairajpuri, 1969
6. *I. parabasidontus* Mulvey and Jensen, 1967
7. *I. qaiseri* Jana, Chatterjee & Manna, 2007

Genus ***Parahadronchus*** Mulvey, 1978

8. *Parahadronchus shakili* (Jairajpuri, 1969) Mulvey, 1978

Genus ***Mulveyellus*** Siddiqi, 1984

9. *Mulveyellus jairi* (Lordello, 1959) Siddiqi 1984

Subfamily **Miconchinae** Andrássy, 1976

Genus ***Miconchus*** Andrássy, 1958

10. *Miconchus aquaticus* Khan, Ahmad and Jairajpuri, 1978
11. *M. rectangularis* Jana, Chatterje & Manna, 2008
12. *M. bulbicaudatus* Jana, Chatterje & Manna, 2008
13. *M. dalhousiensis* Jairajpuri, 1969

Subfamily **Anatonchinae** Jairajpuri, 1969

Genus ***Anatonchus*** (Cobb, 1916) De Coninck, 1939

14. *Anatonchus sukuli* Baqri, Das & Ahmad, 1981

Family MYLONCHULIDAE Jairajpuri, 1969

Subfamily **Mylonchulinae** Jairajpuri, 1969

Genus ***Mylonchulus*** (Cobb, 1916) Altherr, 1950

15. *M. mulveyi* Jairajpuri, 1970
16. *M. contractus* Jairajpuri, 1970
17. *M. incurvus* Cobb, 1917
18. *M. hawaiiensis* (Cassidy, 1931) Goodey, 1951
19. *M. minor* (Cobb, 1893), Cobb, 1916
20. *M. lacustris* (Cobb in Cobb, 1915), Cobb, 1917
21. *M. amurus* Khan and Jairajpuri, 1979
22. *M. dentatus* Jairajpuri, 1970
23. *M. sigmaturus* Cobb, 1917
24. *M. sigmaturellus* Mulvey, 1961
25. *M. wasimi* Jana, Chatterje & Manna, 2008
26. *M. goutami* Jana, Chatterje & Manna, 2010
27. *M. istvani* Jana, Chatterje & Manna, 2010
28. *M. sagarensis* Sinha, Baqri & Choudhury, 1989
29. *M. brachyuris* (Bütchli, 1873) Altherr, 1953
30. *M. brevicaudatus* (Cobb, 1917) Altherr, 1954

Family MONONCHIDAE Chitwood, 1937

Subfamily **Mononchinae** Chitwood, 1937

Genus ***Sporonchulus*** (Cobb, 1917) Pennak, 1953

31. *Sporonchulus vagabundus* Jairajpuri, 1971

Genus ***Mononchus*** Bastian, 1865

32. *Mononchus aquaticus* Coetzee, 1968

Genus ***Clarkus*** Jairajpuri, 1970

33. *Clarkus papillatus* (Bastian, 1865), Jairajpuri, 1970

Genus ***Prionchulus*** Cobb, 1916

34. *Prionchulus muscorum* (Dujardin, 1845) Wu & Hoeppli, 1929

Suborder BATHYODONTINA Coomans & Loof, 1970

Superfamily MONONCHULOIDEA De Coninck, 1965

Family MONONCHULIDAE (De Coninck, 1965) Jairajpuri, 1969

Genus ***Mononchulus*** Cobb, 1918

35. *Mononchulus* sp.

DESCRIPTIONS OF SPECIES

1. *Nullonchus rafiqi* Jana, Chatterjee & Manna, 2006
(Figures : 2, 37)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=2.66-2.88 mm; a=32.37-34.65; b=5.45-5.83; c=8.43-8.70; c'=5.53-5.91; V%=53.22-58.65; G_1=15.05-16.17; G_2=14.56-16.15; buccal cavity=56.6-60X33.3-36.3 µm; ABD=50.7-55.6 µm; tail length=11.5-11.9 µm.

Description : Female : Body long, tapering towards the posterior portion; cuticle thickness varies from lip region to caudal region (3.5-7.5 µm). Labial and cephalic papillae prominent; lip region offset from body. Amphid oval-shaped, buccal cavity devoid of any tooth or denticle, only two pairs of transeverse ridges present; geusids prominent. Pharynx long (456.1-499.5 µm), muscular, cylindrical, pharyngo-intestinal junction tuberculate with medium-sized rounded valve. Vagina slightly oblique, one pre- and one post-advulval papilla present. Gonad amphidelphic, oviduct consists of a distal part and a well-developed proximal *pars dilatata*. Rectum prominent but pre-rectum is not clearly visible. Body pores at caudal region 6-7 in number. Tail filiform, slightly curved ventrally, gradually tapering, proximal third almost cylindrical; caudal glands three in number, spinneret terminal.

Male : Not found.

Remarks : All the species under order Mononchida bears atleast one dorsal tooth in its buccal cavity except the genus *Nullonchus*. Siddiqi (1984) reported three species under the genus *Nullonchus* from Colombia, South America, associated with rain forests. Jana *et al.* 2006 reported the genus *Nullonchus* as well the species *N. rafiqi* from South 24-Parganas, West Bengal, India.

2. *Iotonchus trichurus* (Cobb, 1917) Andrássy, 1958
(Figures : 3, 38)

Locality, associated plants and date of collections: Table 2.

Measurements : ♀♀ L=1.43-1.59mm; a=28-55.45; b=4.69-5.12; c=3.74-4.70; c'=12.2-17; V%=59.09-68.38; G_1=16.72-22.99; buccal cavity=28.2-33.3X15.2-16.7 µm; ABD=23.5-30µm; tail length=305.5-404.2 µm.

Description : Female : Body more or less straight, lower 1/3rd curved upon fixation, tapering sharply behind the vulva. Lip region slightly set off from body. Cuticle thickness varies from 2.25-4.65 µm. Length of buccal cavity more or less twice than its diameter. Dorsal tooth small, basal; geusids prominent at sub-ventral region. Pharynx cylindrical (305.5-339.6 µm), slender and muscular, its length less than 1/5th of total body length. Pharyngo-intestinal junction tuberculate, pharyngeal glands prominent. Lateral chord about 1/3rd as wide as body width. Excretory pore situated behind the nerve ring. Rectum less than one anal diameter long. Vulva situated at 3/5th of the total body length. Gonad monoprodelphic, ovary reflexed, sphincter absent

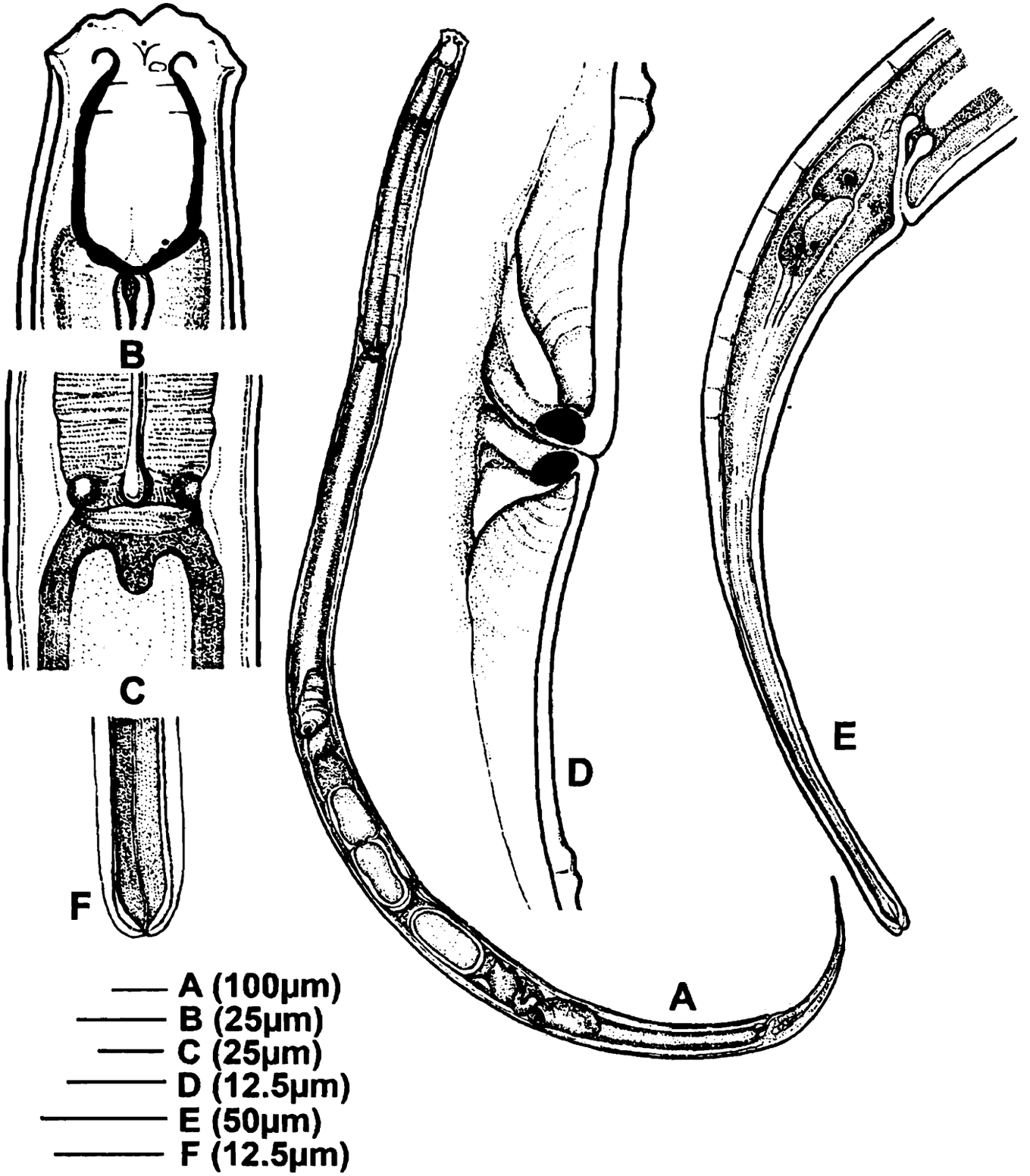

Figure 2. Camera lucida drawings of female *Nullonchus rafiqi* (After, Jana *et al.*, 2006). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Vulval region; E. Tail; F. Tail terminus.

at oviduct-uterus junction; few specimens have intra-uterine eggs (measured as: 103.73-112.7X35.25-42.88 µm); *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent. Tail long, whip-like, its length 1/5th of the total body length. Caudal glands three in number, spinneret terminal.

Male : Not found.

Remarks : Specimens fit well in the descriptions of the species given by Cobb (1917), Mulvey and Jensen (1967), Jairajpuri (1969), Baqri and Khera (1977), Chaturvedi and Khera (1979), Jairajpuri and Khan (1982) and Andrássy (1994). It was reported earlier from many regions of India. Jairajpuri and Khan (1982) reported this species from Andaman, Assam, Andhra Pradesh, Uttar Pradesh. In West Bengal, Chaturvedi and Khera (1979) reported this species from Murshidabad and Midnapur. Baqri and Khera (1977) reported the above species from Jalpaiguri. *Iotonchus trichurus* is widely distributed in India as well as in South 24-Parganas. It is reported here for the first time from the district South 24-Parganas. Apart from India, it has been reported from Singapore, Mauritius, Nigeria, St. Lucia, Brazil, New Zealand, New Caledonia, and Campbell Islands (Andrássy, 1994).

3. ***Iotonchus rotundicaudatus*** Peña-Santiago and Jimēnez-Guirado, 1991
(Figures : 4, 39)

Locality, associated plants and date of collections : Table 2.

Measurements : ♂♂ L=1.94-2.34 mm; a=29.43-36.81; b=4.12-4.62; c=31.69-35.5; c'=1.04-1.04; T%=18.59-16.01; buccal cavity=47.0-49.35X25.85 µm; ABD=58.8-63.5 µm; ventro-median supplements=14-15; tail length=31.1-35.8 µm.

Description : Male : Body long, slender, habitus curved, cuticle thick all over the body, but thickness varies from anterior region to caudal region (4.7-5.2 µm). Lip region offset from body but its width is as same as body width. Amphids cup-shaped, openings almost at the level of constriction. Buccal cavity broad, dorsal tooth at the base of buccal cavity. Excretory pore situated behind the nerve ring, lateral chord occupying one-third of the mid-body diameter. Pharynx cylindrical (470-505.3 µm) and muscular, pharyngeal glands are conspicuous. Pharyngo-intestinal junction tuberculate, cardia tongue-shaped. Intestine uniformly granulated, marked constriction at the posterior part of the intestine, 550.20-565.11 µm before the anus and surrounded by muscles. Testes two, outstretched, *vas deferens* and ejaculatory duct prominent. Ventromedian supplements 14 or 15. Tail bluntly conoid, slightly curved ventrally, no caudal gland or spinneret opening, but a conspicuous hyaline cap-like structure at the tail tip.

Remarks : Peña-Santiago and Jimēnez-Guirado, 1991 described the species from Spain, they found twenty-nine female specimens but no male. Only two males of *I. rotundicaudatus* were found from South 24-Parganas (Jana *et al.* 2009). Body length of male is less than female but other taxonomic characters commensurate well with females.

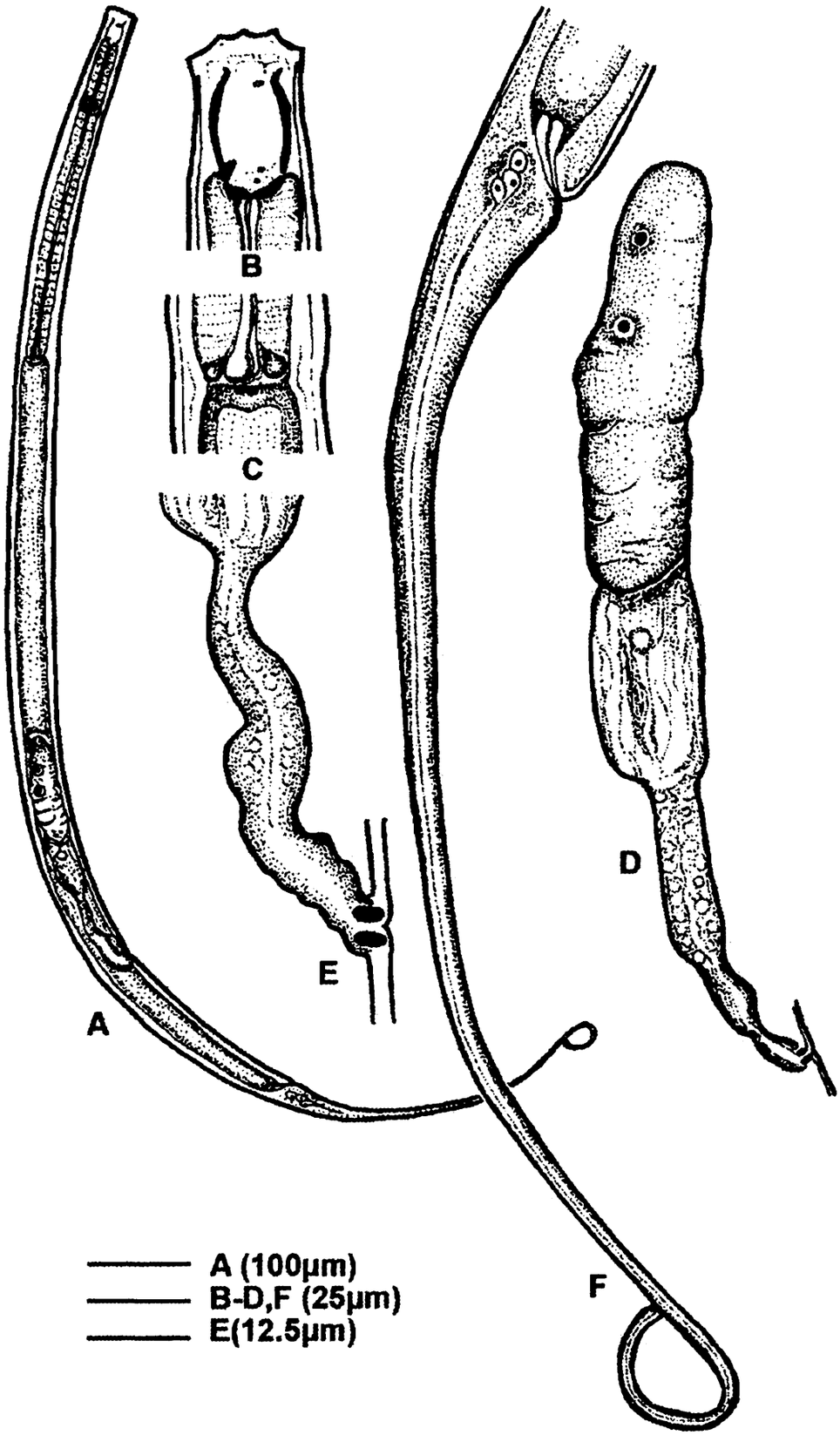

Figure 3. Camera lucida drawings of female *Iotonchus trichurus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

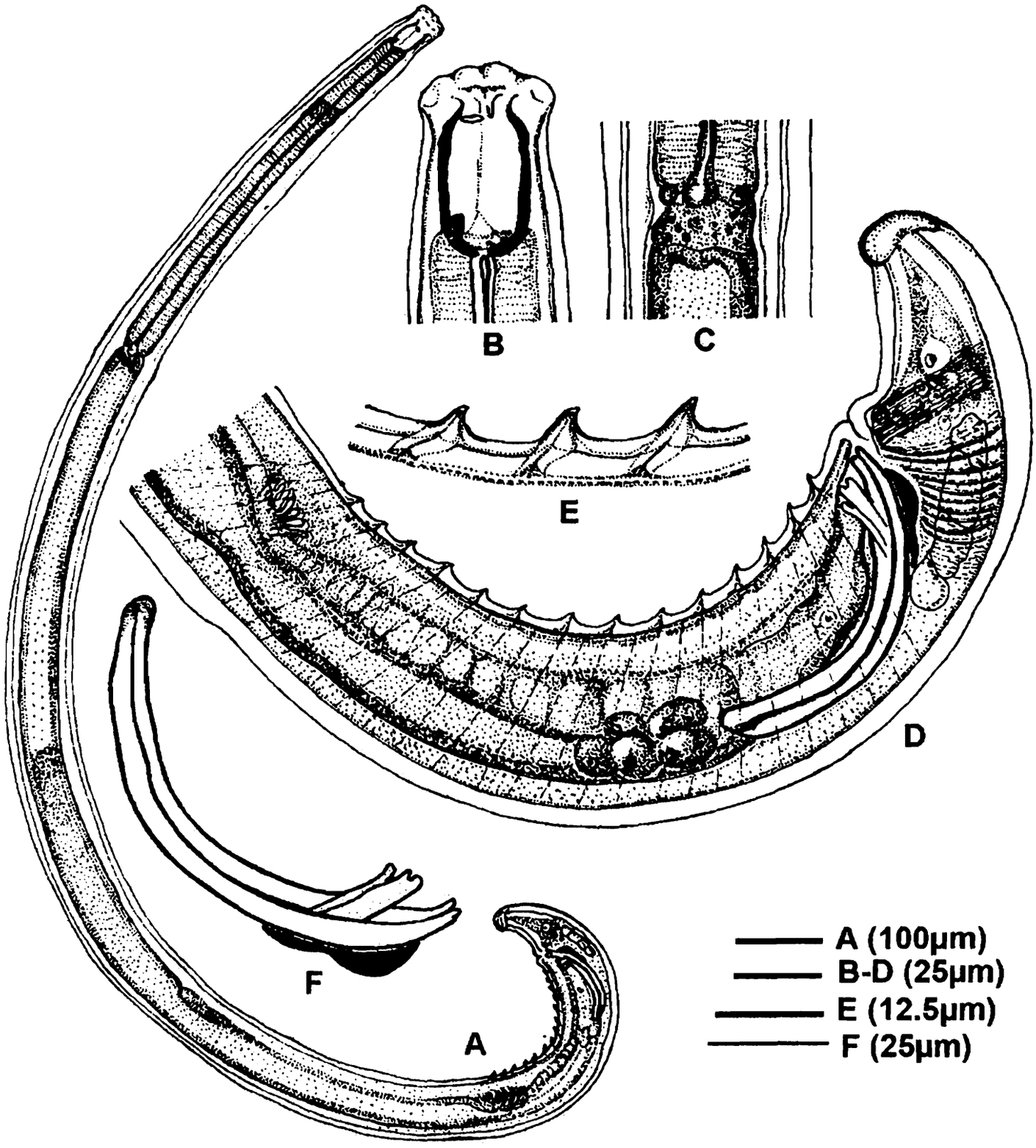

Figure 4. Camera lucida drawings of male *Iotonchus rotundicaudatus* (After, Jana *et al.*, 2009). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Caudal region; E. Ventromedian supplements; F. Spicules, gubernaculum and accessory pieces.

4. ***Iotonchus cuticaudatus*** Jana, Chatterjee & Manna, 2007
(Figures : 5, 40)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L = 2.80-2.90 mm; a=30.39-37.43; b = 4.62-5.81; c = 7.13-10.01; c' = 5.47-7.80; V% = 62.04-64.52; G_1 = 13.03-16.08; G_2 = 14.18-15.96; buccal cavity = 56.61-66.6X33.3-36.63 µm; ABD = 53.2-58.4 µm; tail length = 286.4-406.3 µm.

♀ (bearing double vulva) L = 2.8 mm; a=30.39; b = 4.65; c = 9.15; c' = 5.47; V_1%=61.34; V_2%=64.63; G_1=18.68; G_2=20.92; buccal cavity=66.6X36.63 µm; ABD=56.8 µm; tail length=309.69 µm.

♀♀ L=2.29-3.12 mm; a=29.96-39.25; b=4.36-5.38; c=9.58-14.49; c'=3.10-3.55; T%=39.29-50.79; buccal cavity=49.95-56.61X26.4-29.97µm; ABD=66.6-69.93µm; ventromedian supplements=11-15; tail length=216.5-243.1µm.

Description : Female : Body long, J-shaped; cuticle moderately thick all over the body (3.4-9.5 µm). Lip region set off from body. Dorsal tooth situated at the base of buccal cavity, sub-ventral tooth absent, geusids prominent. Excretory pore situated behind the nerve ring; pharyngeal glands prominent but openings not distinct; pharynx cylindrical (589.4-612.7 µm) and muscular, cardia more than two times wider than its length. Gonads amphidelphic, sphincter at oviduct-uterus junction. Vagina transverse, vulval pore present, pre 2 (1-4) and post 1 (1-4) advulval papillae present. Length of rectum about half of the tail length but pre-rectum inconspicuous. Caudal pores varies in number (3-8). Tail elongated, tip rounded, cuticle at tail terminus swollen, caudal glands three in number, spinneret opening terminal.

Bivulvarity in female : One female specimen possesses two vulvae. All the characters are similar to the rest of the female specimens except two vulva and three gonads (anterior, fused and posterior). Caudal pores four in number. Tip of the tail much swollen than that of the other female specimens.

Male : Highly developed gonad in all the seven specimens. Testes paired, rectal glands in caudal region much developed. Spicules paired, arcuate, spicule-heads knobbed; gubernaculum distinct, lateral guiding pieces simple. Ventromedian supplements prominent, significantly developed and regularly spaced; copulatory muscles distinct in this region. Tail length smaller than females, but, caudal glands, spinneret opening, tail terminus similar to females. Caudal pore absent.

Remarks : *Iotonchus cuticaudatus* found in three blocks under South 24-Parganas. *Iotonchus* Cobb, 1916 is so far the richest genus (Andrássy, 2008). Among all, single species of *I. cuticaudatus* found with rare bivulvarity (Jana *et al.*, 2007). Mulvey earlier (1963, 1967) reported bivulvarity in *Prionchulus muscorum* and *Prionchulus punctatus*.

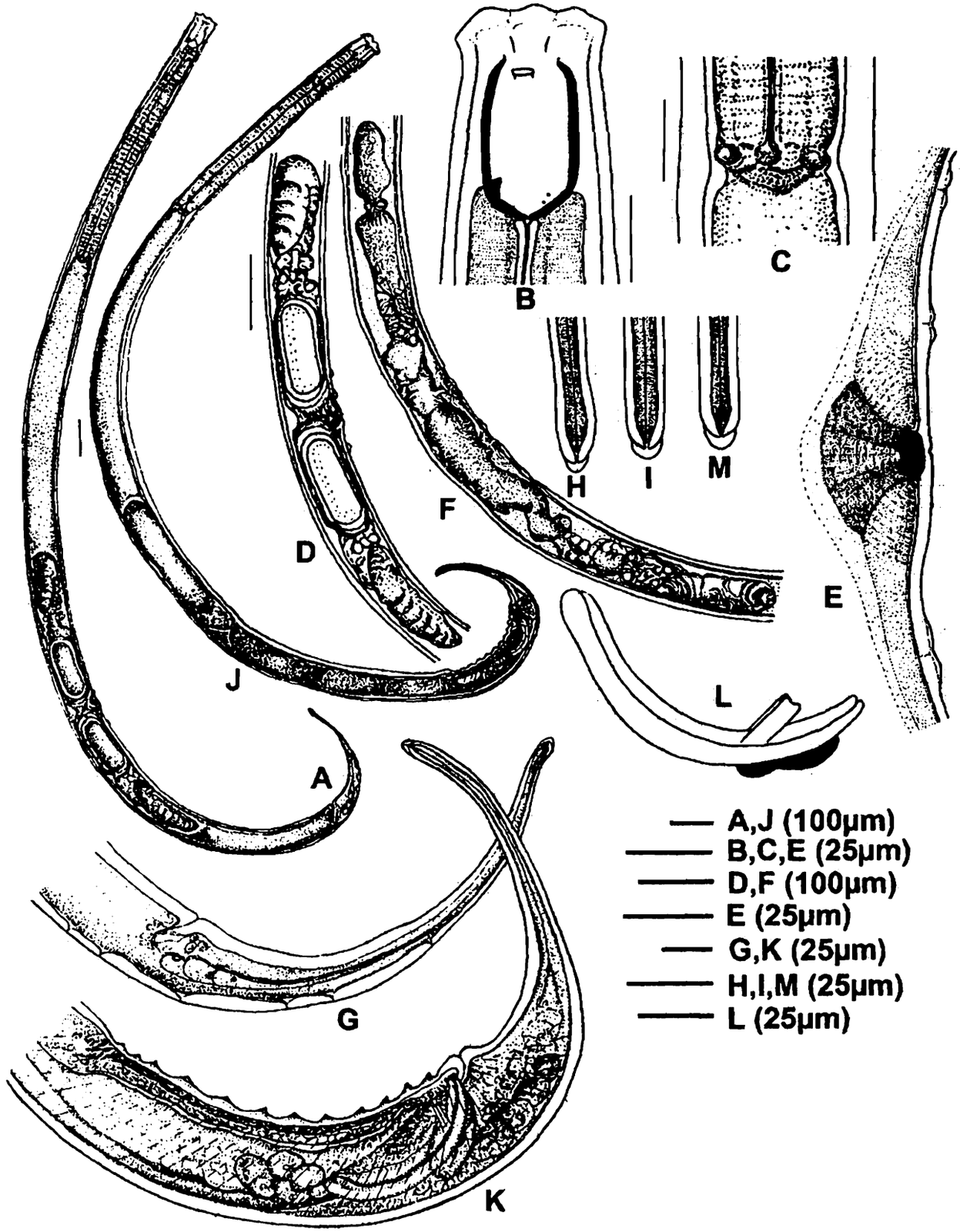

Figure 5. Camera lucida drawings of female and male *Iotonchus cuticaudatus* (After, Jana *et al.*, 2007).

Female : A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Double vulva; G. Tail; H. Tail terminus; I. Tail terminus of the female consists double vulva.

Male : J. Whole body; K. Caudal region; L. Spicules, gubernaculum and accesory pieces; M. Tail terminus.

5. ***Iotonchus indicus*** Jairajpuri, 1969
(Figures : 6, 41)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.69-1.78 mm; a=30-32; b=4.06-4.50; c=4.56-4.67; c'=8.78-8.97; V%=60.58-62.45; G_1=15.56-15.63; G_2=15.88-17; buccal cavity=46.55-47.35X26.95-27.65 µm; ABD=40.4-41µm; tail length=362.6-372.7 µm.

Description : Female : Body long, habitus curved; cuticle moderately thick all over the body but of variable thickness at lip region, mid-body and caudal region (3.68-11.03 µm). Width of lip is less than the adjacent body width. Dorsal tooth situated at the base of buccal cavity, sub-ventral tooth absent, geusids prominent. Excretory pore situated behind the nerve ring; pharyngeal glands prominent but openings not always distinct; pharynx cylindrical (416.5-425.7 µm) and muscular, length and width of cardia more or less same. Gonads amphidelphic, rectum length less than one anal diameter. Caudal pore varies from 4-6. Tail filiform, tip rounded, caudal glands three in number, spinneret opening sub-ventral.

Remarks : Specimens of *Iotonchus indicus* fit well with the specimens described by Jairajpuri and Khan (1982) from Kerala and Uttar Pradesh and the key provided by Andrássy (1994). In the present observation, only the value of 'c' is lower than those specimens mentioned by Jairajpuri and Khan (1982) and Andrássy (1994). This species is reported for the first time from West Bengal. Apart from India, the present species found from St Lucia, El Salvador and Malaysia.

6. ***Iotonchus parabasidontus*** Mulvey and Jensen, 1967
(Figures : 7, 42)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=2.30-2.82 mm; a=31.50-33.32; b=4.78-5.45; c=7.40-8.90; c'=5.55-6.90; V%=60.23-63.22; G_1=13.56-15.60; G_2=12.56-15; buccal cavity=62.35-66.6X33.25-33.3 µm; ABD=53.8-58.4 µm; tail length=287.7-313 µm.

♂♂ L=2.29-3.12 mm; a=29.96-39.25; b=4.36-5.38; c=9.58-14.49; c'=3.10-3.55; T%=39.29-50.79; buccal cavity=49.95-56.61X26.4-29.97 µm; ABD= 66.6-69.9 µm; ventromedian supplements=11-13; tail length=216.5-243.1 µm.

Description : Female : Body long, habitus curved; cuticle moderately thick all over the body (3.2-8.8 µm). Width of lip less than adjacent body width. Dorsal tooth situated at the base of buccal cavity, sub-ventral tooth absent, geusids prominent. Excretory pore situated behind the nerve ring; pharyngeal glands prominent but openings indistinct in few cases; pharynx cylindrical (492.8-582.8 µm) and muscular, length and width of cardia more or less same. Gonads didelphic-amphidelphic. Vagina with three distinct parts, *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae*. Rectum length is less than one anal diameter. Caudal pore 3-6 in number. Tail filiform, tip rounded, caudal glands three in number, spinneret opening terminal.

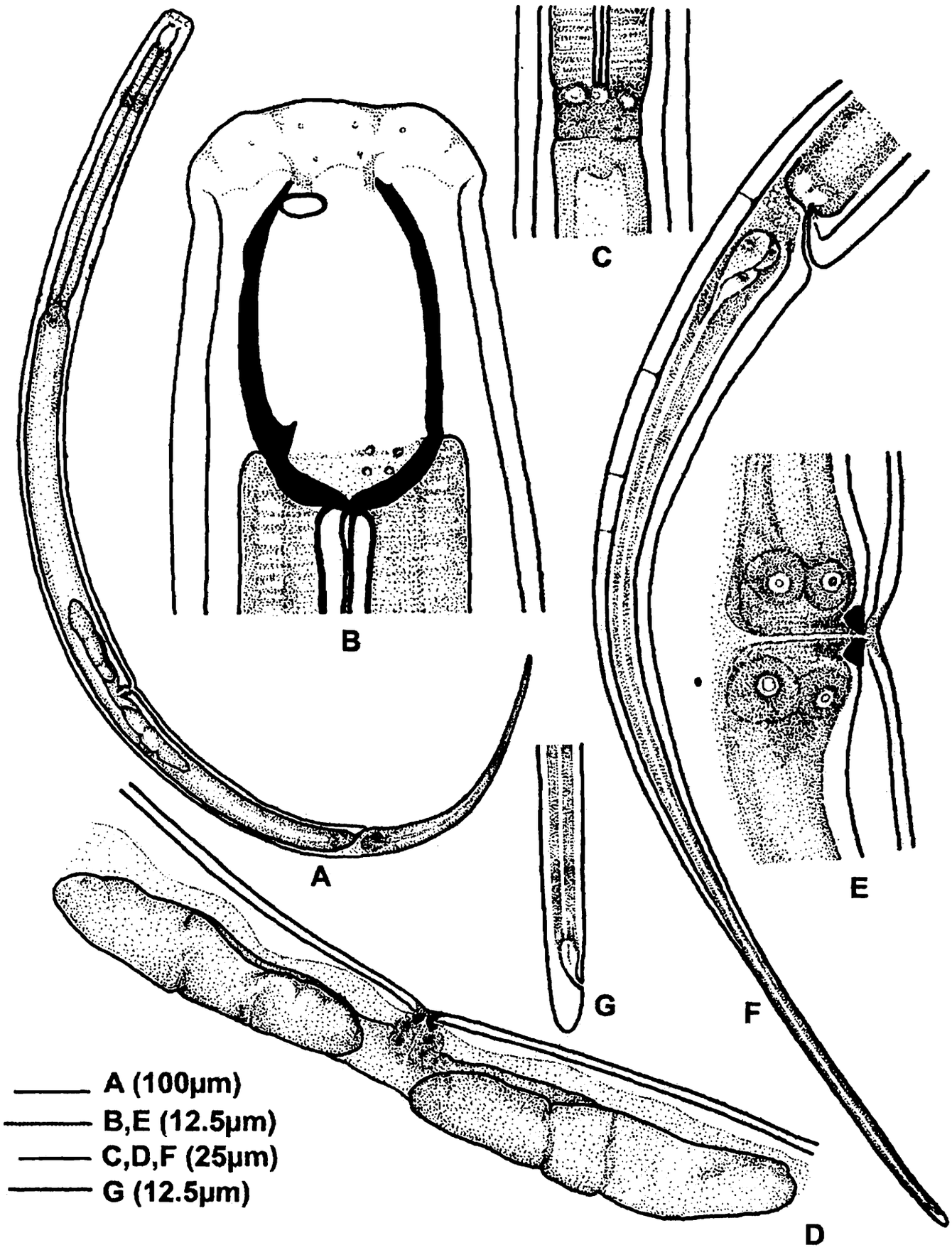

Figure 6. Camera lucida drawings of female *Iotonchus indicus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail; G. Tail terminus.

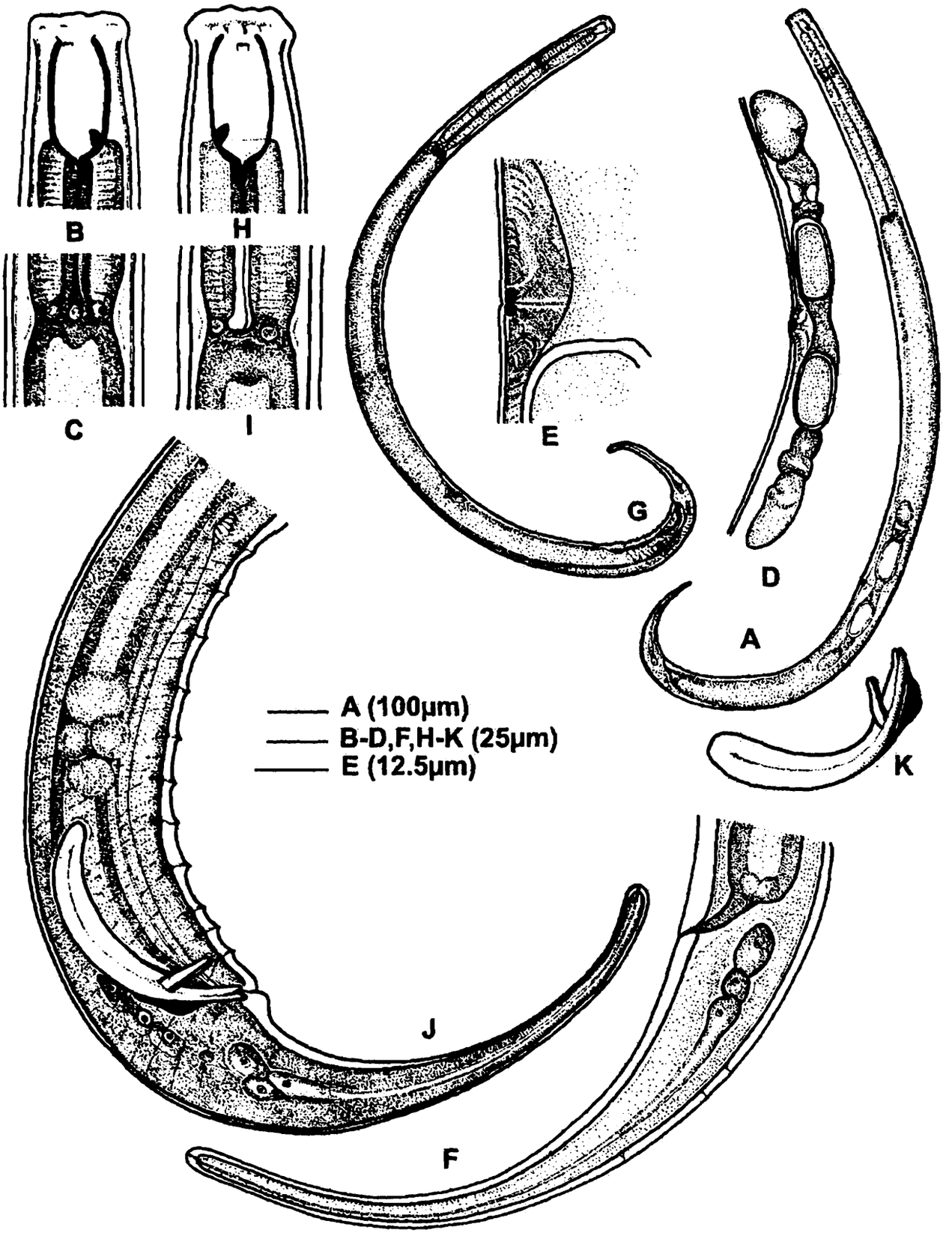

Figure 7. Camera lucida drawings of female and male *Iotonchus parabasidontus*.

Female : A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Male : G. Whole body; H. Head; I. Pharyngo-intestine junction; J. Caudal region; K. Spicules, gubernaculum and accessory pieces

Male : Testes paired, opposed, outstretched; ejaculatory glands distinct in ventromedian supplementary region, rectal glands in caudal region much developed. Spicules paired, arcuate, spicule head knobbed; gubernaculum distinct, lateral guiding pieces simple. Ventromedian supplements significantly developed and regularly spaced. Tail length smaller than female, but, caudal glands, spinneret opening, tail terminus similar to female. Caudal pore absent.

Remarks : Specimens of *Iotonchus parabasidontus* matches well with the specimens described by Jairajpuri and Khan (1982) from Himachal Pradesh and Uttar Pradesh and the key provided by Andrássy (1994). This species is reported for the first time from West Bengal. Other than India it was also reported from Nigeria and South Africa.

7. *Iotonchus qaiseri* Jana, Chatterjee & Manna, 2007
(Figures : 8, 43)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.75-1.89 mm; a=33.25-35.05; b=3.33-3.69; c=5.65-5.71; c'=9.54-9.64; V%=58.69-60.44; G_1=17.89-18.61; buccal cavity=42.32-46.55X22.35-25.73 µm, ABD=33.3-34.6 µm; tail length=325.3-330.8 µm.

Description : Female : Body long, habitus curved; cuticle moderately thick all over the body (2.3-3.5 µm). Lips amalgamated, never distinct; dorsal tooth situated at the base of buccal cavity, sub-ventral tooth absent, geusids clearly visible at the base of buccal cavity. Excretory pore situated behind the nerve ring; pharyngeal glands prominent; Pharynx cylindrical (512.1-514.3 µm) and muscular. Gonad monoprodelphic, sphincter absent at oviduct-uterus junction. Vagina with three distinct parts, *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae*. Rectum less than one anal diameter length. Caudal pore absent. Tail long, filiform, caudal glands three in number, spinneret opening sub-terminal.

Male : Not found.

Remarks : The species is only reported from South 24-Parganas, West Bengal, India.

8. *Parahadronchus shakili* (Jairajpuri, 1969) Mulvey, 1978
(Figures 9, 10, 44)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=2.7-2.9 mm; a=32.9-35.6; b=4.2-4.5; c= 6.3-7.4; c'=7.7-12.8; V%=65.1-72.8; G_1=16.7-27.4; G_2=18.2-24.3; buccal cavity=60-66.6X35-39.96 µm; ABD=45.7-56.6 µm; tail length=385-436.2 µm.

♂♂ L=2.90-3.55 mm; a=45-53.67; b=4.80-5.08; c=8.33-9.70; c'=4.70-6.44; T%=8.70-30.23; buccal cavity=59.94-66.6X36.63-49.95 µm; ABD=59.9-66.6 µm; ventromedian supplements=11-15; tail length=309.7-386.3 µm.

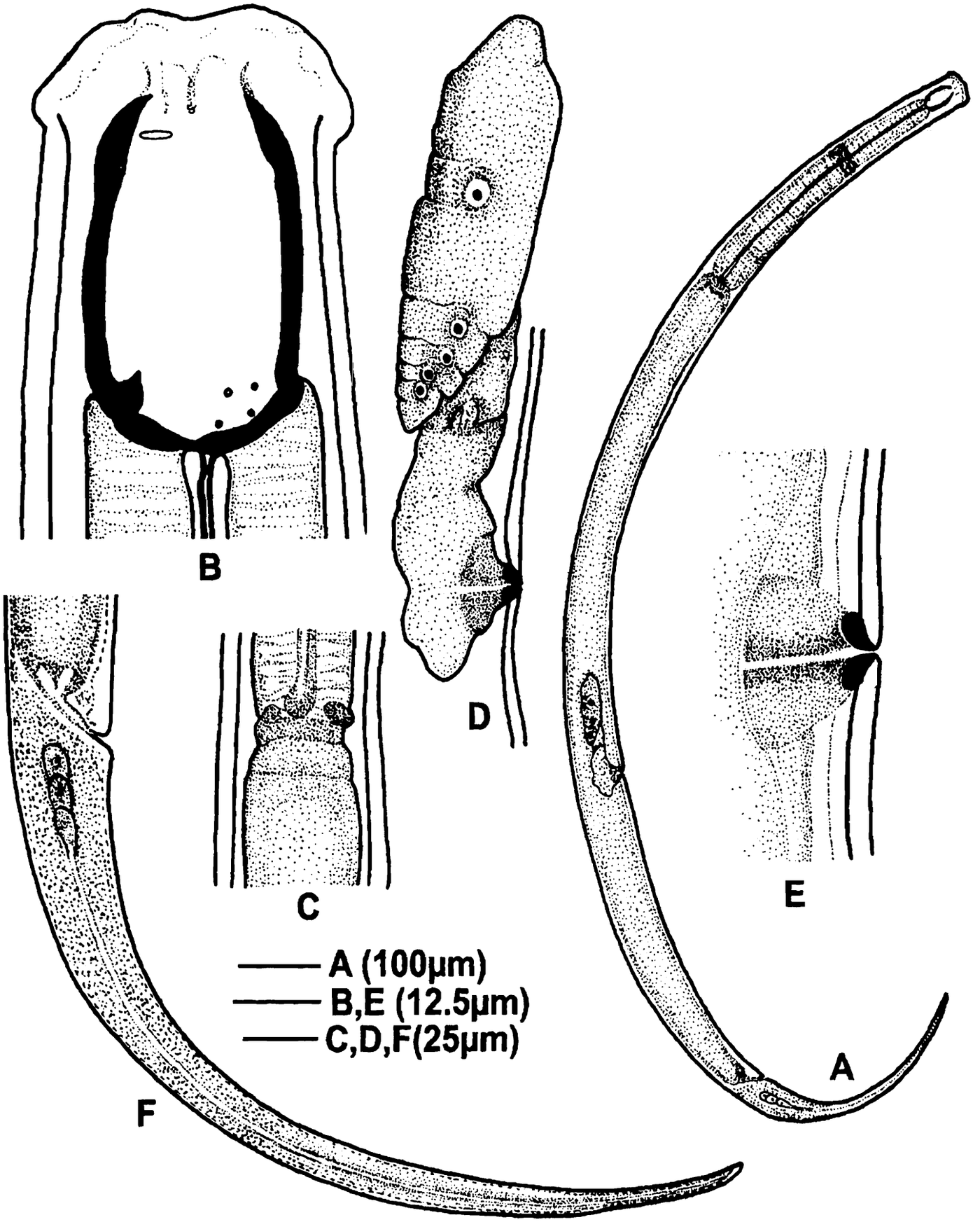

Figure 8. Camera lucida drawings of female *Iotonchus qaiseri* (After, Jana *et al.*, 2007). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

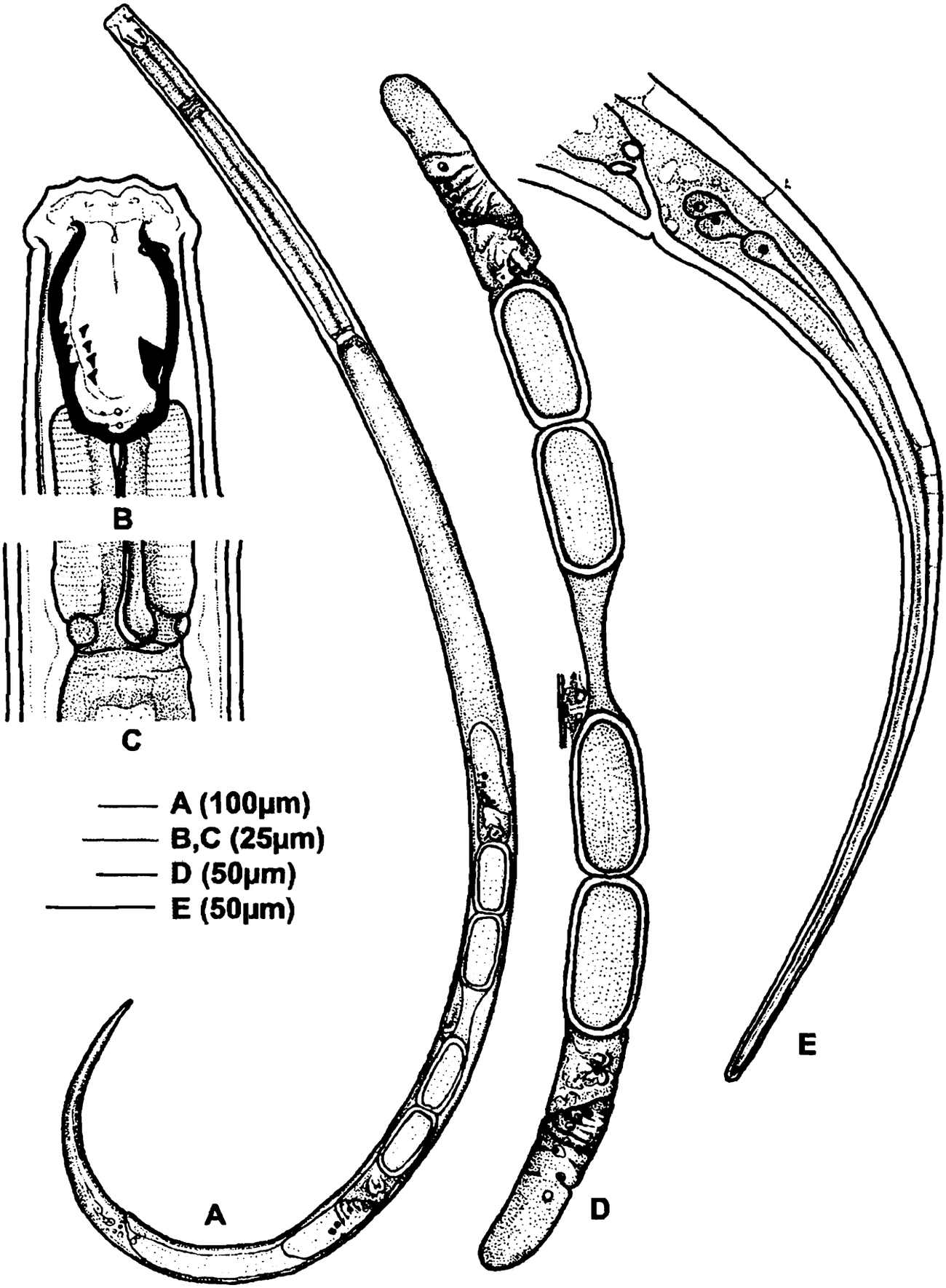

Figure 9. Camera lucida drawings of female *Parahadronchus shakili* (After, Jana *et al.*, 2008). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Tail.

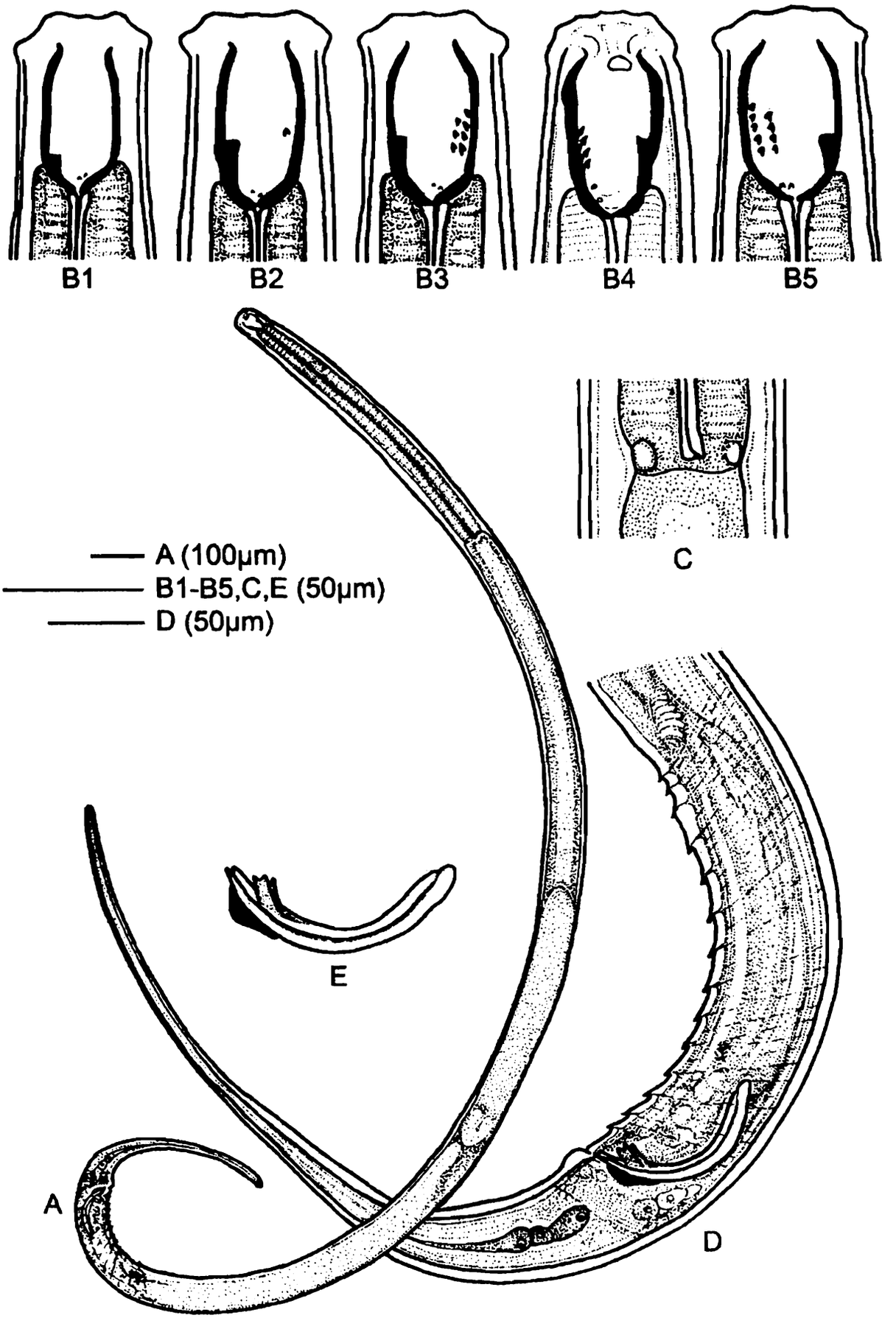

Figure 10. Camera lucida drawings of male *Parahadronchus shakili* (After, Jana *et al.*, 2008). A. Whole body; B1-B5. Variations of number of subventral teeth in buccal cavity; C. Pharyngo-intestine junction; D. Caudal region; E. Spicules.

Description : Female : Body long, habitus curved; cuticle moderately thick all over the body (4.14-8.9 µm). Dorsal tooth basal, sub-ventral walls bear generally 4 teeth, geusids prominent. Excretory pore situated behind the nerve ring; pharyngeal glands prominent; pharynx cylindrical (640-649.4 µm) and muscular. Gonads amphidelphic, ovary reflexed, sphincter distinct at oviduct-uterus junction. Vagina with three distinct parts, *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae*. Rectum length is less than one anal diameter. Caudal pore absent. Filiform tail with rounded tail-tip; caudal glands three in number, spinneret-opening terminal.

Male : Buccal cavity generally bears 4 teeth but variations observed, sub-ventral walls may contain 0-5 teeth (Jana *et al.*, 2008). All the adult males bear matured double testes, spicules, gubernaculum, accessory pieces. Rectal glands and ejaculatory glands much developed.

Remarks : The specimens fit well to the description given by Jairajpuri and Khan (1982) and Andrássy (1994), though in the present observations male specimens found larger than the previously described specimens. Dorsal tooth occupying 39.16-42% of total buccal cavity length in female and 35.29-43.12% in male which is lower than the previously described specimens by Jairajpuri and Khan (1982) and Andrássy (1994). This species was reported only from India. Earlier it was recorded from Kathgodam, Nainital (Uttar Pradesh), Lakhimpur (Kheri), Bareilley and Haridwar (Saharanpur) (Jairajpuri and Khan, 1982). Ahmad and Jairajpuri (1982) reported some abnormalities in buccal cavity of *P. shakili* collected from Uttar Pradesh.

9. ***Mulveyellus jairi*** (Lordello, 1959) Siddiqi 1984
(Figures : 11, 45)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.35-1.59 mm; a=25.63-27.43; b=4.68-5.30; c=15.38-19.20; c'=2.31-2.80; V%=65.98-79.51; G_1=22.56-26.54; buccal cavity=28.2-30.55X14.1-17.55 µm; ABD=30.6-35.5 µm; tail length=70.5-94 µm.

Description : Female : Body long, habitus curved; cuticle moderately thick all over the body (2.2-8.5 µm); width of lip region more or less same as the adjacent body width. Dorsal tooth situated at mid to upper third area of buccal cavity, sub-ventral tooth absent, geusids prominent at the base of buccal cavity. Excretory pore situated behind the nerve ring; pharyngeal glands prominent but gland openings are not prominent in few specimens; Pharynx cylindrical and muscular, length and width of cardia more or less same. Gonads monoprodelphic, ovary reflexed. Single specimen with two intra-uterine eggs, first intra-uterine egg measured as 120X62.55 µm and second intra-uterine egg 120X61.53 µm. Vagina with distinct parts, *pars proximalis vaginae, pars refringens vaginae* but *pars distalis vaginae* absent. Rectum marginally less than one anal diameter. Caudal pore absent. Tail conoid, arcuate, tip rounded, caudal glands and spinneret absent.

Male : Not found.

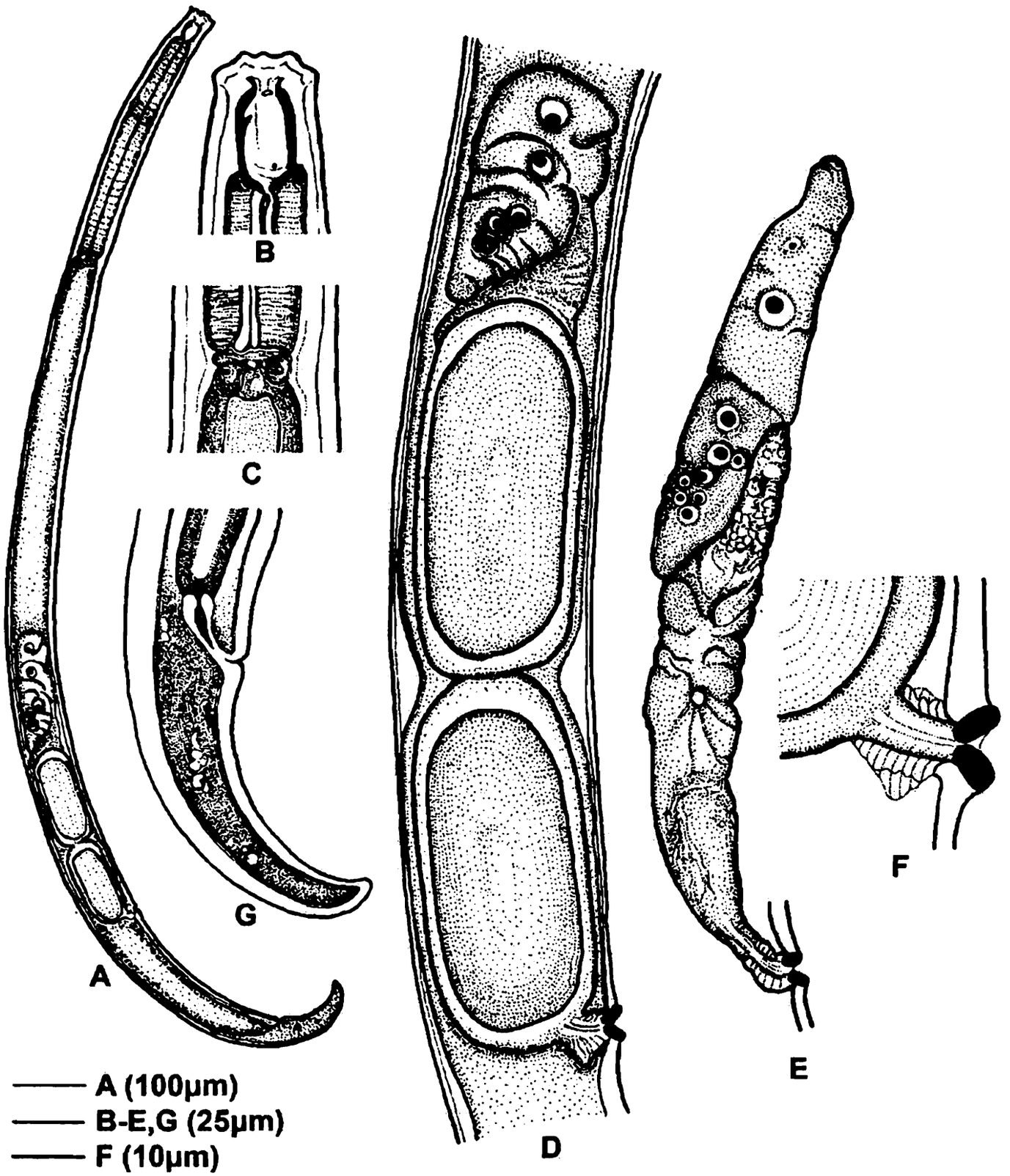

Figure 11. Camera lucida drawings of female *Mulveyellus jairi* (After, Jana *et al.*, 2008). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad consisting intra-uterine eggs; E. Gonad, without egg; F. Vulval region; G. Tail.

Remarks : The genus as well as the species is reported for the first time from West Bengal, India. The specimens match well with the specimens described by Jairajpuri and Khan (1982) from Maharashtra and Uttar Pradesh except the higher 'b' value in present case. Excluding India, it was reported from Nigeria, St. Lucia and Brazil (Andrássy, 1994).

10. ***Miconchus aquaticus*** Khan, Ahmad and Jairajpuri, 1978
(Figures : 12, 46)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=2.05-2.15 mm; a=29.7-33.77; b=4.39-4.67; c=15.79-16.92; c'=3.0-3.12; V%=54-68.7; G_1=18.33-19.66; buccal cavity=44.1-50.23X24.5-29.4 µm; ABD=41.7-42.9 µm; tail length=124.95-132.30 µm.

♂♂ L=1.79-2.50 mm; a=32.04-38.22; b=4.17-4.91; c=16-18.11; c'=2.14-2.5; T%=35.7-42.5; buccal cavity=44.1-48.56X15.64-29.4 µm; ABD=46.6-52 µm; ventromedian supplements=15; tail length=110.25-122.5 µm.

Description : Female : Body long, habitus curved; cuticle moderately thick all over the body (3.3-5.1 µm), width of lip region more or less same as the adjacent body width. Dorsal tooth situated between mid to upper third area of buccal cavity, two sub-ventral teeth present, geusids prominent at the base of buccal cavity. Excretory pore situated behind the nerve ring; pharyngeal glands prominent; Pharynx cylindrical (448.35-480.2 µm) and muscular, cardia simple. Gonads amphidelphic, ovary reflexed, oviduct smaller than uterus. Vagina with distinct parts, *pars proximalis vaginae, pars refringens vaginae* but *pars distalis vaginae* very small. Rectum marginally less than one anal diameter. Caudal pore absent. Tail conoid, arcuate, tip rounded, caudal glands and spinneret absent.

Male : General characters of all males are similar to female. All the adult male bears matured double testes, spicules, gubernaculum, accessory pieces. Rectal glands and ejaculatory glands much developed.

Remarks : The specimens match well with the specimens described by Jairajpuri and Khan (1982) from Rajasthan except the value of 'c' and 'V', which is lower in female and 'T' higher in male in the present observation. The male specimens of South 24-Parganas also have fewer spicules i.e. 15 (*vs* 17-21). The measurements of males and females fit well with the measurements given by Andrássy (1994). Apart from India, it was reported only from Romania (Andrássy, 1994).

11. ***Miconchus rectangularis*** Jana, Chatterjee & Manna, 2008
(Figures : 13, 47)

Locality, associated plants and date of collections : Table 2.

Measurements: ♀♀ L=1.77-1.82 mm; a=26-26.46; b=3.5-3.88; c=24.66-24.7; c'=2.0-2.14; V%=71.33-72.33; G_1=17.46-17.50; G_2=17.23-17.59; buccal cavity=51-51.21X16.88-17.0 µm; ABD=33.54-34.3 µm; tail length=72.77-73.5 µm.

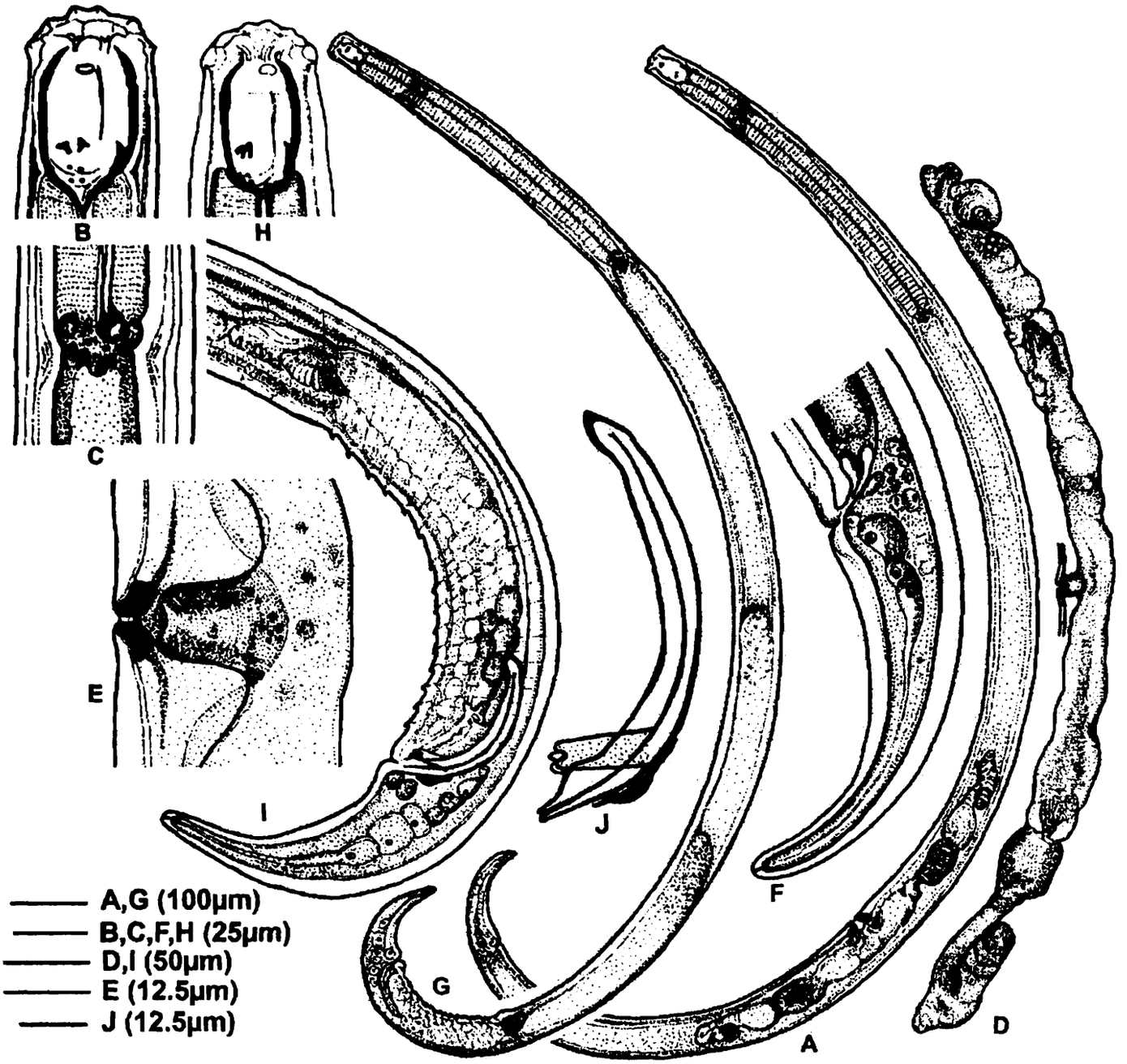

Figure 12. Camera lucida drawings of female and male *Miconchus aquaticus* (After, Jana *et al.*, 2008).

Female : A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Male : G. Whole body; H. Head; I.. Caudal region; J. Spicules, gubernaculum and accessory pieces.

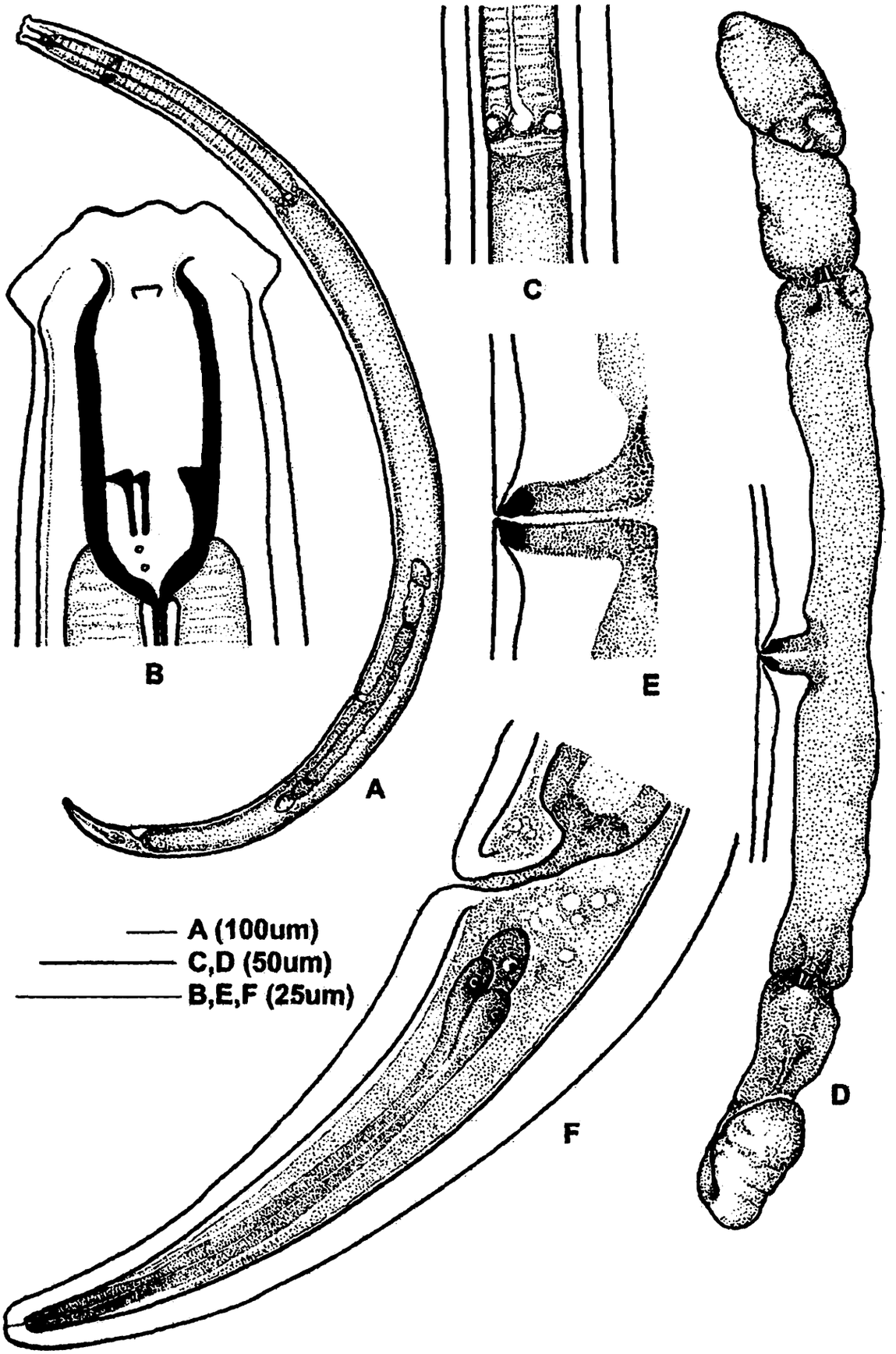

Fig. 13. Camera lucida drawings of female *Miconchus rectangularis* (After, Jana *et al.*, 2008). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Description : Female : Body medium-sized in length, habitus curved; cuticle moderately thick all over the body but of variable thickness at lip region, mid-body and caudal region (2.31-6.60 µm), lip region wider than the adjacent body width, lip region has a prominent constriction. Buccal cavity much narrower, rectangular in shape, wall of buccal cavity straight, width equals 1/3rd of its length. Dorsal tooth and two sub-ventral teeth medium in size, situated at 31.23% from the base of buccal cavity and at same level, geusids prominent. Prominent excretory pore behind the nerve ring; pharyngeal glands prominent; Pharynx cylindrical (462-468 µm) and muscular, cardia tongue-shaped. Gonads didelphic-amphidelphic, ovary reflexed, never reach oviduct-uterus junction, sphincter prominent at oviduct-uterus junction. Vagina with three distinct parts, *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae*. Rectum length less than one anal diameter. Caudal pore single. Tail conoid, arcuate, gradually tapering at the end, tail-tip rounded, caudal glands three in number and spinneret opening terminal.

Male : Not found.

Remarks : The above species is only reported from the district South-24-Parganas, West Bengal, India.

12. ***Miconchus bulbicaudatus*** Jana, Chatterjee & Manna, 2008
(Figures : 14, 48)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=2.1-2.22 mm; a=38.25-40.22; b=4.1-4.3; c=14.2-14.66; c'3.13-3.25; V%=63.5-66.5; G_1=10.23-11; G_2=9.5-9.8; buccal cavity=48.6-49X25.24-26.32 µm; ABD=46.35-47.66 µm; tail length=149.45-151.22 µm.

Description : Female : Body medium in length, habitus curved; cuticle moderately thick all over the body but of variable thickness at lip region, mid-body and caudal region (4.66-8.65 µm); width of lip region and the adjacent body are same. Buccal cavity much broad, length of the buccal cavity is 1.9 times of its width. Dorsal tooth and two sub-ventral teeth small and situated at 31.23% from the base of buccal cavity and at the same level, geusids prominent. Excretory pore behind the nerve ring is prominent; pharyngeal glands prominent; Pharynx cylindrical (486.35-494.9 µm) and muscular, cardia tongue-shaped. Gonads didelphic-amphidelphic, ovary reflexed, never reach oviduct-uterus junction, sphincter prominent at oviduct-uterus junction. Vagina with three distinct parts, *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae*. Rectum length less than one anal diameter. Tail conoid, arcuate, gradually tapering at the end, tail-tip rounded with a bulbutous structure at the tail tip, caudal papillae prominent, caudal glands three in number and spinneret opening terminal.

Male : Not found.

Remarks : The above species *Miconchus bulbicaudatus* is only reported from the district South 24-Parganas, West Bengal, India (Jana *et al.*, 2008c).

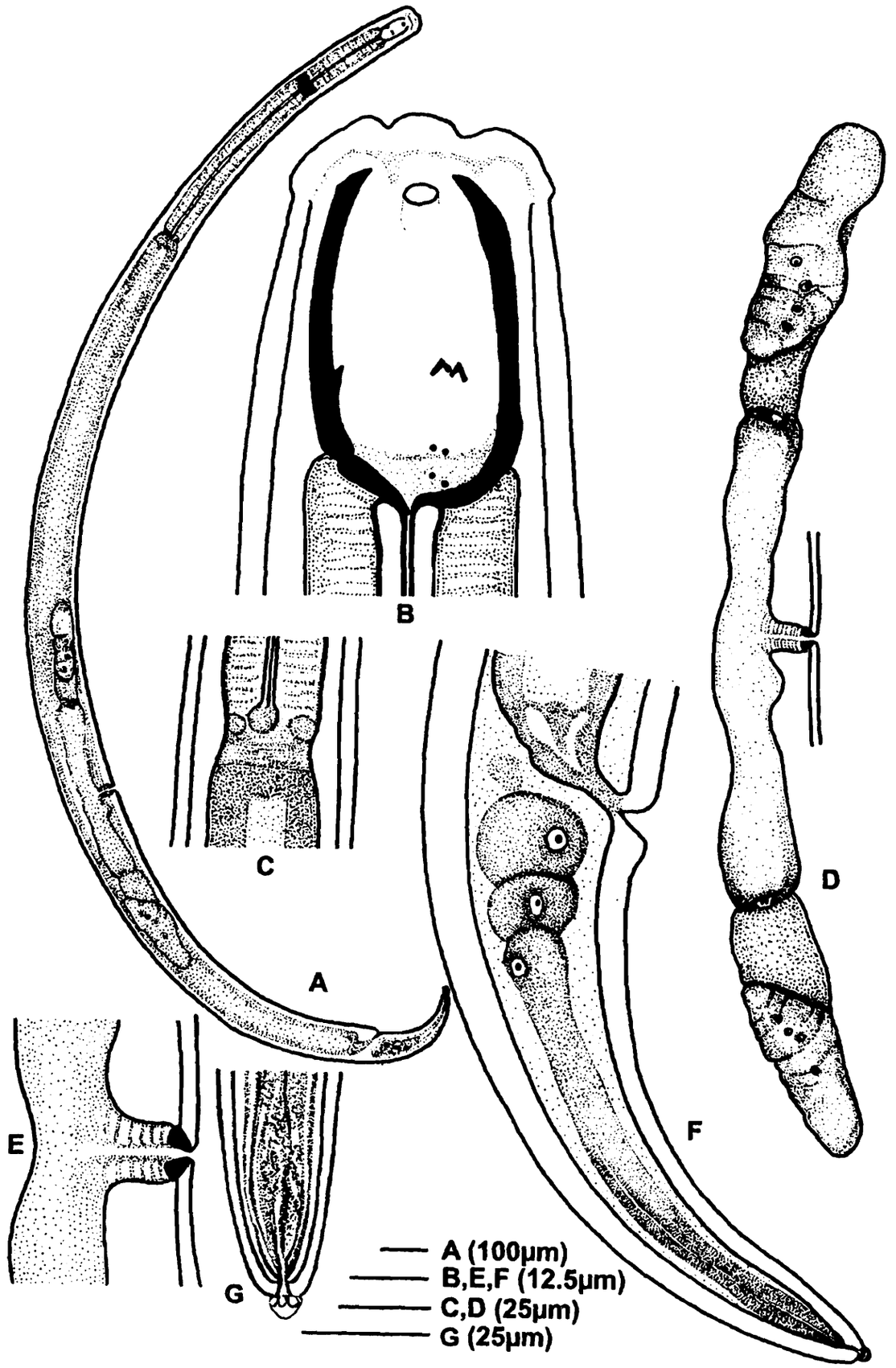

Fig. 14. Camera lucida drawings of female *Miconchus bulbicaudatus* (After, Jana *et al.*, 2008). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail; G. Tail terminus

13. ***Miconchus dalhousiensis*** Jairajpuri, 1969
(Figures : 15)

Locality and associated plants : The species was reported from the district Darjeeling, West Bengal, India, of soil around roots of paddy crop.

Measurements : ♀♀ L=1.9-2.3 mm; a=28-31; b=3.5-4; c=12-14; c'=3.5-4; V%=63-68.

Description : Female : Body ventrally curved in the posterior half upon fixation. Length of buccal cavity less than twice of its width. Apex of dorsal tooth situated 1/3rd position from its base. Two subventral teeth equal in size and at the same level as dorsal tooth. Reproductive system amphidelphic, sphincter not present at oviduct-uterus junction. Tail elongate-conoid, caudal glands and terminal opening absent.

Male : Not found.

Remarks : *Miconchus dalhousiensis* Jairajpuri, 1969 is only reported from the northern part (district Darjeeling) of West Bengal (Baqri & Dey, 1991). In India other than West Bengal it was also reported from Himachal Pradesh and Uttar Pradesh (Jairajpuri & Khan, 1982).

14. ***Anatonchus sukuli*** Baqri, Das & Ahmad, 1981
(Figure : 16)

Locality and associated plants : The species associated with an insectivorous plant, *Drosera burmanni,* at Santiniketan, district Birbhum, West Bengal, India.

Measurements : ♀ L=4.93 mm; a=47; b=5; c=8; c'=7.5; V%=64; G_1=11; G_2=11; buccal cavity=62-73X52-71 µm; tail length=590 µm.

♂♂ L=4.38-4.72 mm; a=43-47; b=5.1-5.2; c=12; c'=4.2-4.4; T%=39-42; ventromedian supplements=14-15; tail length=360-398 µm.

Description : Female : Body ventrally curved in the posterior half upon fixation, tapering slightly anterior to base of Pharynx but markedly posteriorly. Cuticle finely striated, 3-4 µm thick at mid-body. Lateral chord about 1/5th-1/4th of corresponding body-width near middle. Lip region slightly wider than adjoining body. Amphids funnel shaped. Walls of buccal cavity weakly developed. Three medium sized teeth hinged to anterior wall of buccal cavity. Nerve ring 201-225 µm of neck region from anterior end. Rectum 50 µm long. Female reproductive system amphidelphic, vulva a transverse slit; vagina moderately sclerotized distally, extending inwards 41µm or less than 1/3rd of corresponding body-width, marked with muscular bands, surrounded by sphincter. Uterus and oviduct are separated by a well developed sphincter which is almost like a flower. Ovaries reflexed; oocytes arranged in a single row except in growth region. Tail elongate, 7.5 anal body-widths long. Caudal glands three, leading to a terminal duct.

Male : Male is similar to female in general shape except more curved in posterior third of body. Male reproductive system typical. Spicules 142-148µm or about 1.6-

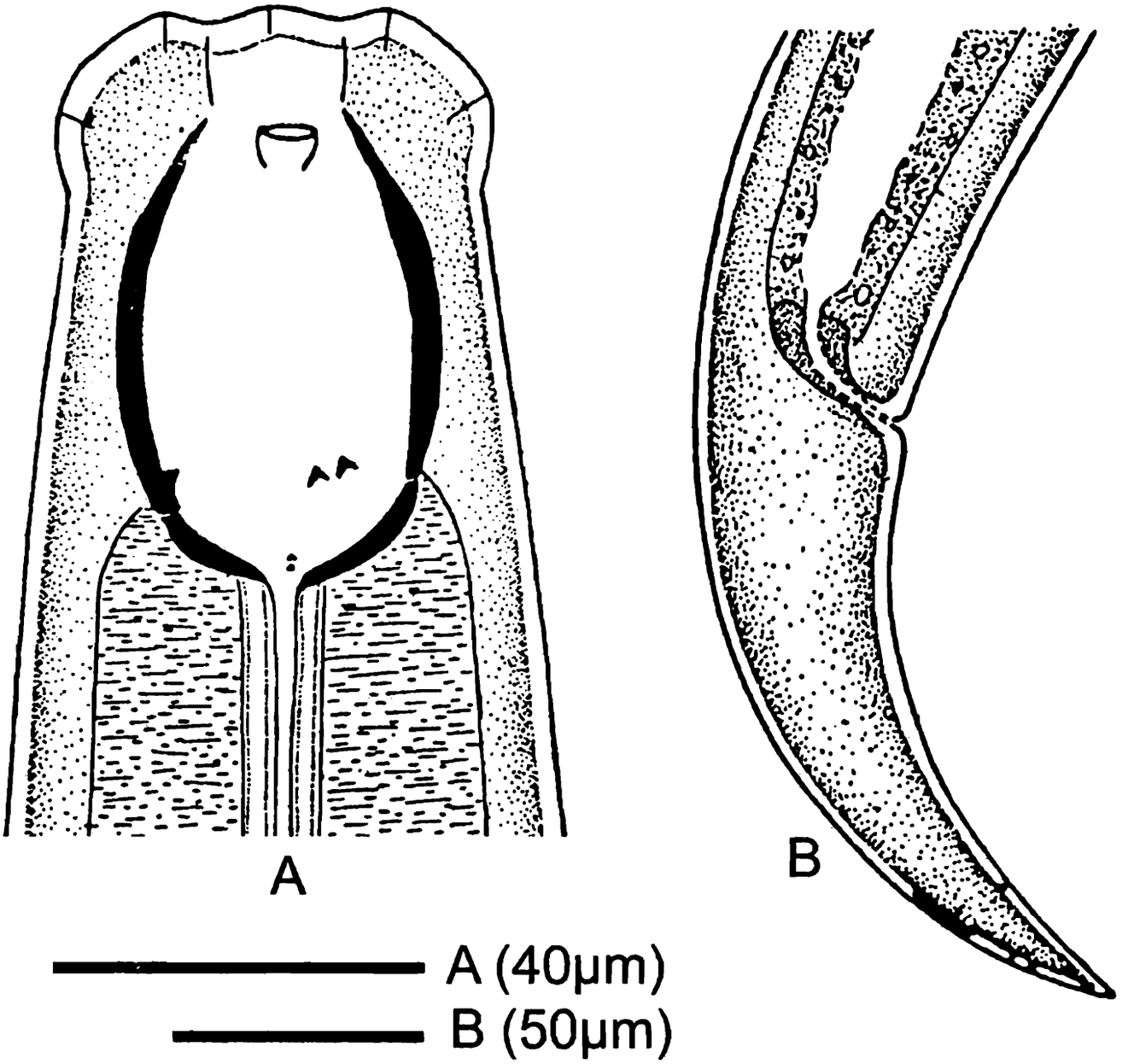

Figure 15. Female *Miconchus dalhousiensis* (After, Jairajpuri and Khan, 1982) A. Head; B. Tail.

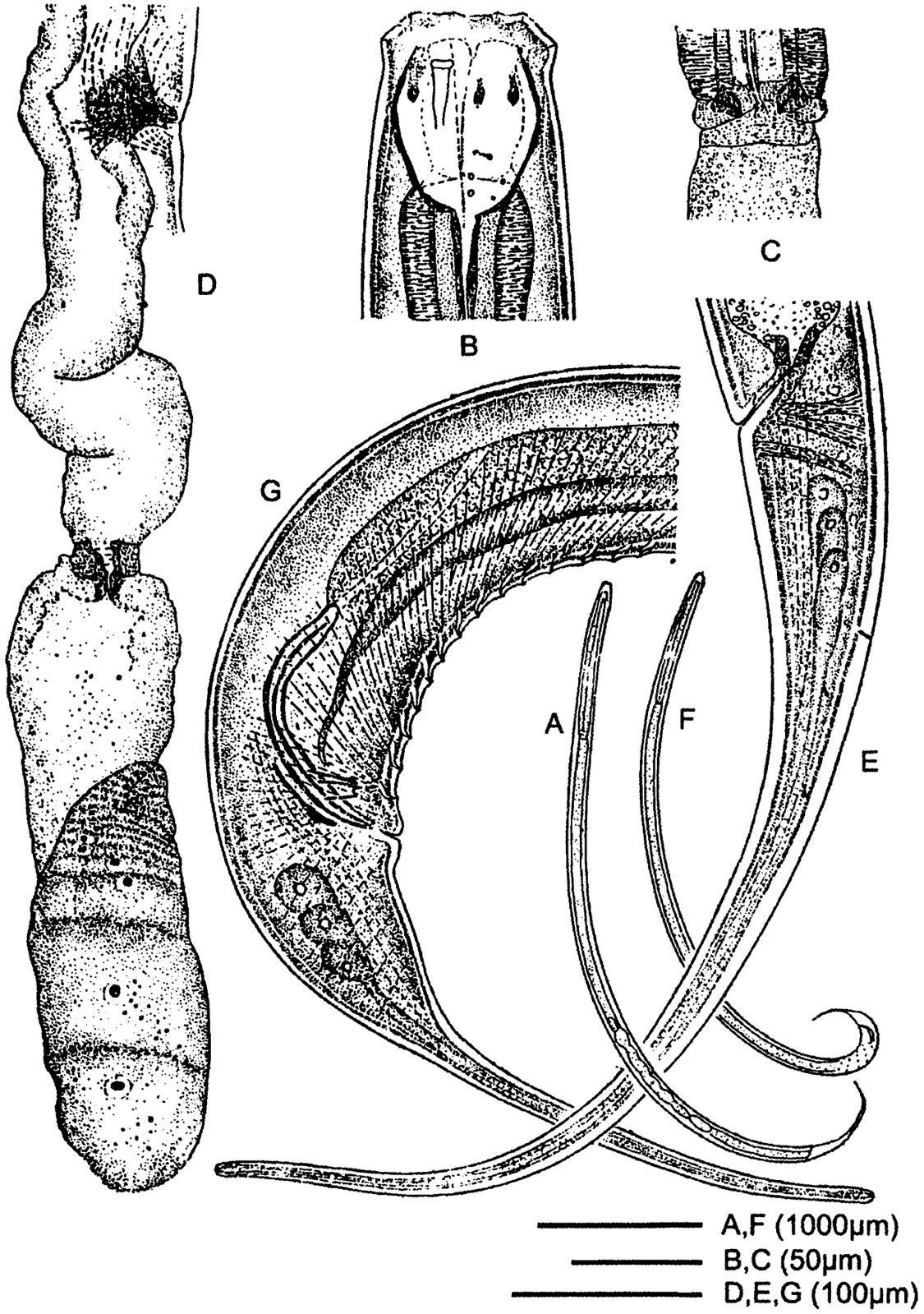

Figure 16. *Anatonchus sukuli* (After, Baqri, Das & Ahmad, 1981).
Female : A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Tail.
Male : F. Whole body; G. Caudal region.

1.7 anal-body widths long medially. Gubernaculum 45-47 µm and lateral accessory pieces 18-19 µm long. Supplements 14-15, spaced nearly at regular intervals. Copulatory muscles 44-46 in number. Tail similar to female, 4.2-4.4 anal body widths long.

Remarks : The above species is only reported from the district Birbhum, West Bengal. (Baqri *et al.*, 1981)

15. ***Mylonchulus mulveyi*** Jairajpuri, 1970
(Figures : 17, 49)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=0.81-1.18 mm; a=26.88-35.75; b=2.69-3.47; c=20.17-29.43; c'=1.17-1.78; V%=65.7-90; G_1=11.58-14.35; buccal cavity=20-23.31X8.33-13.32 µm; ABD=23.31-30 µm; tail length=32.9-53.28 µm.

Description : Female : Body small, ventrally curved upon fixation, tapering slightly towards extremities. Cuticle smooth, thickness varies from lip region to caudal region (2-3.5 µm). Lateral chord about 1/3rd of the total body width. Height of the lip 1/5th of the lip width. Amphid small and its aperture is oval in shape. Buccal cavity bears a large dorsal tooth which spans about 3/4th of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by 2-3 transverse rows of denticles arranged in parallel; small but prominent sub-median tooth on the sub-ventral wall opposite to dorsal tooth. Pharynx long (269.7-363 µm), slender, muscular, measures 1/3rd of total body length; pharyngeal glands prominent; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary small, reflexed, sphincter absent in oviduct-uterus junction, uterus contains intra-uterine eggs in few specimens measuring 65.35-80.65X24.35-34.35 µm; posterior pouch distinct in all female specimens; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent. Tail elongate-conoid. Rectum length less than one anal diameter, prerectum is not prominent. Caudal glands three in number and spinneret opening terminal.

Males : Not found.

Remarks : The measurements of the present species fit well with the descriptions of Jairajpuri (1970), Baqri and Khera (1977) and Jairajpuri and Khan (1982). They reported *Mylonchulus mulveyi* from Saharanpur, Bareilly, Faridpur, Nainital, Assam and Manipur. In West Bengal, *Mylonchulus mulveyi* was reported earlier from Darjeeling disrict by Baqri and Khera (1977) and Baqri and Dey (1991). It is reported for the first time from the district South 24-Parganas. Excluding, India the above species was recorded from El Salvador and St. Lucia (Andrássy, 1992).

16. ***Mylonchulus contractus*** Jairajpuri, 1970
(Figures 18, 50)

Locality, associated plants and date of collections : Table 2.

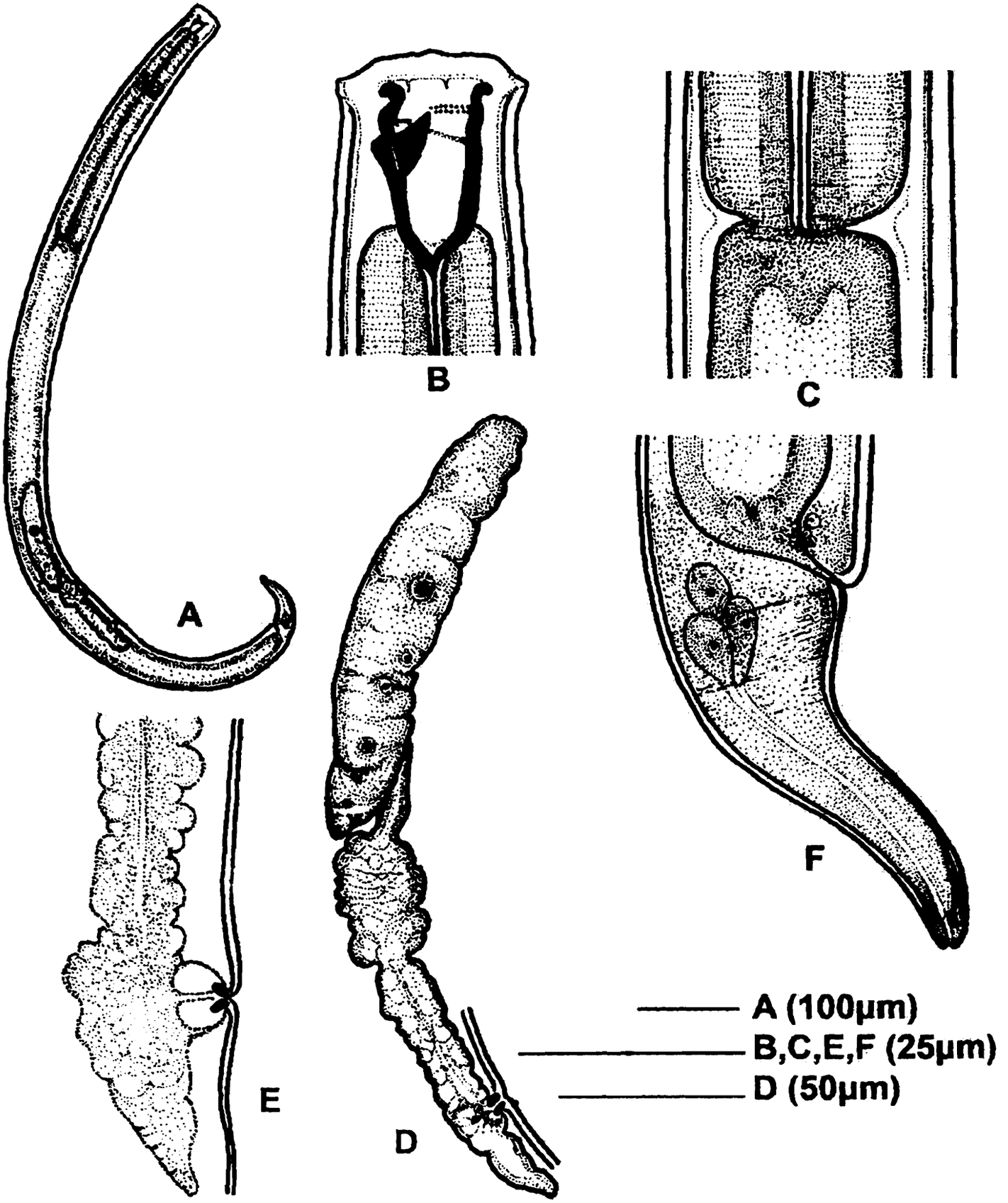

Figure 17. Camera lucida drawings of female *Mylonchulus mulveyi.*
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Measurements : ♀♀ L=0.77-0.88 mm; a=14.64-27.46; b=3.3-3.56; c=30.5-40.04; c'=1-1.33; V%=57.6-60.6; G_1=7.6-12.81; buccal cavity=17.33-20.2X8.95-11.75 µm; ABD=19.23-23.5 µm; tail length=19.23-28.2 µm.

♂ L = 0.87; a = 29.46; b = 2.9; c = 34; c' = 1.07; T% = 50.9; ventromedian supplements = 9; tail length = 25.48 µm.

Description : Female : Body small, ventrally curved upon fixation, slightly tapering towards extremities. Cuticle smooth, thickness varies from lip region to caudal region (2.44-4.5 µm). Lateral chord about 1/3rd of the total body width. Amphid small and its aperture is oval in shape. Length of the buccal cavity twice of its width and bears a large dorsal tooth which covers about three-fourth of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by five transverse rows of denticles arranged in parallel; prominent but small sub-median tooth at the sub-ventral wall opposite to dorsal tooth. Pharynx long (233.1-246.8 µm), slender, muscular, its length 1/3rd of total body length; pharyngeal glands prominent; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary small, reflexed, sphincter absent in oviduct-uterus junction, uterus contains intra-uterine egg; *pars proximalis vaginae, pars refringens vaginae* prominent but *pars distalis vaginae* absent. Tail conoid, with blunt terminus, its length about one anal diameter. Rectum length less than one anal diameter, prerectum is not prominent. Three caudal glands and sub-dorsal terminal spinneret present.

Male : Overall measurements and shape of the body alike females. Prerectum long, rectum shorter than tail length. Ventromedian supplements, spicules and gubernaculum distinct but lateral guiding pieces absent. Tail measures less than one anal diameter.

Remarks : Females fit well with the description of Jairajpuri (1970) and Jairajpuri and Khan (1982), but little differences are seen in male specimen, length shorter, values of 'a' and 'b' lower, 'c' and 'T' much higher. The differences in measurements of few organs in male are due to intra-specific variations. Andrássy (1992) reported this species from India and Dominica. Jairajpuri and Khan (1982) reported this species from Kerala, Assam, Himachal Pradesh, Rishikesh, Shaharanpur, Meerut and Dehra Dun. *M. contractus* is being reported for the first time from West Bengal.

17. ***Mylonchulus incurvus*** Cobb, 1917
(Figures : 19, 51)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=0.83-0.88 mm; a=22.38-27.46; b=3.4-3.56; c=33.9-39.78; c'=1.11-1.3; V%=57.7-60.6; G_1=8.68-12.81; G_2=9.5-11.5; buccal cavity=18.6-20.2X9.4-11.75 µm; ABD=21.15-23.5 µm; tail length=21.15-25.85 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (3-4.5 µm). Lateral chord spans about 2/5th of the

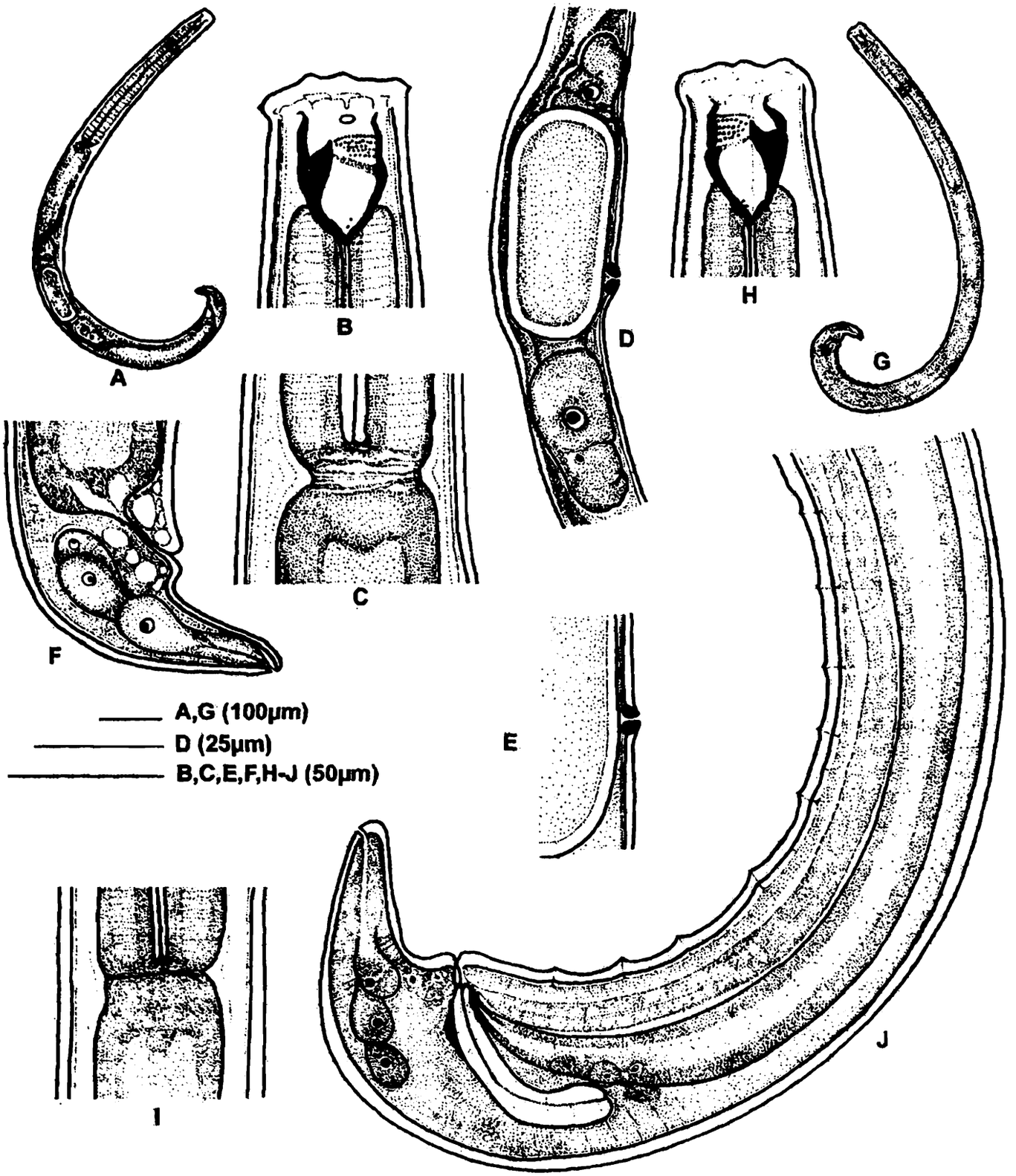

Figure 18. Camera lucida drawings of female and male *Mylonchulus contractus*.
Female: A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.
Male: G. Whole body; H. Head; I. Pharyngo-intestine junction; J. Caudal region.

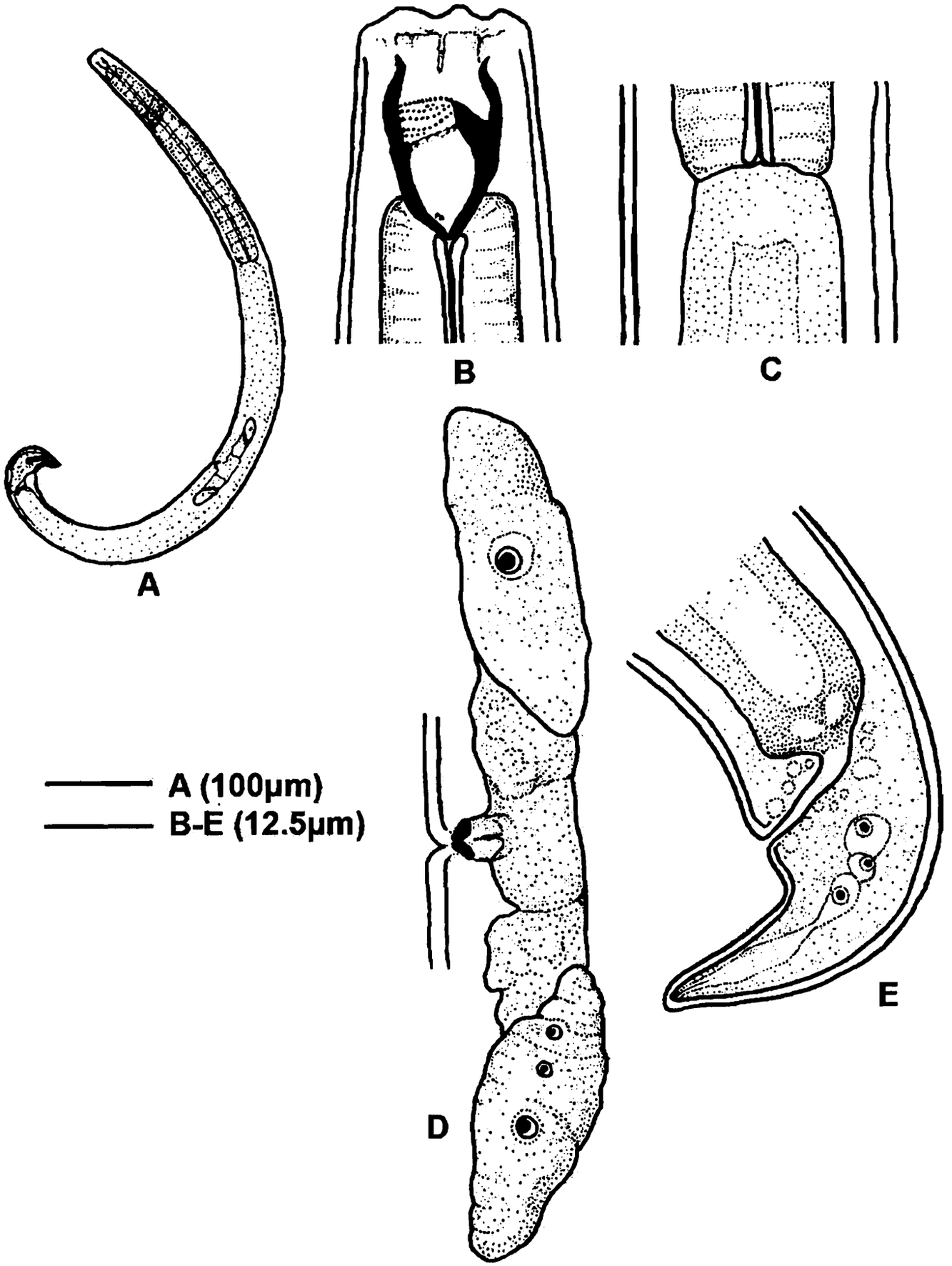

Figure 19. Camera lucida drawings of female *Mylonchulus incurvus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Tail.

total body width. Width of the lip more than four times the lip height. Amphid small, aperture cup-shaped. Length of the buccal cavity about twice of its width and bears a large dorsal tooth which covers more than three-fourth of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by five transverse rows of parallelly arranged denticles; small yet prominent sub-median tooth at the sub-ventral wall opposite to dorsal tooth. Pharynx long (239.7-246.75 µm), slender, muscular, spanning $1/4^{th}$ of total body length; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary long, reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent. Tail nearly one anal diameter in length, posterior digitate part of the tail conoid, distinctly narrowing to its terminus. Rectum scales less than one anal diameter, rectal glands prominent. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : The measurements of above species fit well with the measurements given by Baqri and Khera (1977), Andrássy (1992) except the smaller body length in the present case. *M. incurvus* is widely distributed throughout the world. Previously, it was recorded from Poland, France, Russia, Korea, Thailand, Mauritius, South Africa, Canada, United States, El Salvador, Jamaica and Brazil (Andrássy, 1992). In India, it was reported from the district Darjeeling, West Bengal (Baqri and Khera, 1977). The above species is reported for the first time from the district South 24-Parganas, West Bengal.

18. ***Mylonchulus hawaiiensis*** (Cassidy, 1931) Goodey, 1951
(Figures : 20, 52)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.28-1.4 µm; a=20.32-22.14; b=4-4.3; c=38.98-42.35; c'=1.07-1.3; V%=52.45-56.77; G_1=11.25-13.4; buccal cavity=29.97-32.54X14.56-16.65 µm; ABD=32.54-35.2 µm; tail length=25-36 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (1.23-3.56 µm). Lateral chord scales about $2/5^{th}$ of the total body width. Amphid small, aperture oval. Length of the buccal cavity about twice of its width and bears a large dorsal tooth which covers more than 50% of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by 5-6 transverse rows of denticles arranged regularly and a small sub-median tooth. Pharynx long (325-333.25 µm), slender, muscular, spanning $1/4^{th}$ of total body length; pharyngeal glands obscure in few specimens; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Cardia simple. Gonad didelphic-amphidelphic; ovary long reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, uterus small, *pars dilatata prominent*; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* distinct.

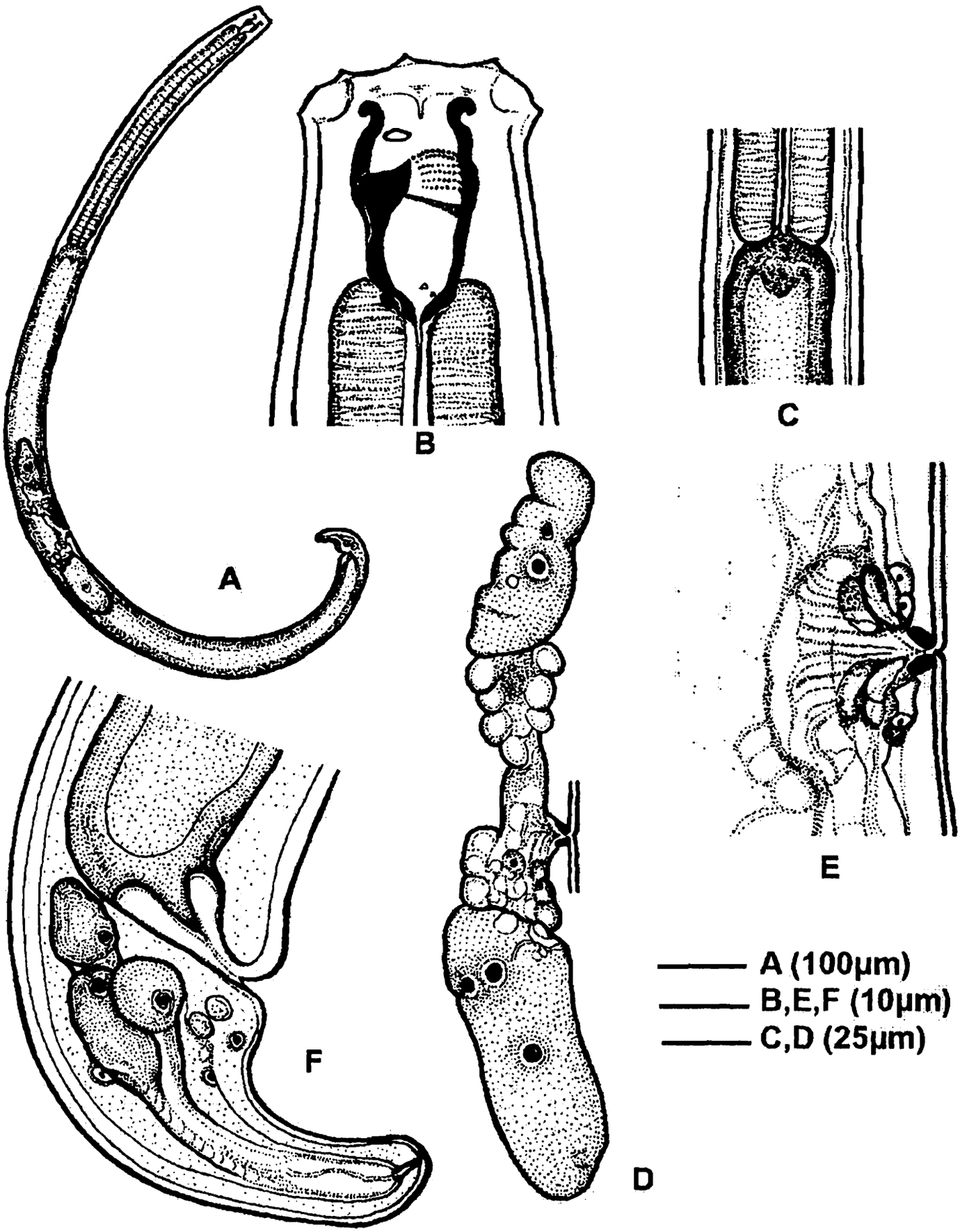

Figure 20. Camera lucida drawings of female *Mylonchulus hawaiiensis.*
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Tail approximately about one anal diameter in length. Rectum length less than one anal diameter. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : The above species is being reported for the first time from West Bengal. The measurements of above species matches well with the measurements given by Jairajpuri and Khan (1982) and Andrássy (1992) except in the value of 'c' In India, the above species was reported from Car Nicobar Island, Chamba, Barog, Jammu and Kashmir, Himachal Pradesh, Garhwal, Mussourie, Clamen town, Dehra Dun and Uttar Pradesh.

19. ***Mylonchulus minor*** (Cobb, 1893), Cobb, 1916
(Figures : 21, 53)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.28-1.59 mm; a=20.96-28.13; b=4.04-4.35; c=33.75-38.93; c'=1.33-1.4; V%=56.33-60.74; G_1=12.82-17.25; G_2=11.82-16.57; buccal cavity=25.85-30.55X14.1-16.45 µm; ABD=23.5-35.25 µm; tail length=32.9-47 µm.

Description : Female : Body medium in size, ventrally curved upon fixation, tapering slightly towards extremities. Cuticle smooth, thickness varies from lip region to caudal region (3.25-4.2 µm). Lateral chord about 2/5th of the total body width. Height of the lip about 1/4th of the lip width. Amphid small and its aperture cup-shaped. Length of the buccal cavity nearly twice of its width and bears a large dorsal tooth which covers about three-fourth the length of buccal cavity. Apex of dorsal tooth directed forward and opposed by five transverse rows of denticles arranged in parallel; small sub-median tooth at the sub-ventral wall opposite to dorsal tooth appears prominent. Pharynx long (317.25-364.25 µm), slender, muscular, its length 1/4th of total body length; pharyngeal glands prominent; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary long reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, uterus contains intra-uterine egg in every specimen measured as 48.99-63.2X22.32-35.4 µm (anterior) and 54.45-65.33X24.35-32.65 µm (posterior); *pars proximalis vaginae, pars refringens vaginae* prominent but *pars distalis vaginae* absent. Tail length scales more than one anal diameter. Rectum less than one anal diameter in length, prerectum not prominent. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : It is reported for the first time from West Bengal during the present work. The measurements of above species fit well with the measurements and description given by Jarajpuri and Khan (1982), however, slightly different from the measurements given by Andrássy (1992). In India, earlier it was reported from Maharashtra, Andhra Pradesh, Kerala, Nainital, Pilibhit and Uttar Pradesh.

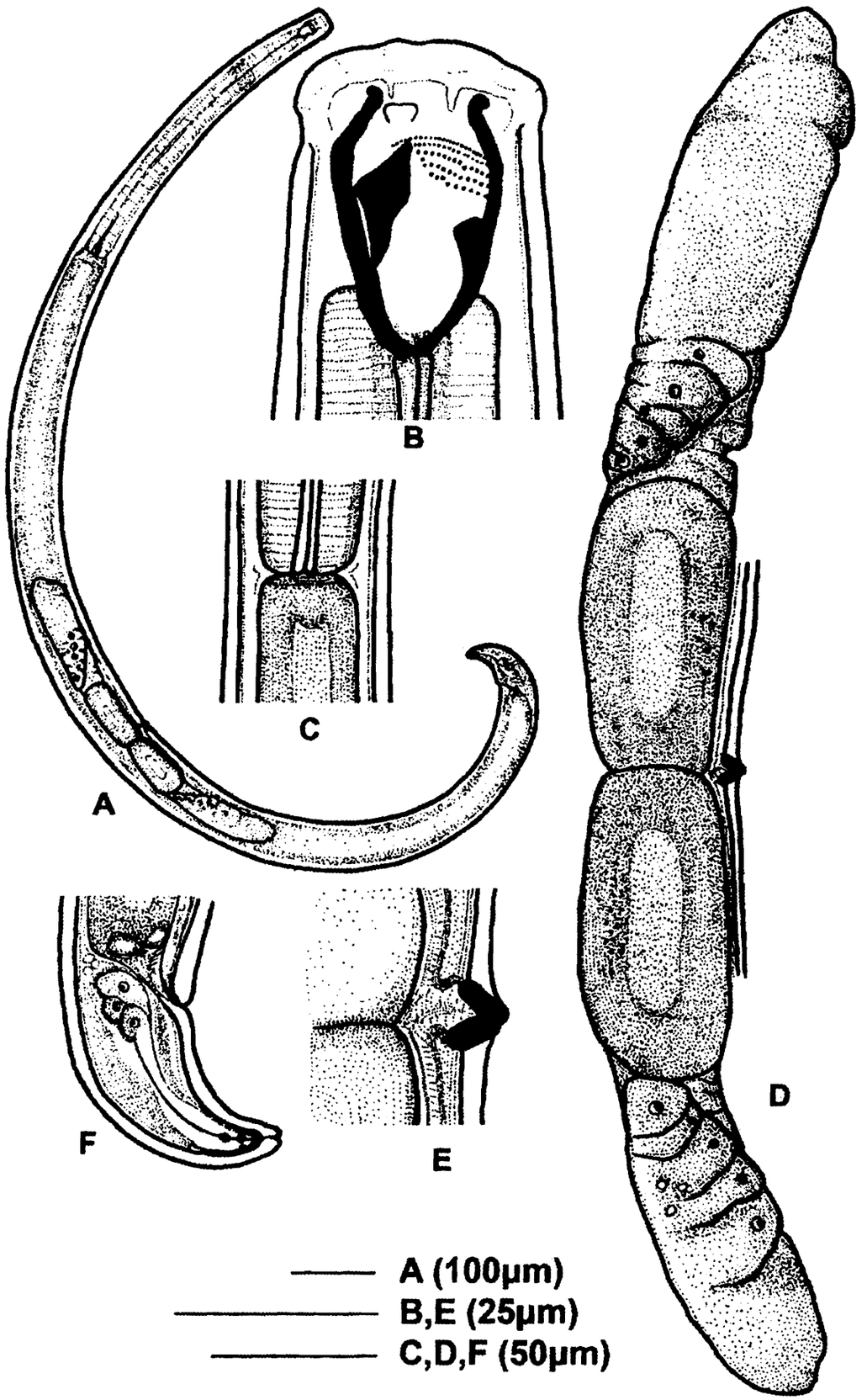

Figure 21. Camera lucida drawings of female *Mylonchulus minor.*
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

20. ***Mylonchulus lacustris*** (Cobb in Cobb, 1915), Cobb, 1917
(Figures : 22, 54)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.12-1.35 mm; a=20.78-22.54; b=3.68-4; c=29.88-38.29; c'=0.97-1.33; V%=54.9-61.09; G_1=17.33-18.54; G_2=17.25-18.52; buccal cavity=29.97-34.25X15.56-17 µm; ABD=33-35.68 µm; tail length=33.3-35.87 µm.

Description : Female. Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (3.2-3.5 µm). Lateral chord about $2/5^{th}$ of the total body width. Width of the lip more than four times the lip height. Amphid small with cup-shaped aperture. Length of the buccal cavity about twice of its width and bears a large dorsal tooth which covers more than three-fourth the length of the buccal cavity. Apex of dorsal tooth directed forward and opposed by five transverse rows of denticles arranged parallel; small sub median tooth at the sub-ventral wall opposite to dorsal tooth appears prominent. Pharynx long (319-333 µm), slender, muscular, spans $1/4^{th}$ of total body length; pharyngeal glands obscure in few specimens; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary long reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, uterus contains three intra-uterine eggs in four specimens, intra-uterine eggs measured as 66.56-74.55X51.62-60.54 µm (anterior), 63.54-71.2X50-55 µm (median) and 71.45-77.85X50-55 µm (posterior); *pars proximalis vaginae, pars refringens vaginae* prominent but *pars distalis vaginae* absent. Rectum scales less than one anal diameter in length, rectal glands prominent. Tail about one anal diameter long, tail shape conoid-arcuate, tail terminus rounded. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : The measurements of above species fit well with the measurements and descriptions given by Jarajpuri and Khan (1982), Chaturvedi and Khera (1979), except the value of 'a' and Andrássy (1992) except the values of 'a' and 'c" Previously it was reported from India, Georgia, Japan, Thailand, Java, Sumatra, Nigeria, Mauritius, Zairi, South Africa, Canada, United States, Mexico, Venezuela, Australia, Panama. In India, Jarajpuri and Khan (1982) reported it from Dehra Dun, Moradabad, Shahjahanpur, Nainital, Uttar Pradesh and West Bengal. Chaturvedi and Khera (1979) reported *Mylonchulus lacustris* from districts Nadia, Howrah, North 24-Paraganas, Midnapur and Burdwan. It is reported for first time from district South 24-Parganas, West Bengal, India.

21. ***Mylonchulus amurus*** Khan and Jairajpuri, 1979
(Figures : 23, 55)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.07-1.21 mm; a=20.89-21.75; b=3.28-3.94; c=42.77-48.33; c'=0.69-0.78; V%=57.44-70.57; G_1=7.79-13.1; G_2=5.59-9.66; buccal

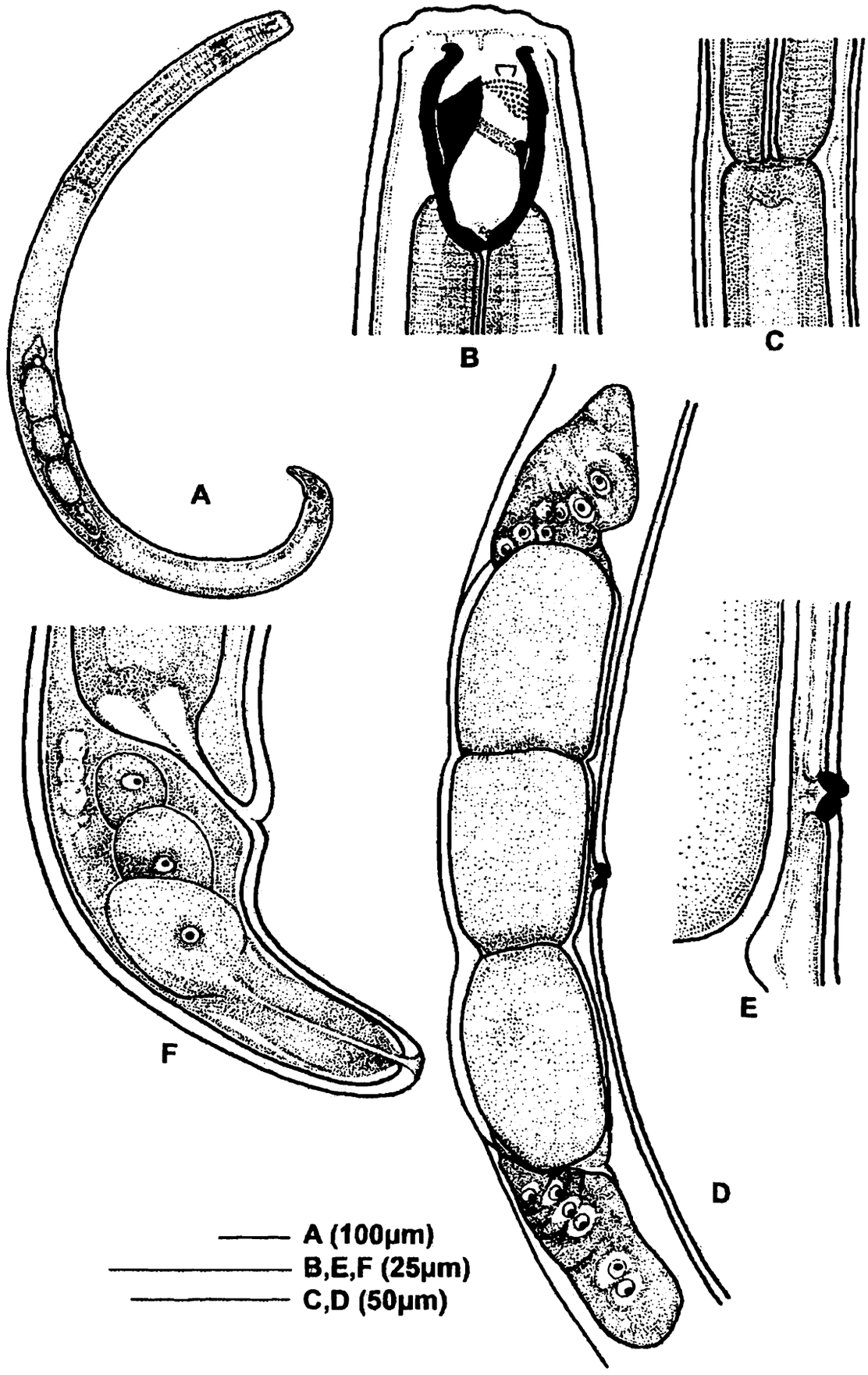

Figure 22. Camera lucida drawings of female *Mylonchulus lacustris*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

cavity=19.6-22.05X14.70-15.93 µm; ABD=31.85-36.75 µm; tail length=22.05-25.73 µm.

Description : Female : Body small, about 1 mm in length, ventrally curved upon fixation. Cuticle smooth, moderately thick (1.23-2.5 µm). Lateral chord about 1/3rd of the total body width. Width of the lip more than four times the lip height. Amphid small with cup-shaped aperture. Length of the buccal cavity about 1.3 times of its width and bears a large dorsal tooth which covers more than 3/4th of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by five transverse rows of denticles, among which upper two are parallel but rest of the three not arranged parallely; sub median tooth absent. Length of pharynx (294-335.65 µm) less than 1/4th of total body length; pharyngeal glands clearly visible; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary small, reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, *pars dilatata* prominent, uterus contains one intra-uterine egg in one specimen measuring 107.8X49 µm; length of the intra-uterine egg more than twice of its diameter; *pars proximalis vaginae, pars refringens vaginae, pars distalis vaginae* prominent. Tail very short, measuring less than one anal diameter. Rectum length less than half of its anal diameter. Caudal glands three in number and spinneret opening terminal.

Male : Not found.

Remarks : This species was reported only from India and Pakistan. In India, it was found in Himachal Pradesh, Kathgodam, Nainital, Rishikesh, Saharanpur, Dehra Dun and Uttar Pradesh. However, it is reported for the first time from West Bengal.

22. ***Mylonchulus dentatus*** Jairajpuri, 1970
(Figures : 24, 56)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.16-1.19 mm; a=36.21-38.21; b=3.17-3.81; c=35.21-36.43; c'=1.08-1.4; V%=40.39-67.65; G_1=16.55-17.34; G_2=14.63-16.64; buccal cavity=25.75-26.5X15.75-16.45 µm; ABD=23.5-30.55µm; tail length=32.9-34 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (2.4-3.5 µm). Lateral chord about 2/5th of the total body width. Width of the lip measures more than four times the lip height. Amphid small, aperture cup-shaped. Length of the buccal cavity about twice of its width and bears a large dorsal tooth which spans more than three-fourth of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by 11-14 transverse rows of denticles arranged parallelly; small sub-median tooth at the sub-ventral wall opposite to dorsal tooth looks prominent. Pharynx long (314.9-376 µm), slender, muscular, scales 1/4th of total body length; pharyngeal glands obscure in few specimens; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary long reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, *pars dilatata*

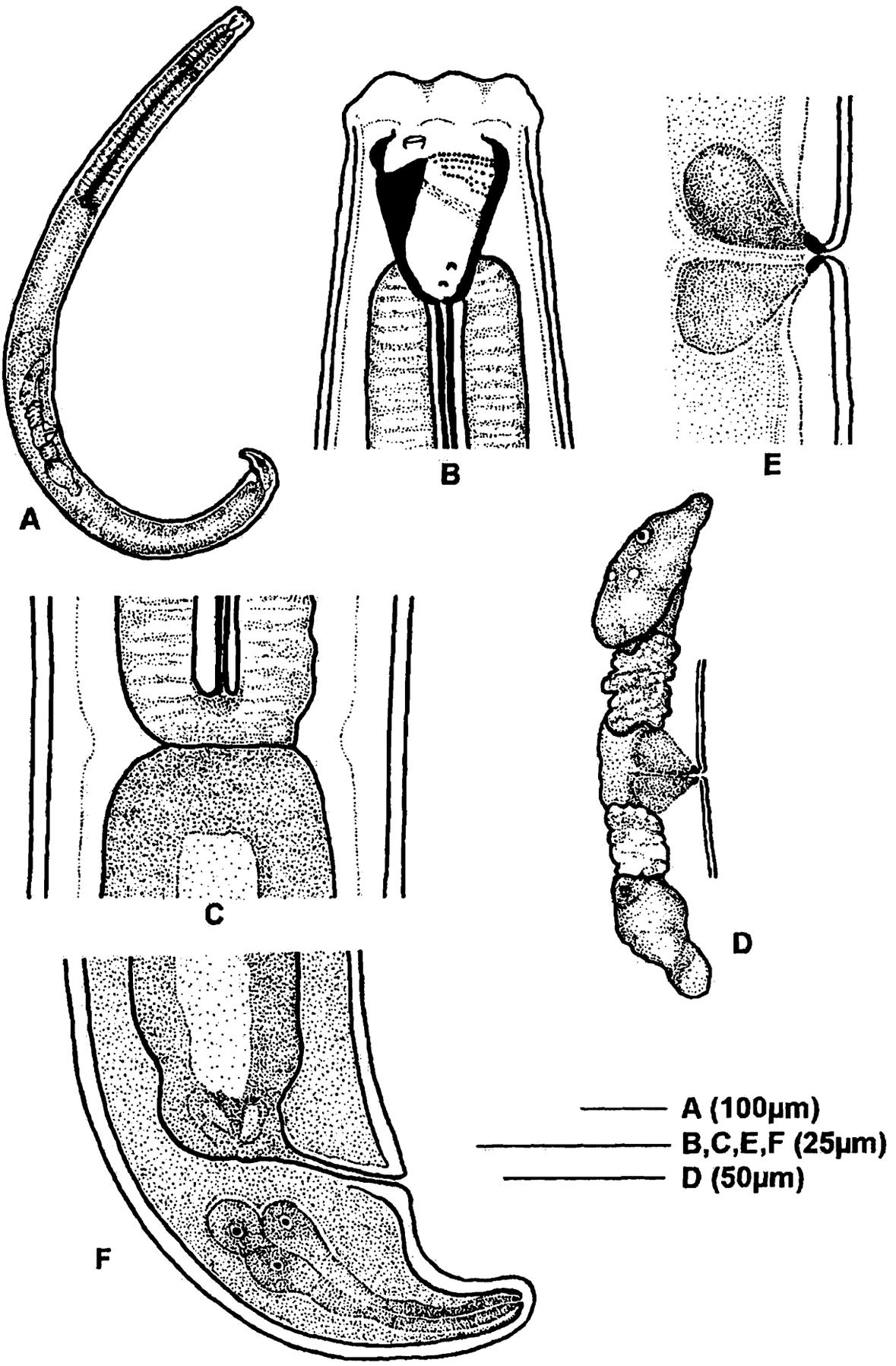

Figure 23. Camera lucida drawings of female *Mylonchulus anurus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

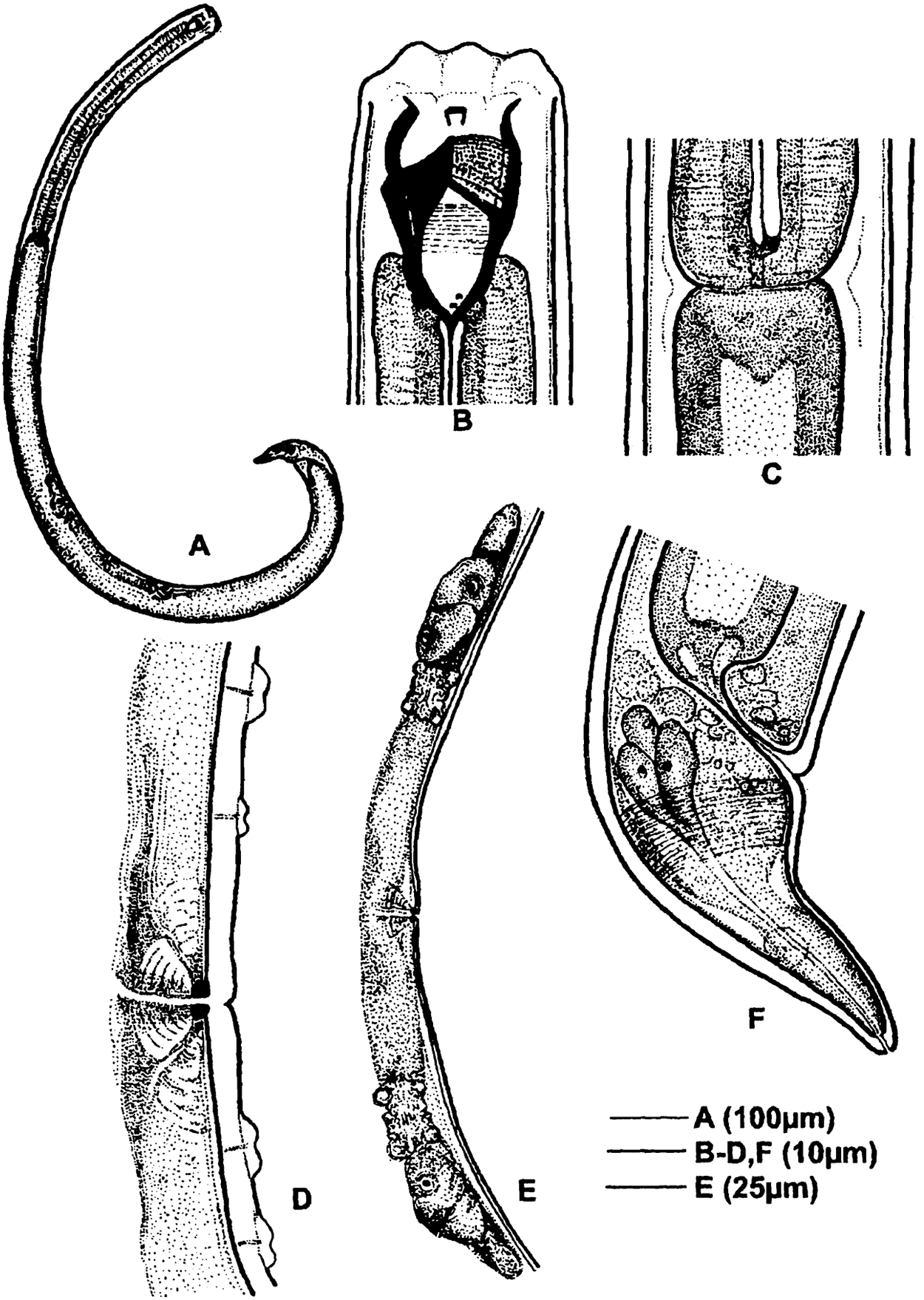

Figure 24. Camera lucida drawings of female *Mylonchulus dentatus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Vulval region; E. Gonad; F. Tail

distinct; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent; pre- and post- advulval papillae present, their number varies (0-2) in both cases. Tail elongate conoid-shaped, nearly one anal diameter in length. Rectum less than one anal diameter, rectal glands prominent. Three caudal glands and terminal spinneret present.

Male : Not found

Remarks : The measurements of above species matches well with the measurements and description given by Jarajpuri and Khan (1982) and Andrássy (1992). In India, earlier it was reported from Bareilly, Pilibhit, Nainital, Uttar Pradesh, Andhra Pradesh and Gujrat, by Jarajpuri and Khan (1982). The above species is reported for the first time from West Bengal.

23. ***Mylonchulus sigmaturus*** Cobb, 1917
(Figures : 25, 57)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.39-1.48 mm; a=32.89-38.24; b=3.22-3.5; c=37.06-45.07; c'=1.08-1.23; V%=61.72-65.93; G_1=21.05-23.33; G_2=18.42-20.33; buccal cavity=23.58-25.85X15.88-16.56 µm; ABD=28.2-30.55 µm; tail length=32.9-37.6 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (2.56-4.2 µm). Lateral chord about $2/5^{th}$ of the total body width. Width of the lip appears more than four times the lip height. Amphid small, aperture cup-shaped. Length of the buccal cavity about twice of its width and bears a large dorsal tooth which covers more than about three-fourth of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by five transverse rows of denticles arranged in parallel; small sub-median tooth at the sub-ventral wall opposite to dorsal tooth appears prominent. Pharynx long (420.65-432.4 µm), slender, muscular, its length measures $1/4^{th}$ of total body length; pharyngeal glands obscure in few specimens; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary long reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, *pars dilatata distinct*; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent. Tail nearly one anal diameter in length, posterior part of the tail straight, neither bent ventrally nor dorsally. Rectum scales less than one anal diameter in length, rectal glands prominent. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : The measurements of above species fit well with the measurements and description given by Jarajpuri and Khan (1982) and Andrássy (1992) but the lip region and the tail length differ from the description and figure provided by Jensen and Mulvey (1968) which had much distict lip and much shorter tail length. In India, earlier it was reported from Bareilly, Pilibhit, Nainital, Uttar Pradesh Andhra Pradesh

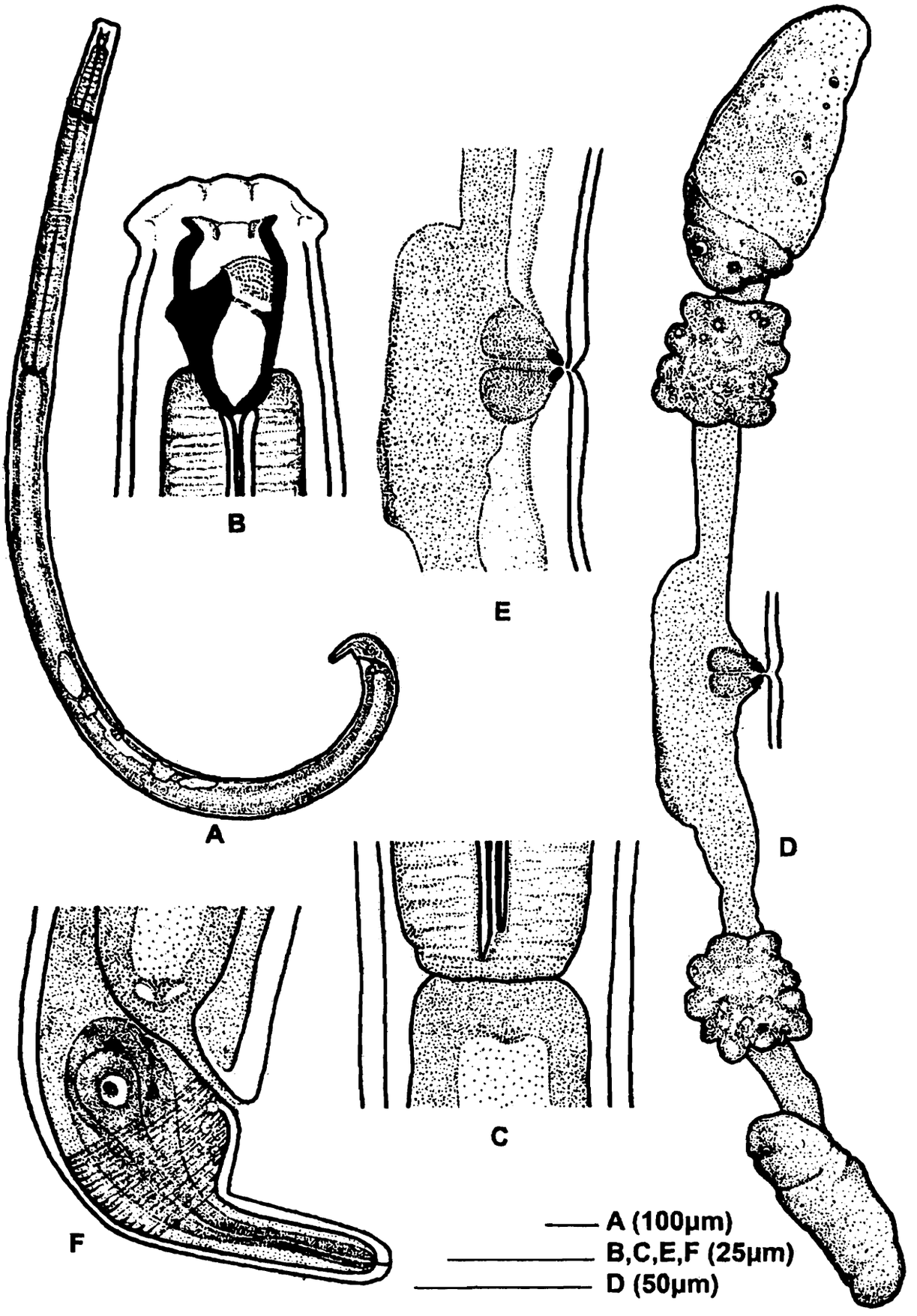

Figure 25. Camera lucida drawings of female *Mylonchulus sigmaturus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

and Gujrat by Jarajpuri and Khan (1982). The above species is being reported for the first time from West Bengal.

24. ***Mylonchulus sigmaturellus*** Mulvey, 1961
(Figures : 26, 58)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.72-1.81 mm; a=31.25-33.58; b=2.88-3.4; c=38.55-45.12; c'=1.3-1.54; V%=64.9-67.89; G_1=14.35-15.51; G_2=15.6-17.41; buccal cavity=25.35-26.6X17.45-18.56 µm; ABD=23.15 µm; tail length=34.87-41.45 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (1-3.6 µm). Lateral chord about 2/5th of the total body width. Width of the lip more than five times the lip height. Amphid small, aperture oval-shaped. Buccal cavity bears a large dorsal tooth, covers more than 80% of the total buccal cavity length. Apex of dorsal tooth directed forward and opposed by 6-8 transverse rows of denticles arranged in parallel; small but prominent sub-median tooth at the sub-ventral wall opposite to dorsal tooth. Pharynx long (532.35-597.22 µm), slender, muscular, its length spans 1/4th of total body length; pharyngeal glands obscure in few specimens; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary long, reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, uterus single specimen contains one posterior intra-uterine egg, measured as 115.15X53.9 µm; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent. Tail scales more than one anal diameter, arcuate in shape, suddenly narrower at the posterior end. Rectum less than one anal diameter. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : The above species is being reported for the first time from India (Jana, 2008). The measurements of above species matches well with the measurements given by Mulvey (1961) except in the smaller value of 'b' and smaller length of the tail thus the higher value of 'c' The measurements are also fit well with the measurements given by Andrássy (1992) except the value of 'b' which is lower in present case.

25. ***Mylonchulus wasimi*** Jana, Chatterjee & Manna, 2008
(Figures 49, 59)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.5-1.85 mm; a=26.94-36.5; b=3.53-3.79; c=35.23-46.07; c'=0.72-1.38; V%=60.95-67.32; G_1=11.93-17.41; G_2=13.51-19.33; buccal cavity=28.2-33.3X16.5-20 µm; ABD=40.2-44.4 µm; tail length=32.9-45 µm.

Description : Female : Body length medium, cuticle thin (1.5-1.7 µm). Dorsal tooth large, opposed by nine regular transverse rows of denticles and a clear sub-ventral tooth (which is about 1/3rd of the dorsal tooth length); amphid cup-shaped,

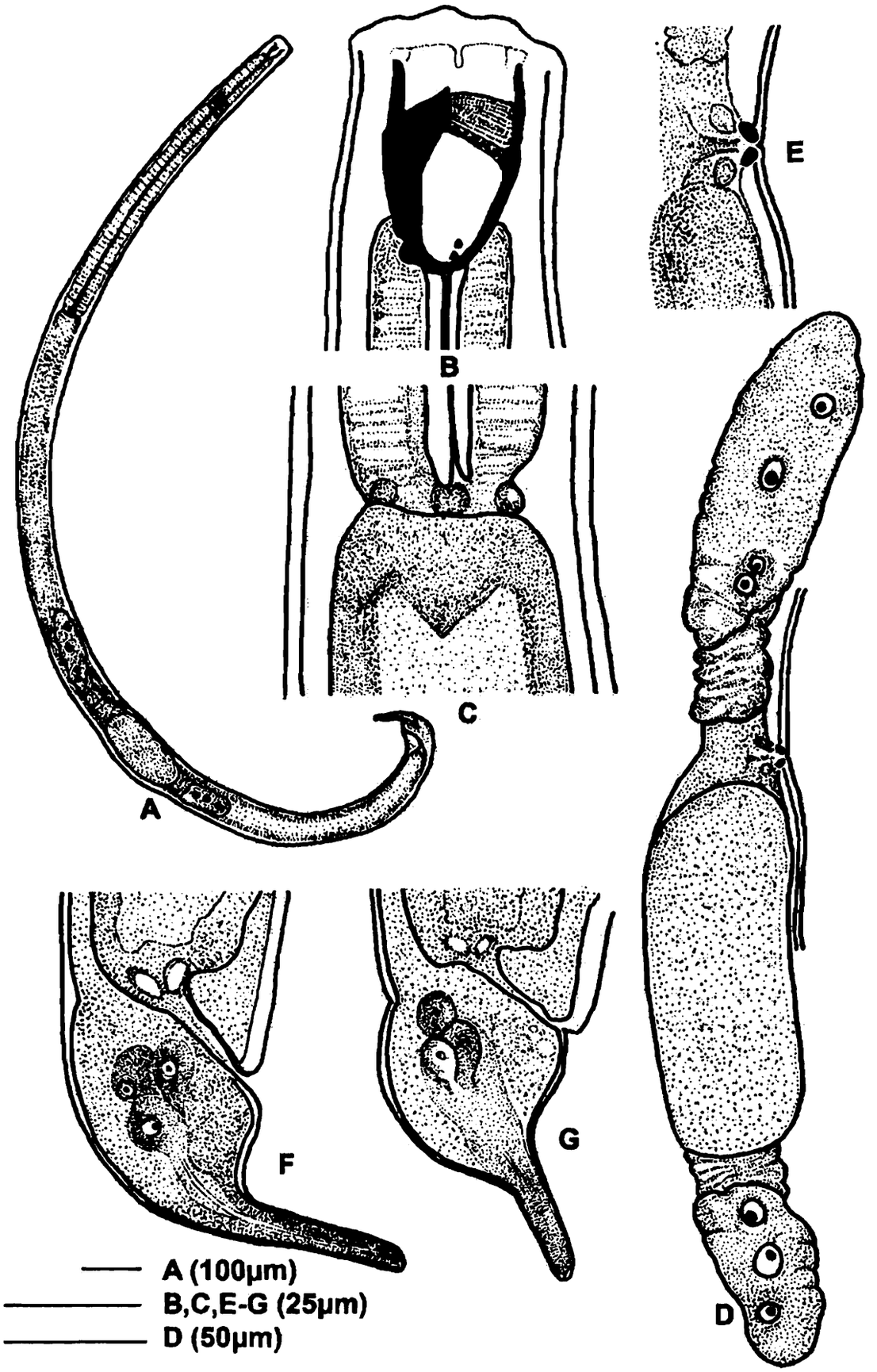

Figure 26. Camera lucida drawings of female *Mylonchulus sigmaturellus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. and G. Tail of two different specimens.

its aperture measures 13.8% of the adjacent body width, buccal capsule mylonchuloid type. Nerve ring situated at about 22% of pharyngeal length from anterior end. Pharynx long (416-506.2 µm), slender; pharyngo-intestinal junction non-tuberculate. Gonad didelphic-amphidelphic, generally anterior gonad shorter than the posterior gonad; ovary reflexed at both the side, *pars proximalis, pars refringes* and *pars distalis* vagina are prominent. A distinct lip-like protuberance at the opening of vulval region; one pre- and one post-advulval papillae present, though variations in their number (pre-advulval papillae: 0-2 and post-advulval papillae: 0-2) were found. Tail one anal diameter long. Digit-like tail, dorsally bent. Caudal glands three in number, large and much developed; clear spinneret with sub-terminal opening.

Male : Not found.

Remarks : It is only reported from the district South 24-Parganas, West Bengal, India.

26. ***Mylonchulus goutami*** Jana, Chatterjee & Manna, 2010
(Figures : 28, 60)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=0.97-1.24 mm; a=29.91-36.29; b=3.39-4.62; c=38.36-55.76; c'=1.35-1.56; V%=42.9-69.67; G_1=11.8-15.38; G_2=8.61-13.46; buccal cavity=19.6-22.05X11.13-12.25 µm; ABD=21.56-25.66 µm; tail length=22.05-26.95 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth and thin (1-1.3 µm). Lateral chord about $1/4^{th}$ of the total body width. Width of the lip region more than four times the lip height. Amphid small and its aperture oval. Length of the buccal cavity less than twice of its width and bears a large dorsal tooth which covers more than three-fourth of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by 7-8 regular transverse rows of denticles arranged parallelly; small sub-median or sub-ventral tooth absent, geusids prominent. Pharynx height (262.15-311.15 µm) less than $1/3^{rd}$ of total body length, it is slender and muscular; pharyngeal glands prominent; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Gonad didelphic-amphidelphic; ovary reflexed, size of ovary is similar or slightly smaller than oviduct in either side, anterior ovary longer than posterior, sphincter absent in oviduct-uterus junction, *pars proximalis vaginae, pars refringens vaginae* prominent but *pars distalis vaginae* very small. Two advulval papillae present at very close proximity to either side of vulval pore. Rectum length less than one anal diameter. Tail short, nearly one anal diameter long, gradually tapering but digitate in shape. Three caudal glands and terminal spinneret present, tail terminus rounded.

Male : Not found.

Remarks : It is only reported from the district South 24-Parganas, West Bengal, India.

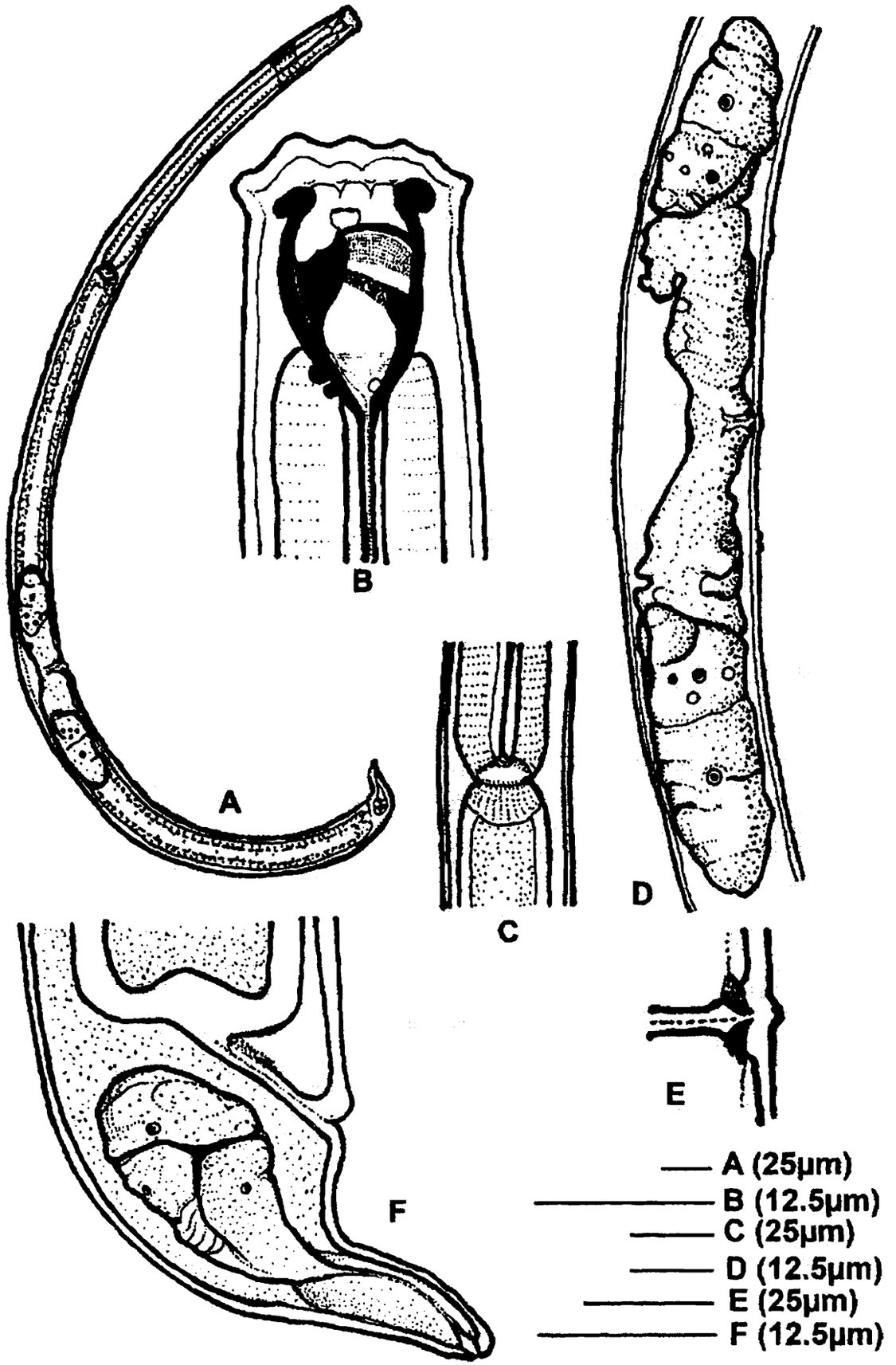

Figure 27. Camera lucida drawings of female *Mylonchulus wasimi* (After, Jana *et al.*, 2006). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

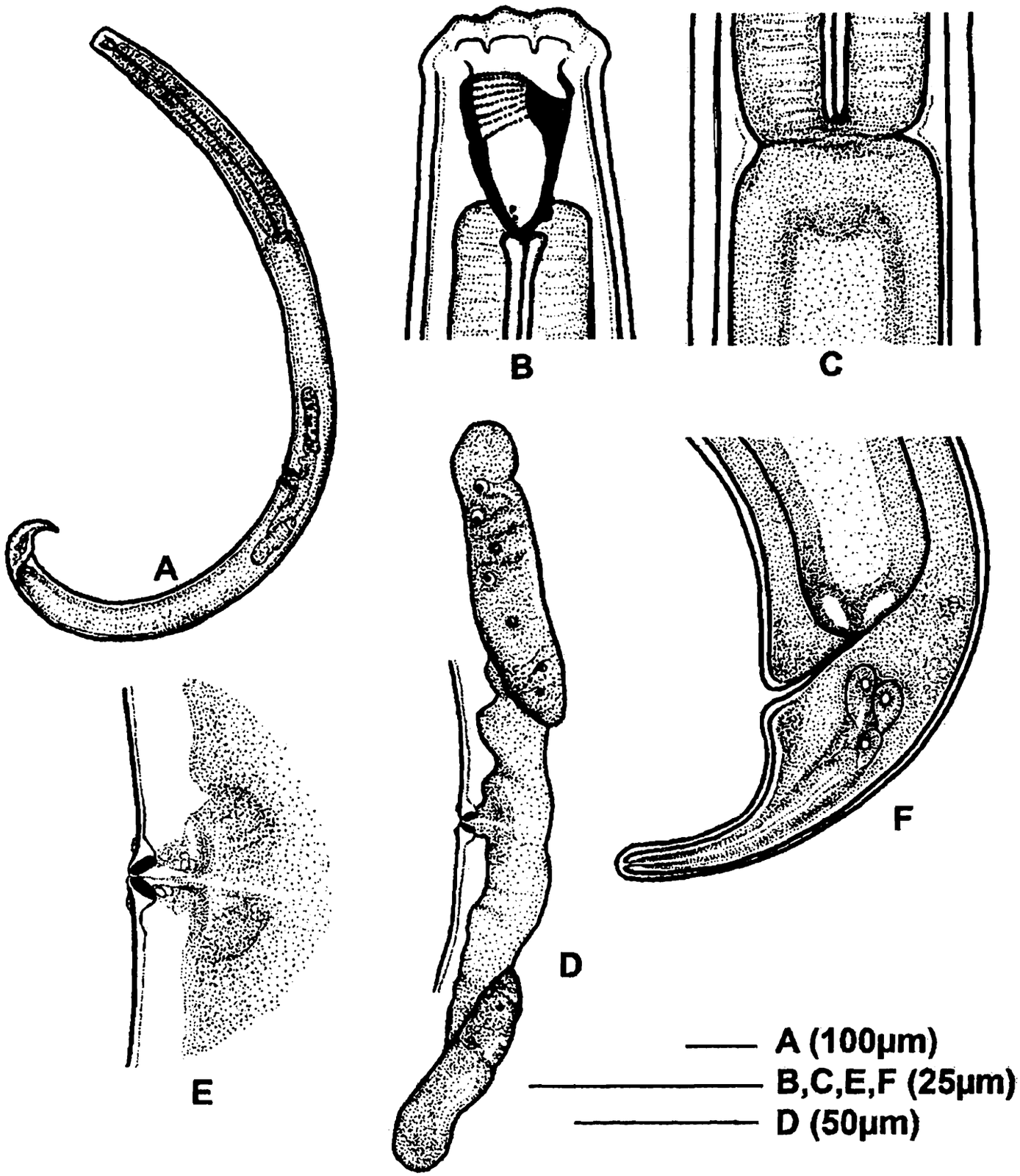

Fig. 28. Camera lucida drawings of female *Mylonchulus goutami* (After, Jana *et al.*, 2010). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

27. ***Mylonchulus istvani*** Jana, Chatterjee & Manna, 2010
(Figures : 29, 61)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=0.7-0.84 mm; a=29.65-32.36; b=2.93-3.21; c=35.6-41; c'=0.88-1.11; V%=79.63-81.2; G_1=30.69-36.54; buccal cavity=18.8-19.45X9.4-10.4 µm; ABD=21.15-22.35 µm; tail length=18.8-23.5 µm.

Description : Female : Body almost arcuate, posterior end slightly curved. Body length medium, cuticle thin (2-2.44 µm); lip region set off from body; a prominent constriction at head region. Buccal cavity mylonchuloid type, upper portion wider than the lower and slightly tapering at the bottom; bears a large dorsal tooth which covers about $3/4^{th}$ of the buccal cavity length. Apex of dorsal tooth directed forward and opposed by four transverse rows of denticles arranged parallelly; a small prominent indentation at the sub-ventral wall opposite to dorsal tooth. Amphid aperture oval, situated at the base of the lip region. Pharynx long (260.2-270.31 µm), muscular; prominent pharyngeal glands; pharyngo-intestinal junction nontuberculate; distinct cone-shaped cardia. Excretory pore situated behind the nerve ring. Gonad monoprodelphic (measures as 236.32-295.29 µm); ovary reflexed with oocytes arranged in a single row; sphincter absent in oviduct-uterus junction, *pars dilatata* distinct, uterus straight; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* prominent; distinct invagination at vulval pore. Tail measures about one anal diameter. Rectum length is less than one anal diameter. Tail tip blunt, not regularly rounded, rather, the anterior portion slightly projected or inclined ventrally. Caudal glands and terminal spinneret present.

Male : Not found.

Remarks : It is only reported from the district South 24-Parganas, West Bengal, India.

28. ***Mylonchulus sagarensis*** Sinha, Baqri & Choudhury, 1989
(Figure : 30)

Locality and associated plant : Ganga sagar, upper littoral zone around the roots of *Phoenix peludosa.*

Measurements : ♀♀ L=1.88 mm; a=49; b=3.8; c=40; c'=1.11; V%=62.5; G_1=36.54; buccal cavity=30X18 µm; tail length=56 µm.

Description : Female : Body curved in posterior half of its length upon fixation. Cuticle 1µm thick allover the body. Lip region setoff, wider than adjoining body. Amphid cup-shaped and situated 15µm from anterior extremity, its opening 4µm wide, located anterior to the apex of dorsal tooth. Buccal cavity is longer than width. Apex of the dorsal tooth about 80% from the base of the buccal cavity. Submedian teeth located about 50% from the base of the buccal cavity. Denticles arranged in 7 rows (2 regular, 5 irregular). Pharynx cylindrical, pharyngo-intestinal junction non-tuberculate. Vulva a transverse slit. Vagina about $1/3^{rd}$ of the corresponding body

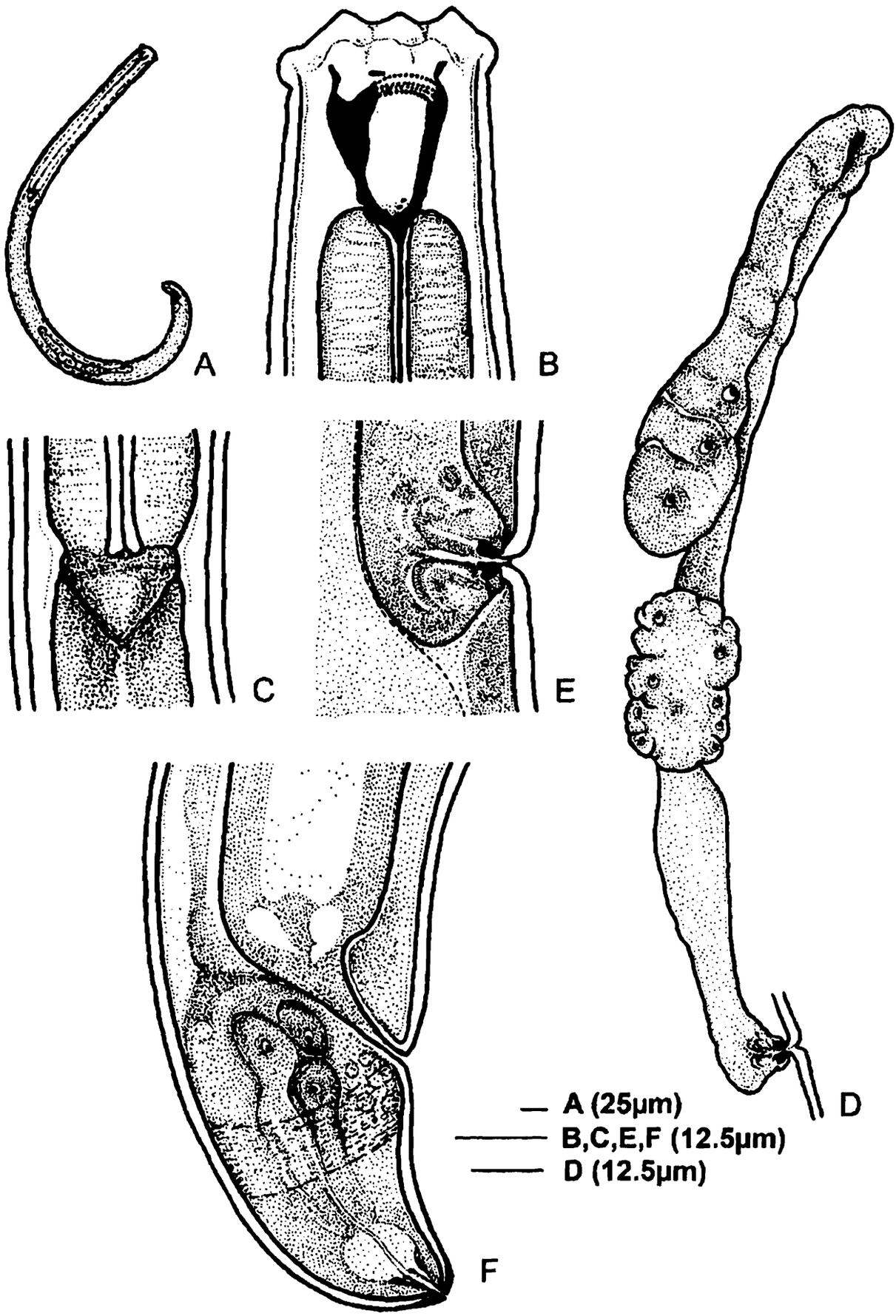

Figure 29. Camera lucida drawings of female *Mylonchulus istvani* (After, Jana *et al.*, 2010). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

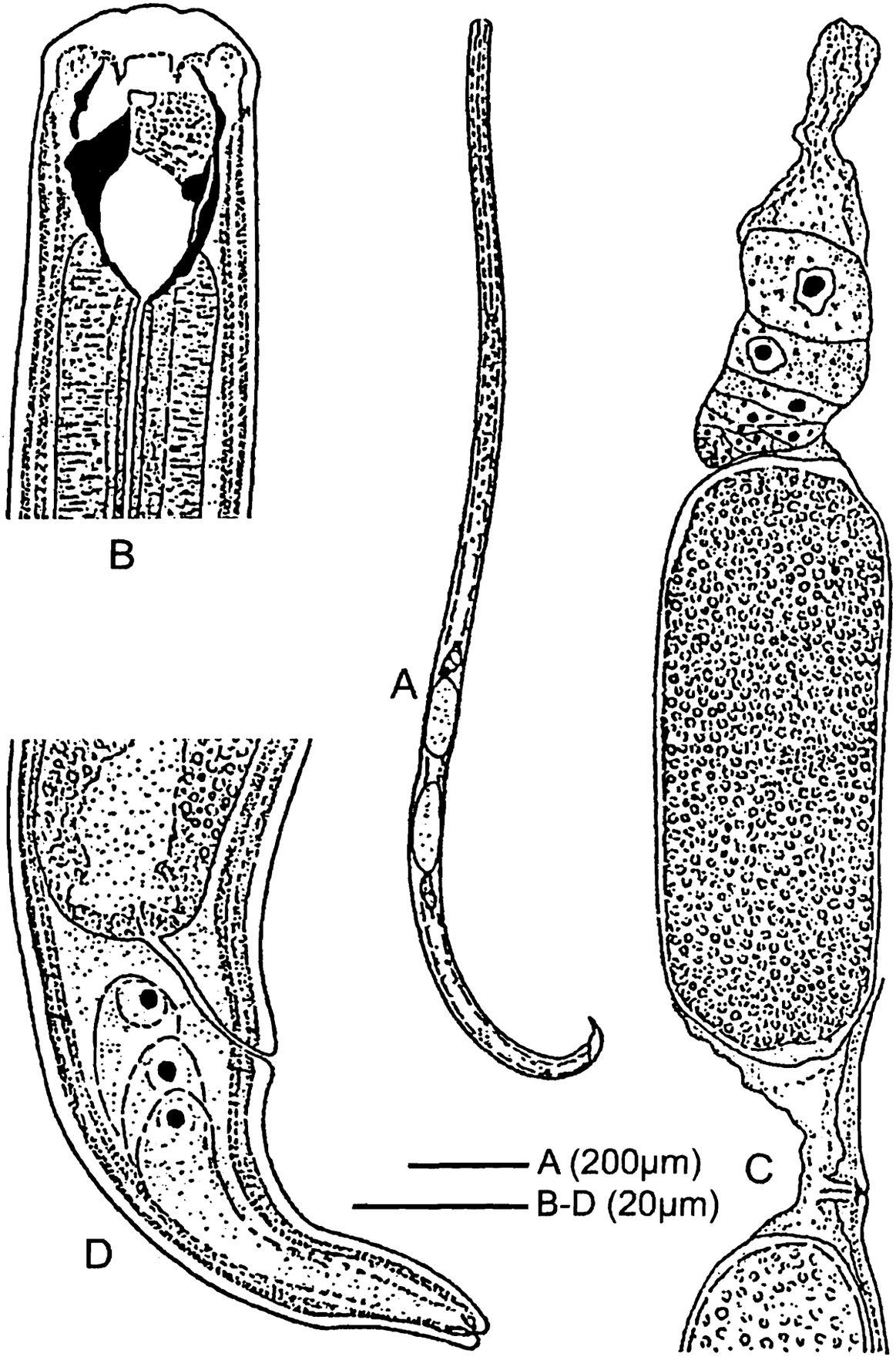

Figure 30. Female *Mylonchulus sagarensis* (After, Sinha, Baqri & Choudhury, 1989) A. Whole body; B. Head region; C. Gonad; D. Tail.

width with cuticularised pieces at vulva-vagina junction. Uterus of each sexual branch consists of an egg. Tail ventrally arcuate, gradually bents in its posterior half, 56 µm or about 2 anal body diameter long with three tandem glands, spinneret terminal.

Male : Not found.

Remarks : The above species is recorded only from southern part of West Bengal, India.

29. ***Mylonchulus brachyuris*** (Bütchli, 1873) Altherr, 1953
(Figure : 31)

Locality and associated plants : Soil around roots of banana plant (*Musa* sp.) from Darjeeling district.

Measurements : ♀♀ L=0.9-1.4 mm; a=20-35; b=3.1-4; c=25-40; c'=1.2-1.5; V%=55-64.

Description : Female : Body ventrally arcuate upon fixation, tapering slightly towards extremities. Cuticle smooth, lateral chords 1/2 to 1/3rd body width wide near middle. Length of buccal cavity about twice the width of it. Dorsal tooth covers more or less 75% of the buccal cavity length. Transverse rows of denticles 6 in number; submedian teeth present. Rectum one anal body width long. Gonad amphidelphic. Sphincter not present at oviduct-uterus junction. Tail conoid with blunt terminus, caudal glands grouped, spinneret subterminal.

Male : Not found.

Remarks : The above species is recorded only from Darjeeling district, West Bengal, India (Baqri & Khera, 1977; Baqri & Dey, 1991).

30. ***Mylonchulus brevicaudatus*** (Cobb, 1917) Altherr, 1954
(Figure : 32)

Locality and associated plants : Soil around the roots of tea from Lebong, district Darjeeling.

Measurements : ♀♀ L=1.4-1.7mm; a=24-30; b=2.9-3.2; c=41-58; c'=0.8-1; V%=63-69.

Description : Female : Body ventrally arcuate upon fixation. Cuticle smooth. Buccal cavity large with thick, prominently striated walls. Dorsal tooth massive, submedian teeth small, inconspicuous, amphid narrow and conspicuous; 6-7 transverse rows of denticles present. Gonad amphidelphic. Tail 0.8-1.0 anal diameter long; caudal glands three, oval shaped and grouped; spinneret opening subterminal.

Male : Not found.

Remarks : The above species is recorded only from district Darjeeling, West Bengal, India (Baqri & Khera, 1977).

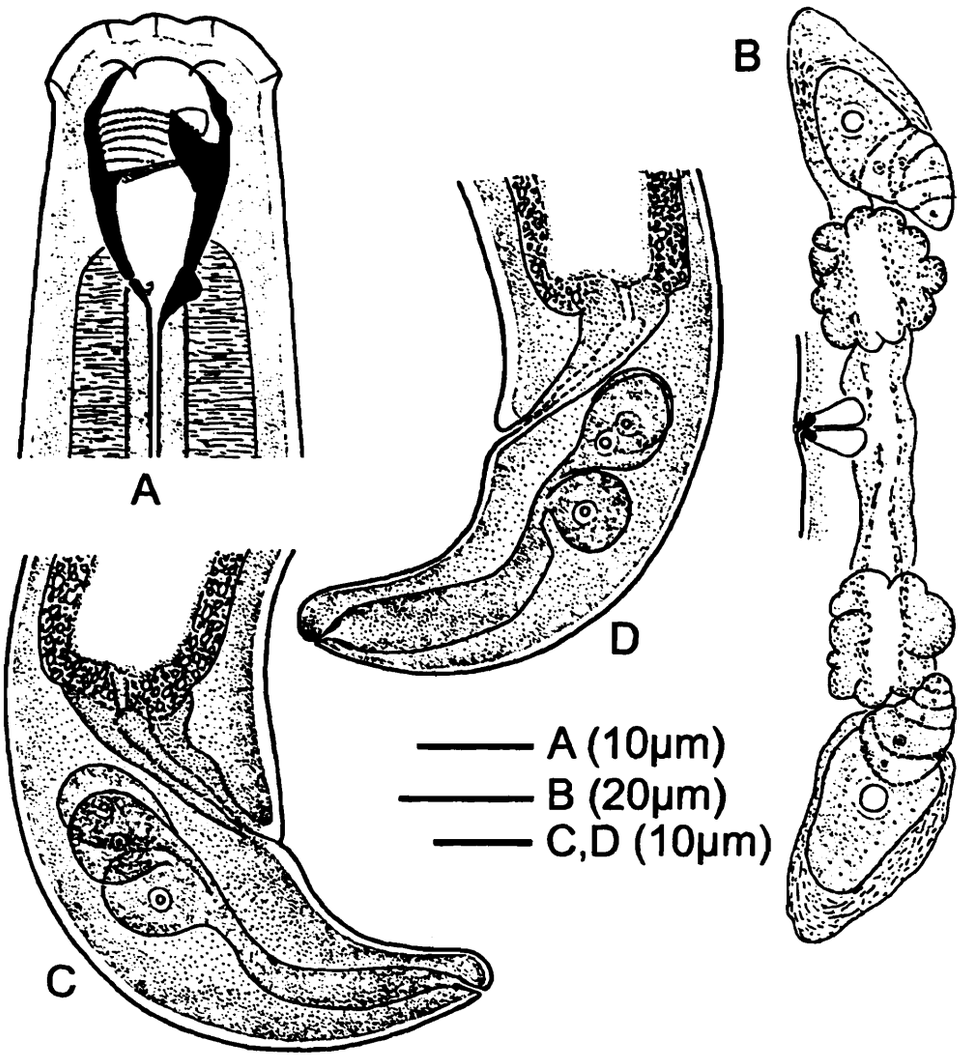

Figure 31. Female *Mylonchulus brachyuris* (After, Jairajpuri, 1970). A. Head; B. Gonad; C., D. Tail.

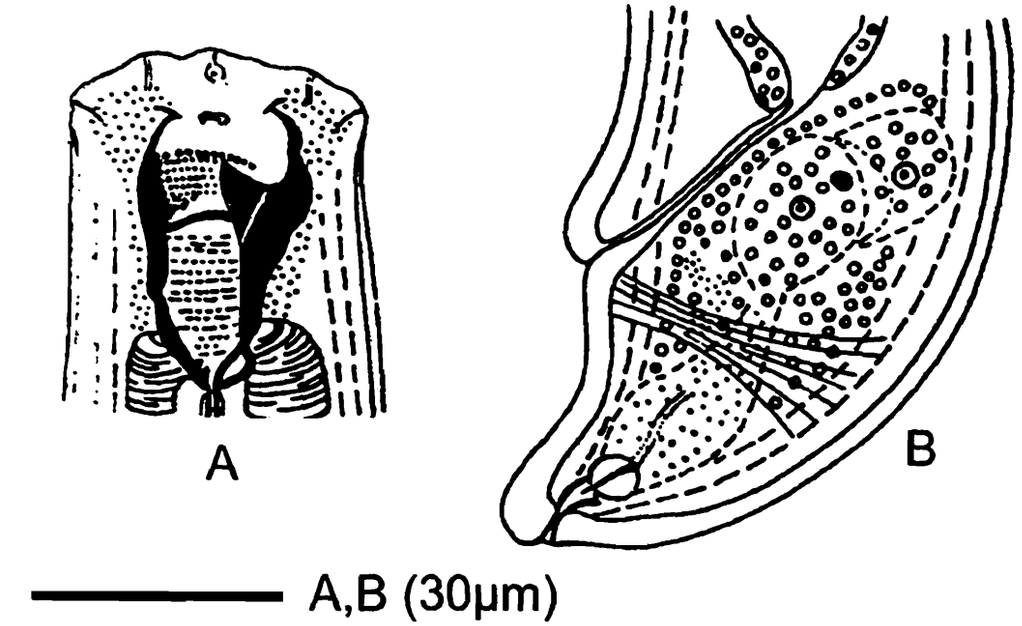

Figure 32. Female *Mylonchulus brevicaudatus* (After, Mulvey, 1961). A. Head; B.Tail.

31. *Sporonchulus vagabundus* Jairajpuri, 1971
(Figures : 33, 62)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.15-1.24mm; a=25.36; b=4.33-4.8; c=20.54-23.2; c'=2-2.5; V%=55-62.5; G_1=8.01-9.7; G_2=7.8-9.12; buccal cavity=30X18 µm; ABD=23.23-26.33 µm; tail length=54.05-58.35 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth, moderately thick (1.65-3.62 µm). Lateral chord about 2/5th of the total body width. Amphid small, aperture oval. Length of the buccal cavity about twice of its width and bears a medium dorsal tooth opposed by 2-4 irregularly arranged denticles. Pharynx long (253.8-320.22 µm), slender, muscular, measures 1/4th of total body length; pharyngeal glands obscure in few specimens; pharyngo-intestinal junction non-tuberculate. Excretory pore situated behind the nerve ring. Cardia simple. Gonad didelphic-amphidelphic; ovary long reflexed, reaches oviduct-uterus junction, sphincter absent in oviduct-uterus junction, uterus small, *pars dilatata prominent*; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* distinct. Tail length approximates one anal diameter. Rectum less than one anal diameter in length. Three caudal glands and terminal spinneret present.

Male : Not found.

Remarks : The above species as well as the genus *Sporonchulus* is reported for the first time from West Bengal. The measurements of above species fit well with the measurements given by Jairajpuri and Khan (1982) and Andrássy (1993). In India, *Sporonchulus vagabundus* was reported from Saharanpur and Uttar Pradesh. Apart from India, it was reported earlier from St. Lucia (Andrássy, 1993).

32. *Mononchus aquaticus* Coetzee, 1968
(Figures : 34, 63)

Locality, associated plants and date of collections : Table 2.

Measurements : ♀♀ L=1.22-1.3 mm; a=36.22-38.55; b=4.08-4.66; c=12.71-13.1; c'=4.09-4.21; V%=53.05-55.14; G_1=15.2-16.65; G_2=12.89-14.41; buccal cavity=31.85-32.66X11.55-11.98 µm; tail length=96-99.35 µm.

Description : Female : Body medium in size, ventrally curved upon fixation. Cuticle smooth and thin (1.2 µm) allover the body. Lateral chord about 1/3rd of the total body width. Amphid small with oval aperture (2.4-2.6 µm wide). Length of the buccal cavity about thrice of its width and bears a medium-sized dorsal tooth situated at above 80% of the buccal cavity length. Pharynx long (278.69-299.3 µm), slender, muscular, its length about ¼th of the body length; pharyngeal glands inconspicuous in few specimens; pharyngo-intestinal junction nontuberculate. Excretory pore situated behind the nerve ring. Cardia simple. Gonad didelphic-amphidelphic; ovary long reflexed, sphincter absent in oviduct-uterus junction; *pars proximalis vaginae, pars refringens vaginae* and *pars distalis vaginae* distinct. Rectum length less than

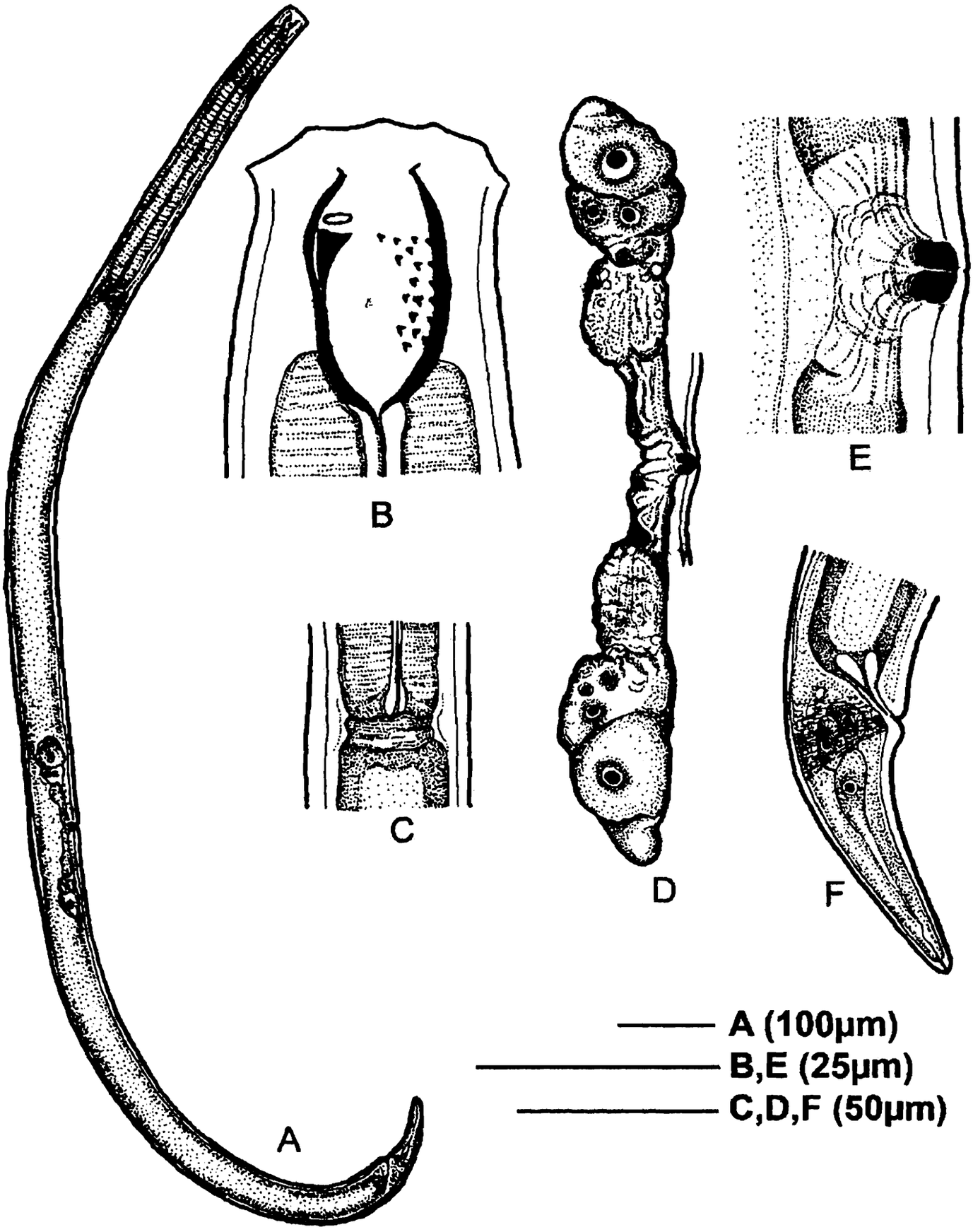

Figure 33. Camera lucida drawings of female *Sporonchulus vagabundus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

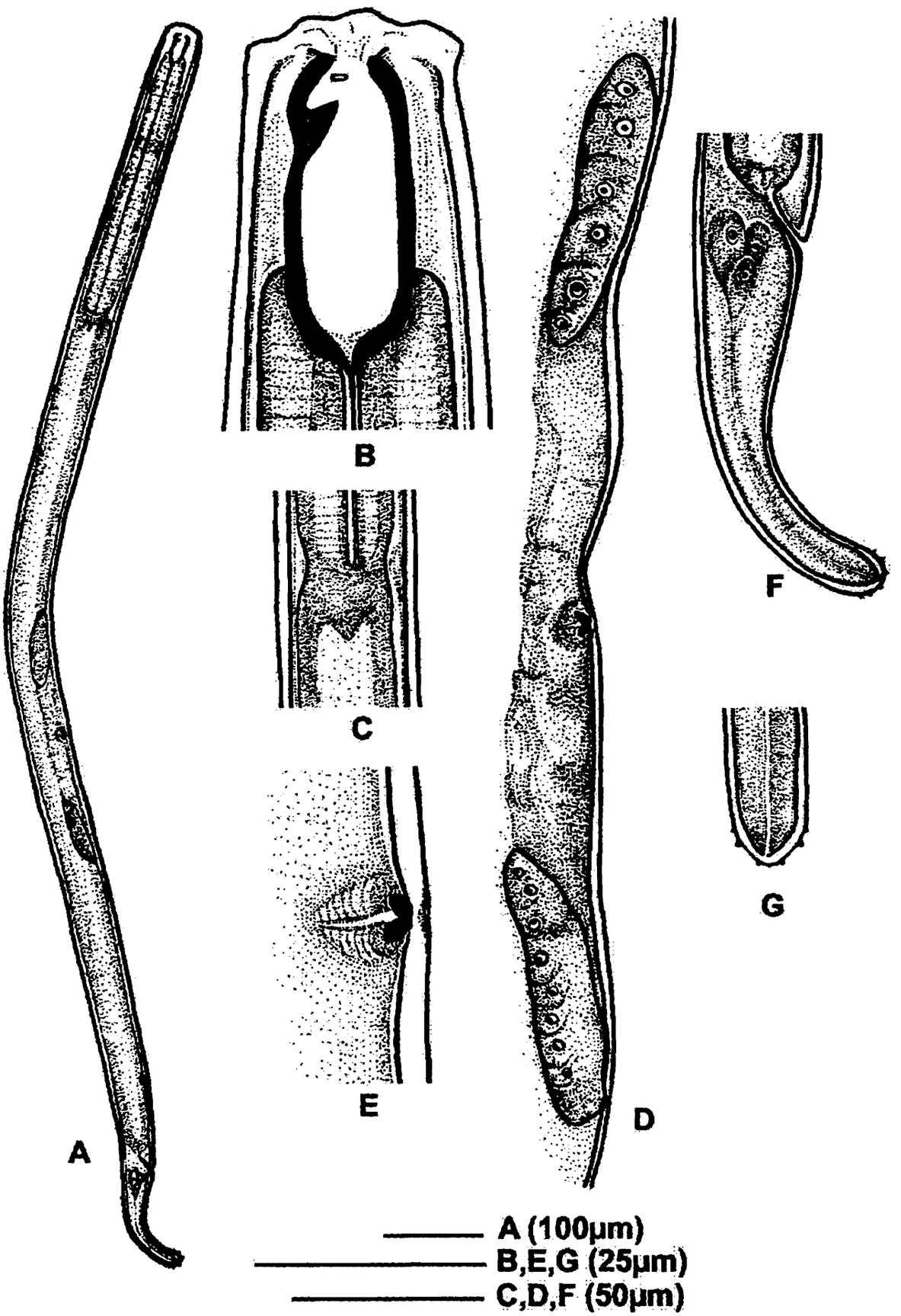

Figure 34. Camera lucida drawings of female *Mononchus aquaticus* (After, Jana *et al.*, 2009). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail; G. Tail terminus.

anal diameter. Tail elongated, clavate at tail end. Three caudal glands and spinneret opening terminal, distinct caudal papillae at the tail terminus.

Male : Not found.

Remarks : The above species as well as the genus *Mononchus* was reported for the first time from West Bengal (Jana, 2009). The measurements of above species fit well with the measurements given by Jairajpuri and Khan (1982) and Andrássy (1993) except shorter tail length, thus the value of 'c' and 'c" differs. This type of differences is possibly due to their intra-specific variation. In India, *Mononchus aquaticus* was reported from Saharanpur, Uttar Pradesh, Kasganj, Etah, Pilibhit, Aligarh, Bareilly, Izatnagar, Chandigarh, Srinagar, Jammu and Kashmir. It was reported earlier, excluding India, from Hungary, Great Britain, Italy, Russia, Kirghizia, Nigeria, South Africa, Mauritius, Mexico and St. Lucia.

33. ***Clarkus papillatus*** (Bastian, 1865) Jairajpuri, 1970
(Figures : 35)

Locality and associated plants : Soil around the roots of banana plant from the district Darjeeling.

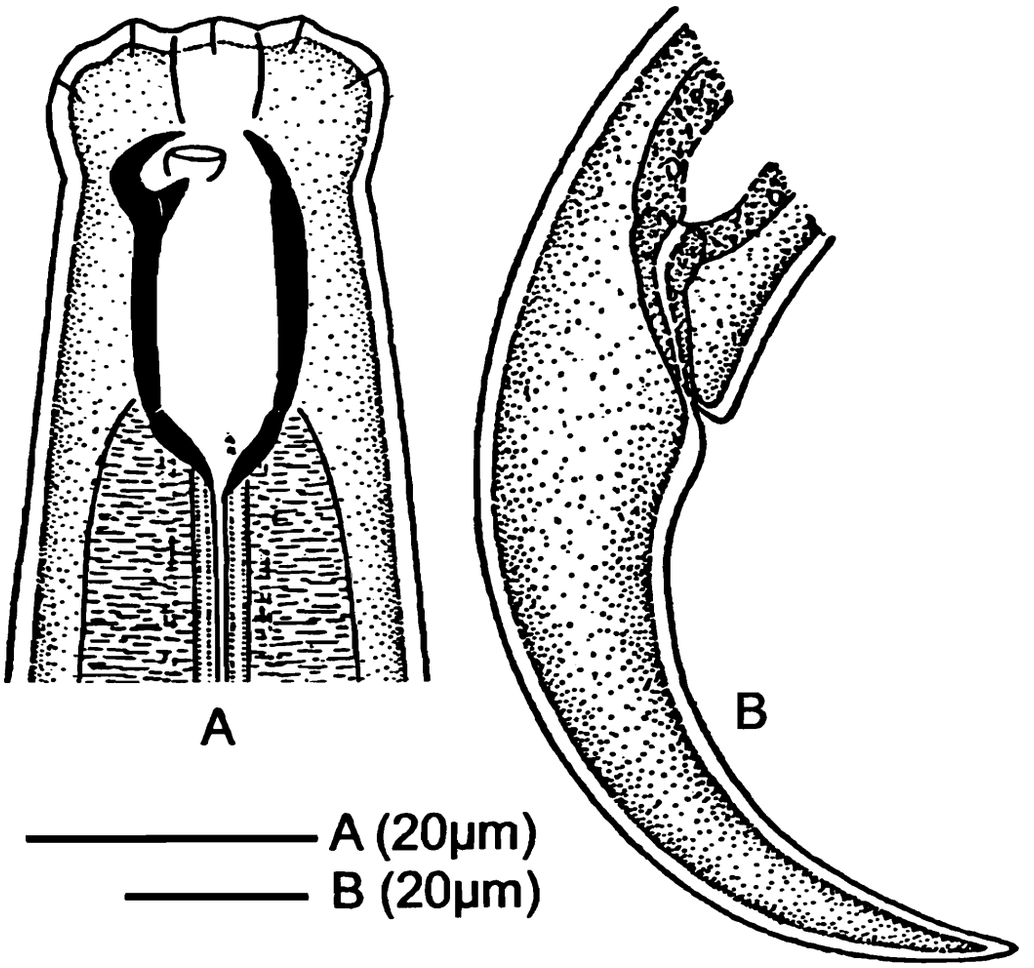

Figure 35. Female *Clarkus papillatus* (After, Jairajpuri & Khan, 1982).
A. Head; B. Tail.

Measurements : ♀♀ L=0.7-1.4 mm; a=17-29; b=3.1-4; c=12-19; c'=2-3; V%=58-68.

Description : Female : Body ventrally curved upon fixation. Lip region angular. Length of buccal cavity about twice its width, walls straight. Dorsal tooth medium in size, situated in anterior half of buccal cavity and its apex cover more than 80% of its length from base. Subventral walls with non-denticulate ridge. Gonad amphidelphic. Sphincter absent in oviduct-uterus junction. Tail conoid, ventrally curved, its length 2-4 anal body diameter; caudal glands and terminal opening absent.

Male : Not found.

Remarks : The above species is recorded only from district Darjeeling, West Bengal, India (Baqri & Khera, 1977).

34. ***Prionchulus muscorum*** (Dujardin, 1845) Wu & Hoeppli, 1929
(Figures : 36)

Locality and associated plants : Soil around the roots of banana plant from the district Darjeeling.

Measurements : ♀♀ L=1.8-2.6 mm; a=25-33; b=3.3-4.4; c=10-18; c'=3-5; V%=58-67.

Description : Female : Body ventrally curved upon fixation. Lip region rounded, slightly offset by a depression. Buccal cavity cylindrical. Dorsal tooth medium in size.

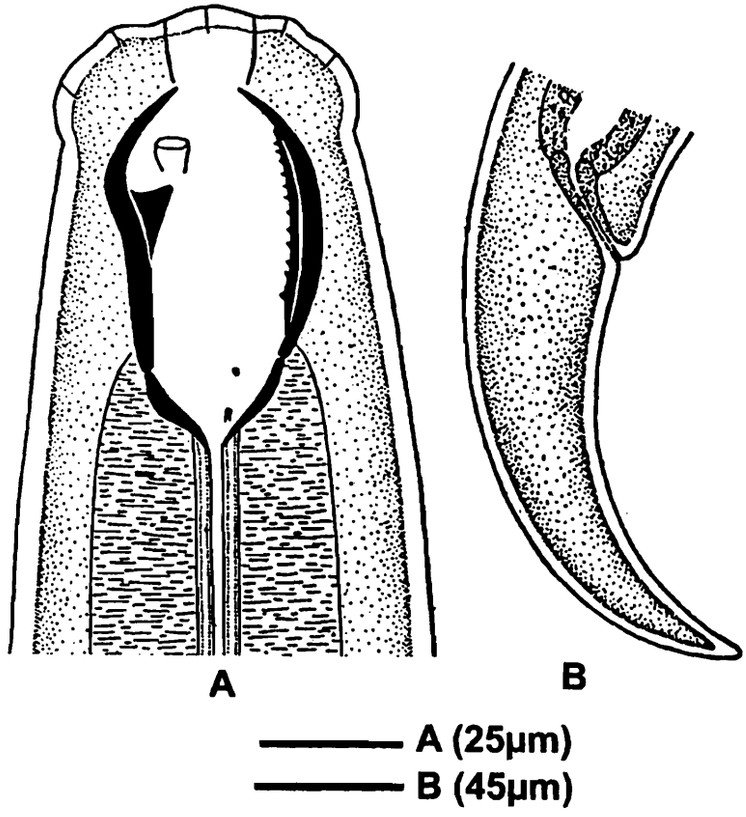

Figure 36. Female *Prionchulus muscorum* (After, Jairajpuri & Khan, 1982).
A. Head; B. Tail;

Subventral denticles 10-14 in number. Cuticular pore small, numerous arranged along the body. Gonad amphidelphic, sphincter absent in oviduct-uterus junction. Tail conoid, ventrally curved, its length 2-4 anal body diameter; caudal glands and terminal opening absent.

Male : Not found.

Remarks : The above species is recorded only from district Darjeeling, West Bengal, India (Baqri & Khera, 1977).

35. *Mononchulus* sp.

Locality and associated plants : Soil around the roots of paddy from Tufangung, district Cooch Behar.

Measurements : ♀♀ L=1.01 mm; a=25; b=4; c=10; V%=61.

Female : Single juvenile found (Baqri & Khera, 1977).

Male : Not found.

Remarks : The general description is not mentioned here as the species was not mentioned.

DISCUSSION

The order Mononchida, an exclusive predatory group, stands at the top of the soil food pyramid. Therefore, their availability in the soil will be fewer in number. In the present observation, 27 mononchid species are reported from district South 24-Parganas among which five were already reported earlier along with other eight mononchid species from different parts of West Bengal.

During the current observation for 21 species only females were reported. Five species with both females and males, and a lone species with only males were found. Males are more scarce compared to females. Reproductive rate of a species occupying the top of the food pyramid always reflects its minimum number, which is also true in case of mononchs. On other hand, the difficulties associated with approximation of the opposite sex, often are encountered by the lower group of organisms particularly like that of mononchs where the population is minimum in soil and their movement is also much restricted (like all other nematodes). It may be assumed that, to overcome this vital difficulty for survivality, the females undergo parthenogenetic mode of reproduction; possible reason for the non-availability of the male in many cases. Though in insects parthenogenesis is very common (Seiler & Schaeffer, 1938, 1940; Suomalainen, 1940; White, 1945).

The genus *Mylonchulus* is widely distributed throughout the world. Concomitantly, in South 24-Parganas the genus *Mylonchulus* is prevalent, may be due to their advanced morphological characters. Practically, the dorsal tooth in *Mylonchulus* is so much developed like a dagger, that even a single tooth may be considered sufficient to provide predatory efficiency to this genus. Hard sclerotization

makes the buccal cavity significantly powerful in the members of this genus. They also have 2 - 3 types of buccal teeth, viz. single dorsal tooth, 2 sub-ventral or sub-median teeth (absent in few cases) along with 2 - 15 transverse rows of denticles. Such type of buccal cavity is highly efficient to capture and grind the prey.

Few species under *Mylonchulus* bear monodelphic but mostly with didelphic gonad, which further, augment their reproductive success. Such type of vigorous reproductive ability consequently transcripted into relatively higher growth of population, the raw material upon which the selective, rather, adaptive radiation do act, and ultimately through the process of isolation, produces more number of species.

All the species under the genus *Mylonchulus* have shorter tails which provide additional benefit to them during movement through the soil compared to those with longer tails.

So, all these highly manifested characteristics in *Mylonchulus* like (i) powerful food capturing and grinding mechanism, (ii) efficient gonad and (iii) shorter tail put them at relatively advantageous stage, in comparison to most other genera of mononchs and then through the age-long process of natural selection might have produced a good number of species under the genus. More simply this may be explained, that the process of manifestation (i.e. evolution) has always tried to put them, at different degree of perfection and that is the root-cause of so much variation which ultimately produced so many species under the genus.

In the male specimens of *Parahadronchus shakili,* collected from district South 24-Parganas, the number of sub-ventral teeth varies from 0–5, on both the sub-ventral walls of buccal cavity. This fact simply reflects the existence of intra-specific variation within this species and the specimens are definitely not of different species (Figure 17). Previously, Jairajpuri *et al.* (1975) and Ahmad and Jairajpuri (1982) reported this species with some abnormalities - presence of sub-ventral teeth on sub-ventral wall of buccal cavity, from Bareilly, Uttar Pradesh.

Single specimen under the species *Iotonchus cuticaudatus* consist two gonads at the either of the sides of two vulvae along antero-posterior axis. The intermidiate portion between two vulvae is the zone of amalgamation. This type of double vulva or bivulvarity may occur due to some anomaly during the early phase of cell division in zygote (i.e. during early stages of embryonic development, like blastula etc.).

But, this should be mentioned that in the present scope of work, though the gut content were not analyzed in detail, during the taxonomic study, the apparent presence of other nematodes (including other mononchs) were observed (Figures 64. A-D) in a good number of cases [Small (1987) included six ways to determine the preys of predators, 'without dissection', that is also one of the ways mentioned by him]. At least, in two of these cases, the remnants of undigested highly sclerotized buccal cavity of other mononchs have been clearly observed near the anal region of the gut (Figures 64. A, C). All these are indicative of the presence of an efficient alimentary system.

Table 1. Prey and prey remnants in the intestine of few mononch species (Fig. 64. A-D, 26.D)

Mononch species	Prey or prey remnants in intestine	Comments
Iotonchus parabasidontus	Sclerotized buccal cavity of *Iotonchus* sp. (Figure 64 A)	Cannibalism found, the whole body was digested, only highly sclerotized buccal cavity remained
	Whole body of *Mylonchulus* sp. (Figure 64 B)	Highly active predator, can engulf the entire body of other predatory nematode genera
	Whole body of tylenchid species (Figure 64.B)	May regulate the plant parasitic nematodes, thus, used as bio-controlling agent
Miconchus sp. (juvenile)	Sclerotized buccal cavity of *Miconchus* sp. (Figure 64 C)	Cannibalism found, the whole body was digested, except, highly sclerotized buccal cavity
Miconchus aquaticus	Two unidentified nematodes (Figure 64 D)	Can engulf the whole body of other nematodes, so efficient predator
Miconchus bulbicaudatus	Three unidentified nematodes (Figure 48 D)	Active predators, can engulf whole body of other nemas

II. ECOLOGY

Diversity and community analysis of mononchid population of the district South 24-Parganas

During the survey period from 2004-2007 in South 24-Parganas, 594 soil samples were collected from various fields spread throughout 29 blocks of the district, of which only 228 (38.38%) soil samples contained mononchids. Total 27 mononchid species under 8 different genera were collected from this survey area.

Studies on diversity of mononchids of this district reveals that the genus *Mylonchulus* dominates over the whole mononchid population with 13 species, followed by *Iotonchus* with 6 species, *Miconchus* with 3 species, *Mulveyellus, Parahadronchus, Nullonchus, Sporonchulus* and *Mononchus* each with single species. The species collected during the survey were - *Mylonchus mulveyi, M. contractus, M. sigmaturus, M. dentatus, M. lacustris, M. hawaiiensis, M. minor, M. goutami, M. sigmaturellus, M. istvani, M. incurvus, M. amurus, M. wasimi, Iotonchus trichurus, I. parabasidontus, I. cuticaudatus, I. indicus, I. rotundicaudatus, I. qaiseri, Miconchus bulbicaudatus, M. rectangularis, M. aquaticus, Mulveyellus jairi, Parahadronchus shakili, Nullonchus rafiqi, Sporonchulus vagabundus,* and *Mononchus aquaticus.*

Most of the soil samples contained 2 or 3 genera consisting of 3-4 species. However, in a particular soil sample highest recorded genera were 5 with 6 species and least recorded single genus with lone species. The species *Mylonchulus mulveyi* (N=135,

AF= 22.73%, RF= 29.27%) was most prevalent followed by *M. contractus* (N= 79, AF= 13.30%, RF= 17.13%), *Iotonchus trichurus* (N= 63, AF= 10.61%, RF= 13.66%), *I. parabasidontus* (N= 55, AF= 9.26%, RF= 11.93%), *Miconchus aquaticus* (N= 24, AF= 4.04%, RF= 5.20%), *Sporonchulus vagabundus* and *Mulveyellus jairi* (N= 12, AF= 2.02%, RF= 2.60% in each species), *Mylonchulus sigmaturus* and *I. cuticaudatus* (N= 11, AF= 1.85%, RF= 2.38%), *Mylonchulus dentatus* and *Parahadronchus shakili* (N= 10, AF= 1.68%, RF= 2.16%), *Mylonchulus lacustris* (N= 8, AF= 1.35%, RF= 1.73%), *M. hawaiiensis* (N= 6, AF= 1.01%, RF= 1.74%), *M. minor* and *M. goutami* (N= 3, AF= 0.51, RF= 0.66% in each species), *M. istvani, M. incurvus, M. amurus, M. wasimi, I. indicus* and *Mononchus aquaticus* (N= 2, AF= 0.34%, RF= 0.44% in each species). The least frequency was recorded in *I. rotundicaudatus, I. qaiseri, Miconchus bulbicaudatus, M. rectangularis* and *Nullonchus rafiqi* (N= 1, AF= 0.34%, RF= 0.44%) [Fig. 66 A-C].

The highest density (D) was recorded in *Mylonchulus mulveyi* (D= 0.485), followed by *I. parabasidontus* (D= 0.222), *M. contractus* (D= 0.209), *I. trichurus* (D= 0.125), *Parahadronchus shakili* (D= 0.103), *Miconchus aquaticus* (D= 0.098), *Mulveyellus jairi* (D= 0.084), *Sporonchulus vagabundus* (D= 0.066), *Mylonchulus dentatus* (D= 0.050), *M. sigmaturus* (D= 0.047), *I. cuticaudatus* (D= 0.035), *Mylonchulus lacustris* (D= 0.034), *M. hawaiiensis* (D= 0.030), *M. wasimi* and *M. minor* (D= 0.014 in each species), *M. amurus* (D= 0.012), *M. goutami* and *M. sigmaturellus* (D= 0.01 in each species), *Nullonchus rafiqi* (D= 0.008), *M. istvani, M. incurvus, Iotonchus indicus, I. qaiseri, Miconchus bulbicaudatus* (D= 0.007), *M. rectangularis* and *Mononchus aquaticus* (D= 0.005) and the lowest density recorded in *I. rotundicaudatus* (D= 0.003) [Fig. 66 D].

Based on these, the prominance value (PV) of the above-mentioned species were calculated. The highest PV was found for *Mylonchulus mulveyi* (PV= 2.312), followed by *Mylonchulus contractus* (PV= 0.762), *I. parabasidontus* (PV= 0.676), *I. trichurus* (PV= 0.407), *Miconchus aquaticus* (PV= 0.197), *Parahadronchus shakili* (PV= 0.134), *Mulveyellus jairi* (PV= 0.119), *Sporonchulus vagabundus* (PV= 0.094), *Mylonchulus dentatus* (PV= 0.065), *M. sigmaturus* (PV= 0.064), *I. cuticaudatus* (PV= 0.048), *M. lacustris* (PV= 0.04), *M. hawaiiensis* (PV= 0.03), *M. minor* (PV= 0.01), *M. wasimi* (PV= 0.008), *M. amurus* and *M. goutami* (PV= 0.007 in each species), *M. sigmaturellus* (PV= 0.006), *M. istvani, M. incurvus* and *I. indicus* (PV= 0.004 in each species), *I. qaiseri, Miconchus bulbicaudatus, Nullonchus rafiqi* and *Mononchus aquaticus* (PV= 0.003 in each species), *Miconchus rectangularis* (PV= 0.002) and the least recorded PV= 0.001 in *I. rotundicaudatus* [Fig. 66 E].

The highest total biomass was recorded in *Iotonchus parabasidontus* (TG= 2178.634 µg, G= 16.505 µg), followed by *Parahadronchus shakili* (TG= 938.008 µg, G= 15.377 µg), *Miconchus aquaticus* (TG= 457.484 µg, G= 7.888 µg), *I. cuticaudatus* (TG= 356.007 µg, G= 16.953 µg), *Mylonchulus mulveyi* (TG= 284.989µg, G= 0.990µg), *I. trichurus* (TG= 235.665 µg, G= 3.185 µg), *M. contractus* (TG= 235.397µg, G= 1.898 µg), *Mulveyellus jairi* (TG= 165.367µg, G= 3.307 µg), *Mylonchulus dentatus* (TG= 83.297 µg, G= 2.777 µg), *M. lacustris* (TG= 66.002 µg, G= 3.3 µg), *M. hawaiiensis*

(TG= 63.588 µg, G= 3.533 µg), *Sporonchulus vagabundus* (TG= 62.931 µg, G= 62.375 µg), *Nullonchus rafiqi* (TG= 62.931 µg, G= 1.61 µg), *M. sigmaturus* (TG= 51.635 µg, G= 1.844 µg), *M. wasimi* (TG= 33.3 µg, G= 4.163 µg), *M. minor* (TG= 29.679 µg, G= 3.710 µg), *M. sigmaturellus* (TG= 19.792 µg, G= 3.299 µg), *M. amurus* (TG= 16.809 µg, G= 2.401 µg), *Miconchus bulbicaudatus* (TG= 16.310 µg, G= 4.078µg), *M. rectangularis* (TG= 16.059 µg, G= 5.353 µg), *I. indicus* (TG= 14.130 µg, G= 3.533 µg), *I. qaiseri* (TG= 13.727 µg, G= 3.432 µg), *I. rotundicaudatus* (TG= 12.664 µg, G= 6.332 µg), *Mylonchulus goutami* (TG= 5.794 µg, G= 0.966 µg), *M. incurvus* (TG= 3.11 µg, G= 0.778 µg), *Mononchus aquaticus* (TG= 2.788 µg, G= 0.929 µg) and the least total biomass was recorded in *Mylonchulus istvani* (TG= 0.351 µg, G= 1.403 µg) [Fig. 66 F,G].

Total 909 female and 102 male ($1/10^{th}$ of total specimens) specimens of monochids were collected during the survey. The most number of female was found in *Mylonchulus mulveyi* counts 288, followed by *M. contractus* - 123, *I. trichurus* - 74, *Parahadronchus shakili* - 61, *Miconchus aquaticus* - 58, *Mulveyellus jairi* - 50, *Sporonchulus vagabundus* - 39, *Mylonchulus dentatus* - 30, *I. cuticaudatus* - 21, *M. lacustris* - 20, *M. hawaiiensis* - 18. Few specimens were found in *M. minor* - 8, *M. wasimi* - 8, *M. amurus* - 7, *M. sigmaturellus* - 6, *M. goutami* - 6. Very minimum specimens were found in *Nullonchus rafiqi* - 5, *I. qaiseri*, *Miconchus bulbicaudatus*, *Mylonchulus incurvus* and *Mylonchulus istvani* - 4 each, *Mononchus aquaticus* - 3, *Miconchus rectangularis*- 3 and the least number of specimens found in *Iotonchus rotundicaudatus* - 2. No female was found in *Iotonchus rotundicaudatus*. Males were comparatively rare as evidenced by the collected data. Highest number of male was found in *I. parabasidontus*, counting - 52 followed by *Miconchus aquaticus* - 23, *Parahadronchus shakili* - 16, *I. cuticaudatus* - 8 and *I. rotundicaudatus* - 2. Single specimen was found in *Mylonchulus contractus*. Male representatives of the rest of the species were not found in the sample soil.

SOIL TYPE

Soil of South 24-Parganas is primarily clayey and loamy. Soils of the two fields of Shalipur and Balarampur were also found clayey having the ratio of sand : silt : clay of 5 : 6 : 39 and 11 : 13 : 76 (Figure 67). Electrical conductivity of the soil samples from Shalipur guava orchard and Balarampur guava orchard ranged from 0.18 - 0.9 m.mhos and 0.11 - 0.93 m.mhos and the pH showed a range from 5.0 - 6.3 and 5.2 - 6.8 respectively.

Population fluctuation and regression lines of mononchids, dorylaimids and tylenchids in two guava orchards of Shalipur and Balarampur

A detailed study of population fluctuation of mononchid popúlation along with dorylaimid and tylenchid population (genera) in two guava orchards was performed. In Shalipur guava orchard total 10 genera were found, consisting of 4 mononchids (*Iotonchus, Mylonchulus, Parahadronchus* and *Miconchus*), 4 dorylaimids (*Aporcelaimellus, Aporcelaimus, Dorylaimus* and *Laevides*) and 2 tylenchids

Table 2. Mononchid diversity and distribution in twenty nine blocks in five subdivisions of district South 24-Parganas

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
1	Alipore (Sadar)	Bishnupur-I	28	12	6	*Mylonchulus contractus*	03.05.04 10.05.04 13.09.05 22.08.05	Ma, L, G, J, C, Gr
					2	*M. incurvus*	10.05.04	J
					7	*M. mulveyi*	10.05.04 13.09.05	Ma, L, G, J, C, Gr, A
					3	*M. lacustris*	22.08.05	G, J, Ka
					4	*Iotonchus trichurus*	03.05.04 13.09.05	Ma, L, G, J, C, Gr, Co
					7	*I. parabasidontus*	22.08.05	Ma, L, G, J, C, Gr
		Bishnupur-II	28	11	14	*Mylonchulus contractus*	17.05.04 31.05.04 05.09.05 12.09.05	Ma, L, G, J, C,Gr, A
					3	*M. hawaiiensis*	31.05.04 12.09.05	J, C, Gr, A, L
					2	*M. lacustris*	05.09.05	G, Ma
					1	*M. dentatus*	17.05.04	Co
					6	*Iotonchus trichurus*	17.05.04 05.09.05	Ma, L, Gr

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					5	*I. parabasidontus*	12.09.05	G, Ma
					4	*Parahadronchus shakili*	17.05.04 05.09.05	Ma, L, G
					3	*Miconchus aquaticus*	12.09.05	Ma, L, G
		Budge Budge-I	23	12	8	*Mylonchulus mulveyi*	07.06.04 19.09.05 26.09.05	Ma, L, G, J, C, A,Co
					7	*Iotonchus parabasidontus*	14.06.04 19.09.05	C, Gr, A, Co
					6	*I. cuticaudatus*	26.09.05 21.05.07	C, Gr, A, Co
		Budge Budge-II	20	9	8	*Mylonchulus contractus*	28.06.04 05.07.04 03.10.05 10.10.05	Ma, L, G, J, Gr, C, A, Co
					6	*M. mulveyi*	05.07.04 03.10.05 10.10.05	G, J, Gr, C, A, Co
					3	*Iotonchus parabasidontus*	03.10.05 10.10.05	Co
		Maheshtala	16	6	1	*I. indicus*	12.07.04 24.10.05	L

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					2	*I. cuticaudatus*	26.07.04 17.10.05	Ma, L, G, J
					3	*Sporonchulus vagabundus*	24.10.05	G, Po, Ka
					2	*Mononchus aquaticus*	24.10.05	Po
2.	Baruipur	Baruipur	34	18	7	*Mylonchulus contractus*	19.07.04 02.08.04 07.11.05 18.07.05 12.02.07	B, P, G, Po, J, Ma, L
					3	*M. dentatus*	19.07.04 12.02.07	J, Ma, L
					1	*Nullonchus rafiqi*	19.07.04	G
					8	*Mylonchulus mulveyi*	19.07.04 07.11.05 18.07.05 12.02.07	B, P, G, Po, J, Ma, L
					3	*M. lacustris*	07.02.07 12.02.07	J, Ma, L, B, P, G
					3	*M. hawaiiensis*	18.07.05	J, L, Ma
					2	*M. istvani*	27.07.04	G

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					2	*M. wasimi*	19.07.04 12.02.07	G
					2	*M. minor*	18.07.05 12.02.07	J, L, Ma, G, C
					3	*M. sigmaturus*	02.08.04 18.07.05	L, G
					6	*Iotonchus trichurus*	19.07.04 07.11.05 18.07.05	J, Ma, L, G
					8	*I. parabasidontus*	19.07.04 02.08.04 18.07.05	J, Ma, L, G, Ka
					3	*I. cuticaudatus*	19.07.04 18.07.05	B, P, G
					4	*Mulveyellus jairi*	02.08.04 07.11.05	B, R G, P
					3	*Sporonchulus vagabundus*	07.11.05 18.07.05 12.02.07	Br, P, G, Ka
		Bhagore-I	19	8	1	*Mylonchulus mulveyi*	09.08.04 16.08.04 28.11.05	B, P, G, Po, J, Ma,

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
							05.12.05 16.04.07	
					4	*Mulveyellus jairi*	16.08.04 28.11.05	Co, Ka
					5	*Sporonchulus vagabundus*	28.11.05 16.04.07	G, Co
					6	*Iotonchus trichurus*	09.08.04 05.12.05 16.04.07	G, Co
		Bhagore-II	21	8	4	*Mulveyellus jairi*	23.08.04 30.08.04	P, G
					3	*Sporonchulus vagabundus*	30.08.04 12.12.05	P, G
					6	*Parahadronchus shakili*	19.12.05	P, G, J, Ma
					7	*Mylonchulus contractus*	09.04.07	B, P, G, Po, J, Ma
					6	*M. mulveyi*	19.12.05 09.04.07	B, P, G, Po, J, Ma
					2	*M. sigmaturus*	30.08.04	G, Co
		Joynagar-I	30	12	6	*Iotonchus trichurus*	06.09.04 15.08.05 09.01.06	J, Ma

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					1	*I. rotundicaudatus*	15.08.05	L
					3	*I. parabasidontus*	06.09.04 02.01.06	B, P, G, Ka
					2	*Mylonchulus dentatus*	26.02.06 14.04.07	J, Ma
					7	*M. mulveyi*	06.09.04 15.08.05 09.01.06 14.04.07	B, P, G, Po, J, Ma,
					8	*M. contractus*	06.09.04 15.08.05 09.01.06 14.04.07	B, P, G, Po, J, Ma,
					2	*M. sigmaturellus*	15.08.05 14.04.07	Ma
		Joynagar-II	27	13	2	*Mylonchulus dentatus*	20.09.04	L
					8	*M. mulveyi*	27.09.04 16.01.06 05.03.07	J, Ma, L, Co
					4	*M. sigmaturus*	30.01.06	B, P, G
		Kultali	21	7	5	*M. mulveyi*	04.10.04 11.10.04	J, Ma, L

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
							13.02.06 23.04.07	
					6	*M. contractus*	04.10.04 06.02.06 13.02.06 23.04.07	B, P, G
					2	*M. sigmaturus*	06.02.06	L, Ka
		Sonarpur	23	9	2	*M. mulveyi*	18.10.04	L
					6	*Miconchus aquaticus*	25.10.04 06.03.06 26.03.07	Ma, G, Bb
					9	*Mylonchulus mulveyi*	25.10.04 06.03.06	G, P, C, Ma
					2	*M. dentatus*	25.10.04 06.03.06	R
					7	*M. contractus*	18.10.04 06.03.06 26.03.07	G, R, Co, P, B, Ma
					1	*Miconchus rectangularis*	20.02.06	L
3.	Diamond Harbour	D. Harbour-I	28	11	6	*Iotonchus trichurus*	01.11.04	J
					6	*Iotonchus parabasidontus*	20.03.06 19.02.07	Ma

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					3	*Miconchus aquaticus*	19.02.07	L
					8	*Mylonchulus mulveyi*	08.11.04 13.03.06	P, G, L, B
		D. Harbour-II	28	10	4	*Iotonchus trichurus*	15.11.04 02.04.07	L, R
					2	*Miconchus aquaticus*	22.11.04 03.04.06	L, R
					6	*Mylonchulus mulveyi*	15.11.04 10.04.06 02.04.07	G, L, R
		Falta	24	8	4	*Iotonchus trichurus*	06.12.04 13.12.04 17.04.06	G, L, R
					3	*Miconchus aquaticus*	13.12.04 17.04.06	L, R
					6	*Mylonchulus mulveyi*	01.05.06 30.04.07	L, R
		Kulpi	16	7	3	*Sporonchulus vagabundus*	20.12.04 03.01.05 08.05.06 15.05.06	L, R
					6	*Iotonchus parabasidontus*	03.01.05 08.05.06 15.05.06	P, G, L, B

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
		Mograhat-I	18	6	4	*Iotonchus trichurus*	10.01.05 22.05.06	P, G, L, B
					3	*Miconchus aquaticus*	17.01.05 05.06.06 07.05.07	G, L, B
					4	*Mylonchulus mulveyi*	17.01.05 05.06.06 07.05.07	G, L,
		Mograhat-II	12	4	4	*Iotonchus trichurus*	24.01.05 07.02.05 19.06.06 14.05.07	G, L, P
					1	*Miconchus bulbicaudatus*	07.02.06	Ma
					3	*Mylonchulus mulveyi*	24.01.05 07.02.05 12.06.06	Po, L, Bb
		Mandirbazar	15	5	1	*Miconchus aquaticus*	14.02.05	L
					2	*Mylonchulus mulveyi*	21.02.05 03.07.06	P, L, Ka

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					3	*M. contractus*	21.02.05 03.07.06 10.07.06	P, G, L
		Mathurapur-I	17	6	3	*Iotonchus trichurus*	07.03.05 14.08.06 21.08.06	G, L
					2	*Miconchus aquaticus*	14.03.05 14.08.06	G
					2	*Iotonchus qaiseri*	07.09.05	Co
		Mathurapur-II	13	5	4	*Mylonchulus mulveyi*	21.03.05 28.03.05 04.09.06 11.09.06	G, L, Co, Ka
					5	*Iotonchus parabasidontus*	28.03.05 04.09.06 11.09.06	G, L, Co
4.	Kakdwip	Kakdwip	14	6	6	*Mylonchulus mulveyi*	04.04.05 11.04.05 18.09.06 02.10.06	C, G
		Namkhana	12	5	3	*Iotonchus trichurus*	18.04.05 25.04.05 16.10.06	G, L

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					1	*Miconchus aquaticus*	09.10.06 16.10.06	P
					5	*Mylonchulus mulveyi*	18.04.05 25.04.05 16.10.06	P, G, L, Co
		Patharpratima	13	3	3	*Mylonchulus mulveyi*	02.05.05 09.05.05 30.10.06 06.11.06	G, L
		Sagore	14	4	2	*Iotonchus trichurus*	16.05.05	B, P, G
					4	*Mylonchulus mulveyi*	23.05.05 13.11.06 20.11.06	Po, J, Ma, L
5.	Canning	Basanti	15	3	1	*Iotonchus trichurus*	06.06.05 13.06.05 04.12.06 11.12.06	Gr
					2	*Mylonchulus contractus*	13.06.05 04.12.06	C, G
					3	*M. mulveyi*	13.06.05 04.12.06	B, P
					1	*M. minor*	04.12.06 11.12.06	Po

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
		Canning-I	24	8	2	*Iotonchus trichurus*	20.06.05 18.12.06 01.01.07 12.03.07	G, L
					3	*I. parabasidontus*	04.07.05 01.01.07	G, L
					1	*I. qaiseri*	01.09.06	Co
					4	*Mylonchulus contractus*	20.06.05 18.12.06 01.01.07 12.03.07	B, P, G, L
					5	*M. mulveyi*	20.06.05 18.12.06 01.01.07	B, P, G, L
					1	*M. goutami*	04.05.05	M
		Canning-II	25	7	2	*Iotonchus trichurus*	11.07.05 18.07.05 15.01.07 19.03.07	G, L
					1	*I. indicus*	08.01.07	Gr
					3	*Mylonchulus contractus*	18.07.05 15.01.07 19.03.07	G

Sl. No.	Sub-divisions	Blocks under Sub-division	No. of soil samples collected	No. of soi samples consist mononchid	No. of soil samples consist particular species	Species found	Date of collection	Associated plants
					5	*M. mulveyi*	18.07.05 15.01.07 19.03.07	B, P, G, L
		Gosaba	16	5	2	*Iotonchus parabasidontus*	01.08.05	G, Co
					4	*Mylonchulus mulveyi*	08.08.05 05.01.07	B, P, G, L
					4	*M. contractus*	29.01.07 05.01.07	B, P, R, G

Abbreviations used : **G**- Guava (*Psidium guajava* L.), **L**- Litchi (*Litchi chinensis* Sonn.), **R**- Rose (*Rosa sinensis* L.), **P**- Paddy (*Oryza sativa* L.), **C**- China rose (*Hibiscus rosa sinensis* L.), **Gr**- Grass (*Cymbopogon citrates* L.), **Ma**- Mango (*Mangifera indica* L.), **Co**- Coconut (*Cocos nucifera* L.), **Po**- Potato (*Solanum tuberosum* L.), **A**- Arecanut (*Areca catechu* L.), **J**- Jack fruit (*Artocarpus heterophyllus* L.), **Bb**- Black berry (*Rubus* spp.), **Pi**- Pinaple (*Ananas comosus* L.), **Pa**- Papaya (*Carica papaya* L.), **Le**- Lemon (*Citrus limon* L.), **Pu**- Pumpkin (*Cucurbita maxima* L.), **T**- Tomato (*Lycopersicon esculentum* L.), **Ba**- Banana (*Musa paradiciaca* L.), **Ka**- Karamcha (*Ribes* sp.), **B**- Brinjal (*Solanum melongena* L.), **Ca**- Carambola (*Averrhoa carambola* L.), **S**- Sunflower (*Helianthus annuus* L.), **Bm**- Bamboo (*Bambusa* sp.)

(*Helicotylenchus* and *Hoplolaimus*). In Balarampur guava orchard 9 genera were found, which include 4 mononchids (*Iotonchus, Mylonchulus, Parahadronchus* and *Sporonchulus*), 4 dorylaimids (*Aporcelaimellus, Discolaimus, Dorylaimus* and *Paratrichodorus*) and 1 tylenchid (*Helicotylenchus*) genera.

In Shalipur guava orchard the mononchid population increased during May through October and the population decreased during February through April, dorylaimid population increased during period of May-September and decreased during December-April and the tylenchid population increased during May-August and decreased during October-April. So, highest number of nematodes during three years 2004-2007 (mean number- 3168.6, 3134 and 2629.4) were found in the month of July and the least (mean number- 304.4, 315.1 and 307.9) were in April. Nematodes were available maximum in monsoon season than pre-monsoon or post-monsoon period (Fig. 68 A).

In Balarampur guava orchard, fewer numbers of nematodes per unit volume of soil were found compared to Shalipur Guava orchard throughout the three consecutive years. The mononchid population increased during July-August and the population decreased during February-April. To state groupwise, dorylaimid population increased during June-August and decreased during December-May. Tylenchid population was very low in this field, their number increased during June-August and decreased during February-May. Here, too, the most number of nematodes during three years 2004-2007 (mean number- 824.8, 827.2 and 827) were found in the month of July and the least (mean number- 161.2, 164.7 and 168) were observed in April. Nematodes were available maximum in monsoon season than pre-monsoon or post-monsoon period (Fig. 68 B).

Table 3. Mean population (adults & juveniles) data of dorylaimids, tylenchids, mononchids and other nematodes in guava orchards of Shalipur and Balarampur in the district South 24-Parganas.

Year	Months	Shalipur Guava Orchard					Balarampur Guava Orchard				
		Dorylaimids	Tylenchids	Mononchids	Others	Total	Dorylaimids	Tylenchids	Mononchids	Others	Total
2004	April	120.2	125	30.4	28.8	304.4	56.7	22.1	48.5	33.9	161.2
	May	516.8	383.5	70.2	29.9	1000.4	58.1	23.3	69.5	34.8	185.7
	June	579.2	600.8	73.4	53.5	1306.9	210.5	68.1	94.3	39.9	412.8
	July	1767.6	1193.6	115.8	91.6	3168.6	352.6	142.4	208.4	121.4	824.8
	Aug.	896.4	630.5	74.6	55.9	1657.4	147.2	69	112.7	48.9	377.8
	Sept.	447.3	312.5	68.8	27.2	855.8	83.7	42	62.8	38.7	227.2
	Oct.	429	272.3	83.1	36.9	821.3	166	30.8	124.5	110.8	432.1
	Nov.	335.5	243.4	79.4	29.7	688	171.8	57.5	80.1	62.4	371.8
	Dec.	232.9	230.2	51.3	23.3	537.7	94.4	34.2	68.8	32.7	230.1

Year	Months	Shalipur Guava Orchard					Balarampur Guava Orchard				
		Dorylaimids	Tylenchids	Mononchids	Others	Total	Dorylaimids	Tylenchids	Mononchids	Others	Total
2005	Jan.	355.2	269.1	44	30.1	698.4	86.4	63.7	63	29.4	242.5
	Feb.	266.1	184.8	39.3	30.2	520.4	65.3	35.6	48	26.2	175.1
	Mar.	199.5	207	36.6	29	472.1	60.9	26.6	48.5	24.7	160.7
	April	118.9	132.6	30.7	32.9	315.1	57.4	25.9	46.9	34.5	164.7
	May	546.1	339.9	48.6	29.7	964.3	69.9	26.5	76	29.1	201.5
	June	543.4	820.6	78.5	52.2	1494.7	205.2	69.2	98	32.7	405.1
	July	1871.9	1042.6	101.6	117.9	3134	344.4	155.9	215.7	111.2	827.2
	Aug.	717.2	539.3	66.9	42.8	1366.2	149.2	72.7	108.4	40.7	371
	Sept.	464.1	263.1	46.9	28.2	802.3	84.2	35	74.1	43.1	236.4
	Oct.	421.9	202.8	65	40.5	730.2	165.9	28.7	129.9	121.6	446.1
	Nov.	396.8	286.1	64.9	26.1	773.9	161.2	51.2	81.5	59.2	353.1
	Dec.	231.1	183.5	53.5	28.5	496.6	93.3	26.4	72.9	31.3	223.9
2006	Jan.	419.8	279.4	49.3	35.6	784.1	80.6	67.7	72.4	34.1	254.8
	Feb.	235.8	215.9	45.4	31.5	528.6	62.6	31	52.7	21.8	168.1
	Mar.	168.9	186.8	39.3	31.8	426.8	61	26	45.9	22.4	155.3
	April	134.4	124.6	26.2	22.7	307.9	57.8	25.7	46.1	38.4	168
	May	532.3	180.4	55.6	34.7	803	70.1	22.9	83.8	32.6	209.4
	June	549.8	454.2	72.2	37.4	1113.6	186.7	80.5	87.7	35.8	390.7
	July	1710.1	709.1	92.1	118.1	2629.4	358.3	139	222.5	107.2	827
	Aug.	689.3	355.5	70	32.6	1147.4	144.8	70.2	95.7	46.6	357.3
	Sept.	472.8	277.6	51	32.6	834	80.8	35.1	86.6	36.3	238.8
	Oct.	361.1	161.8	68.6	47.7	639.2	162	28.9	132.1	113.2	436.2
	Nov.	365.5	203.2	67.7	31.2	667.6	149.6	37.9	94.1	58.6	340.2
	Dec.	238.3	168.7	52.4	30.6	490	96.4	41.7	77.8	35.9	251.8
2007	Jan.	407.6	215.6	41.8	28.2	693.2	88.2	69.7	66.5	28.9	253.3
	Feb.	230	164.1	34.1	31.3	459.5	60.8	27.1	53.3	25.1	166.3
	Mar.	209.9	170.2	37.4	29	446.5	65.6	21.3	49.6	22.9	159.4

Table 4. Correlation coefficient (r) of mononchid population with dorylaimid and tylenchid population in two guava orchards

	Site (guava orchards)	Dorylaimid population	Tylenchid population
Mononchid population	Shalipur	+0.796	+0.404
	Balarampur	+0.934	+0.814

Table 5. Mean population size (month-wise) of each mononch genus in Shalipur guava orchard and mean value of corresponding abiotic factors (**Mononchid Genera : Io** - *Iotonchus*, **My** - *Mylonchulus*, **Pa** *Parahadronchus*, **Mi** - *Miconchus*), (**Soil abiotic factors : EC** - Electrical Conductivity [m.mhos], **N** - Nitrogen [ppm], **P** Phosphorus [ppm], **K** -Potassium [ppm], **pH**, **OC** Organic Carbon [%], **Temp.** - Temperature [°C], Moist. - Moisture [%])

Yrs.	Month	Mononchid genera				Soil abiotic factors							
		Io	My	Pa	Mi	EC	N	P	K	pH	OC	Temp	Moist
2	April	8.1	8.2	10.2	3.9	0.9	70.59	14.7	278.6	5.3	0.28	34	12.8
0	May	25.5	22.9	17.5	4.3	0.89	113.72	7.2	169.3	5	0.52	35.5	13.4
0	June	23.4	30.8	14.3	4.9	0.72	165	8.79	195.6	5.2	0.66	31.2	24.2
4	July	37.1	44.3	25.5	8.9	0.29	186.12	9.07	211.7	6.1	0.77	29.6	30.23
	Aug.	28.4	28.3	12.4	5.5	0.45	173.27	8.55	195.15	5.5	0.68	30.3	27
	Sept.	18.7	26.4	18.8	4.9	0.33	149.31	6.9	116.58	5.4	0.58	31	23
	Oct.	24.8	30.4	21.3	6.6	0.21	170.81	11.2	167.25	6	0.67	30	21.5
	Nov.	16.8	37.8	18.3	6.5	0.28	164	10.95	184.96	5.2	0.61	24	29.6
	Dec.	16.7	22	9.1	3.5	0.68	123.2	14.78	288.9	5.1	0.51	22.4	12
2	Jan.	13.8	14.9	11.4	3.9	0.59	119.11	15.11	298.2	5.4	0.48	19.2	16
0	Feb.	11.2	13.4	10.2	4.5	0.69	102.03	15.79	288.65	5.4	0.44	24.2	14.4
0	Mar.	11	12.7	9	3.9	0.78	94.33	15.89	265.3	5.1	0.36	30	12
5	April	9.1	8	11	2.6	0.9	90.52	13.25	210	5.2	0.3	35	11.1
	May	15.5	15.8	12.2	5.1	0.86	120.78	6.7	118.54	5.2	0.48	35	12
	June	23.5	27.9	20.5	6.6	0.79	160.3	11.78	154.47	5.2	0.65	32.2	24
	July	29.5	41.7	22.6	7.8	0.3	193.43	8.87	194.52	6.3	0.76	29	30
	Aug.	20.3	25.3	16.3	5	0.38	180.5	9.37	175.25	5.7	0.67	30.5	22.4
	Sept.	16.3	16.2	10	4.4	0.26	150.2	8.22	198.6	5.6	0.59	30	26
	Oct.	22.9	14.4	21	6.7	0.18	191.21	8.23	199	6.2	0.7	30	24.2
	Nov.	19.8	25.1	15.3	4.7	0.24	181.18	9.13	160	5.2	0.66	23	29
	Dec.	18.1	15.9	15.6	3.9	0.42	164.18	10.01	177.4	5.2	0.62	22.2	11.2
2	Jan.	14.8	14.5	15.8	4.2	0.68	148.73	8.27	146.58	5.3	0.58	19	13.3
0	Feb.	14.5	11.7	15.8	3.4	0.63	123.23	5.9	197.46	5.4	0.49	23	13
0	Mar.	10.8	11.6	12.8	4.1	0.72	111.22	7.3	201.7	5	0.44	29	11
6	April	7.5	7.5	8.8	2.4	0.79	85.65	12.55	180.25	5.1	0.29	33.5	11.5

Yrs.	Month	Mononchid genera				Soil abiotic factors							
		Io	My	Pa	Mi	EC	N	P	K	pH	OC	Temp	Moist
	May	16.2	15.8	16.1	7.5	0.82	106.74	11.35	125.66	5.3	0.55	35.3	13
	June	20.1	23.2	20.9	8	0.56	154.35	10.25	145.65	5.1	0.58	31	23.8
	July	26.7	30.6	25.3	9.5	0.29	170.25	8.8	185.45	6	0.7	29.4	30.21
	Aug.	23.8	25.1	15.9	5.2	0.44	155.35	8.4	170.5	5.4	0.62	30.6	25.33
	Sept.	17.4	17.8	10.9	4.9	0.35	144.25	10.4	185.45	5.5	0.55	31.25	26.2
	Oct.	20.1	20	22.7	5.8	0.2	168.58	7.5	168.54	5.9	0.73	31.3	23.22
	Nov.	21.2	28.1	14.2	4.2	0.3	174.58	11.22	190.25	5	0.62	23.5	28.2
	Dec.	16.7	18	12	5.7	0.53	155.44	13.4	200.54	5.1	0.59	22.1	11
2	Jan.	15.1	10.5	11.6	4.6	0.66	120.55	11.55	220.8	5.4	0.45	19	14.2
0	Feb.	12.2	8.4	9.9	3.6	0.67	98.65	7.8	231.54	5.3	0.5	23.5	13.6
0 7	Mar.	11.8	10.7	9.2	5.7	0.7	125.35	12.5	234.77	5.2	0.43	28.7	11.3

Table 6. Mean population size (month-wise) of each mononch genus in Balarampur guava orchard and mean values of corresponding abiotic factors (**Genera**: Mononchids: **Io** - *Iotonchus*, **My** *Mylonchulus*, **Pa** *Parahadronchus*, **Sp** *Sporonchulus*), (**Soil abiotic factors**: **EC** - Electrical Conductivity [m.mhos], **N** - Nitrogen [ppm], **P** –Phosphorus [ppm], **K** - Potassium [ppm], **pH**, **OC** - Organic Carbon [%], **Temp.** –Temperature [°C], **Moist.** - Moisture [%])

Yrs.	Mon.	Mononchid genera				Soil abiotic factors							
		My	Pa	Io	Sp	EC	N	P	K	pH	OC	Temp.	Moist.
2	April	20	8.5	14.1	5.9	0.88	77.89	11.45	254	5.8	0.29	36	13.3
0	May	29.7	11.9	21.1	6.8	0.91	138.77	8.9	160.53	6	0.51	36.5	15
0	June	41.1	16.8	29.7	6.7	0.61	150.34	9.2	198.2	6.2	0.6	32	22.2
4	July	107.4	37.9	52.4	10.7	0.21	190.17	7 7	130.2	6.4	0.68	31.2	29.9
	Aug.	50.5	19.1	35.8	7.3	0.34	161.28	8.8	195	6	0.6	30.2	26.2
	Sept.	29.1	9.6	17	7.1	0.24	159.22	8.3	211.3	6 1	0.59	33	23
	Oct.	73.7	8.5	33.9	8.4	0.15	175.11	8.9	147	6.3	0.62	31.2	30
	Nov.	38.1	16.3	19.7	6	0.23	162.63	8.7	255	6	0.59	25	12.6
	Dec.	35.3	11.6	14.1	7.8	0.15	127.27	7.9	288.9	6.2	0.52	24	9.6
2	Jan.	27.7	10.8	17.9	6.6	0.11	93.76	15.7	321.78	6	0.44	20.6	10.2
0	Feb.	19.6	8.6	14.6	5.2	0.28	82.33	14	288.65	6	0.32	29.5	8
0	Mar.	24.8	10.1	10.8	2.8	0.72	81.25	14.3	321.78	6.1	0.3	34.5	9.6
5	April	18.9	7.8	13.7	6.5	0.79	63.48	14.5	260.78	5.9	0.26	35.5	14.1
	May	37.4	12.3	19.7	6.6	0.93	123.56	9.3	117.5	5.9	0.42	37.5	14
	June	38.9	20.2	32.9	6	0.57	148.71	10.2	152.36	6.1	0.56	36.2	17
	July	110.8	29.3	62.8	12.8	0.21	187.55	7.8	123.36	6.4	0.63	34.1	26.8

Yrs.	Mon.	Mononchid genera				Soil abiotic factors							
		My	Pa	Io	Sp	EC	N	P	K	pH	OC	Temp.	Moist.
	Aug.	44.7	15.9	41.2	6.6	0.23	173.1	9.2	98.36	6.2	0.61	32.2	26
	Sept.	41.7	9.9	16.4	6.1	0.21	131.53	10.3	68.12	6.2	0.53	31.2	27
	Oct.	68.4	9.9	42.7	8.9	0.17	193.21	6.9	143.2	6.8	0.66	30	30.2
	Nov.	38.8	14.8	20.5	7.4	0.21	165.79	8.2	153.54	6.3	0.61	25	13.1
	Dec.	36.4	12	17.9	6.6	0.14	145.31	9.3	174.6	6	0.56	23.2	11
2	Jan.	37.8	10.5	17	7 1	0.12	125.72	11.3	146.58	5.9	0.49	20.5	11
	Feb.	24	9.1	14.7	4.9	0.24	83.81	16.2	115.99	6	0.41	29	9
o	Mar.	21.7	10.5	10.7	3	0.67	75.02	13.8	298.59	6.1	0.38	33.5	10.1
	April	19.6	8.4	12.1	6	0.56	85.65	16.3	112.3	5.7	0.33	34.2	12.8
o	May	42.8	11.5	21.4	8.1	0.78	120.35	13.25	145.3	5.2	0.45	36.2	14.5
	June	39.3	17.5	24.6	6.3	0.6	145.65	11.35	133	5.9	0.51	34.5	18.3
6	July	108.6	34.7	66	13.2	0.24	177.65	10.5	125.35	6.1	0.6	33.5	28.6
	Aug.	28.8	14.9	45.4	6.6	0.25	155.21	12.35	110.54	6	0.59	31.6	25.9
	Sept.	51.9	9.7	18.2	6.8	0.23	160.2	10.25	123.55	6	0.55	33.5	26.5
	Oct.	71.3	9.9	42.5	8.4	0.16	173.25	9.65	130.25	6.2	0.61	30.62	31.5
	Nov.	55.2	14.4	16.7	7.8	0.3	162.5	10.25	122.35	5.9	0.62	25.6	14
	Dec.	36.9	12.9	21.2	6.8	0.15	120.5	11.24	120.5	5.9	0.55	22.7	11.4
2	Jan.	34.6	10.2	15.5	6.2	0.1	100	15.3	135.44	5.7	0.46	20	12.3
o	Feb.	22.9	9.4	16.1	4.9	0.2	113.75	14.5	188.65	5.9	0.47	27.6	10.2
7	Mar.	22.7	10.3	14	2.6	0.41	98.64	13.89	200.55	6	0.38	31	10

Table 7. Correlation coefficient (r) of mononchid genera with different soil parameters. '+' and '–' indicates significant positive and significant negative correlation respectively ($P < 0.05$), Non-significant values are shown in black bold faces. (**Genera:** Io - *Iotonchus,* My - *Mylonchulus,* Pa - *Parahadronchus,* Mi - *Miconchus,* Sp *Sporonchulus*), (**Soil abiotic factors:** N - Nitrogen, P - Phosphorus, K - Potassium, EC - Electrical Conductivity, pH Hydrogen ion concentration, OC - Organic Carbon, Temp. Temperature, Moist. Moisture) (**Site- Guava orchards:** Shalipur- S; Balarampur- B)

Order	Genus	Site (guava orchards)	N	P	K	EC	pH	OC	Temp.	Moist.
MONONCHIDA	Io	S	+0.80	-0.43	**-0.33**	-0.60	+0.60	+0.87	**+0.13**	+0.73
		B	+0.74	-0.50	-0.43	**-0.27**	+0.48	+0.66	**+0.21**	+0.80
	My	S	+0.58	**-0.25**	**-0.28**	-0.56	+0.43	+0.80	**+0.06**	+0.80
		B	+0.76	-0.60	-0.43	-0.35	+0.48	+0.68	**+0.09**	+0.73
	Pa	S	+0.69	-0.46	-0.49	-0.55	+0.63	+0.80	**+0.33**	+0.62
		B	+0.57	-0.42	**-0.26**	**-0.14**	**+0.30**	+0.53	**+0.13**	+0.45
	Mi	S	+0.60	**-0.20**	**-0.33**	-0.45	+0.60	+0.70	**+0.20**	+0.60
	Sp	B	+0.70	-0.56	-0.42	**+0.09**	**+0.30**	+0.63	**+0.03**	+0.63

Correlation coefficient (r) and linear regression of nematode genara with soil abiotic factors in two guava orchards at Shalipur and Balarampur in South 24-Parganas

Under Mononchida, the genera *Iotonchus, Mylonchulus* and *Parahadronchus* were found common in both the guava orchards at Shalipur and Balarampur. Apart from these common genera, Shalipur guava orchard contained another genus *Miconchus* and Balarampur guava orchard contained *Sporonchulus* in addition.

In Shalipur guava orchard, temperature, phosphorus and potassium had negligible effect on mononchid nematodes as the value of 'r' varied between (+) 0.06 to (+) 0.33, (-) 0.20 to (-) 0.46 and (-) 0.28 to (-) 0.49. But significant positive correlation was found between soil moisture and mononchid nematodes as 'r' value varied between (+) 0.60 to (+) 0.80. Nitrogen had positive correlation as 'r' value ranged between (+) 0.58 to (+) 0.80. Organic carbon and pH of soil were also found positively correlated with mononchids as the value of 'r' varies between (+) 0.70 to (+) 0.87 and (+) 0.43 to (+) 0.63, respectively. Electrical conductivity significant had negative effect on mononchs ['r' value ranges from (-) 0.45 to (-) 0.60].

Similar relations were also found in Balarampur guava orchard. Temperature, phosphorus and potassium of soil had insignificant (at a significance level of $P \leq 0.05$) effect on mononch population as the value of 'r' varied between (+) 0.03 to (+) 0.21, (-) 0.42 to (-) 0.60 and (-) 0.26 to (-) 0.43, respectively for these three factors. However, significant positive correlation was observed between moisture and mononchids as 'r' value varied between (+) 0.45 to (+) 0.8. Nitrogen had positive

correlation with mononchids as 'r' value ranged between (+) 0.57 to (+) 0.76. Organic carbon and pH also positively correlated with those nematodes as the value of 'r' varied in between (+) 0.53 to (+) 0.68 and (+) 0.30 to (+) 0.48. Electrical conductivity had little but negative effect on nematodes as 'r' value ranges from (-) 0.14 to (+) 0.09.

Correlation coefficient (r) of mononchid population with that of tylenchid (plant-parasitic) and dorylaimid populations in two guava orchards are positive. The 'r' values in both the cases ranges between (+) 0.404 to (+) 0.934. The values between mononchids with tylenchids and dorylaimids in Shalipur guava orchard are (+) 0.404 and (+) 0.796, where as mononchids with tylenchids and dorylaimids in Balarampur guava orchard are (+) 0.814 and (+) 0.934. So, both the tylenchid and dorylaimid populations directly proportional to that of mononch population in two orchards. Though the result showing positive correlation between mononch population with tylenchid and dorylaimid population, it is hardly can conclude that this findings is due to the prey-predator relationship, because in the natural habitat other various biotic and abiotic factors affecting always.

It was also observed that whenever the potassium level was increased i.e. in the month of February every year the population of nematodes of all the groups did show an inverse peak, i.e. the population decreased. But in regard of organic carbon content of soil the response was exactly opposite to that of potassium, so, increase of nematode population.

The population of *Miconchus* sp. and *Sporonchulus* sp. were least influenced by the change of most of the edaphic factors rather their population remained least influenced through out the entire period of observation (2004-2007), and maintained more or less constant around the mean.

DISCUSSION

Normally, amongst the animal communities the population at the higher trophic level (viz. carnivores) are always counted minimum, this is true for the predatory nematodes like mononchs too. During the random survey in the entire district there was never much deviation from this expected observation, that is, the mononch population within the nematode population was very small. However, exception had been observed in case of two experimental fields (guava orchards) for ecological studies. In both the cases, the relative mononch population was found significantly larger. This apparently paradoxical observation may find some reasonability if we do consider (i) in orchard regular ploughing is not observed, (ii) the soil is not exposed to direct sun light, (iii) minimum pesticides used, (iv) a continuous process of humus formation (from the leaf litters) goes on. All these factors together help in building a good population of microorganisms, upon which nematodes as a whole, particularly, the predatory mononchs live upon. Thus, an orchard harbours several favourable factors to flourish such large mononchid population.

Correlation coefficient of mononchid population with that of tylenchid (plant parasitic) and dorylaimid population are always positive and the value of 'r' ranges

between 0.404 - 0.934, that means that all the population directly proportional to each other. But this would not be wise to conclude that, this positive correlation is solely due to prey-predator relationship between mononchids and other two groups, tylenchids and dorylaimids. Numerous factors viz. physical factors and a number of other biotic factors often have significant influence on nematode population dynamics in a naturally occurring habitat/ecosystem.

The linear regressions as well as the correlation between different nematode populations and edaphic factors have been estimated (taking the mean values of the population of all the thirty-six months). In case of mononchid *vs* dorylaimid population and mononchid *vs* tylenchid population in Shalipur and Balarampur, the correlation coefficients are 0.796, 0.934 and 0.404, 0.814 respectively. That means in both the instances the correlation is positively significant at 0.05 level. Population changes of dorylaimids and tylenchids (as dependent variables) were taken into account against the population of mononchs (as independent variable).

A close observation regarding population fluctuation in four categories viz. Dorylaimida, Tylenchida, Mononchida and other nematodes, reveals that in almost every case the maximum rise in population in all these groups occurred in the month of July, every year. These have been followed by a gradual reduction in proceeding months of the year and with another insignificant rise in the month of October of each year. The factors responsible for these types of changes may be better understood by studying overall changes in the soil environment, which definitely have influence on the growth or decline of population.

The apparent reason seems that the population grows to the peak in rainy season or monsoon i.e. during the month of July. In Southern part of Bengal, there is only one rainy season, which generally commences from June and ends in August. Thus, the peak period of population growth coincides with the middle of the rainy season. The relative increase in population in the above-mentioned groups shows almost proportionate degree of fluctuation.

From the data of Tables (Table 5 and 6) and the graphical representation (Figures 71 and 72) this can be concluded that among the eight edaphic factors, which were estimated throughout the year; four factors namely, organic carbon, nitrogen, temperature and moisture increased to the maximum level in the rainy season. The trend for other four factors viz. electrical conductivity, phosphorus, potassium and pH (the value increased but acidity decreased) showed an overall decrease (almost minimum) during the same period. The possible reason for the increase of the aforementioned factors is that, in rainy season the litter accumulated in the orchard is converted into humus, which in turn adds to nitrogen as well as organic carbon to the soil when decomposed The moisture is directly added to the soil through rains and the temperature though not maximum but moderately high (due to a little minimization by the rainfall) is high enough, rather optimum, for their growth of population. Rainfall at monsoon season generally ranges between 1750-1770 mm in South 24-Parganas, which frequently flow over the earth surface and consequently washes away, the easily soluble minerals like phosphates, potassium and sodium (the

later two being responsible for soil electrical conductivity) as well as decreases the acidity of soil, and thus, results in an increase in the pH value. Practically, these are the inherent causes for the reduction of the last four factors.

The growth of nematode population is not directly related with the parameters like organic carbon and nitrogen, but these factors help to build up population of microorganisms as well as vegetations and thus, have indirect bearing upon the nematode population. Extreme low or high temperature is not conducive for breeding of the nematodes; rather an optimum or ideal temperature is the requirement, which is predominantly observed during the rainy season. Basically, the life (and possibly the nematodes as well) had originated in aquatic media! Naturally, the availability of sufficient degree of water is expected to favour the breeding phenomena of the nematodes. Maximum aquatic environment is available in rainy season only.

An excellent observation is about the population of *Miconchus* and *Sporonchulus* which were least influenced by the change of most of the edaphic factors rather their population remained least influenced through out the entire period of observation and maintained more or less constant around the mean.

As the mononchs mostly feed on a wide variety of micro- and meiofauna, different from dorylaimids and tylenchidsso there are no marked changes in the population structure of dorylaimids and tylenchids observed. In that sense, they show a high degree of resistance and resilience allowing increase of stability in community structure (McNaughton, 1977; Schoenly *et al.* 1991). Thus, it may be safely concluded that, mononchs show marginal bearing upon the population of other nematode groups.

During the systematic study of the samples collected from South 24-Parganas a very significant observation has been made. Those genera which include an appreciable number of species have also shown a good count of population. On the contrary, the genera with few or a single species, in the present collection, also has shown very poor population size. For example, 13 species are available under the single genus *Mylonchulus* and its population counts 551 (adult specimens, excluding juveniles). Similarly, the genus *Iotonchus,* comprising six species had shown a population of 237 (adult specimens, excluding juveniles). In contrast, the genera like *Parahadronchus, Mulveyellus, Sporonchulus, Nullonchus* and *Mononchus,* where single species is available under each of them have been found to have a population size of 61, 50, 39, 5 and 3, respectively. Earlier, Chatterjee and Sen (2000) also reported similar finding. The main reason behind such observation seems that, a good number of species is expected to have a diversified and non-overlapping ecological requirement different from each other to avoid intra-specific competition. So, the population under the genus can grow better, where as genus with a single species do possess narrower, yet, specific ecological requirements. Accordingly, they cannot exploit variable sets of environmental parameters, thus, do not flourish well. In case negative selection pressure works on them, their population may face increased vulnerability for extinction.

Mean biomass (G) and total biomass (TG) have been calculated following the method formulated by Norton (1978). The formulae provided are utilized in such a

way that a specimen with good population not necessarily would prove to have greater biomass though they have higher frequency and higher density of the population. On the other hand, a species with larger body size (length and width) would definitely be proved to have greater biomass. This is because the biomass is also related to the energy flow from one trophic level to next higher trophic level and in that regard an individual having larger physique would require more energy than the smaller one (Andrassy, 1956 cf. Norton, 1978). Thus, *Mylonchulus mulveyi* which has the values N = 135, AF% = 22.73, RF% = 29.7, found to have total biomass (TG) 284.98 µg. In contrast to this value, *Iotonchus parabasidontus* which has the values: N = 55, AF% = 9.26, RF% = 11.93 only, yielded total biomass of 2178 µg.

SUMMARY

The present work encompasses taxonomy and ecology of predatory soil nematodes, order-Mononchida of West Bengal, India. For the taxonomical studies, composite soil samples collected from a distance of about 1 ft. from different tree trunk, spread around each block throughout the year from a depth of 0-15 cm. The taxonomic part of this study of mononchids included morphometric analyses of twenty-seven mononchid species, as well as their descriptions. Their habitat and locality, respective date of collections were also recorded. The species were identified on the basis of their taxonomic characters and their measurements. Newly described species were compared with their closely related species and detailed illustrations have been drawn and their photomicrographs have also been provided. Except these twenty seven mononchid nematodes encountered in present investigation, another eight were reported from other parts of West Bengal by earlier workers. The description of these eight mononchids have also been included in the present work.

For ecological study, two guava orchards were chosen in Baruipur subdivision for monthly collection of soil samples through out the period 2004-2007. Soil samples were collected from those fields from a distance of about 1 ft. away from guava tree trunk. Ten soil samples were collected randomly from each field in every third week of each month. Ecological works on these nematodes included community structure analyses, species dominance, their frequencies, density, prominence value and biomass. The highest numbers of species (thirteen) were found under the genus *Mylonchulus*; among them *Mylonchulus mulveyi* had the highest frequency, absolute frequency, relative frequency, density and prominence value. The highest mean biomass was recorded for *Iotonchus cuticaudatus* and the highest total biomass was recorded in case of *I. parabasidontus*. In addition, monthly population fluctuations of various genera under order Mononchida from two guava orchards were recorded. Generally number of all the nematodes was highest in the monsoon season (June through August). Effects of eight important soil abiotic factors were analyzed, to reveal whether they have any significant relationship or effect on nematode populations. In nut shell, soil moisture, organic carbon, nitrogen content and pH showed a significant ($P \leq 0.05$) positive correlation and phosphorus, potassium, electrical conductivity showed a significant negative correlation (at the same level of significance) with mononchid population. Temperature had little effect on them as

the temperature varied in South 24-Parganas within their optimum temperature limits required for their life activity. Total number of dorylaimid and tylenchid population also taken into account to know if they have any ecological association with mononchid population as there may exist some prey-predator relationships. Dorylaimid and tylenchid population fluctuations were directly correlated with that of mononch population.

Among nematodes in soil, mononchids are at the apex of the soil food pyramid as they are predators. Accordingly, their availability is much less, compared to other free-living or plant-parasitic nematodes.

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COLOUR PLATES AND GRAPHS

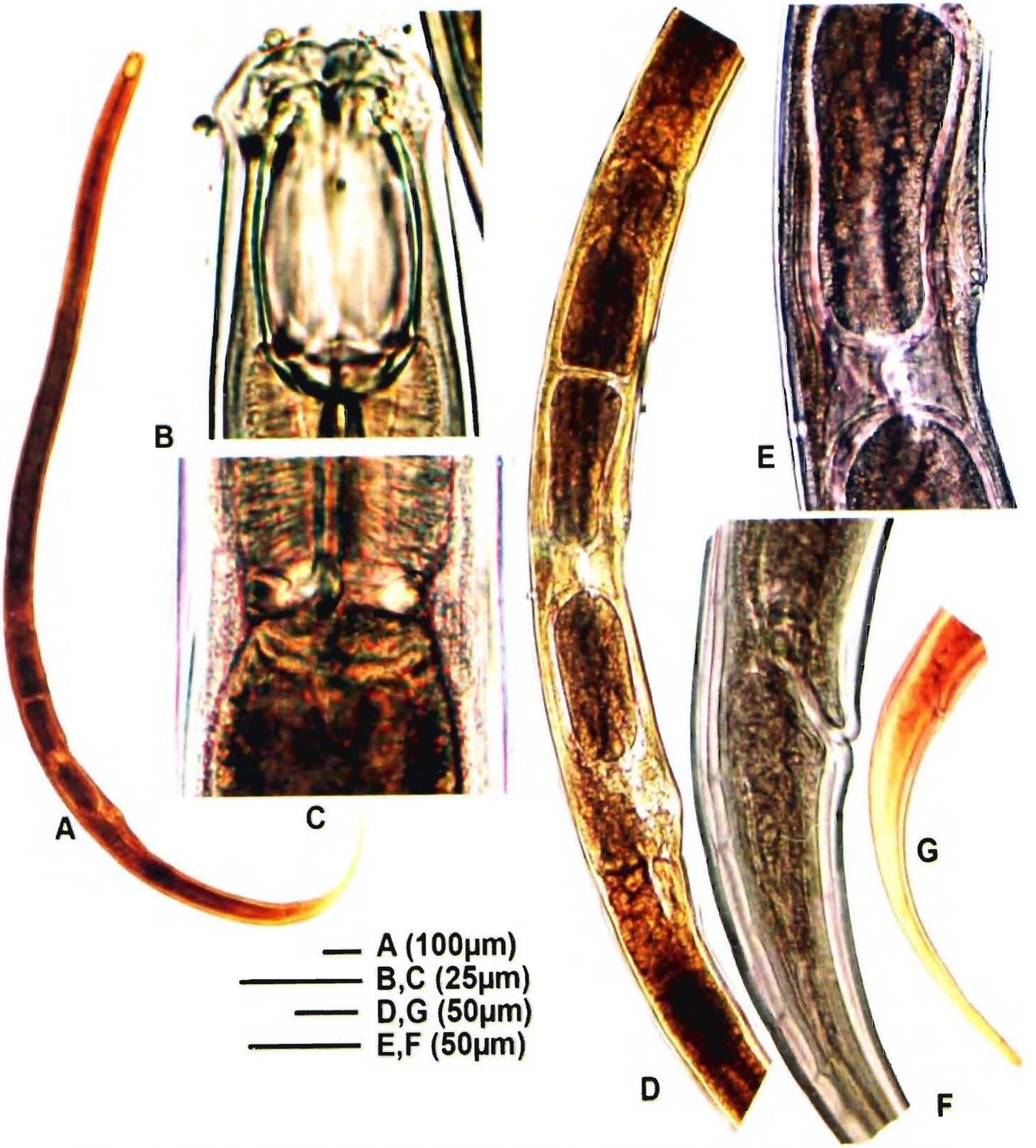


Figure 37. Photomicrographs of female *Nullonchus rafiqi* (After, Jana *et al.*, 2006). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Caudal region; G. Tail.

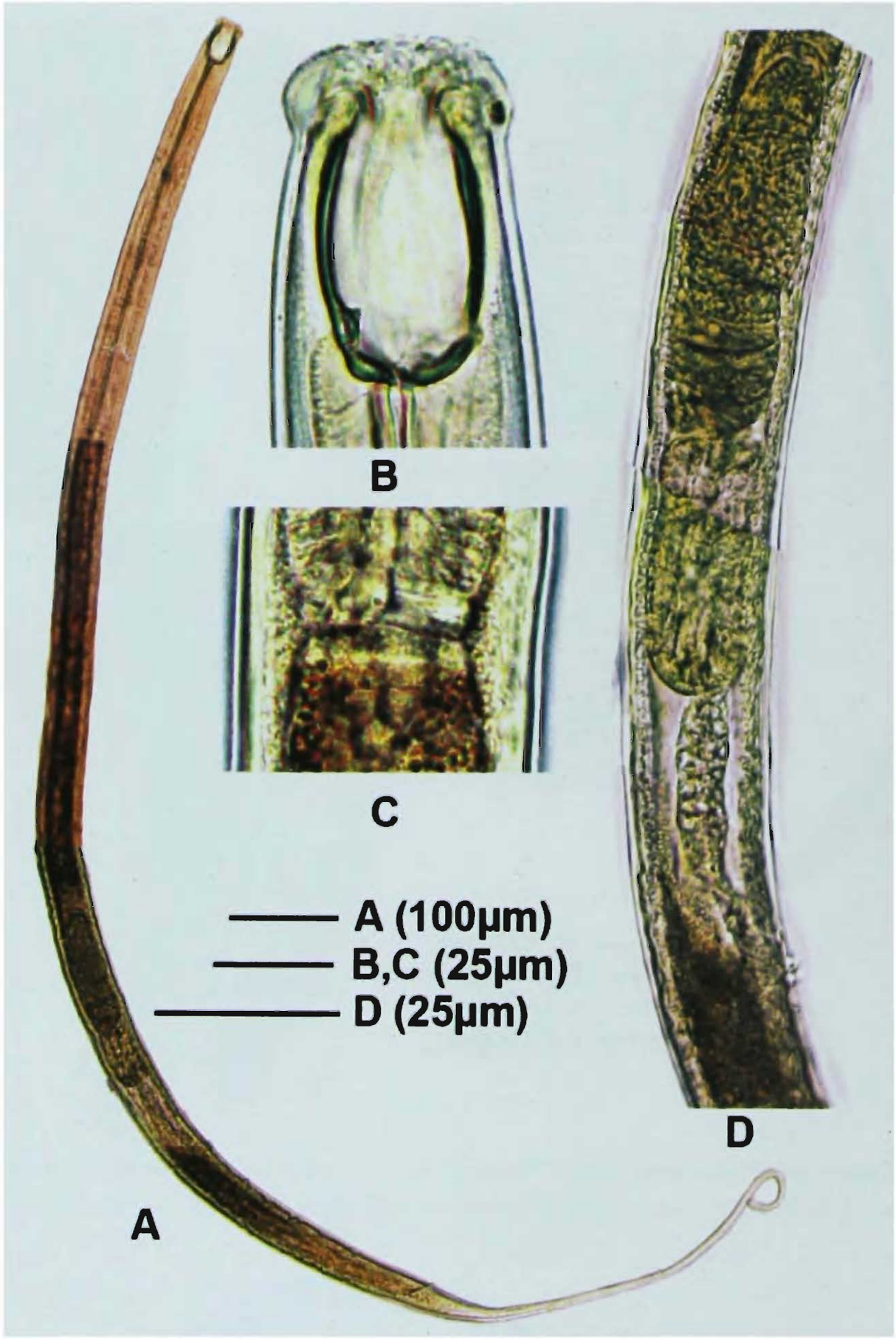


Figure 38. Photomicrographs of female *Iotonchus trichurus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad.

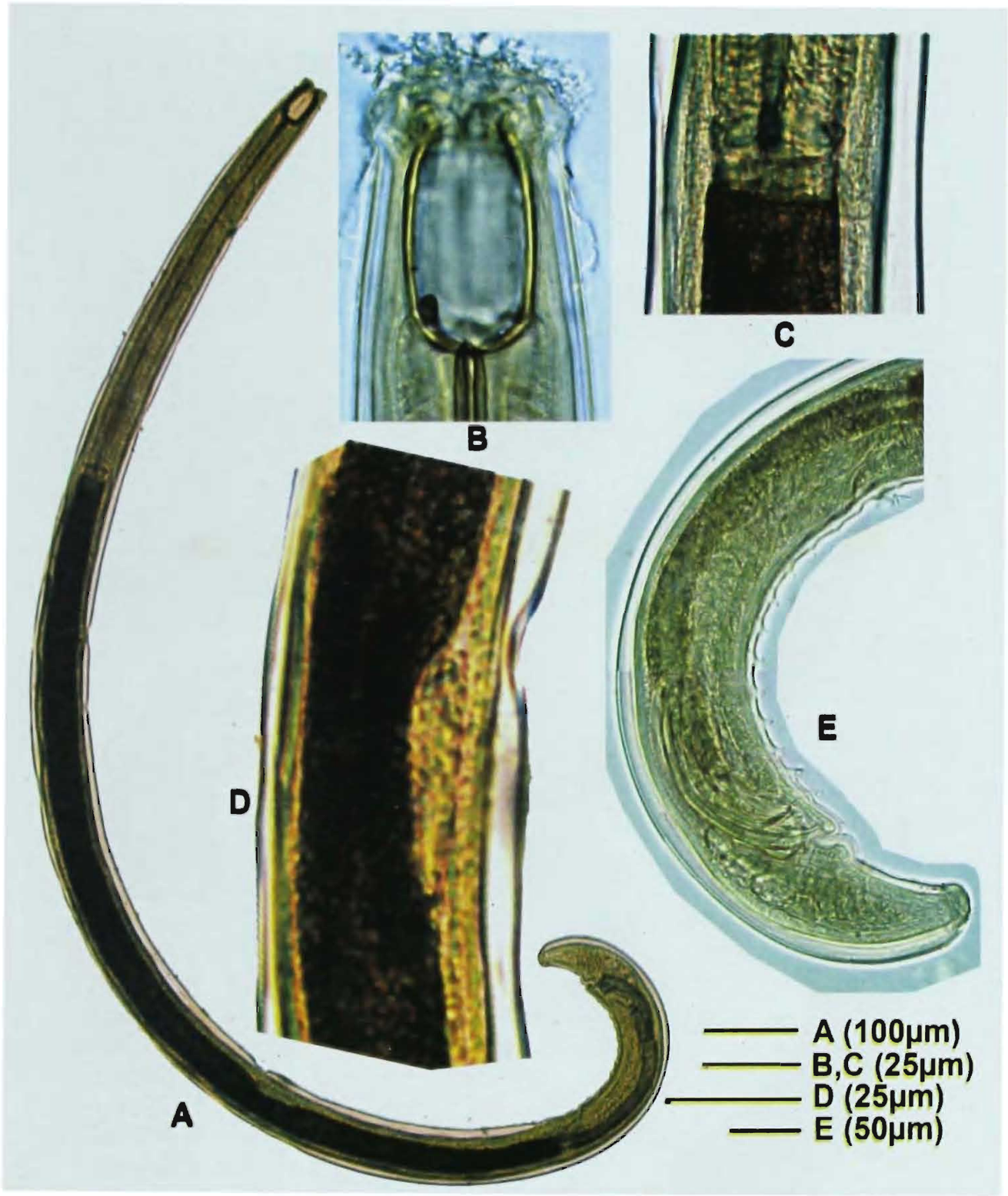


Figure 39. Photomicrographs of male *Iotonchus rotundicaudatus* (After, Jana *et al.*, 2009). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Intestinal constriction; E. Caudal region.

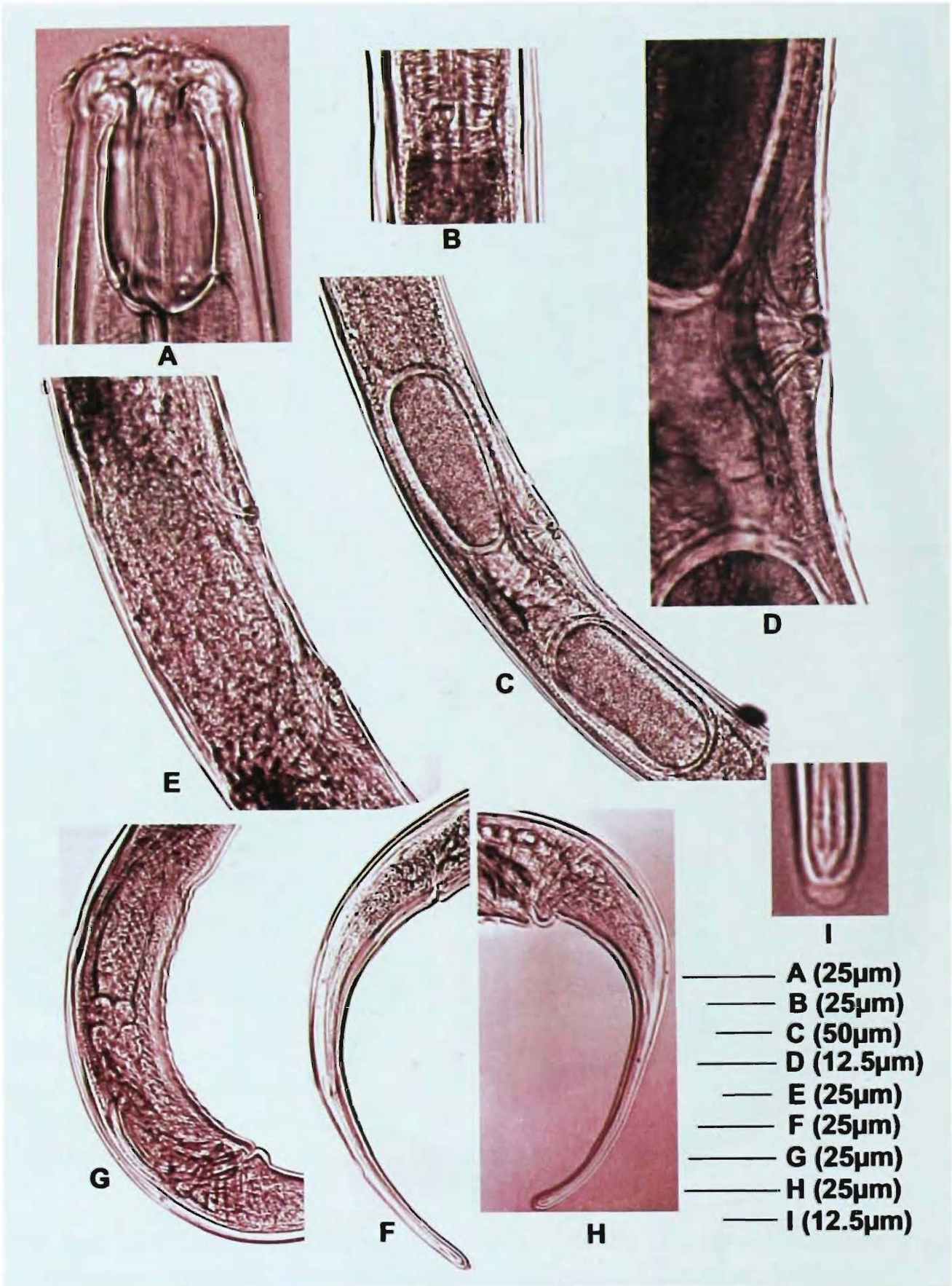


Figure 40. Photomicrographs of female and male *Iotonchus cuticaudatus* (After, Jana *et al.*, 2007). **Female:** A. Head; B. Pharyngo-intestine junction; C. Gonad; D. Vulval region; E. Double vulva; F. Tail.

Male: G. Caudal region; H. Tail; I. Tail terminus showing cuticular out growth.

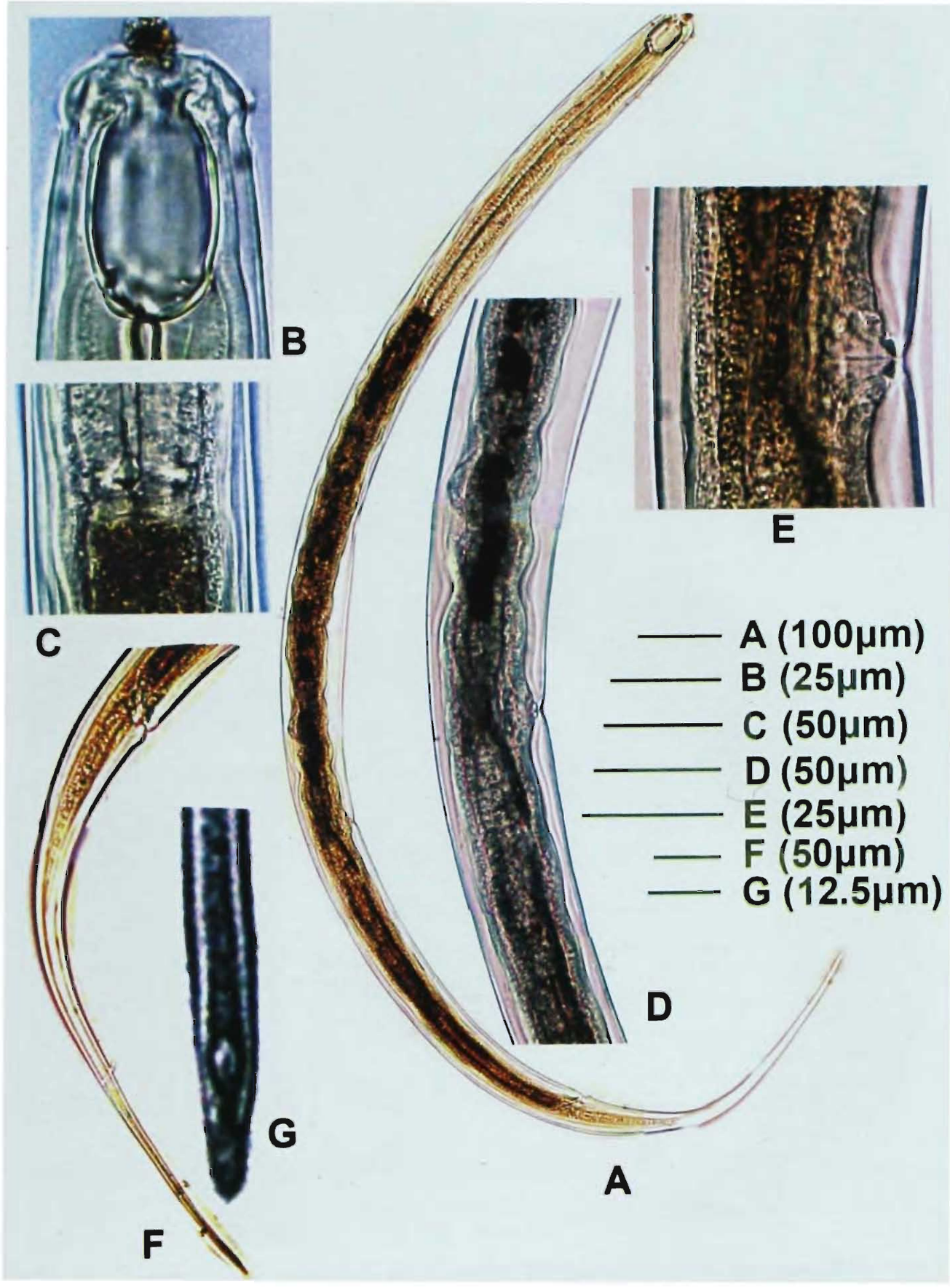


Figure 41. Photomicrographs of female *Iotonchus indicus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail; G. Tail terminus.

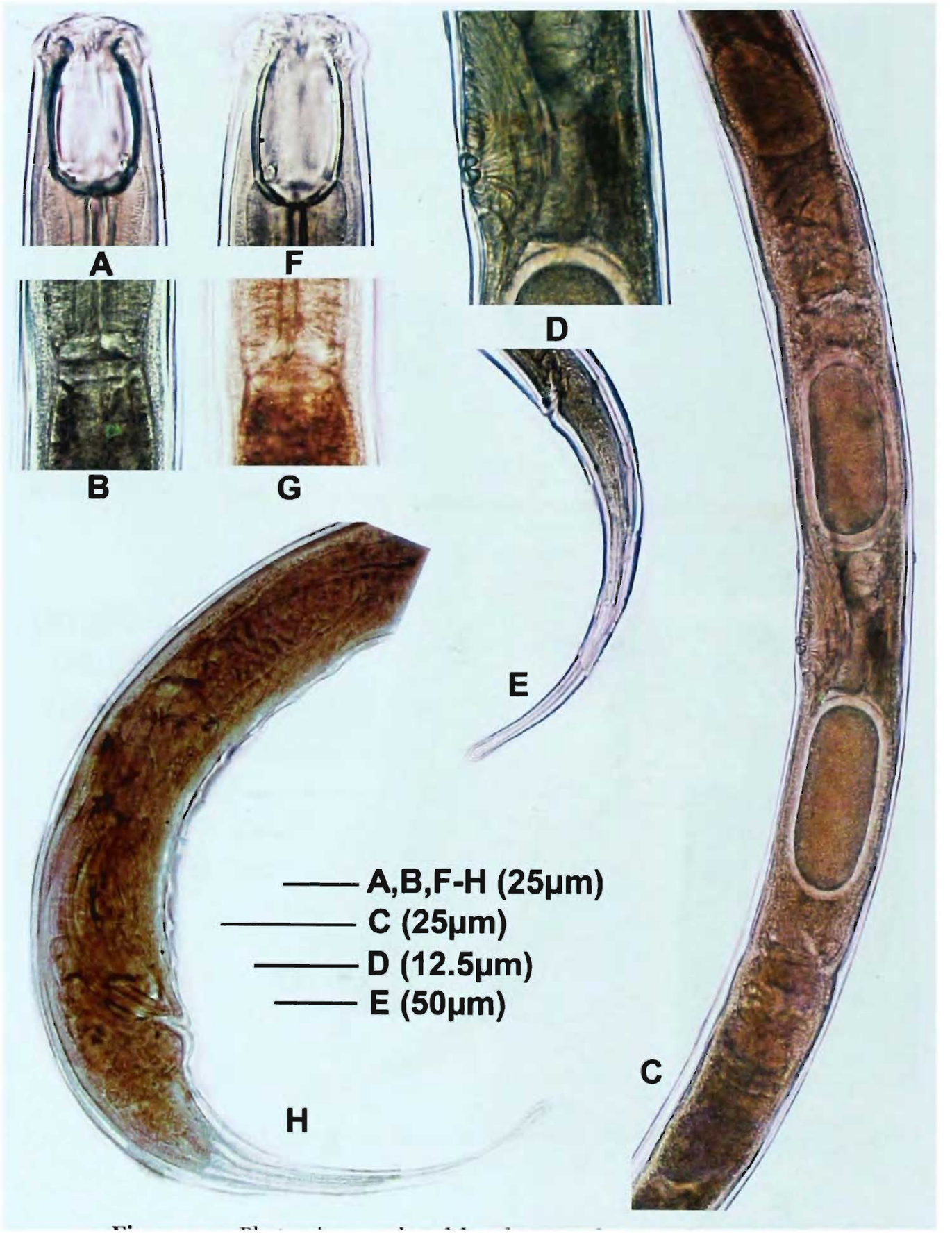


Figure 42. Photomicrographs of female *Iotonchus parabasidontus*.
Female: A. Head; B. Pharyngo-intestine junction; C. Gonad; D. Vulval region; E. Tail.
Male: F. Head; G. Pharyngo-intestine junction; H. Caudal region.

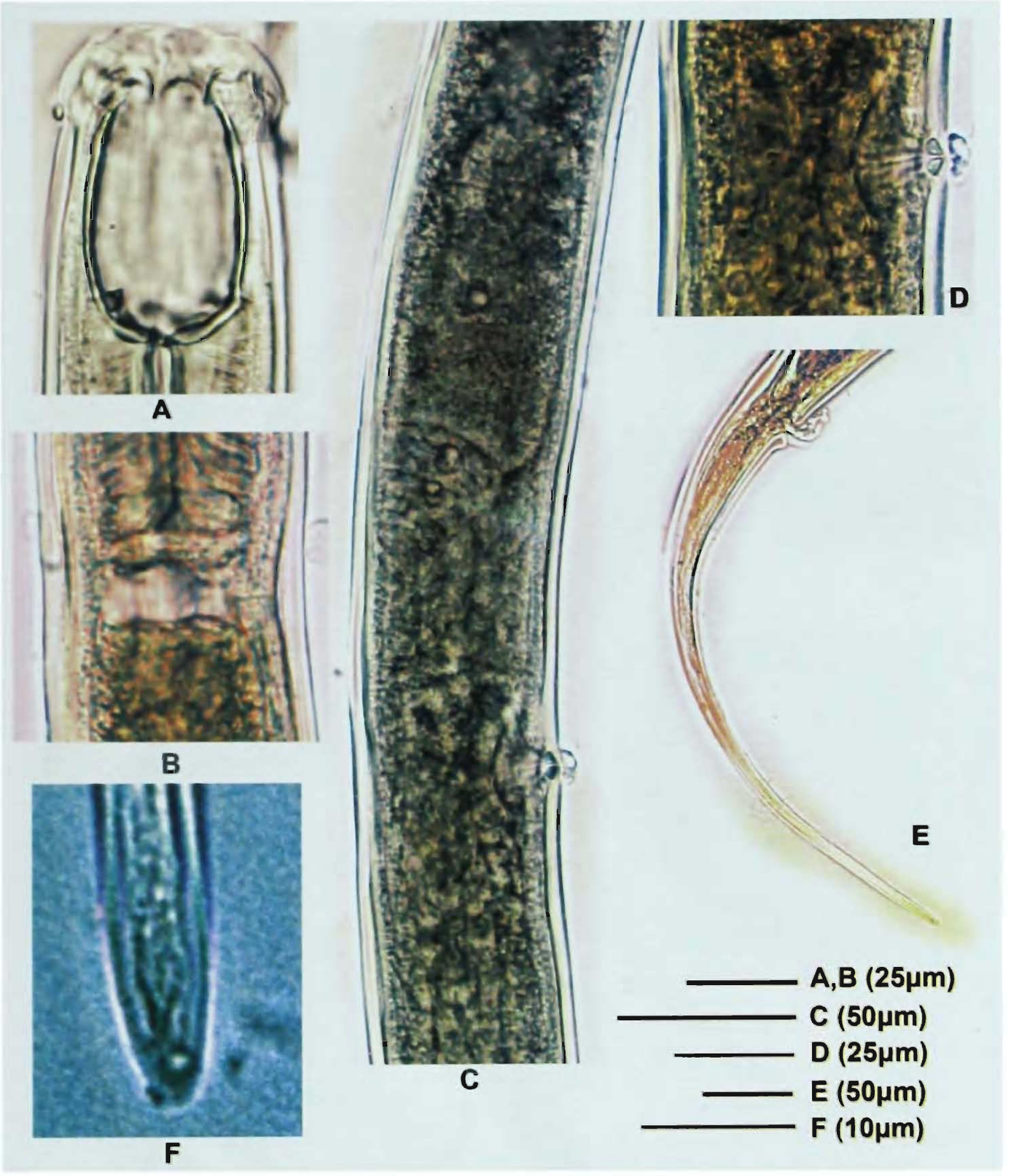


Figure 43. Photomicrographs of female *Iotonchus qaiseri* (After, Jana *et al.*, 2007). A. Head; B. Pharyngo-intestine junction; C. Gonad; D. Vulval region; E. Tail; F. Tail terminus.

Figure 44. Photomicrographs of female and male *Parahadronchus shakili* (After, Jana *et al.*, 2008).
Female: A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.
Male: G. Whole body; H. Head; I. Pharyngo-intestine junction; J. Caudal region.

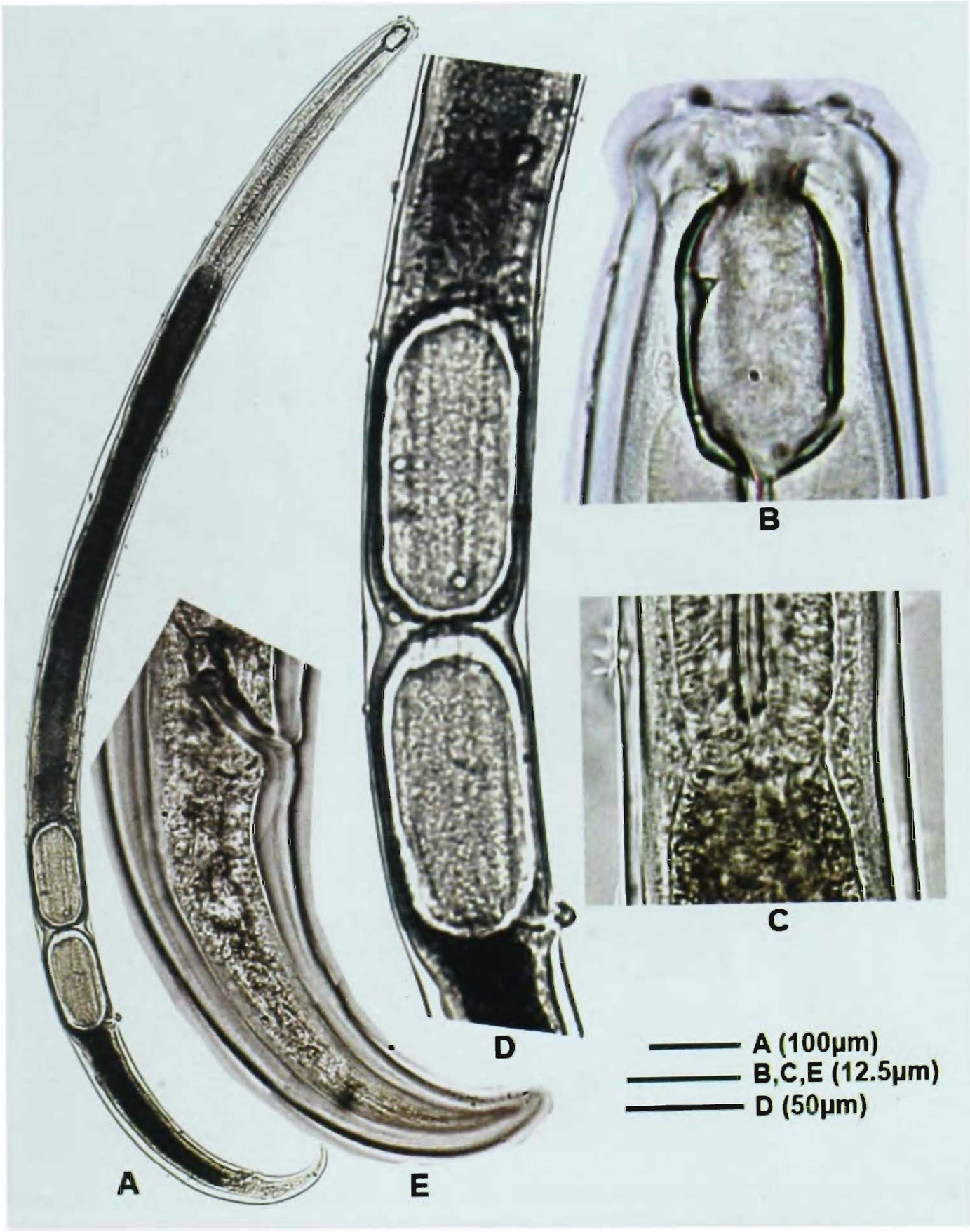


Figure 45. Photomicrographs of female *Mulveyellus jairi.*
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Tail.

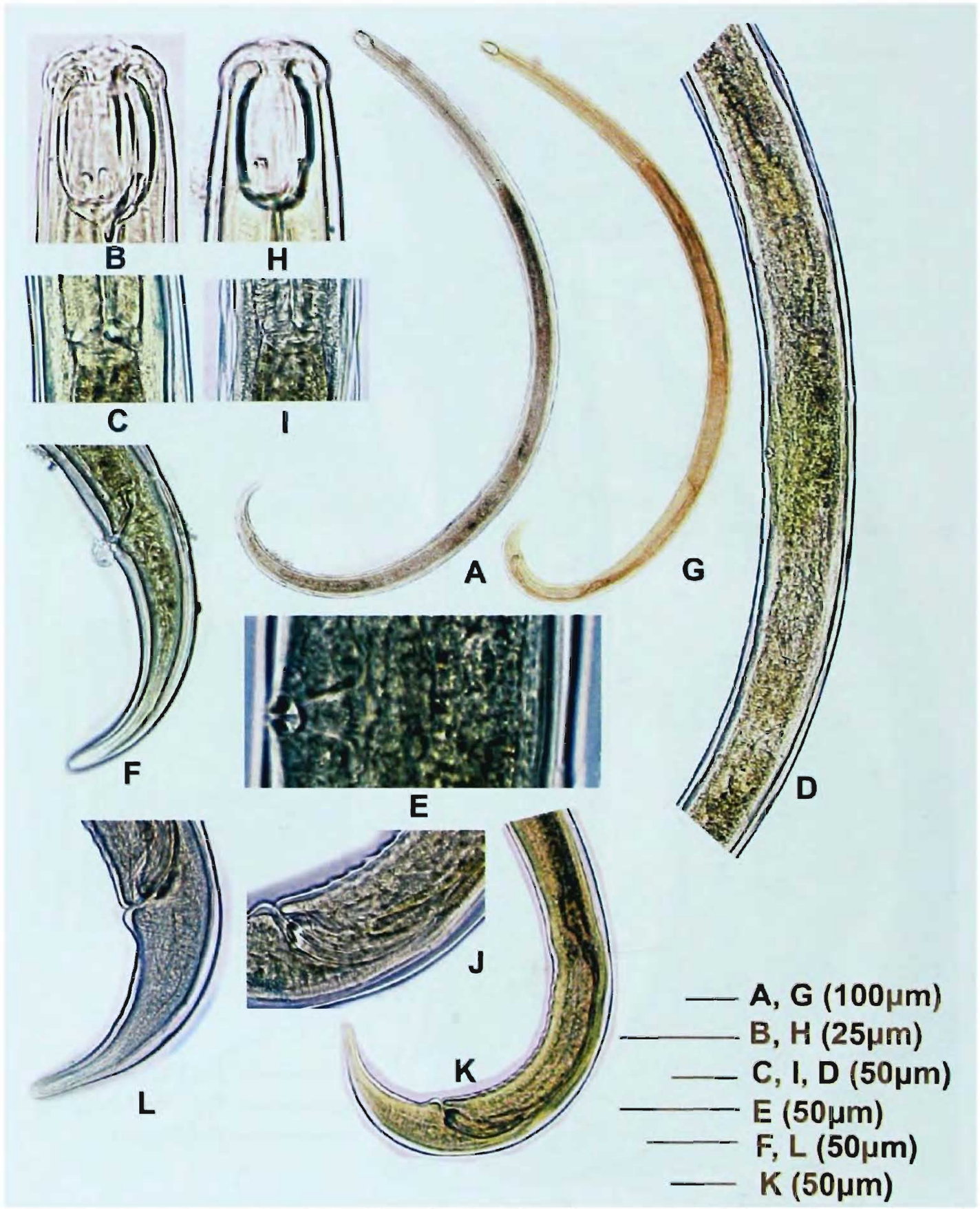


Fig. 46. Photomicrographs of female and male *Miconchus aquaticus* (After, Jana *et al.*, 2008).

Female: A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Male: G. Whole body; H. Head; I. Pharyngo-intestine junction; J. Spicules, gubernaculum and accessory pieces; K. Caudal region; L. Tail.

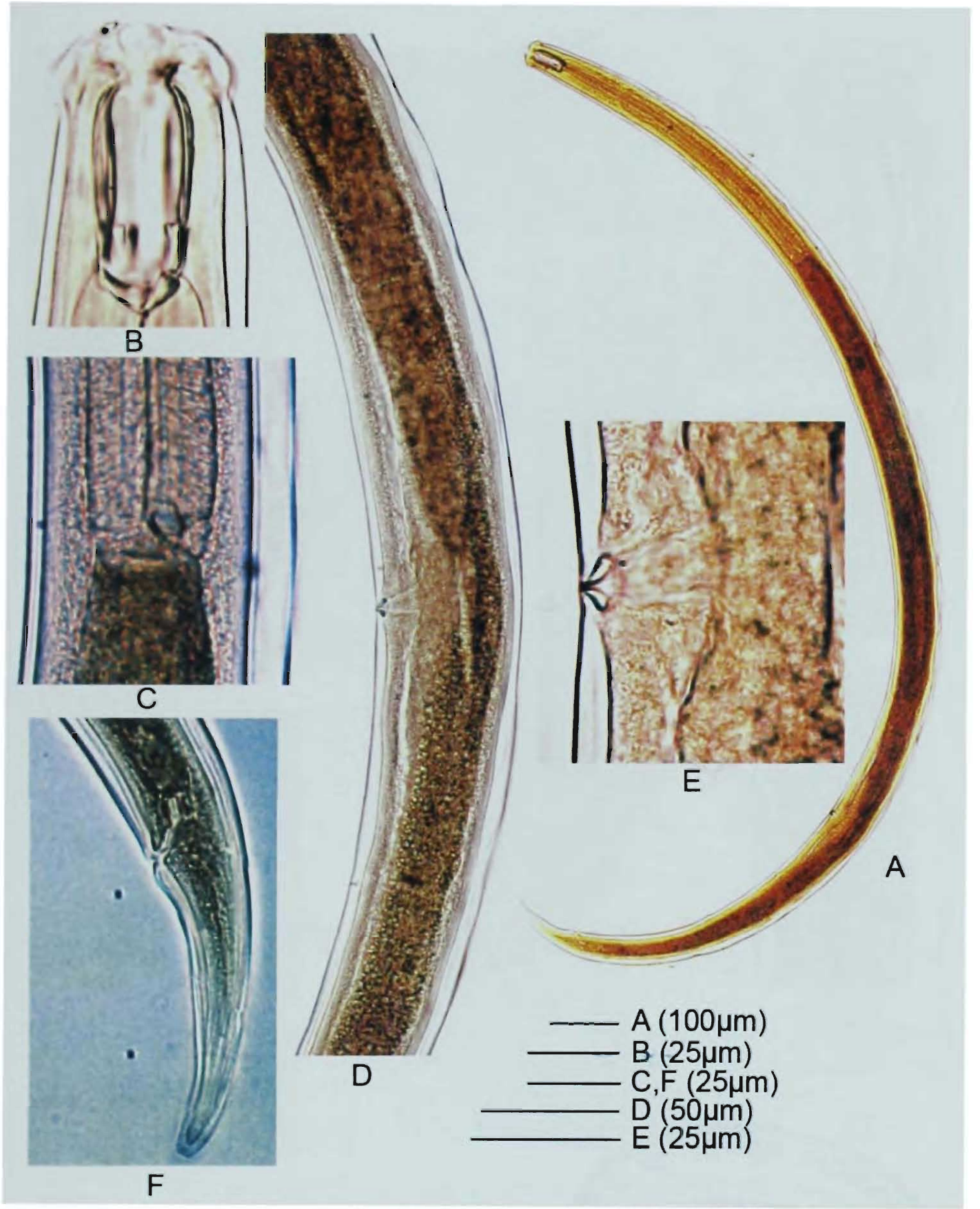


Figure 47. Photomicrographs of female *Miconchus rectangularis* (After, Jana *et al.*, 2008). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

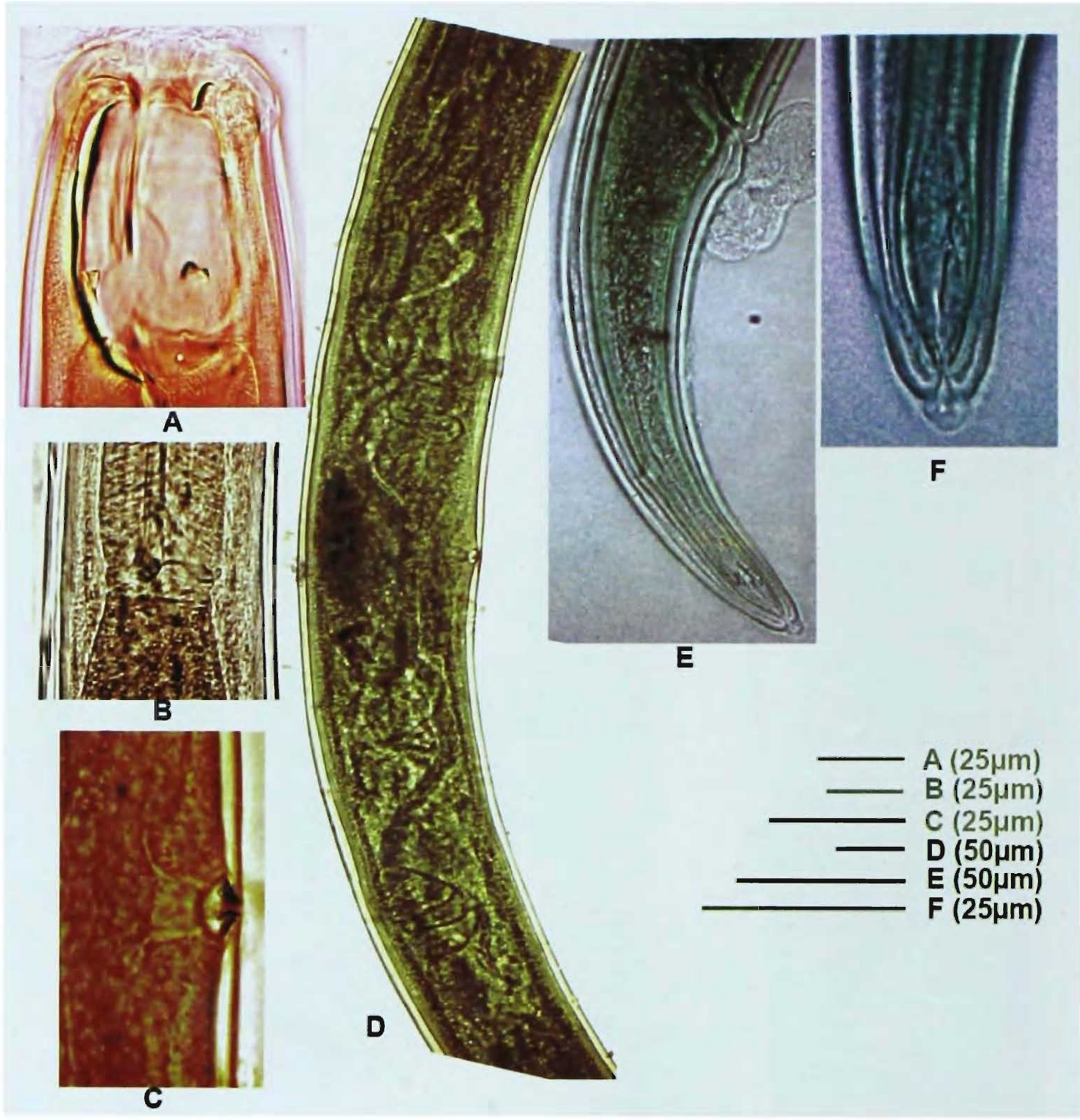


Figure 48. Photomicrographs of female *Miconchus bulbicaudatus* (After, Jana *et al.*, 2006). A. Head; B. Pharyngo-intestine junction; C. Vulval region; D. Gonad; E. Tail; F. Tail terminus showing bulbous outgrowth with six caudal papillae.

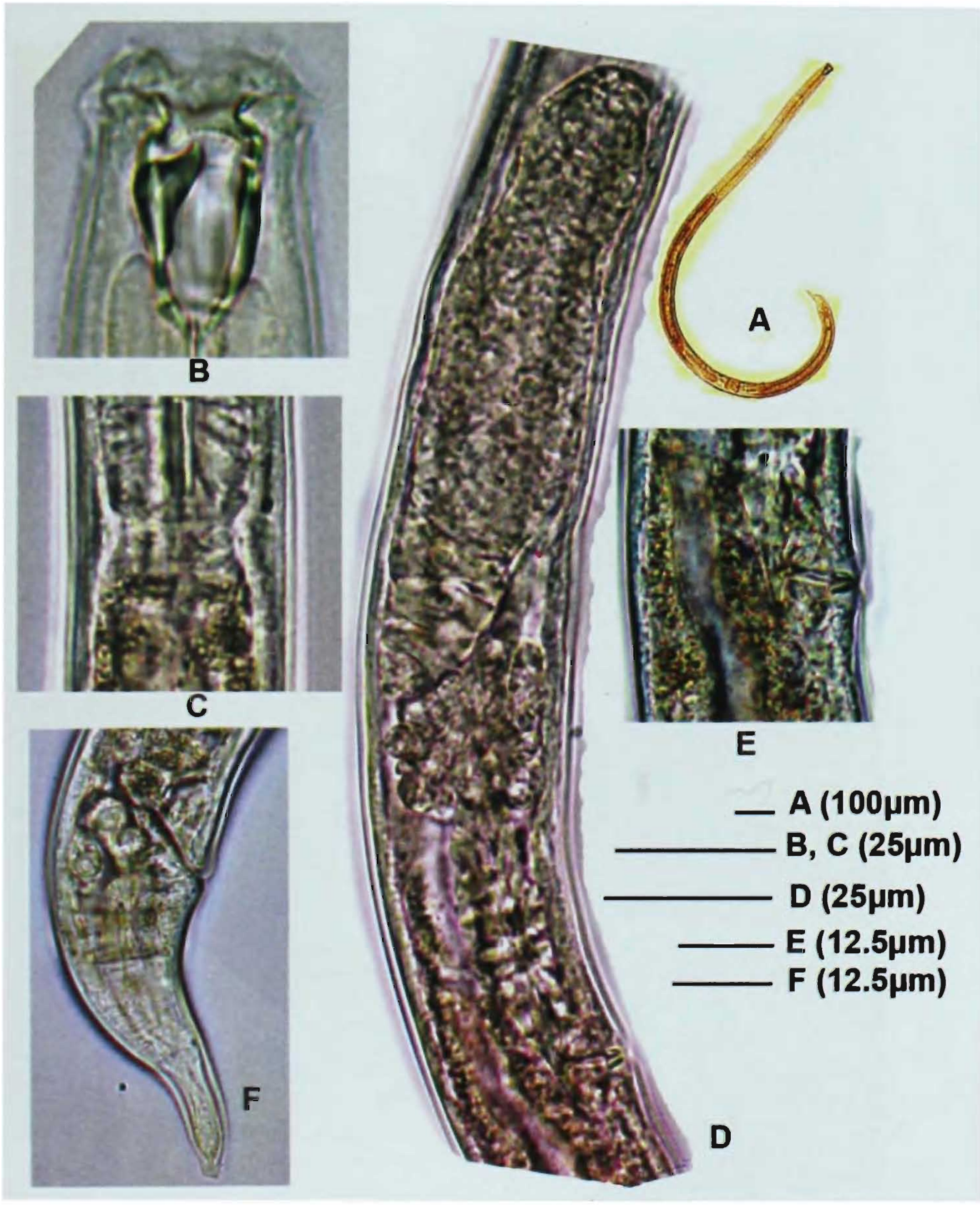


Figure 49. Photomicrographs of female *Mylonchulus mulveyi*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

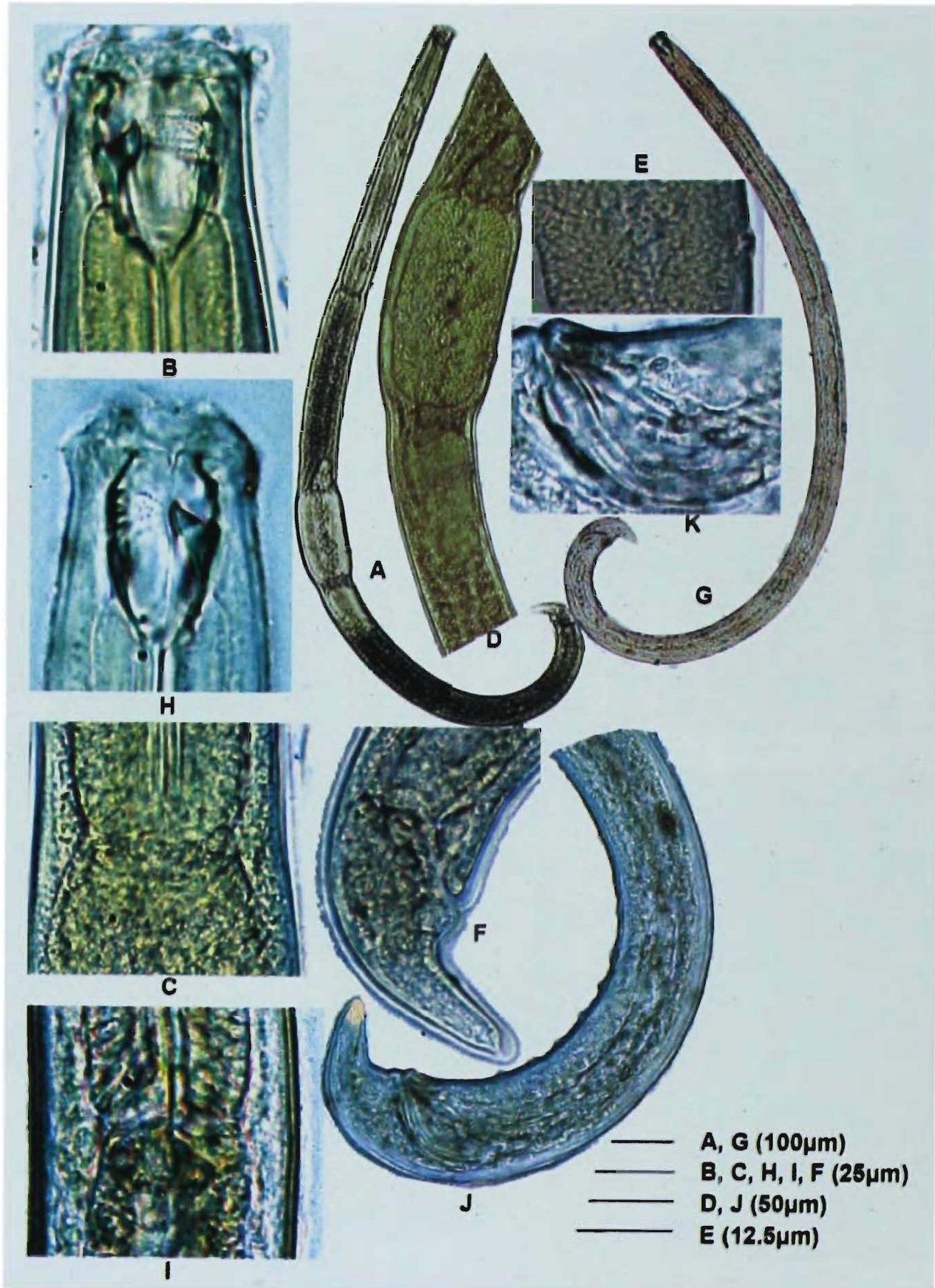


Figure 50. Photomicrographs of female and male *Mylonchulus contractus*.

Female: A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Male: G. Whole body; H. Head; I. Pharyngo-intestine junction; J. Caudal region.

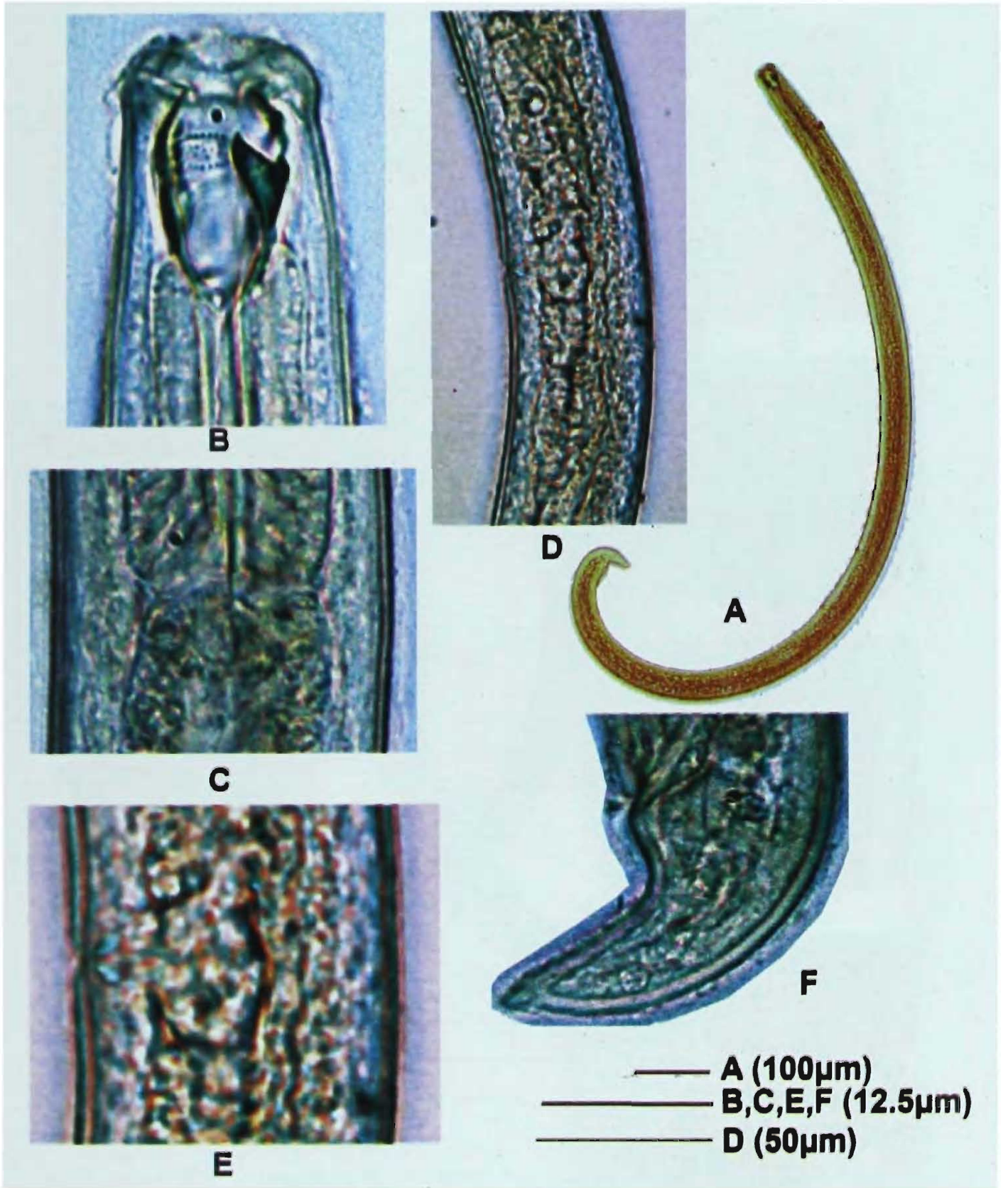


Figure 51. Photomicrographs of female *Mylonchulus incurvus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

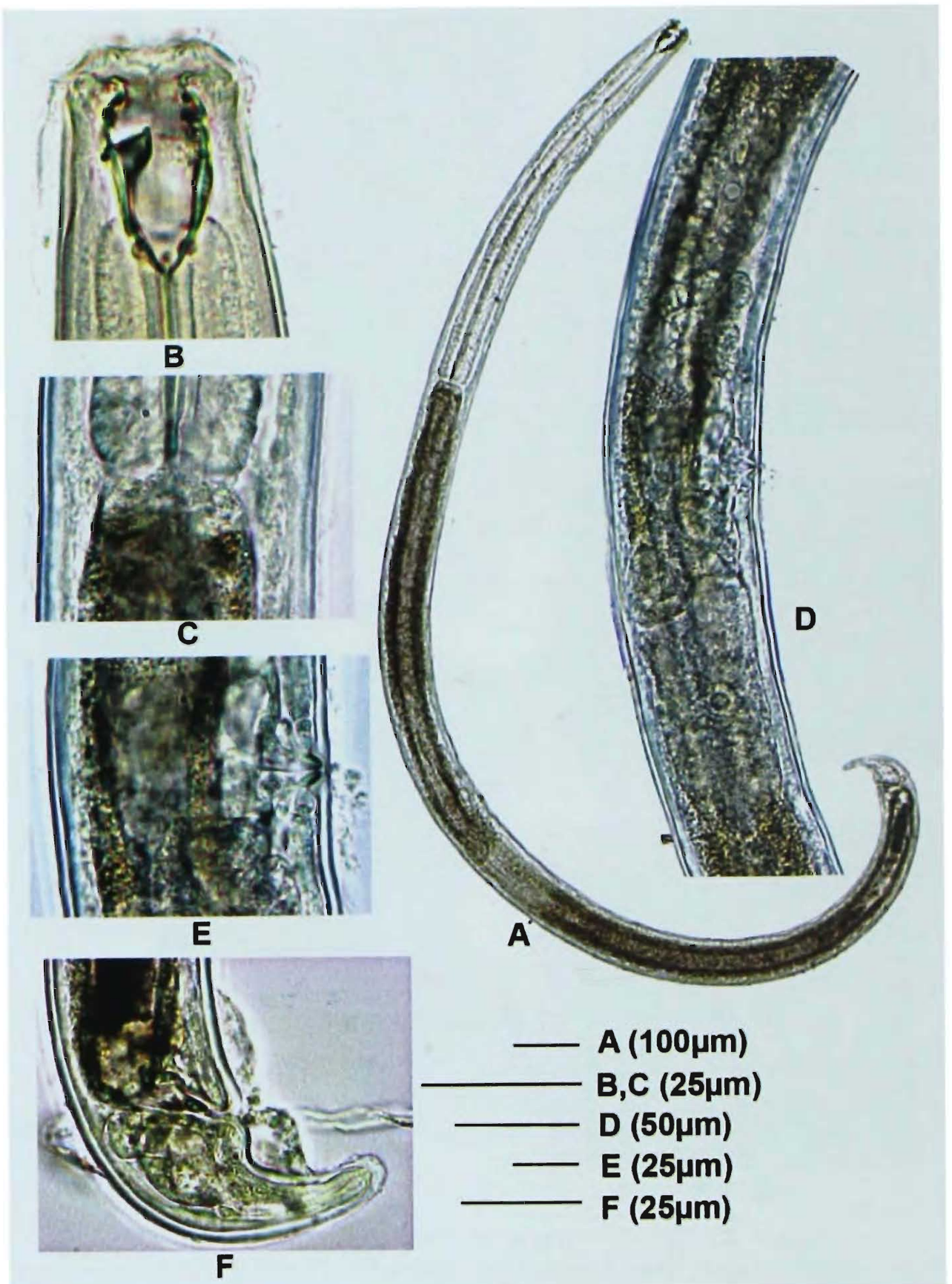


Figure 52. Photomicrographs of female *Mylonchulus hawaiiensis*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

Figure 53. Photomicrographs of female *Mylonchulus minor*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

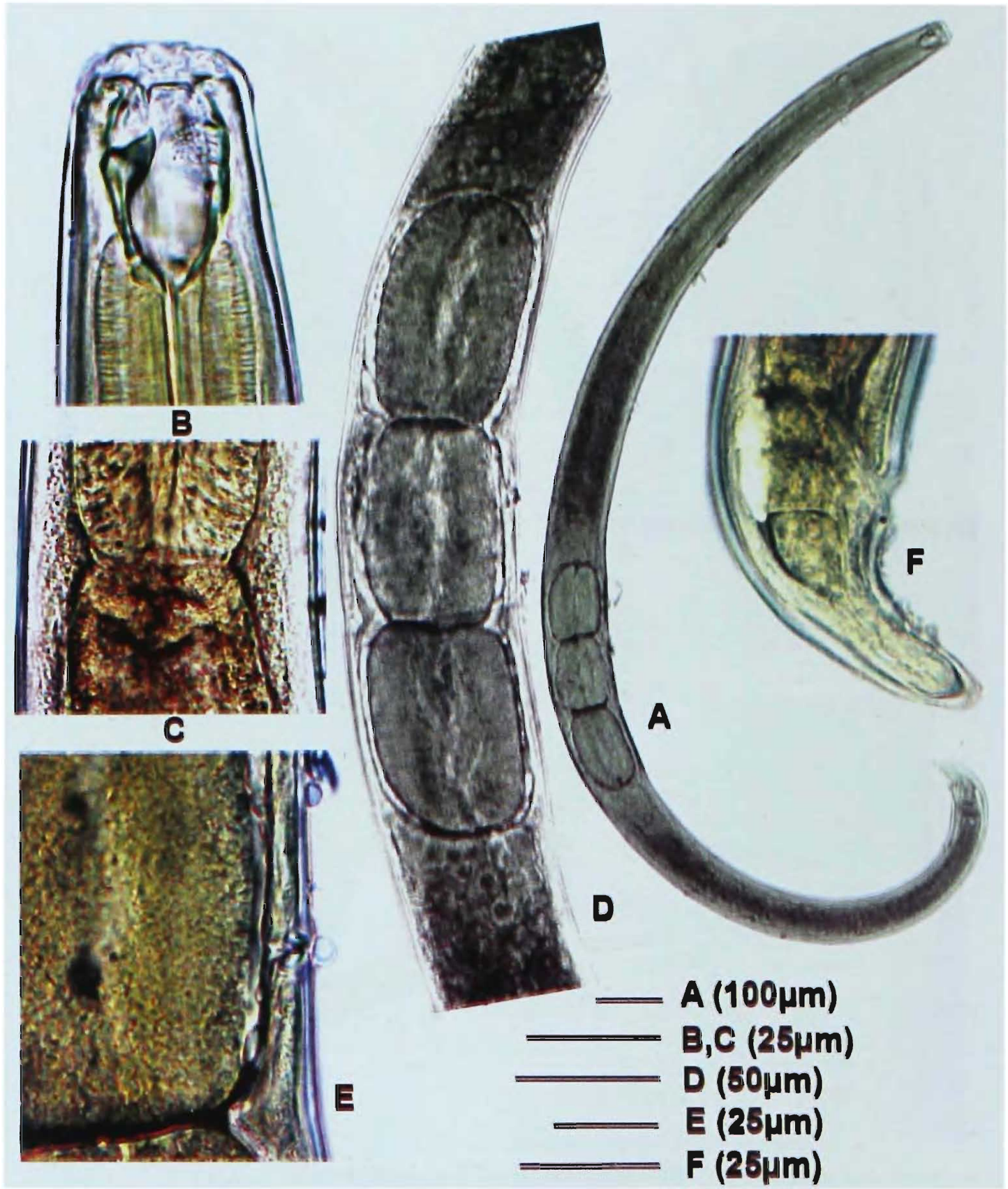


Figure 54. Photomicrographs of female *Mylonchulus lacustris*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

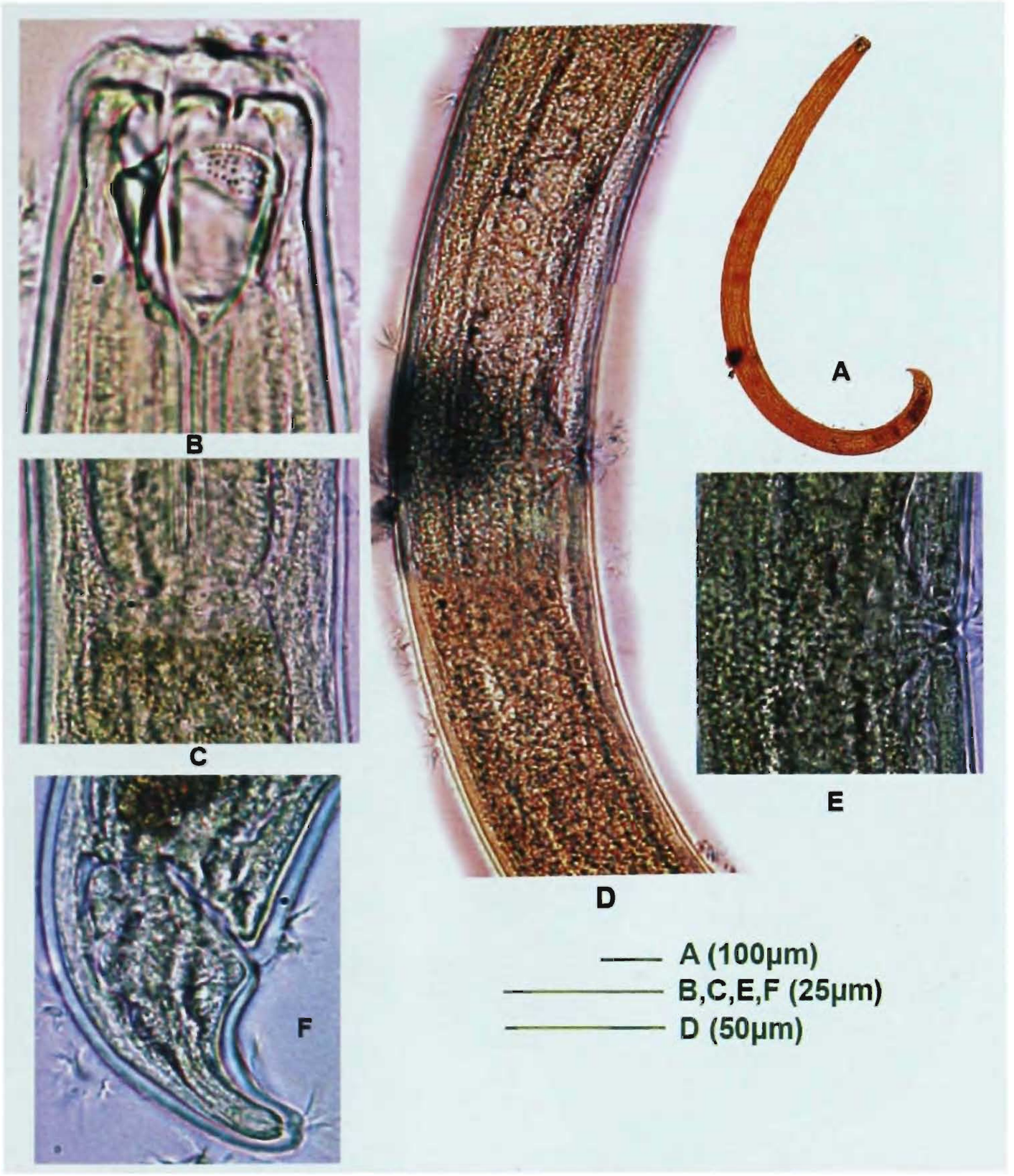


Figure 55. Photomicrographs of female *Mylonchulus amurus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

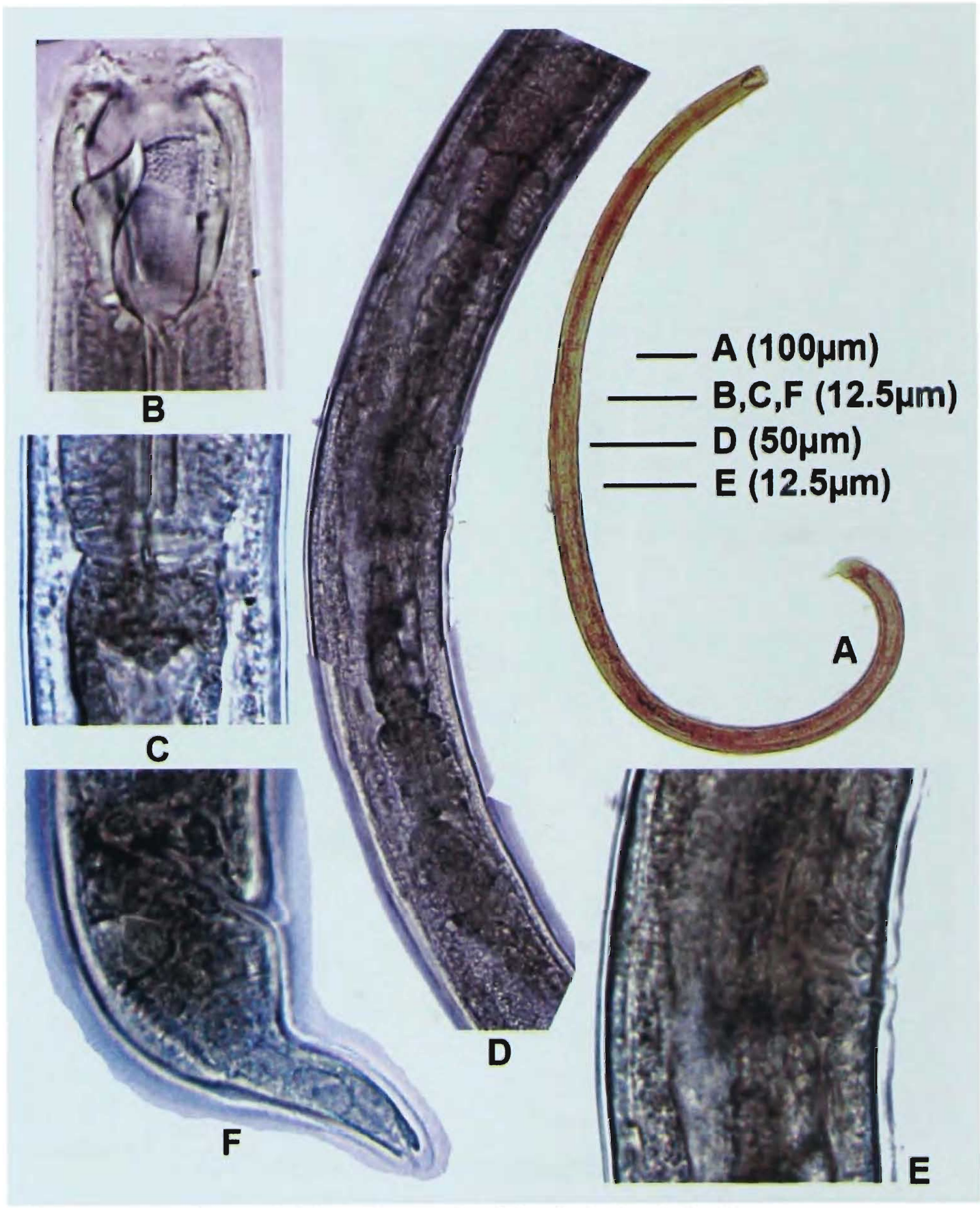


Figure 56. Photomicrographs of female *Mylonchulus dentatus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Vulval region; E. Gonad; F. Tail.

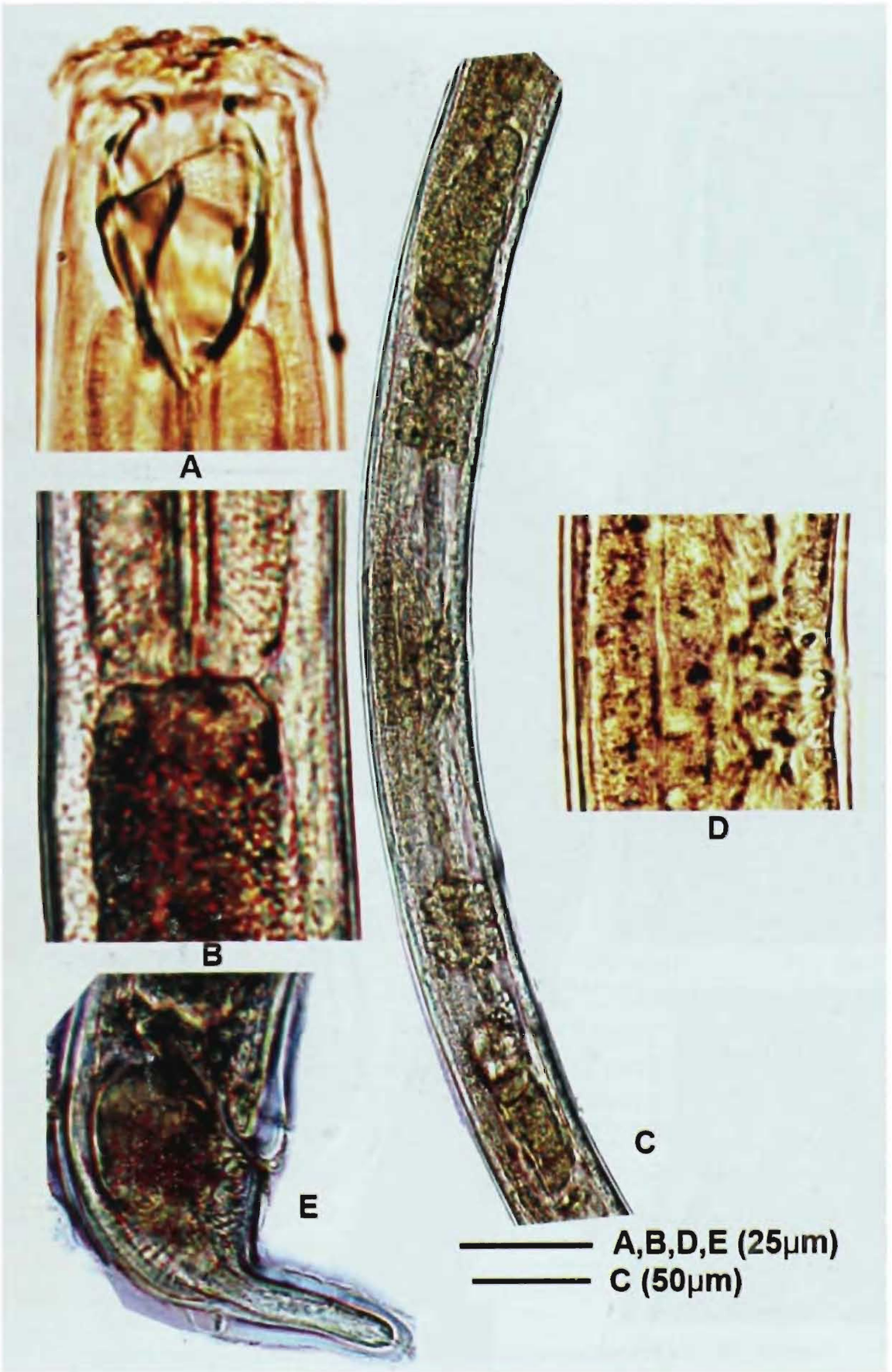


Figure 57. Photomicrographs of female *Mylonchulus sigmaturus*.
A.Head; B. Pharyngo-intestine junction; C. Gonad; D. Vulval region; E. Tail.

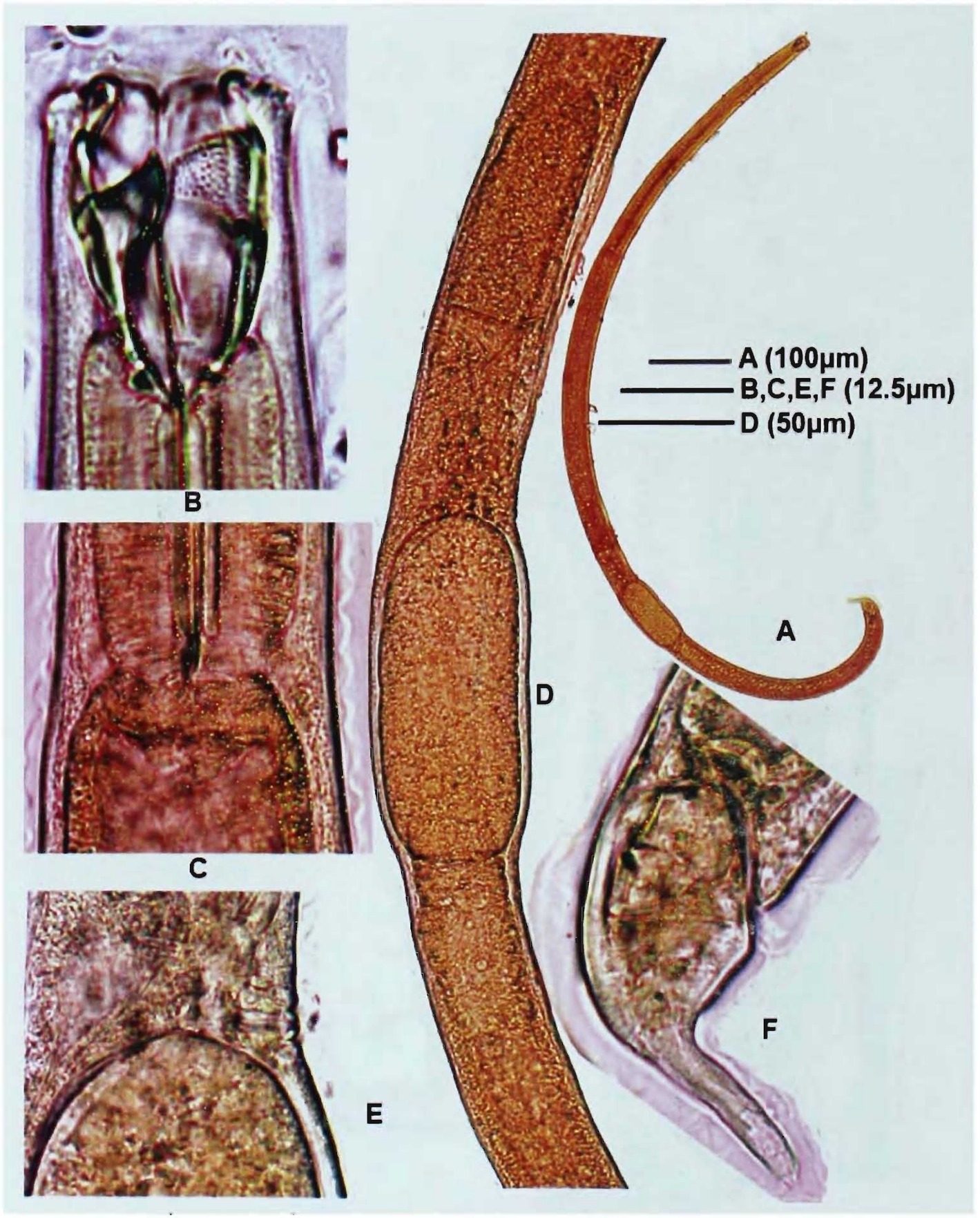


Figure 58. Photomicrographs of female *Mylonchulus sigmaturellus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

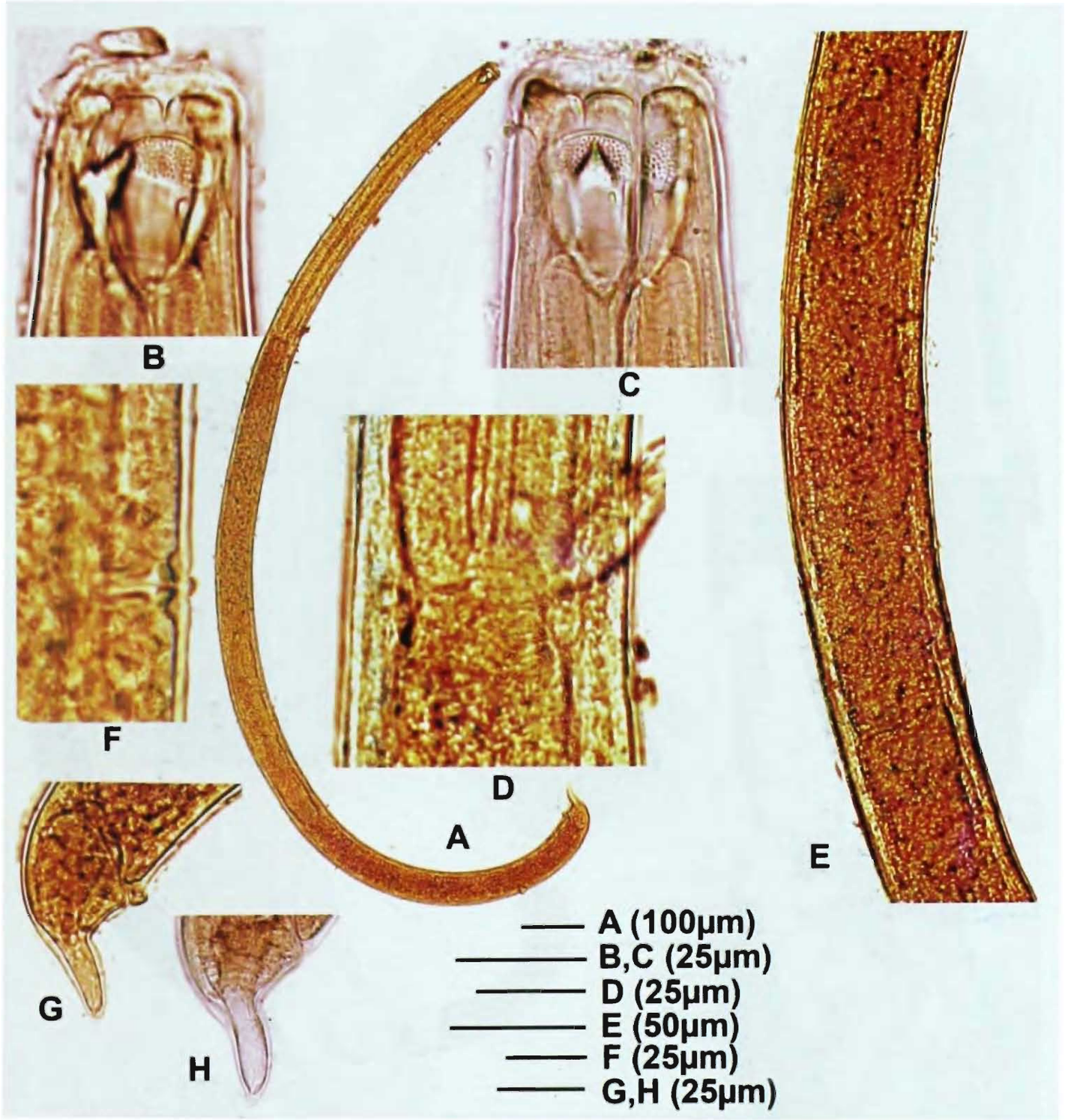


Figure 59. Photomicrographs of female *Mylonchulus wasimi* (After, Jana *et al.*, 2006). A. Whole body; B. Head; C. Head of one paratype; D. Pharyngo-intestine junction; E. Gonad; F. Vulval region; G. Tail; H. Tail of another paratype.

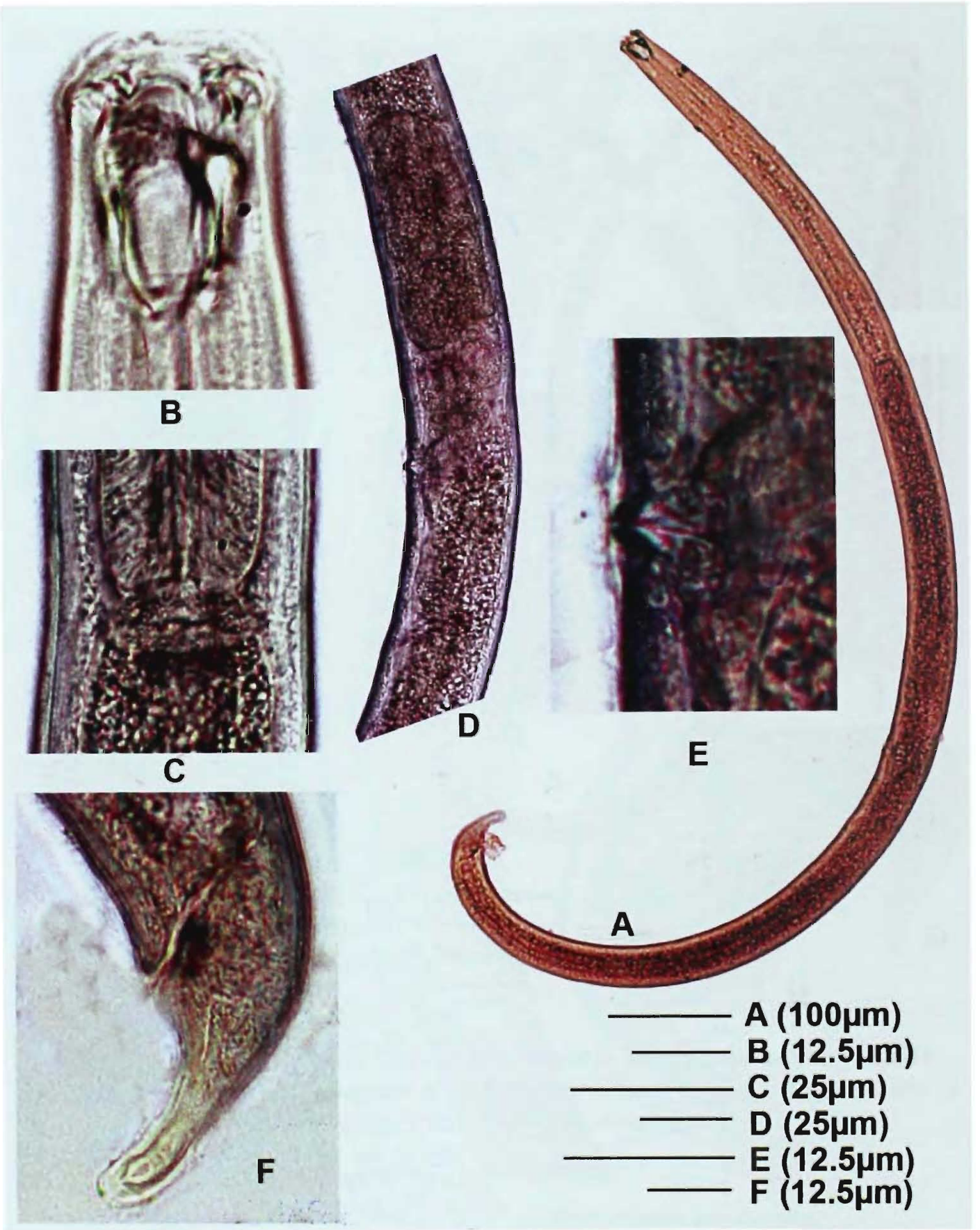


Figure 60. Photomicrographs of female *Mylonchulus goutami* (After, Jana *et al.*, 2010). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

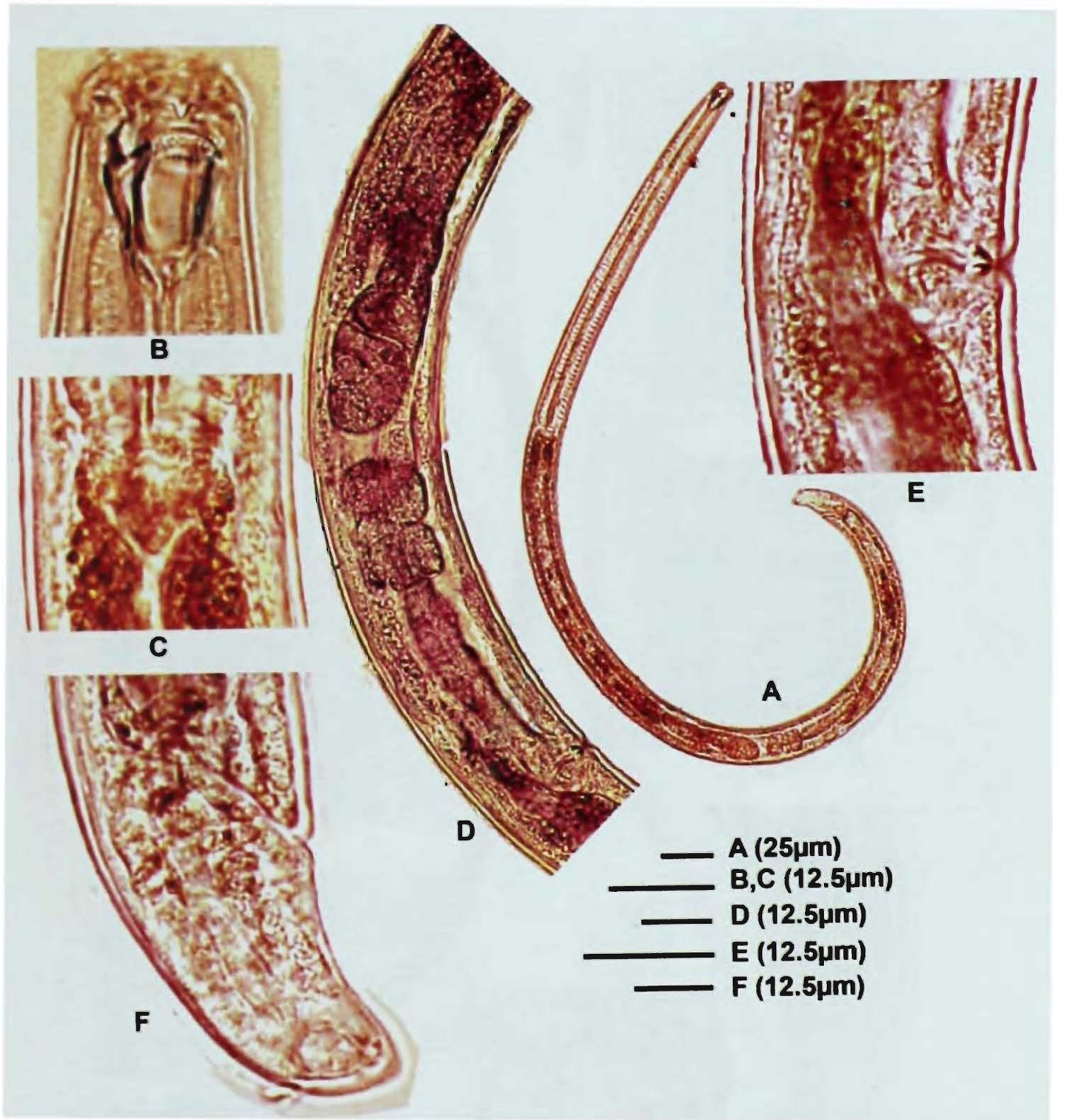


Figure 61. Photomicrographs of female *Mylonchulus istvani* (After, Jana *et al.*, 2010). A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Gonad; E. Vulval region; F. Tail.

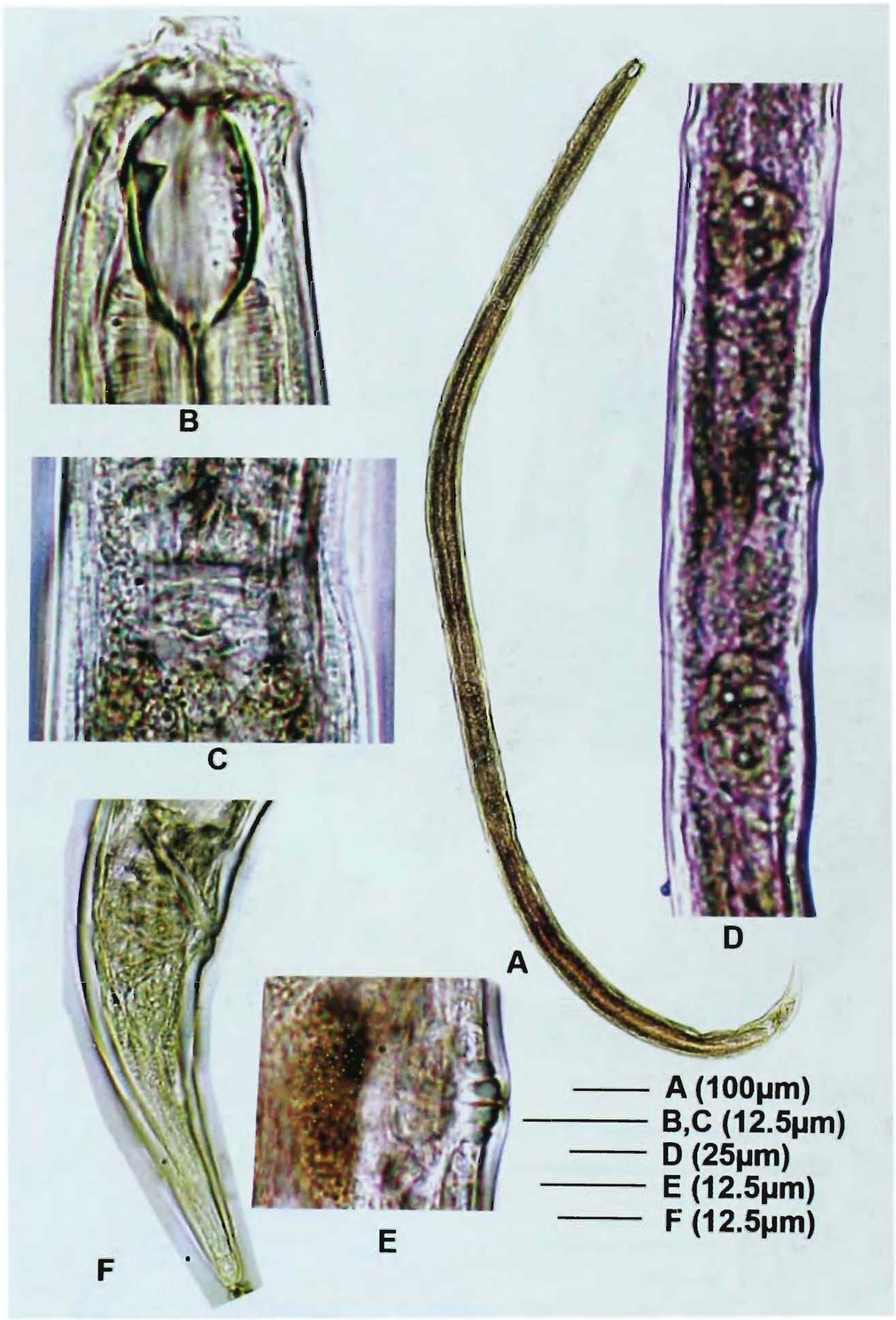


Figure 62. Photomicrographs of female *Sporonchulus vagabundus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D.Gonad; E. Vulval region F.Tail;

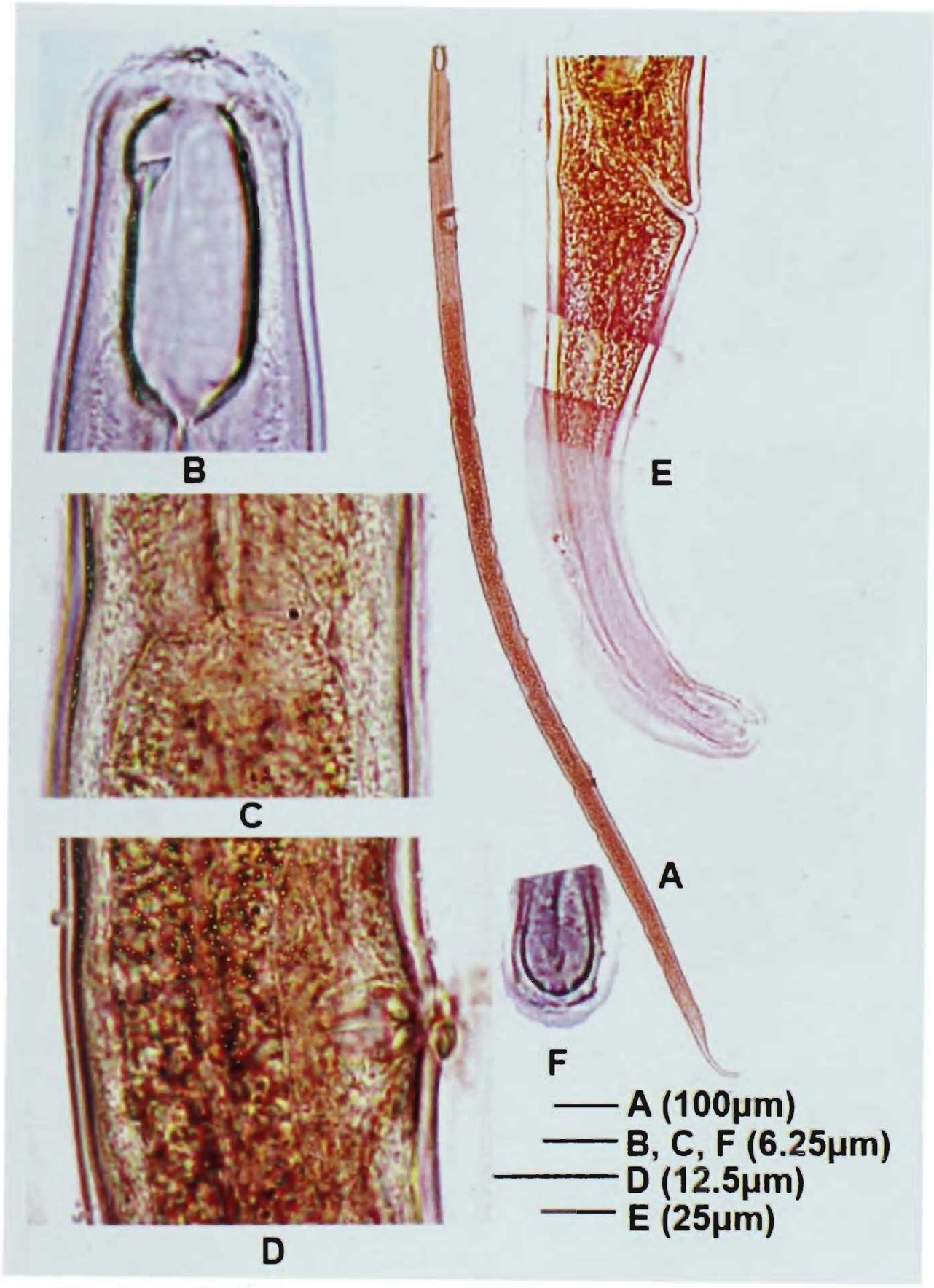


Figure 63. Photomicrographs of female *Mononchus aquaticus*.
A. Whole body; B. Head; C. Pharyngo-intestine junction; D. Vulval region; E. Tail; F. Tail terminus.

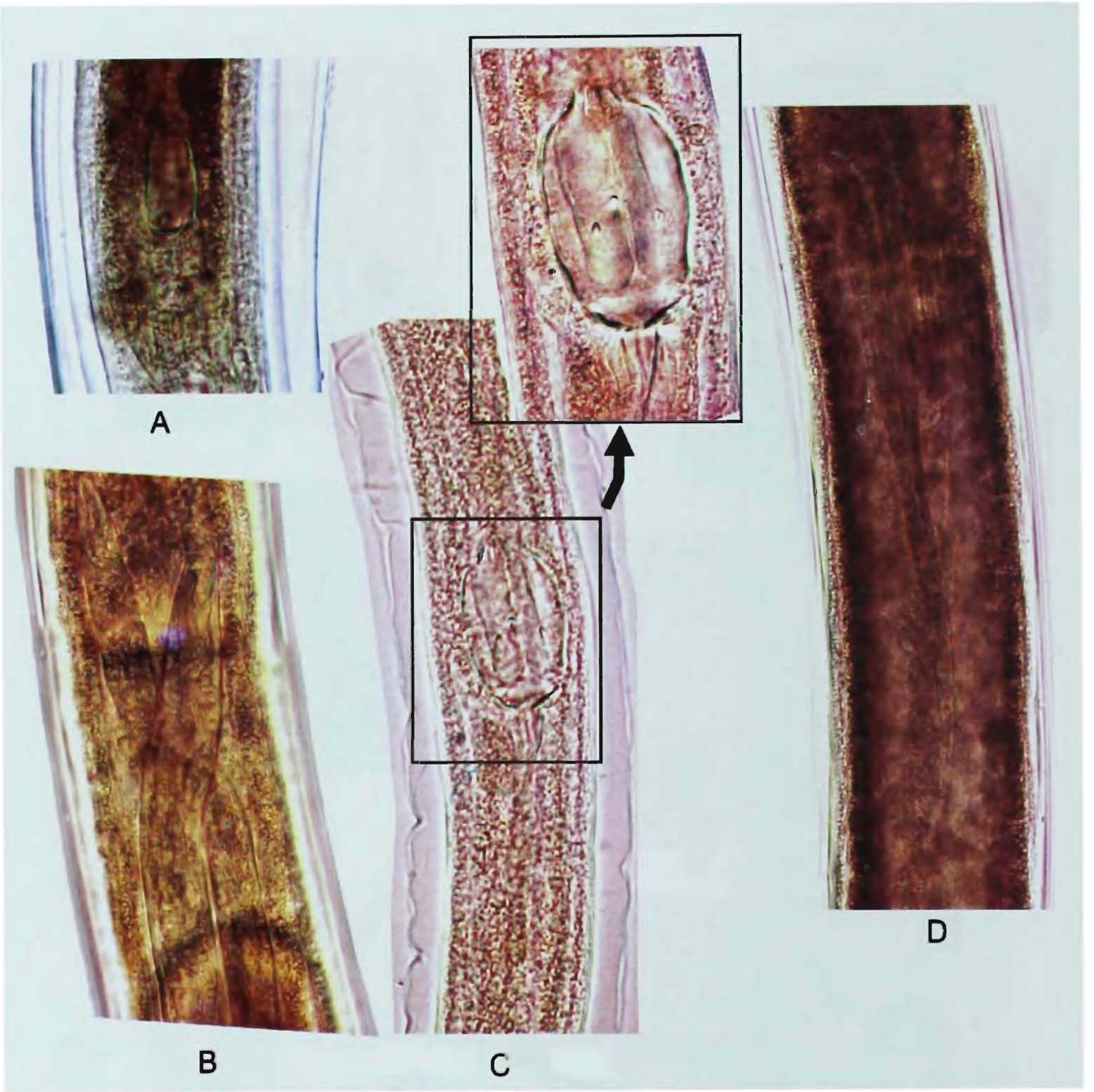
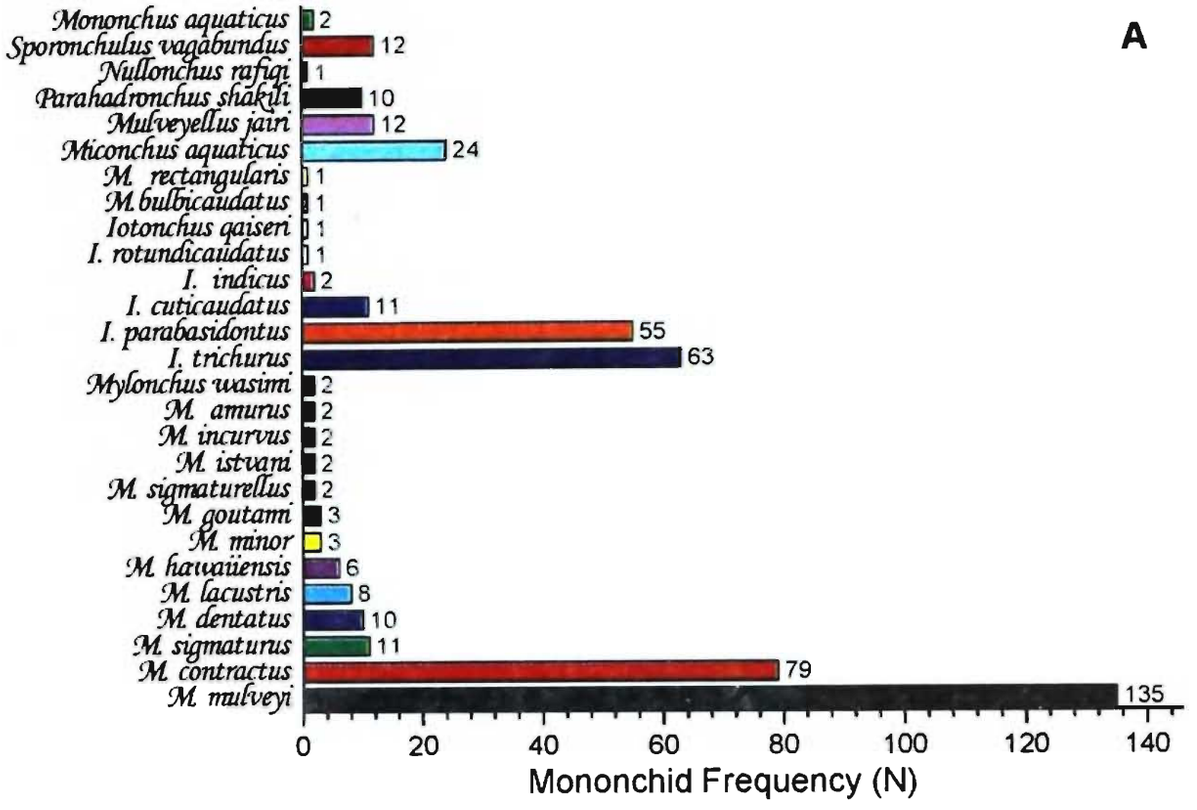


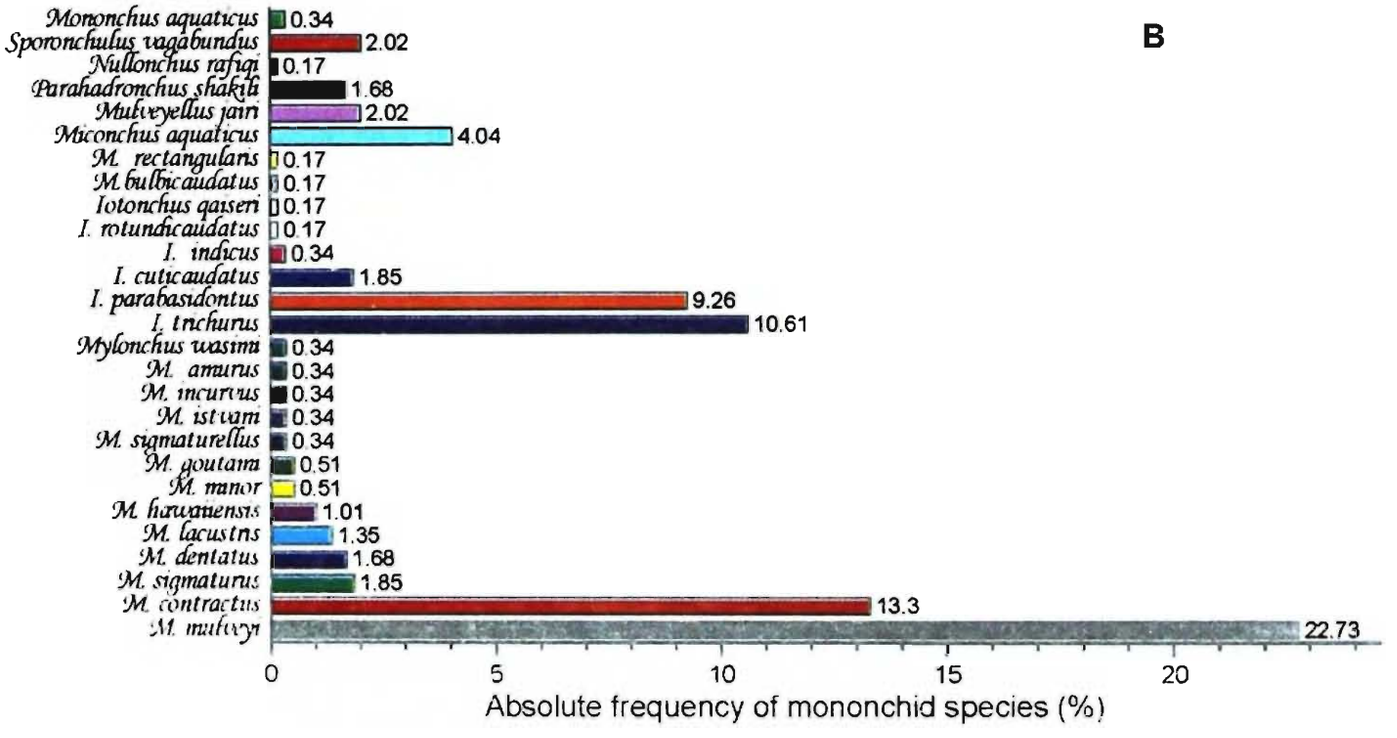
Figure 64. Cannibalism, prey and prey remnants in the intestine of few mononch species; A. Sclerotized buccal cavity of *Iotonchus* sp. in the lower part of intestine (near the anal aperture) of *I. parabasidontus;* B. Whole body of one *Mylonchulus* sp. and one tylenchid species in the intestine of *I. parabasidontus;*. C. Sclerotized buccal cavity of *Miconchus* sp. in the intestine of another *Miconchus* sp. (juvenile); D. Two unidentified nematodes in the intestine of *Miconchus aquaticus.*

A. Shalipur guava orchard

B. Balarampur guava orchard

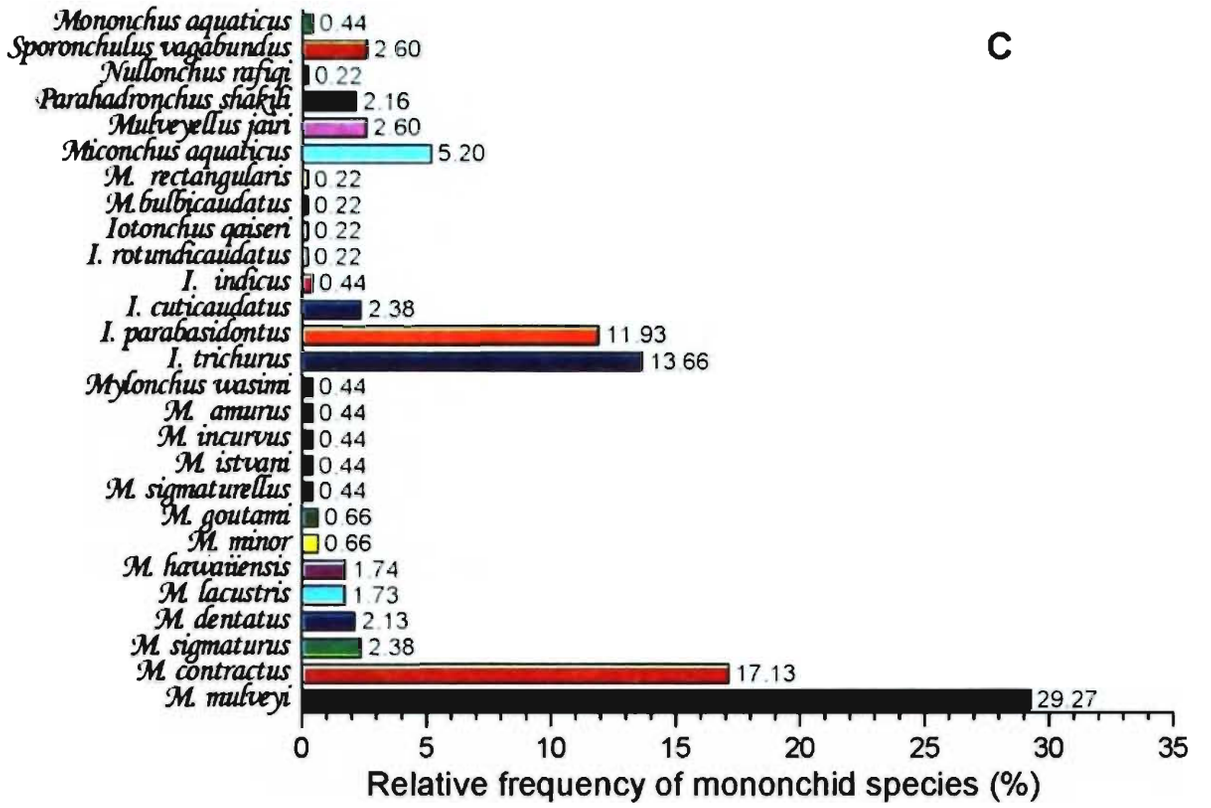
Figure 65. Guava orchards at Baruipur block (district South 24-Parganas). A. Shalipur guava orchard; B. Balarampur guava orchard.





mononchid population of district South 24-Parganas (A-G)

A. Frequency of mononchid species; B. Absolute frequency of mononchid species (%).



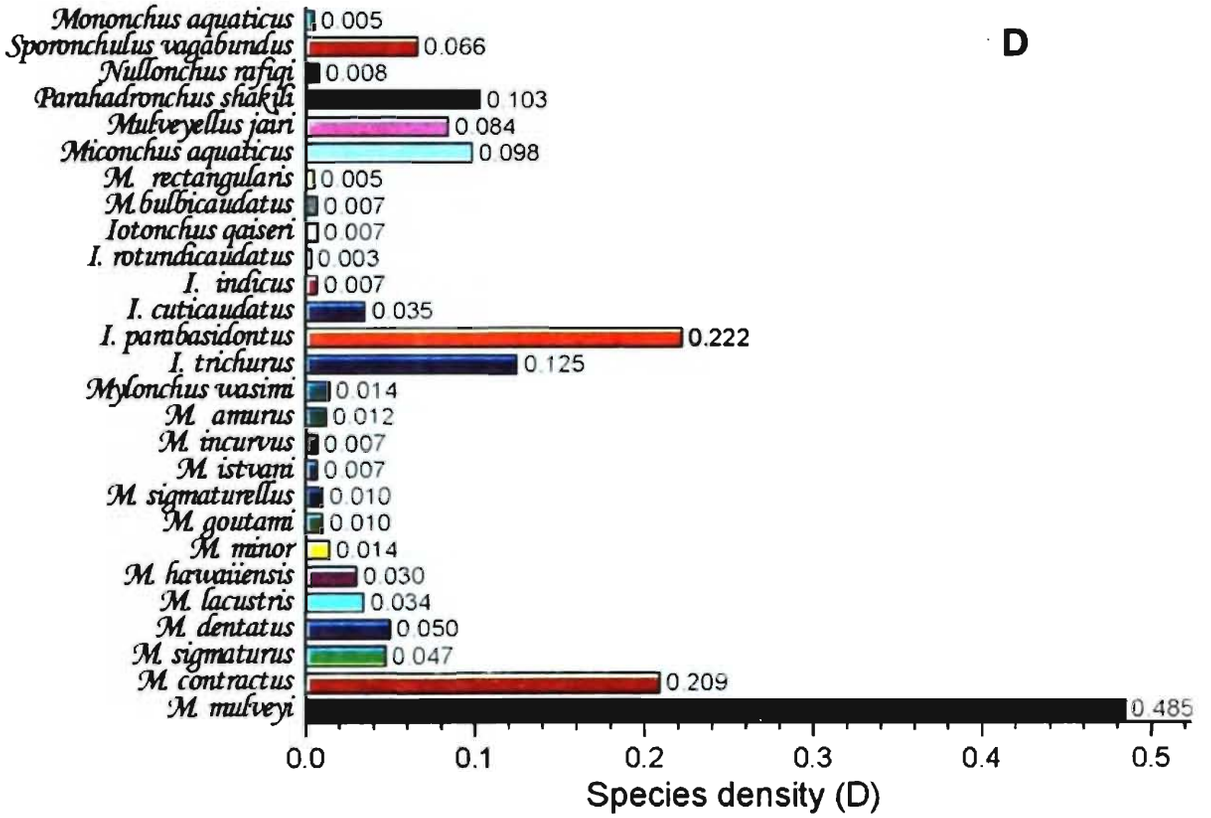
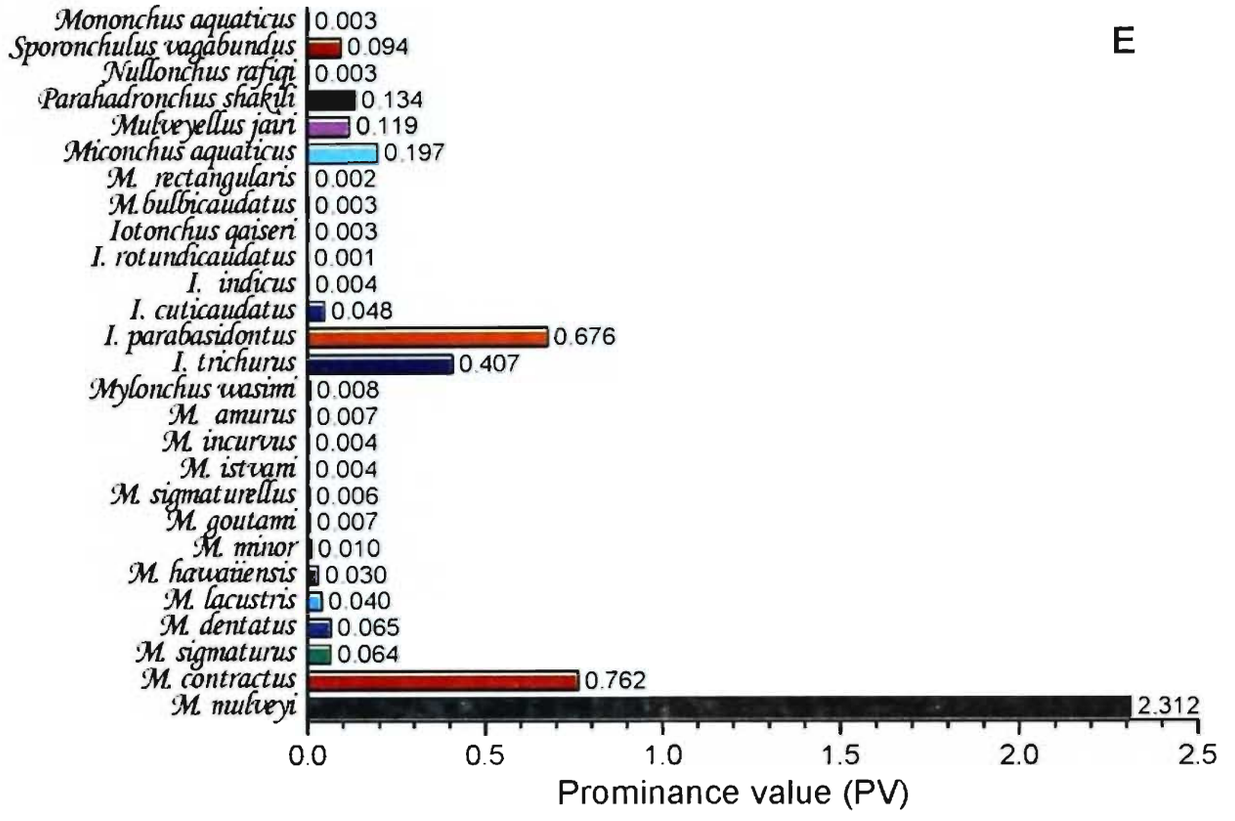


Figure 66. Bar diagram representation of data obtained from community analyses of mononchid population of district South 24-Parganas (A-G)

C. Relative frequency of mononchid species (%); D. Density of each mononchid species.



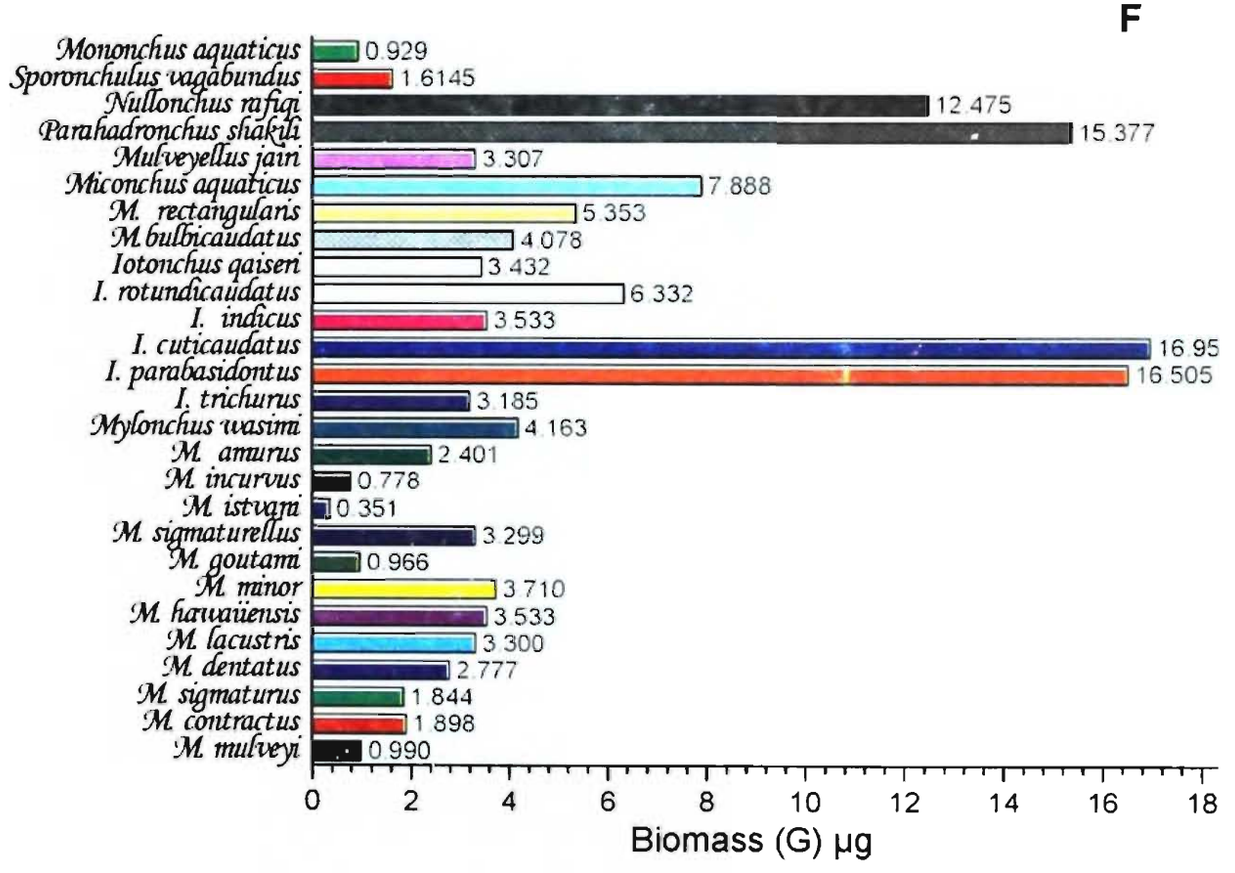


Figure 66. Bar diagram representation of data obtained from community analyses of mononchid population of district South 24-Parganas (A-G).

E. Prominence value of mononchid species; F. Biomass (G µg) of each specimen (mean) of particular mononch species.

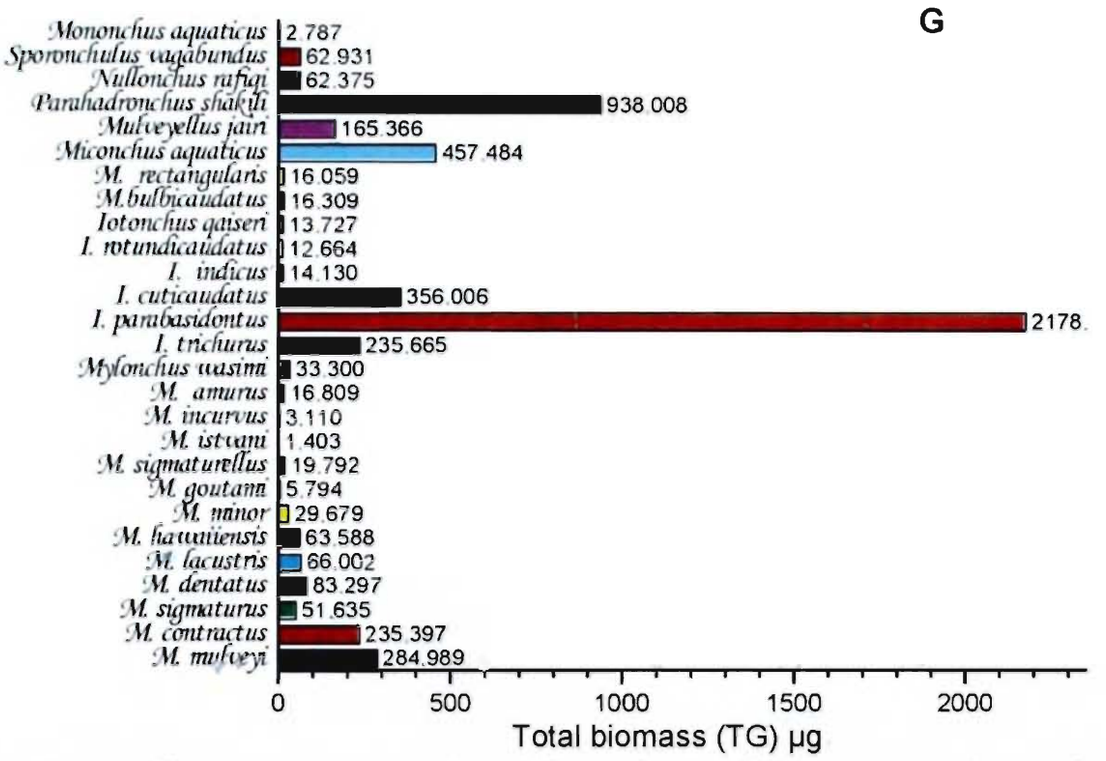


Figure 66. Bar diagram representation of data obtained from community analyses of mononchid population of district South 24-Parganas (A-G).

G. Total biomass (TG µg) of each species

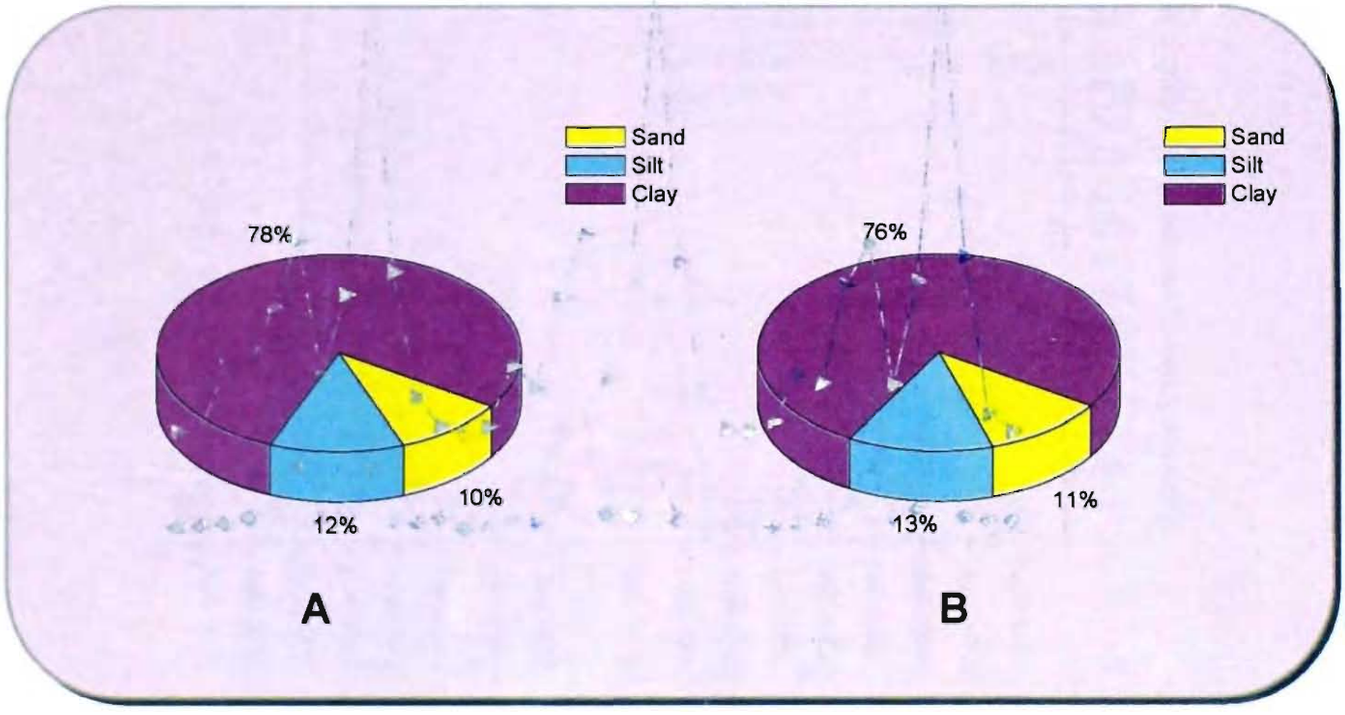


Figure 67. Percentage of Sand, silt and clay in Shalipur guava orchard (A) and Balarampur guava orchard (B)

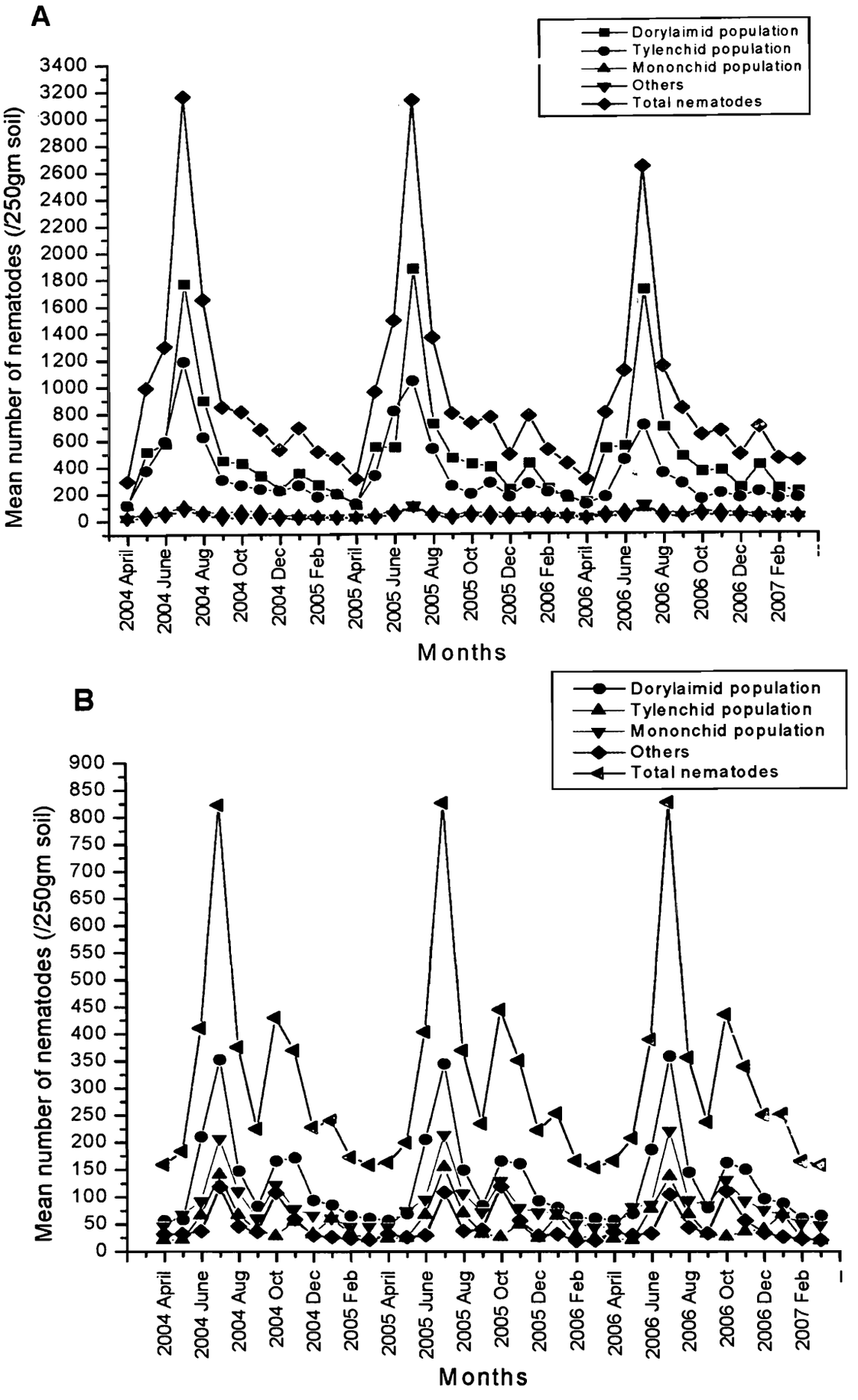
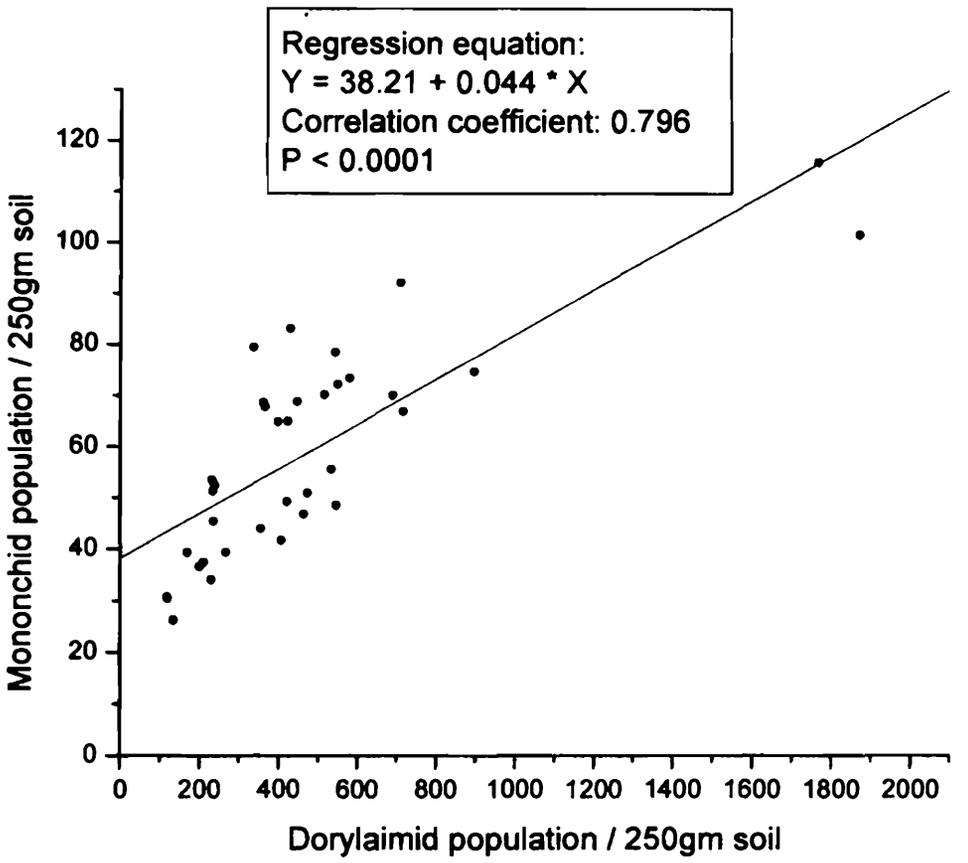
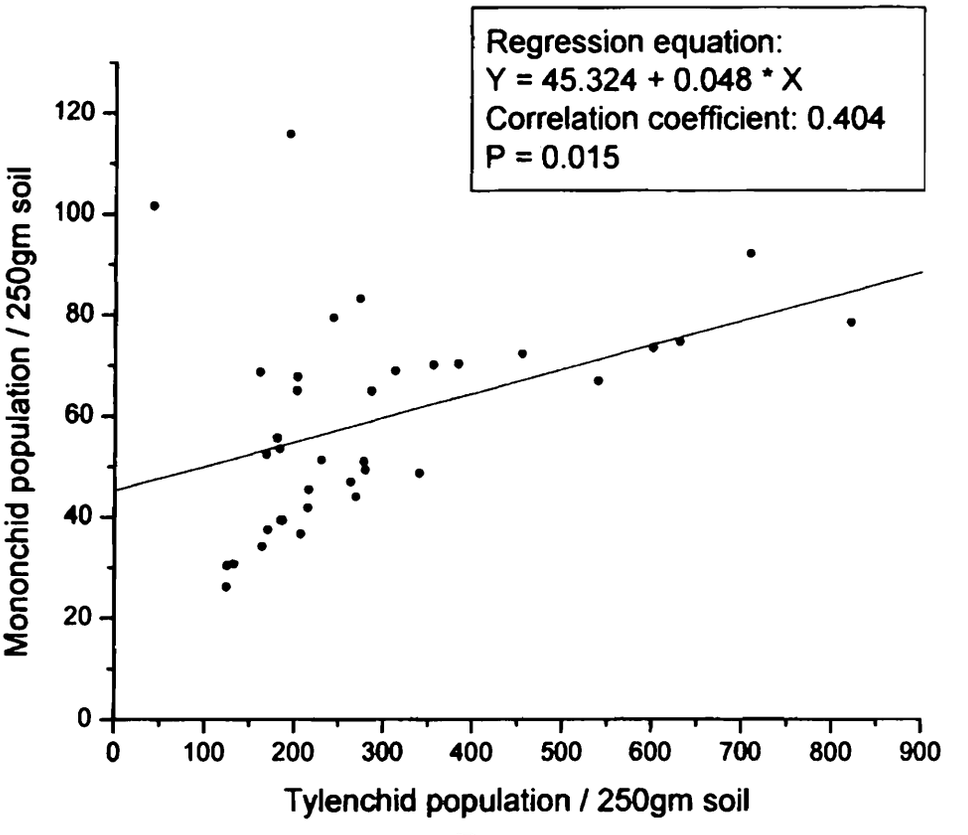


Figure 68. Graphical representation of total (adults and juveniles) number of nematodes in Shalipur guava orchard (A) and in Balarampur guava orchard (B) [data shown in Table 3]

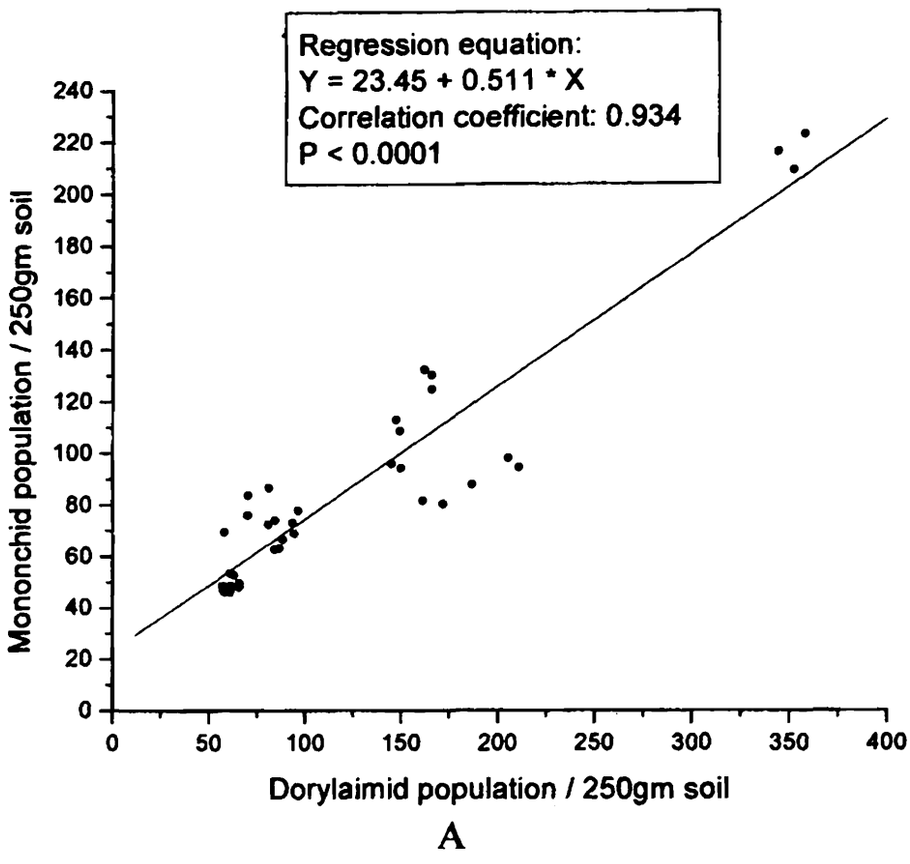


A

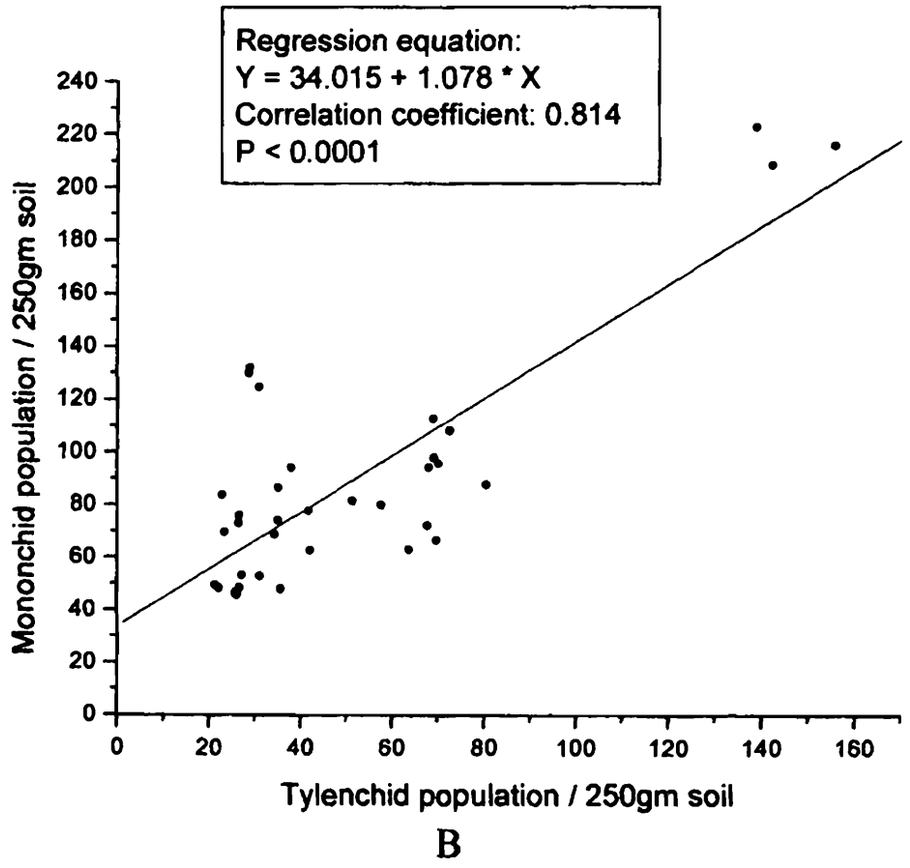


B

Figure 69. Linear regression of mononchid population with dorylaimid population (A), mononchid population with tylenchid population (B) in Shalipur guava orchard



A



B

Figure 70. Linear regression of Mononchid population with Dorylaimid population (A), Mononchid population with Tylenchid population (B) in Balarampur guava orchard

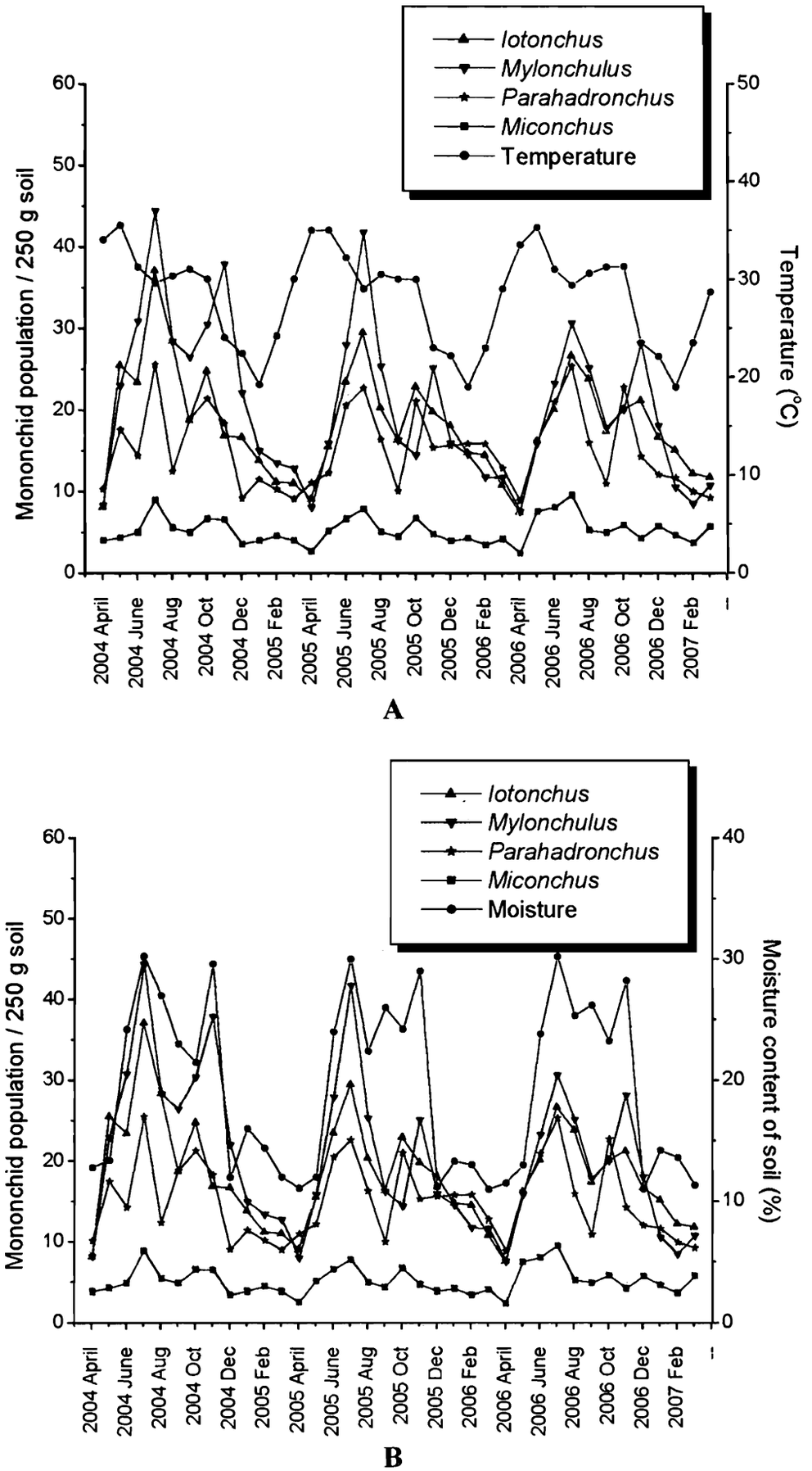


Figure 71. Population fluctuation of mononchids (Genera: *Iotonchus, Mylonchulus, Parahadronchus, Miconchus*) related to soil abiotic factors: Temperature (A), Moisture (B) in Shalipur guava orchard. [Data shown in Table 5]

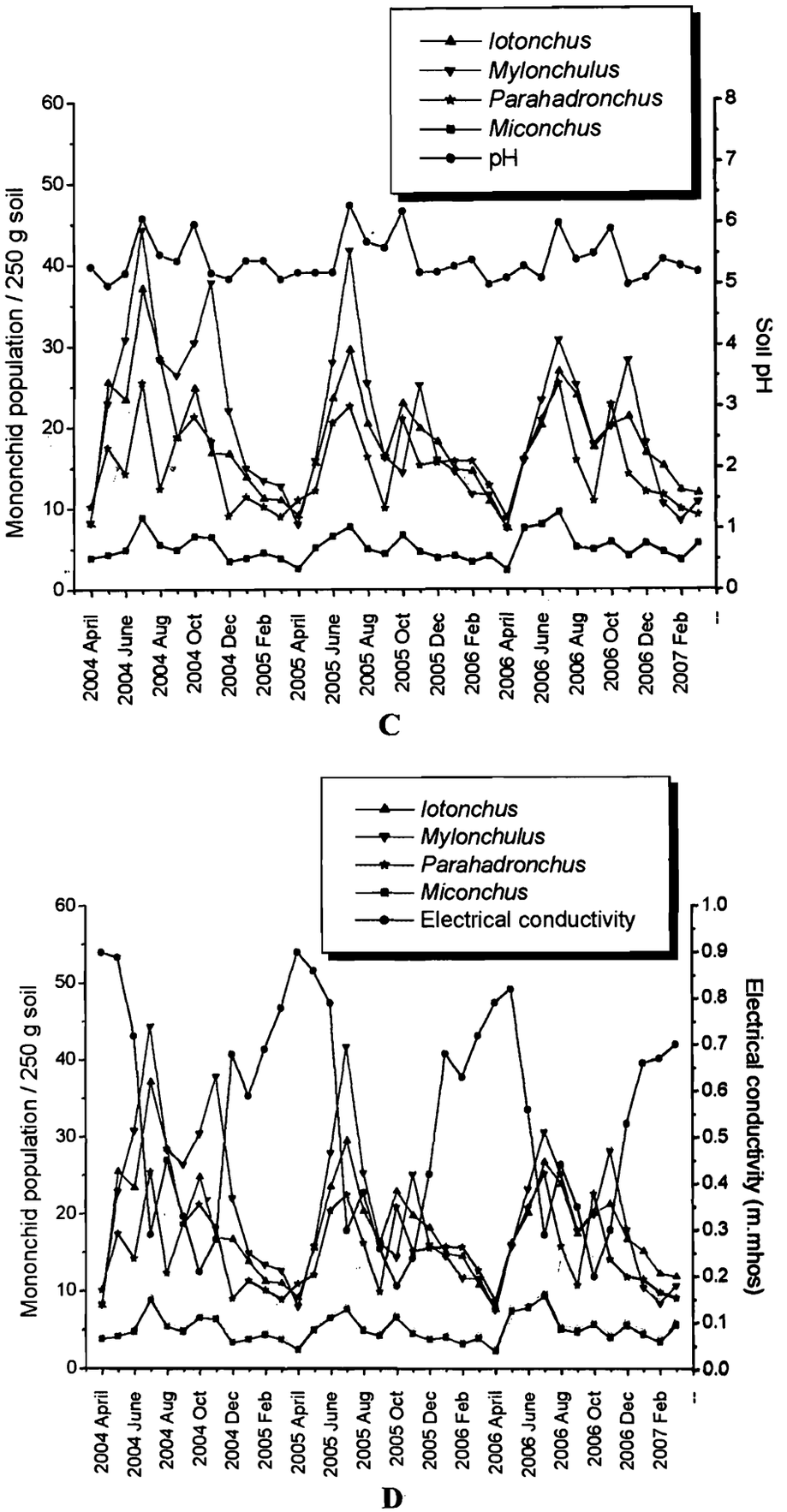
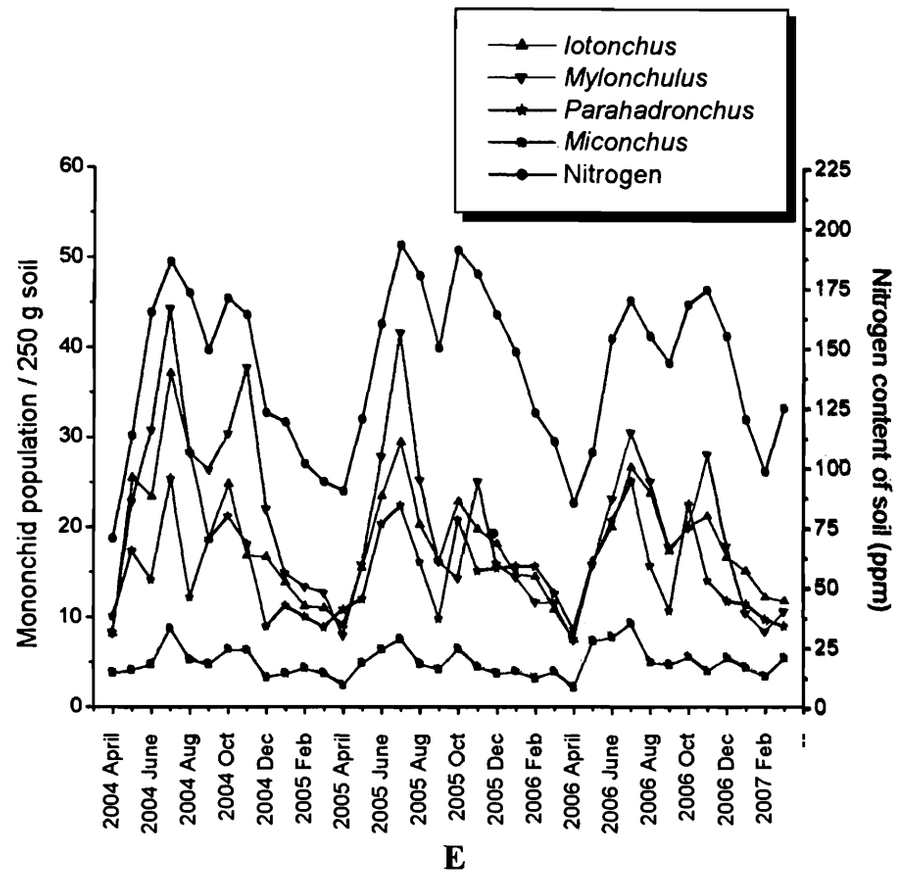
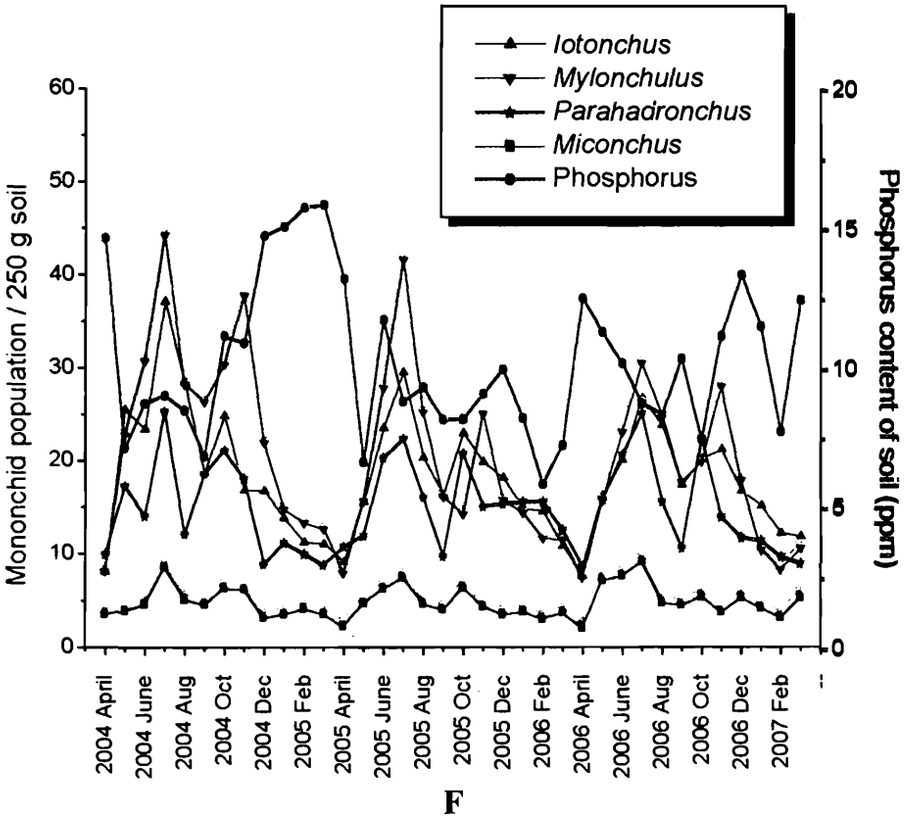


Figure 71. Population fluctuation of mononchids (Genera: *Iotonchus, Mylonchulus, Parahadronchus, Miconchus*) related to soil abiotic factors: pH (C), Electrical Conductivity (D) in Shalipur guava orchard [Data shown in Table 5]

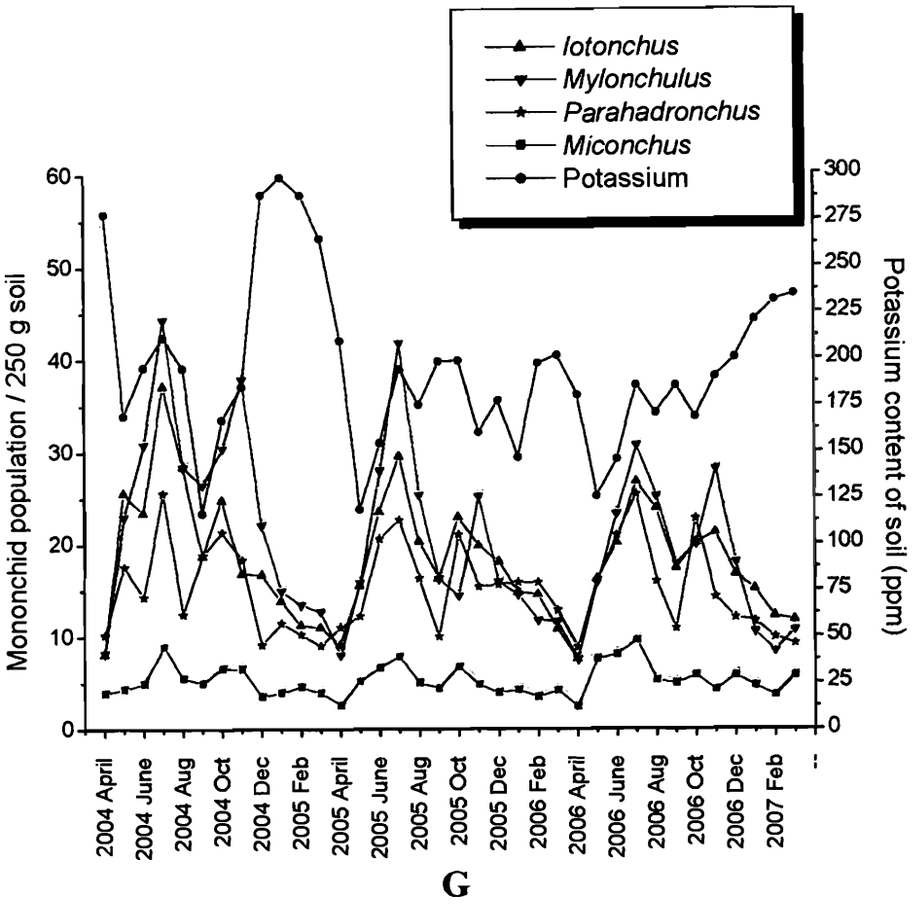


E

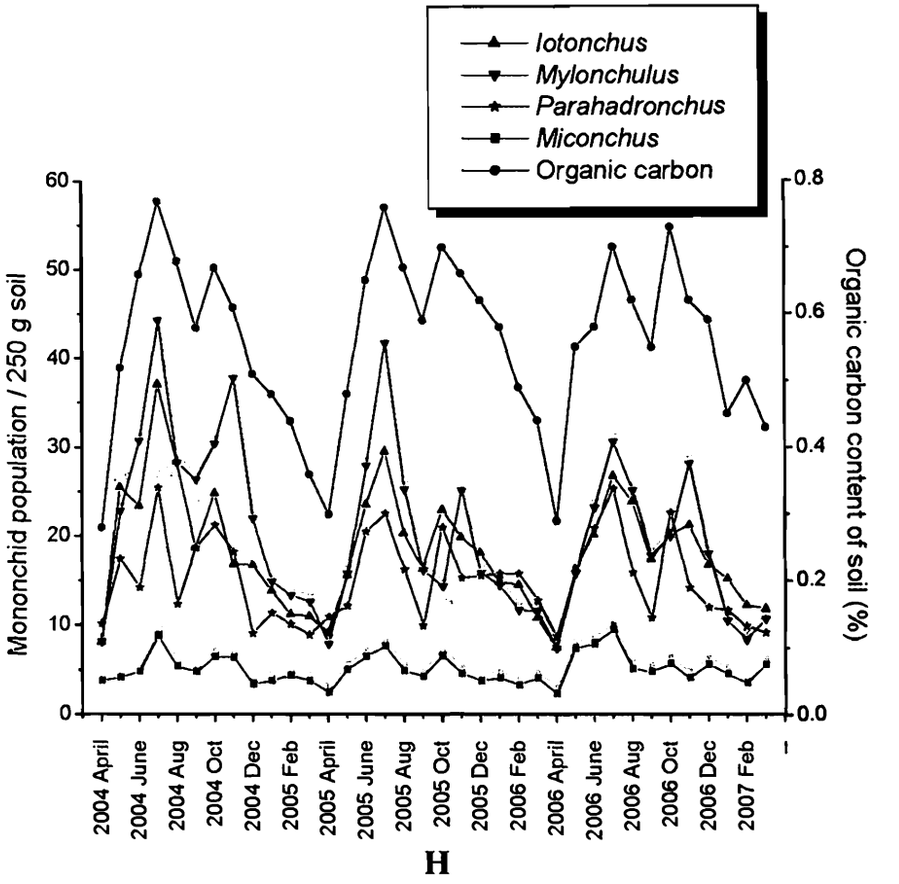


F

Figure 71. Population fluctuation of mononchids (Genera: *Iotonchus, Mylonchulus, Parahadronchus, Miconchus*) related to soil abiotic factors : Total Nitrogen content (E), Total Phosphorus content (F) in Shalipur guava orchard [Data shown in Table 5].



G



H

Figure 71. Population fluctuation of mononchids (Genera: *Iotonchus, Mylonchulus, Parahadronchus, Miconchus*) related to soil abiotic factors : Total Potassium content (G), Organic Carbon content (H)] in Shalipur guava orchard [Data shown in Table 5]

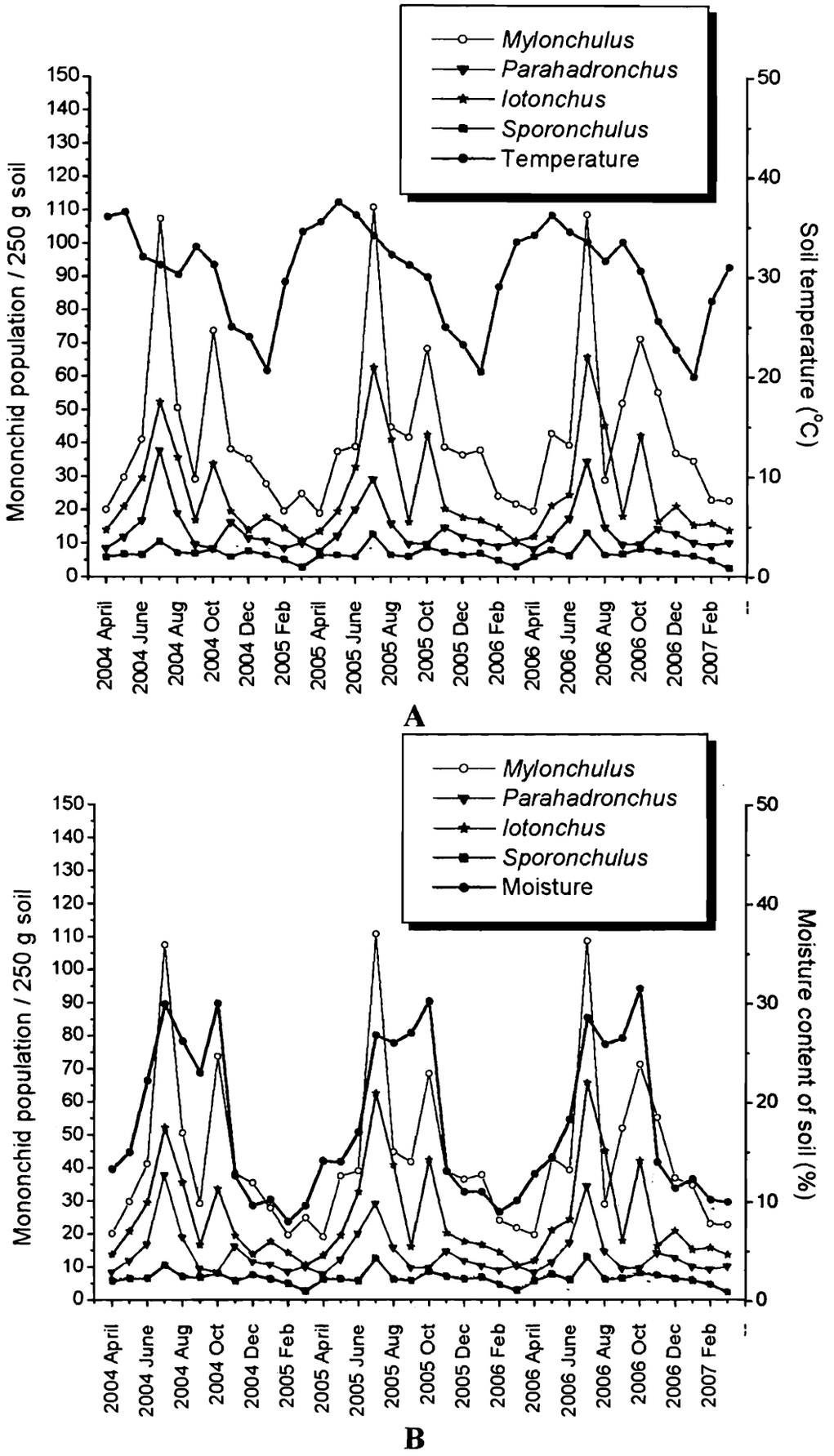
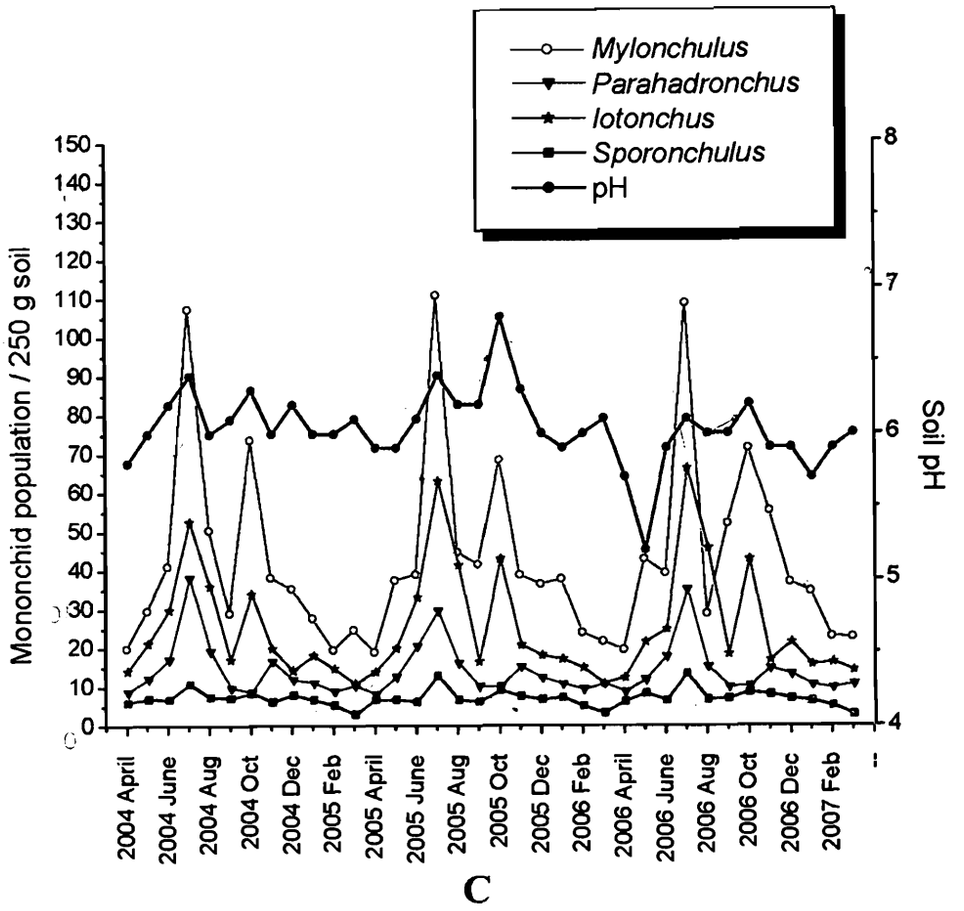
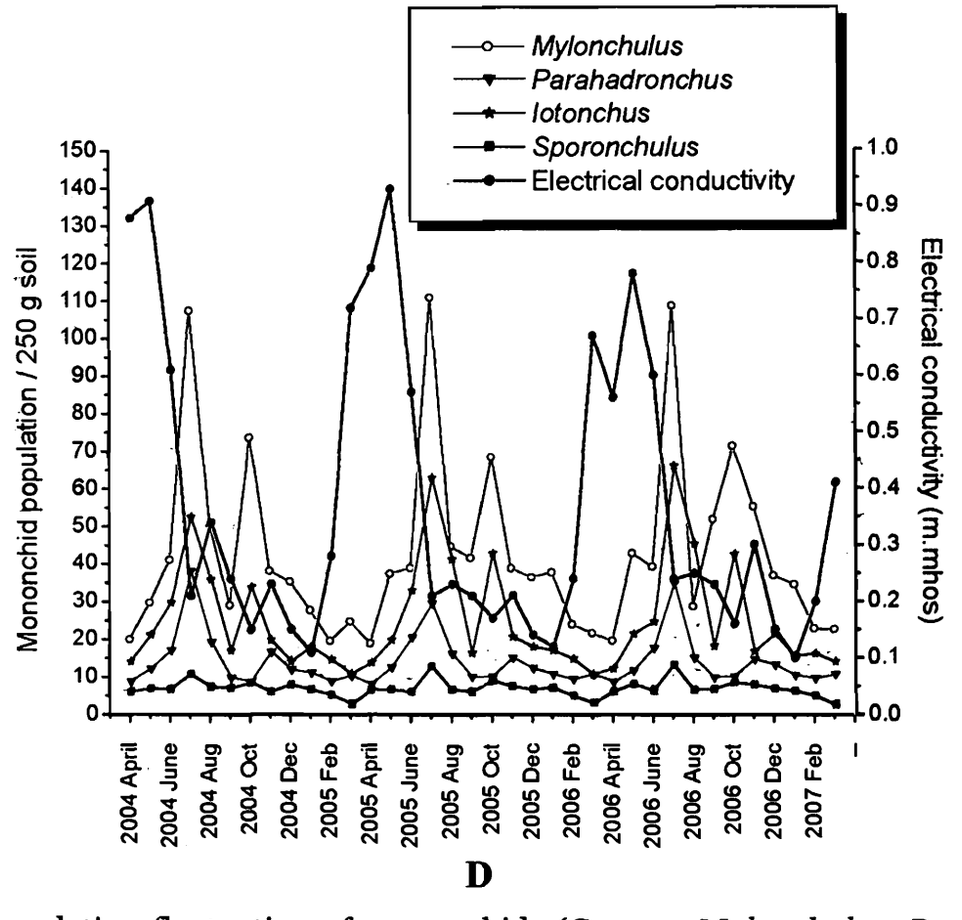


Figure 72. Population fluctuation of mononchids (Genera: *Mylonchulus, Parahadronchus, Iotonchus, Sporonchulus*) in relation with soil abiotic factors: Temperature (A), Moisture (B) in Balarampur guava orchard [Data shown in Table 6]



C



D

Figure 72. Population fluctuation of mononchids (Genera: *Mylonchulus, Parahadronchus, Iotonchus, Sporonchulus*) in relation with soil abiotic factors: pH (C), Electrical Conductivity (D) in Balarampur guava orchard [Data shown in Table 6]

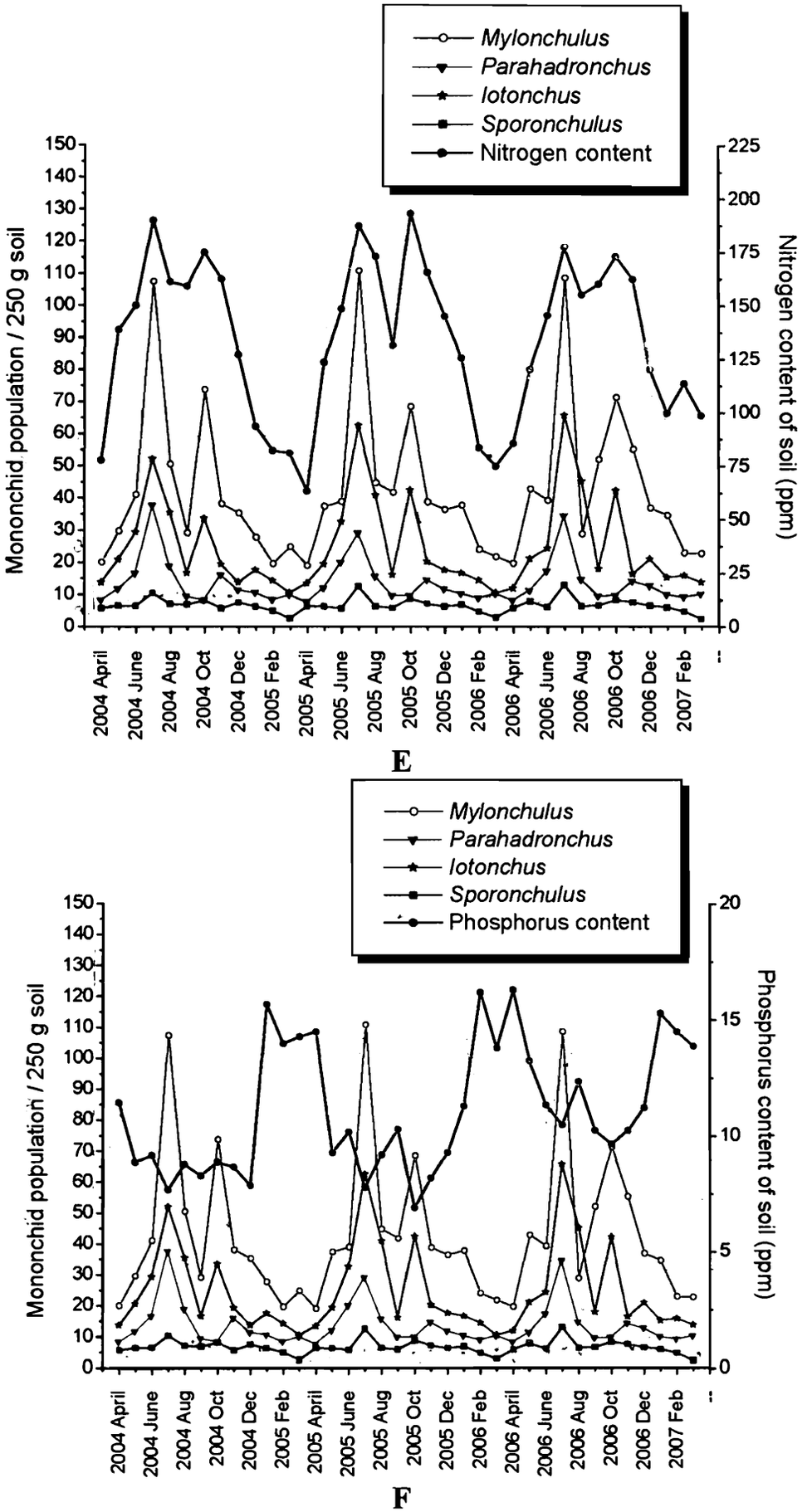


Figure 72. Population fluctuation of mononchids (Genera: *Mylonchulus, Parahadronchus, Iotonchus, Sporonchulus*) in relation with soil abiotic factors : Total Nitrogen content (E), Total Phosphorus content (F) in Balarampur guava orchard [Data shown in Table 6]

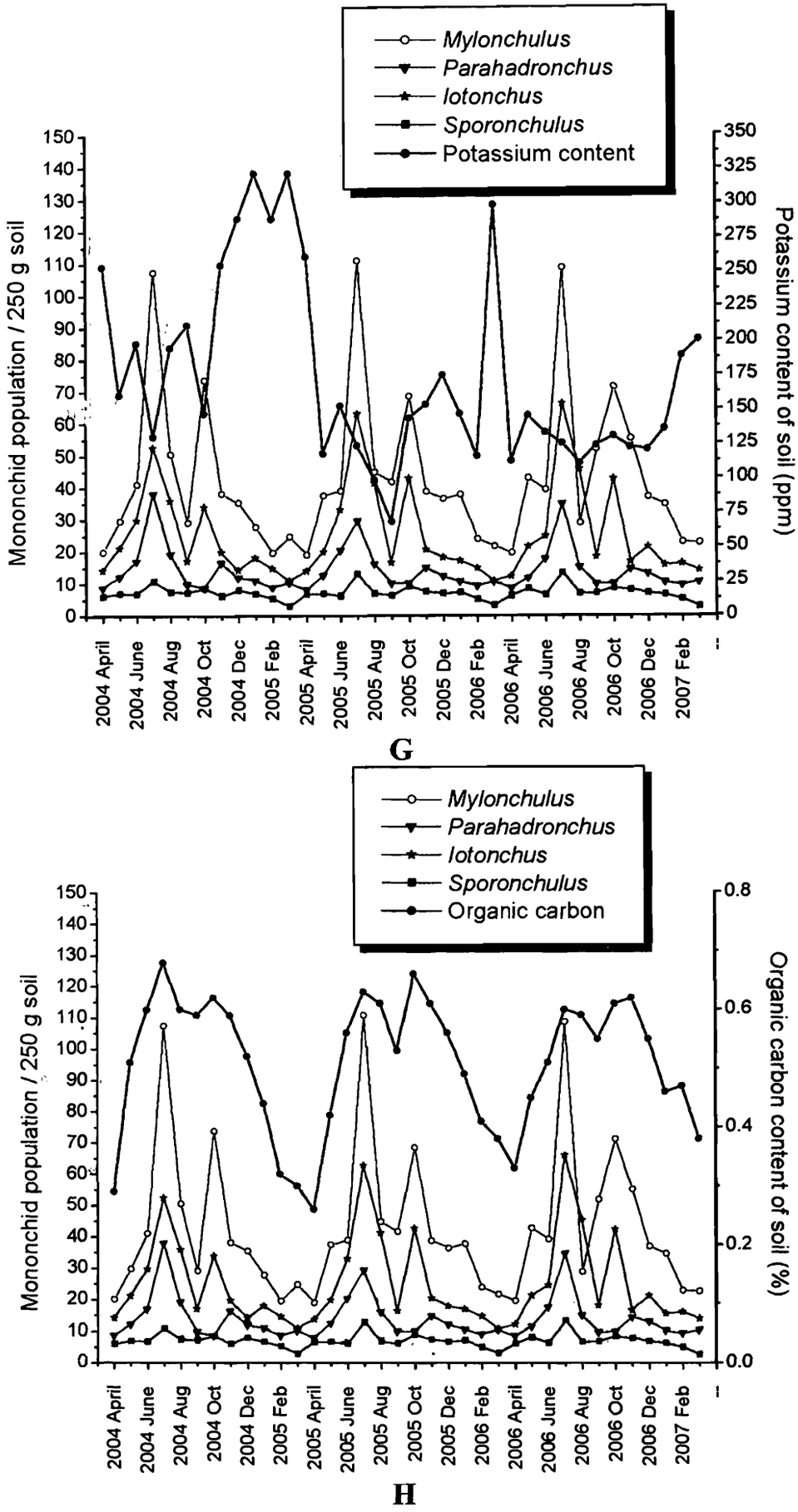


Figure 72. Population fluctuation of mononchids (Genera: *Mylonchulus, Parahadronchus, Iotonchus, Sporonchulus*) in relation with soil abiotic factors : Total Potassium content (G), Organic Carbon content (H)] in Balarampur guava orchard [Data shown in Table 6]

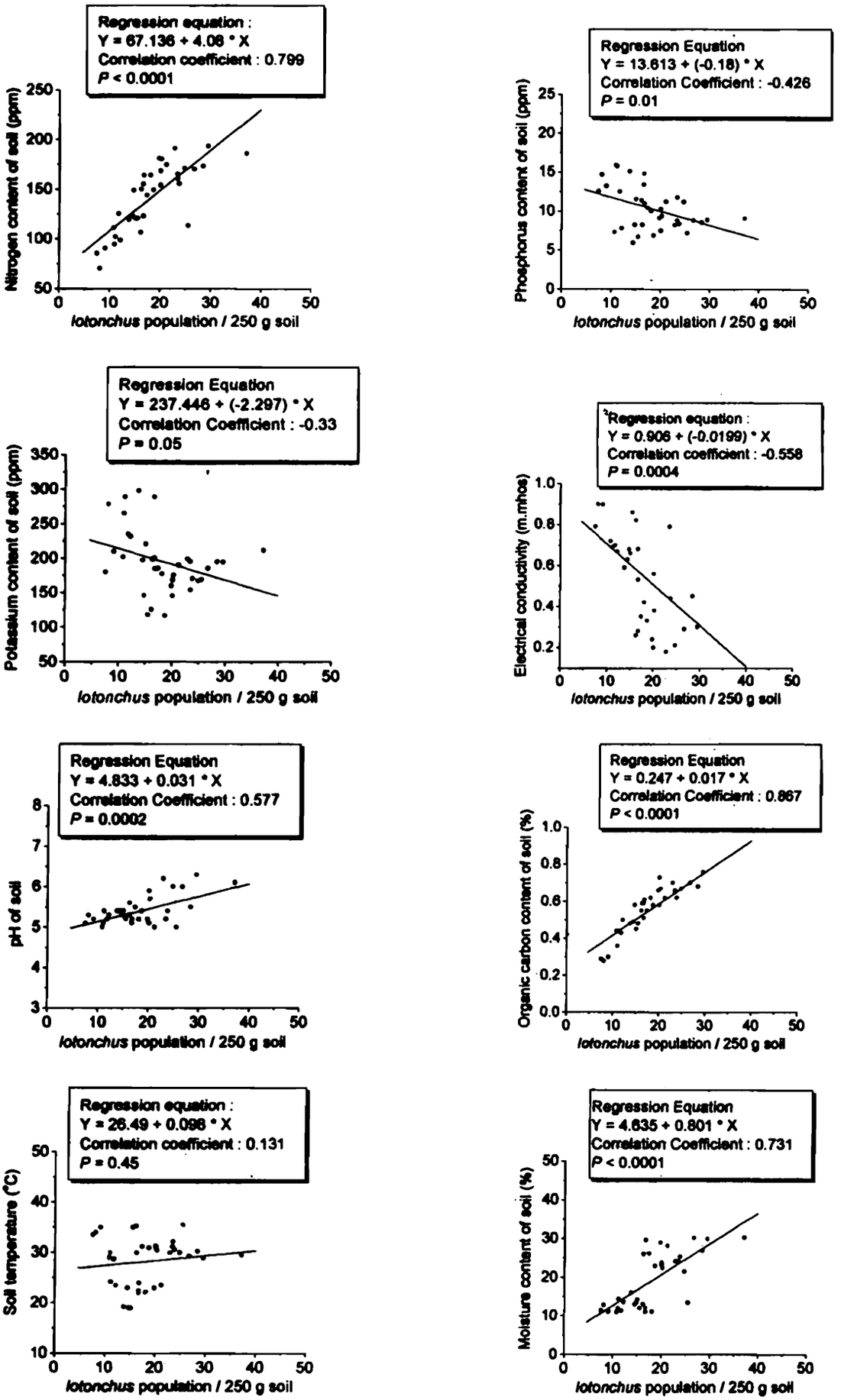


Figure 73. Linear regressions of mononchid population (genus, *Iotonchus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Shalipur guava orchard.

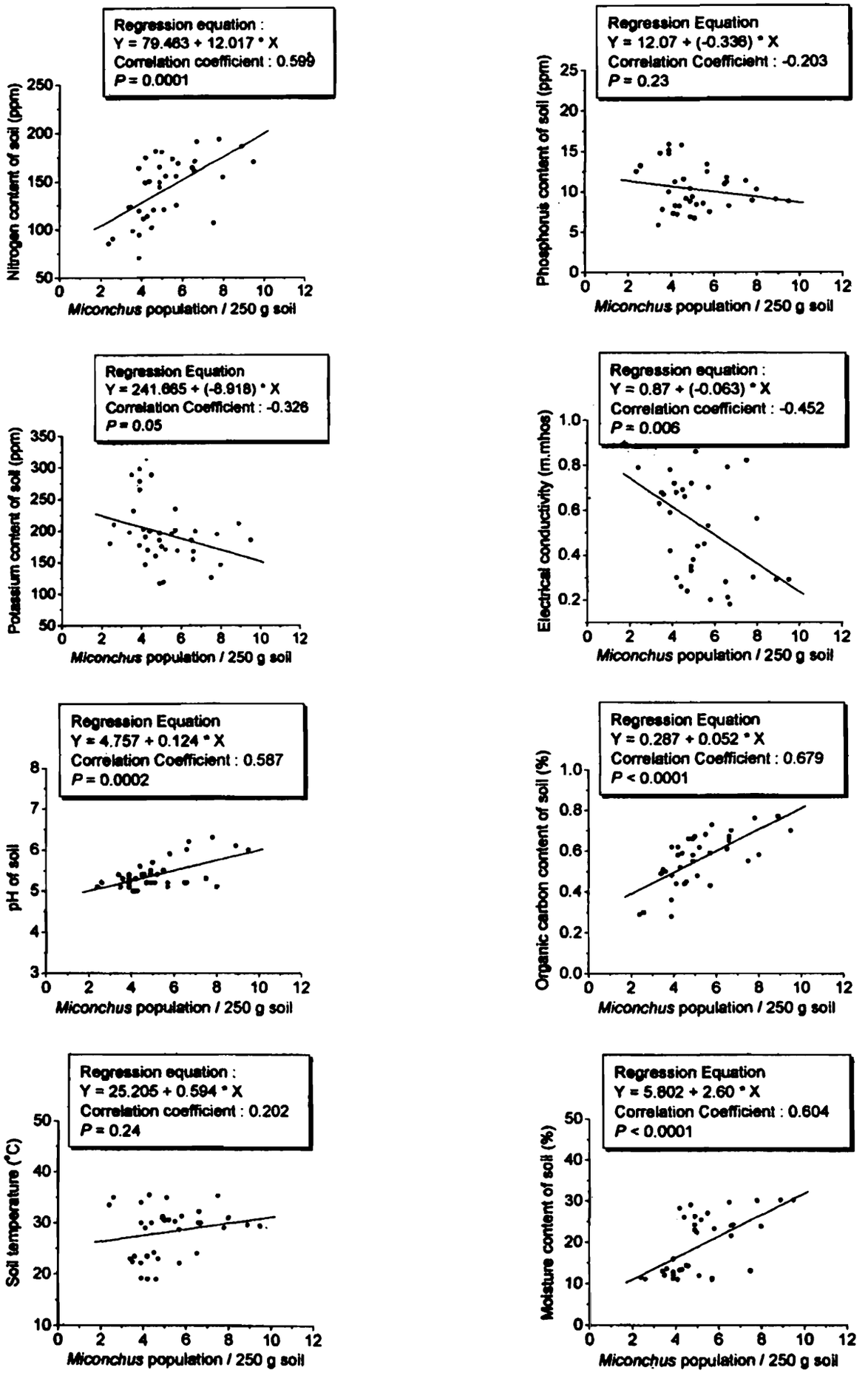


Figure 74. Linear regressions of mononchid population (genus, *Miconchus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Shalipur guava orchard.

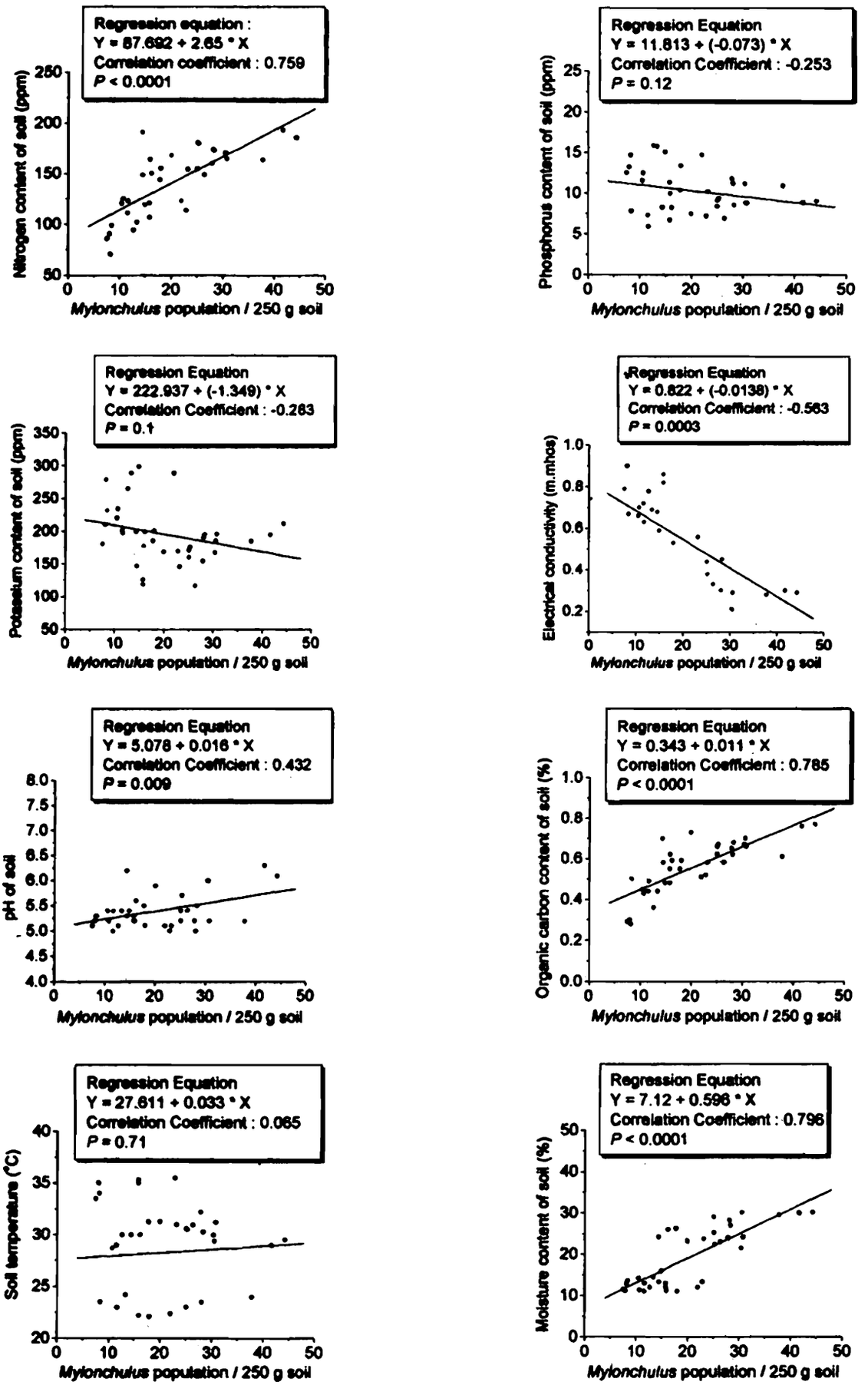


Figure 75. Linear regressions of mononchid nematode population (genus, *Mylonchulus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Shalipur guava orchard.

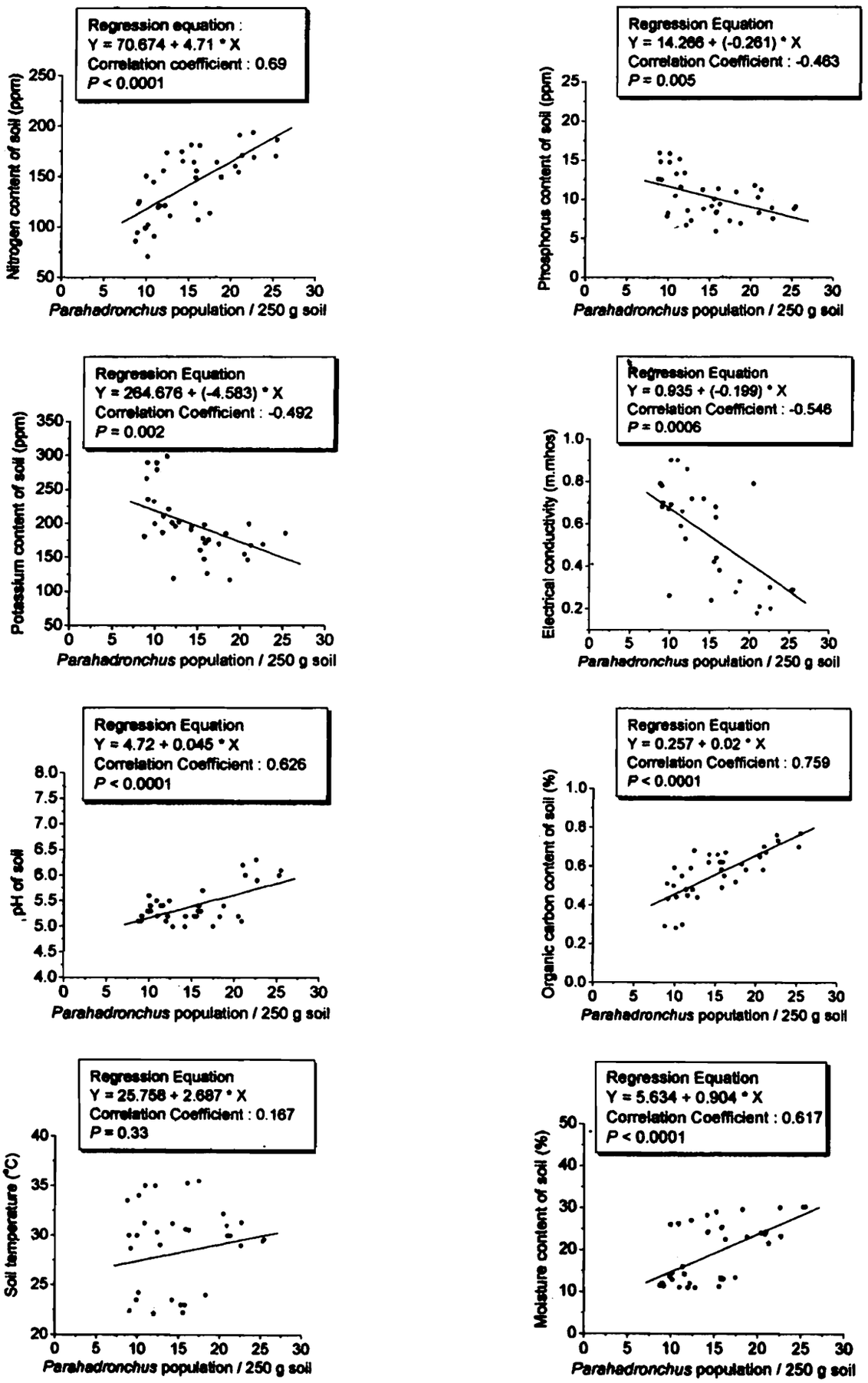


Figure 76. Linear regressions of mononchid nematode population (genus, *Parahadronchus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Shalipur guava orchard.

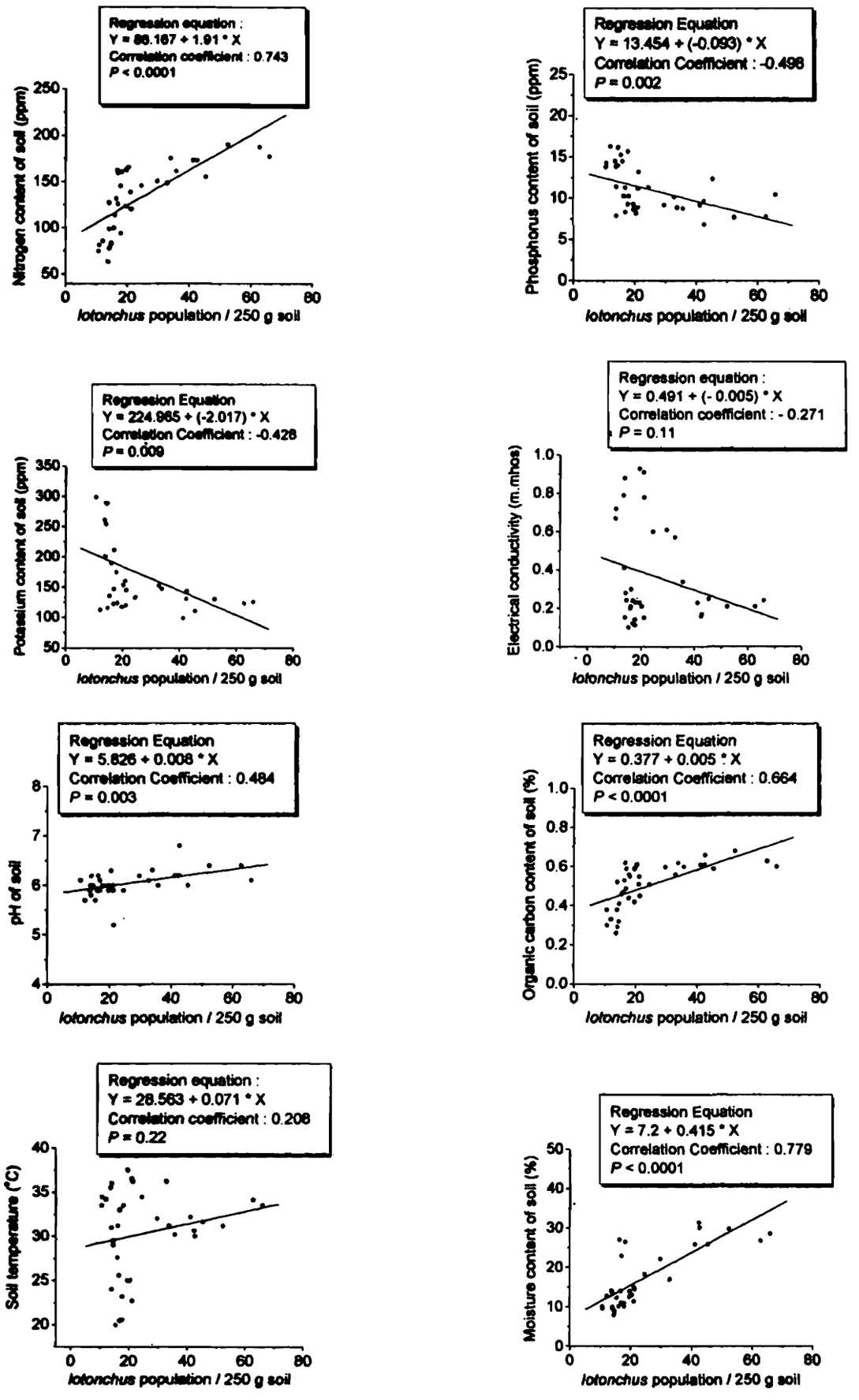


Figure 77. Linear regressions of mononchid nematode population (genus, *Iotonchus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Balarampur guava orchard.

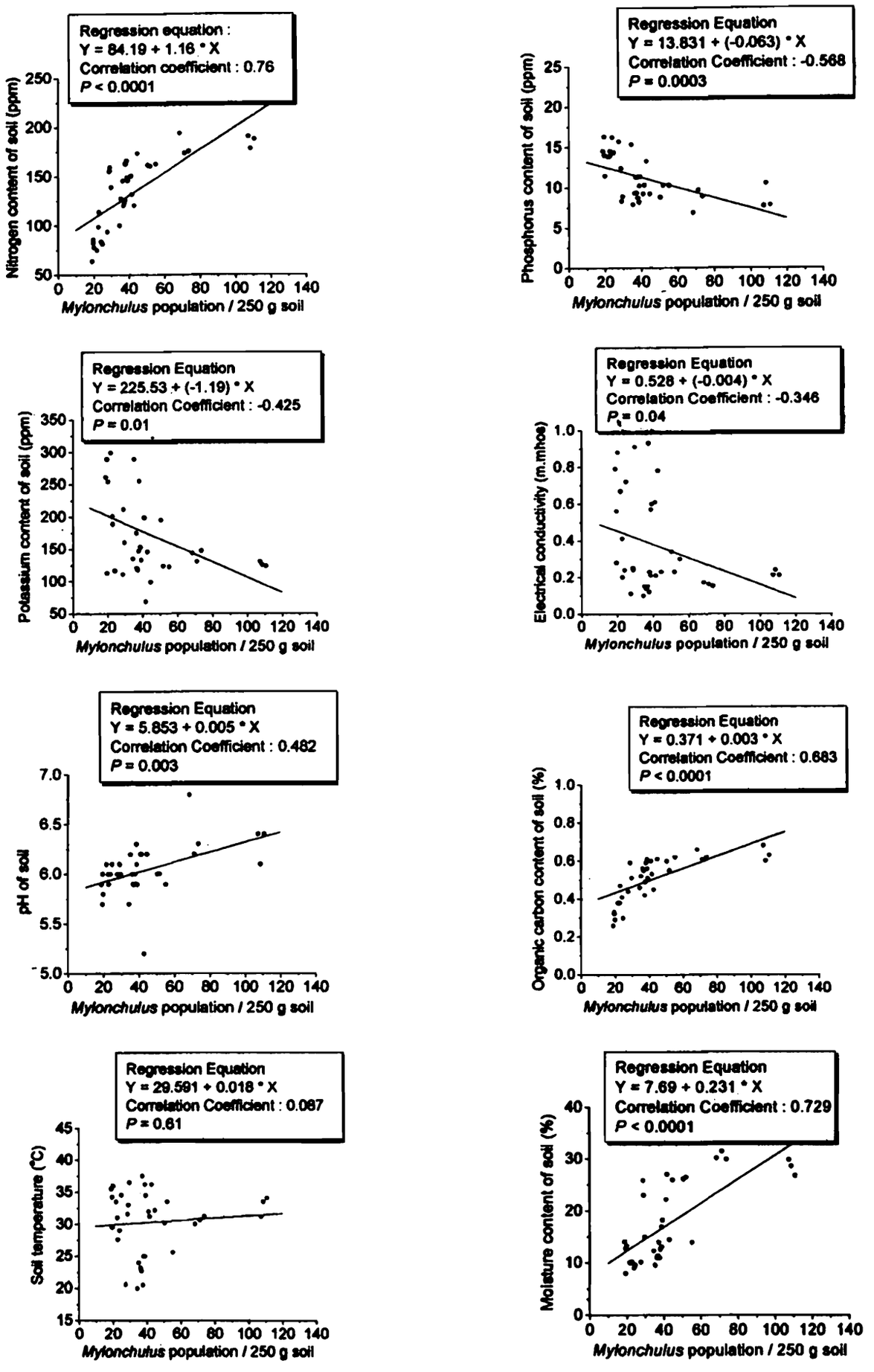


Figure 78. Linear regressions of mononchid nematode population (genus, *Mylonchulus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Balarampur guava orchard.

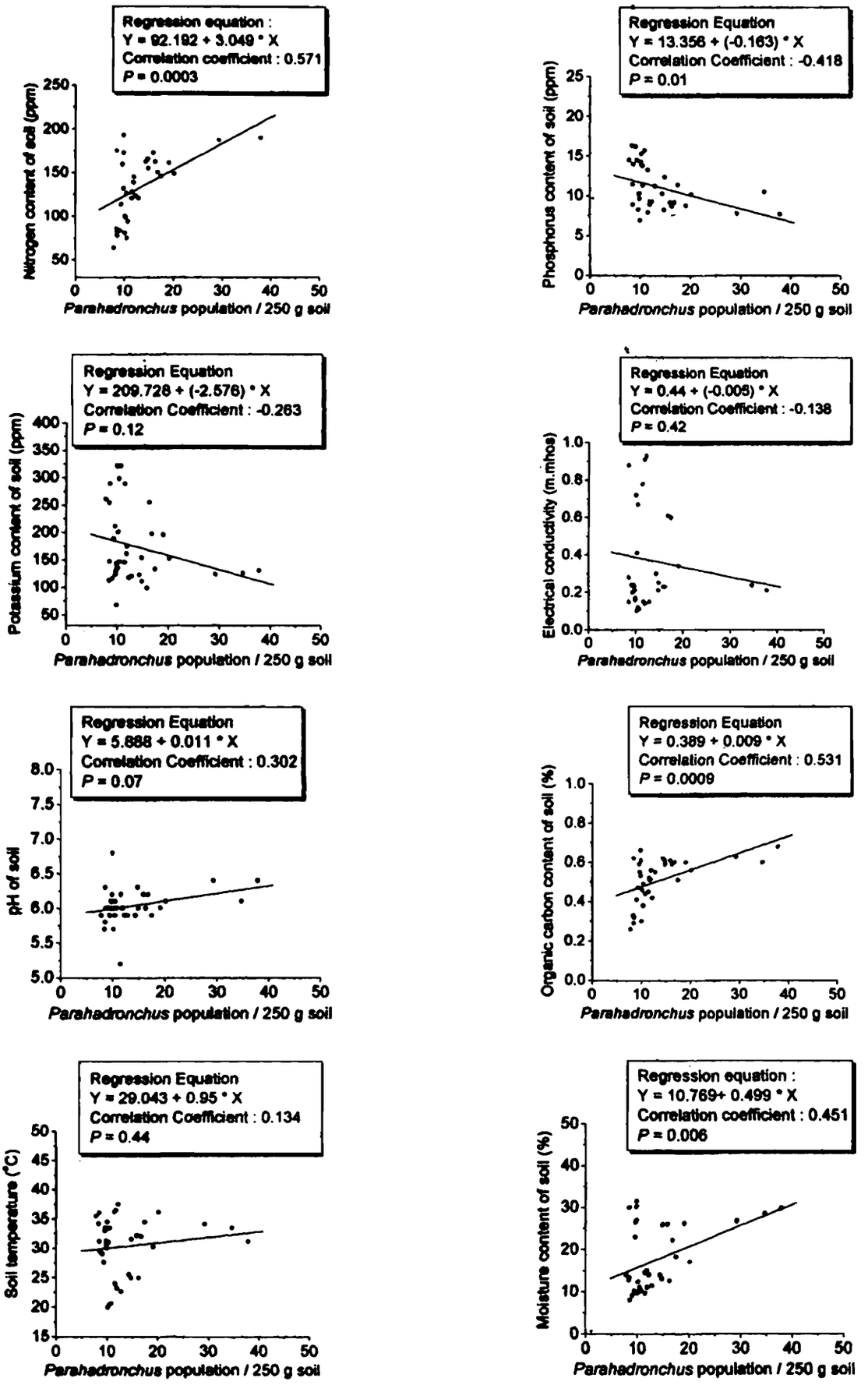


Figure 79. Linear regressions of mononchid nematode population (genus, *Parahadronchus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Balarampur guava orchard.

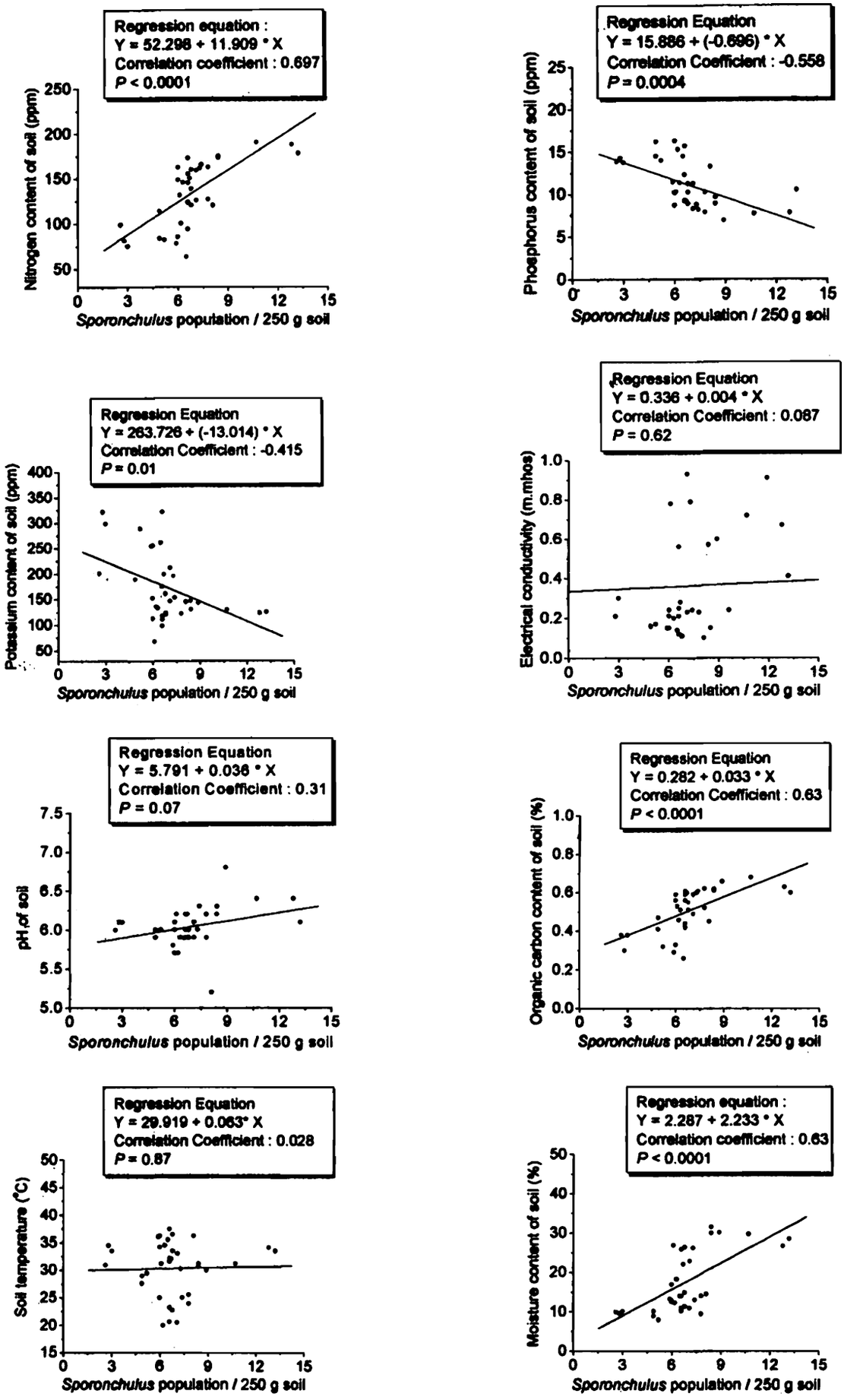


Figure 80. Linear regressions of mononchid nematode population (genus, *Sporonchulus*) in relation with different soil abiotic factors (as mentioned in Y axis title) in Balarampur guava orchard.