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Parasitic Nematodes of some Insects from Manipur, India

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1. Introduction

Manipur is situated in the north east of India. The state covers an area of 22,356 sq.kms of which the hilly region is about 91.75%, while the remaining 8.25% of the geographical area constitutes the central valley region. It lies between $23^0$51`N and $25^0$41`N latitudes and $93^0$2`E to $94^0$47`E longitudes. Generally, two types of climatic conditions are found in this state according to latitude, topography and direction of the prevailing wind system. Tropical monsoon type of climate prevails in the valley area whereas the cool temperate climate prevails in the hilly areas. The average maximum temperature of this state is 31^0C, the minimum temperature is 5^0C and the rainfall is about 2077mm per annum. Manipur being part of The North East India represents an important part of the Indo-Myanmar biodiversity hot spot recognized recently in the year 2005 among 34 Biodiversity hotspot of the world.

The present work mainly concerns with the nematodes of insects of Manipur. Nematodes are regarded as the most numerous multicellular animals on earth. There are over 20,000 described species classified in the phylum Nematoda. Most of the free-living nematodes are microscopic; many of the parasitic species invade the body fluids such as blood or lymph channels of their hosts. They exhibit a wide range of feeding habits. Many feed entirely on the microorganisms present in decaying vegetable matter (saprophytic), others live on plants and wander destructively through the tissues and suck their sap. In vertebrates they may parasitize every organ often causing destructive and painful diseases and producing immeasurable hardships. Their life cycle ranges from very simple to extremely complicated. The majority of the nematodes are oviparous, but some are ovoviviparous. All nematode juveniles whether they hatch in water or soil or within the animal host must undergo a series of 4 moults before reaching maturity. Entomophilic or insect nematodes are distributed in 27 families among nine major groups of nematodes viz., Rhabditoid, Tylenchoid, Aphelenchoid, Strongyloid, Oxyuroid, Ascaridoid, Spiruroid, Filaroid and Mermithoid. The first eight groups belong to the Rhabditea (plant and animal parasitic form) and the 9th belong to the Enoplea (mostly free living, microbotrophic aquatic nematodes). The Order Oxyurida contains parasites that parasitize both invertebrate and vertebrate hosts. The nematodes parasitizing the vertebrate hosts belong to the superfamily

Oxyuroidea and those nematodes parasitizing the invertebrate hosts belong to the superfamily Thelastomatoidea. The families listed under the latter superfamily are Thelastomatidae, Travassosinematidae, Protrelloididae, Hystrignathidae and Pseudonymidae [Adamson & Waerebeke, 1992a,b,c]. With the discovery of haplodiploid reproduction [Adamson, 1984] in this group of nematodes in which males develop from unfertilized eggs (haploid) and females from fertilized eggs (diploid) more attention is being paid to the above group of nematodes in the recent time. The present information will provide an impetus on understanding the biodiversity of the region. We all know that biodiversity ensures the essential ecological functions on which life depends. The well being and survival of human populations are dependent on millions of species of plants, animals and microbes. India is one of the twelve mega biodiversity regions of the world with 7.7% genetic resources of the microorganisms, plants and animals as well as the ecosystem, which they inhabit.

Entomophilic nematodes vary greatly in size and shape, have insects as intermediate or as definitive hosts, may be facultative or obligatory in their host relations and often involve other microorganisms in their relationships with their hosts. Though there are no report on important pathogens of man or domestic animals in these groups, entomophilic nematodes cause debilitation, sterility (partial/complete) or death of a large number of insects belonging to various Orders and families. They have evolved to parasitize every kind of insects , so it is not too surprising to find them killing, sterilizing or otherwise debilitating millions of different kinds of insects such as mosquitoes, blackflies, chironomid flies, grasshoppers, moths, ants, bees and many other insects and invertebrates. The nematodes recovered were found to represent four families viz., Thelastomatidae, Travassosinematidae, Pseudonymidae and Protrelloididae. Parasitism by the members of the superfamily Thelastomatoidea revealed 16 species of nematodes spread over 11 known genera. The article encompasses diagnosis on four families and 11 genera, key to genera of four families and key to species of 10 genera.

2. Materials and methods

Insects were anaesthesised with chloroform and dissected immediately in normal saline. Gut was teased out with fine needle and the contents were mixed with saline. The nematodes were picked up using horse hair under low power stereoscopic binocular microscope. The parasitic nematodes collected from insect hosts namely *Periplaneta americana* Linn, *Gryllotalpa africana* Beauvois, *Hydrophilus triangularis* Say were killed and fixed in TAF (Triethanolamine formaline) fixative [Courtney *et al.,* 1955]. They were dehydrated by slow method (anhydrous $CaCl_2$) and mounted on glass slides in anhydrous glycerine. Glass wool or wire of suitable thickness was used to avoid the flattening of the nematode specimens. Measurements were taken using ocular micrometer and illustrations were drawn using drawing tube attached to Nikon (Alphaphot2-YS2 and Optiphot2) microscopes. Photomicrography was done using Olympus BX50 DIC Microscope with C5050 digital camera. De Man's ratios/formula [De Man,1884] was used to denote the dimensions of the nematodes *i.e.*, a=total body length/maximum body width, b=total body length/distance from anterior end to the base of oesophagus, c=total body length/tail length, V=distance of vulva from anterior end x 100/total body length.

3. Key to families of Thelastomatoidea

1. Vulva posterior to base of oesophagus……2
- Vulva anterior to base of oesophagus….....Protrelloididae Chitwood, 1932
2(1). Cervical cuticle with transverse rows of spines...….Hystrignathidae Travassos, 1920
- Cervical cuticle without spines……3
3(2). Eggs with filaments……..4
- Eggs without filaments……Thelastomatidae Travassos, 1929
4(3). Egg filaments twisted around shell, polar egg filaments absent.....…….. ……Pseudonymidae (Kloss, 1958) Adamson, 1989
- Egg filaments not twisted around shell, polar egg filaments present…….. ….....……..Travassosinematidae Rao, 1958

4. Family: Thelastomatidae Travassos, 1929

4.1 Key to genera of Thelastomatidae Travassos, 1929

1. Egg bearing spine-like outgrowths……..…….....*Gryllophila* Basir,1942a
- Egg without spine-like outgrowths……..……..…..2
2(1). Buccal cavity provided with cuticular modifications…….……3
Buccal cavity without cuticular modifications…..……...…….4
3(2). Buccal cavity with 3 tooth-like projections, eggs elongate and has longitudinal lines...……...*Severianoia* (Schwenk, 1926) Travassos, 1929
- Buccal cavity with intermediate thickenings of the cuticle which form small teeth, eggs oval without longitudinal lines…….....*Fontonema* Chitwood,1930
4(2). Isthmus surrounded by nerve ring…….....…….5
- Isthmus not surrounded by nerve ring…..……..……9
5(4). Egg with operculum…….*Suifunema* Chitwood,1932
- Egg without operculum……...…….6
6(5). Corpus clavate……..……...…….7
- Corpus pyriform……...……....*Aoruroides* Travassos & Kloss,1958
7(6). Egg elongate, flattened on one side……..……...……...…8
- Egg oval to ellipsoidal……..……...……...*Johnstonia* Basir,1956
8(7). 4 pairs of caudal papillae in male…..……..….*Galinanema* Spiridonov,1984
- 5 pairs of caudal papillae in male…..…….*Golovatchnema* Spiridonov,1984
9(4). End bulb with valve……..……..10
- End bulb without valve…..…….*Robertia* Travassos & Kloss,1960
10(9). Spicule present……..……...…..11
- Spicule absent……..……...…..…21
11(10). Caudal papillae 3 pairs……..……...….12
- Caudal papillae 4-5pairs…...……..……...14
12(11). Female tail filiform……..……*Euryconema* Chitwood,1932
- Female tail not filiform……..……...…..13
13(12). Cephalic extremity with expanded 2nd annule……...…… ……..……..…*Leidynemella* Chitwood & Chitwood, 1934
- Cephalic extremity with simple 2nd annule……...….*Cameronia* Basir,1948a
14(11). Female tail not filiform; 4 pairs of caudal papillae in male…….…...……..15
- Female tail filiform;4-5 pairs of caudal papillae in male…...…….....16
15(14). Ovary monodelphic……..……..……*Galebia* Chitwood,1932

- Ovary didelphic……..……..……*Wetanema* Dale, 1967
16(14). Female tail filiform ; caudal papillae 4 pairs in male…..……..……..…17
- Female tail filiform ; caudal papillae 5pairs in male……..……...
……..*Leidynema* Schwenk in Travassos, 1929
17(16). Ovary didelphic, uteri amphidelphic…….……..……18
- Ovary didelphic, uterus prodelphic……...*Hammerschmidtiella* Chitwood,1932
18(17). Vulva near midbody…..……..……...……..……..……...19
- Vulva at posterior third of body……...……...…20
19(18). Egg oval to ellipsoidal……..……..……..*Thelastoma* Leidy,1849
- Egg elongate……..……..……*Tetleyus* Dale, 1964
20(18). Excretory pore posterior to base of oesophagus.……*Cephalobellus* Cobb,1920
Excretory pore anterior to base of oesophagus……..…*Desmicola* Basir,1956
21(10). Oral opening surrounded by membranous flaps.....*Coronostoma* Rao,1958
- Oral opening not surrounded by membranous flaps…..……..…….22
22(21). Egg ellipsoidal to elongate…..……...23
Egg broadly oval…..……..……..……..25
23(22). Egg ellipsoidal……..……..……....……..24
- Egg elongate……..……..……..……...*Cranifera* Kloss,1960
24(23). 3 pairs of caudal papillae in male…..……..……..*Blattophila* Cobb,1920
4 pairs of caudal papillae in male…..……..……....*Aorurus* Leidy,1849
25(22). 2 pairs of caudal papillae in male…..……..……*Buzionema* Kloss,1966
- 4 pairs of caudal papillae in male……26
26(25). Gonads didelphic……....……....…….27
- Gonads monodelphic……..……*Blatticola* Schwenk, 1926
27(26). Vulva at posterior-third of body, anterior vulval lip not swollen……...
...……..……*Cordonicola* Ali & Farooqui, 1969
- Vulva at midbody, anterior vulval lip swollen……...……*Corydiella* Rao & Rao, 1965

4.2 Genus: *Cameronia* Basir, 1948a

4.2.1 Generic diagnosis

Female: Cephalic extremity formed by single annulus and simple second annulus. Oesophagus consisting of a cylindrical corpus, an isthmus which may be distinct or indistinct and a valvular bulb. Cardia lobed or simple. Vulva in the posterior third of body, vagina directed anteriorly. Gonads amphidelphic. Eggs elongate, elliptical, flattened on one side, fused in pairs or more along their flattened surfaces with ridges and furrows or simply attached to one another forming a chain. Polar egg filaments present or absent. Tail conical or with a terminal spike.

Male: Cephalic extremity formed by single annulus. Oesophagus consisting of a cylindrical corpus, distinct or indistinct isthmus with a bulb. Spicule single or absent. Caudal papillae comprising 3-5 pairs. Tail very short, rounded, with or without a spine like process on its ventral side.

4.2.2 Species

Cameronia triovata Shah, 2007a (Figs. 1 & 2); **Host:** *Gryllotalpa africana* Beauvois ; **Habitat:** Gut ; **Locality:** Imphal, Manipur, India.

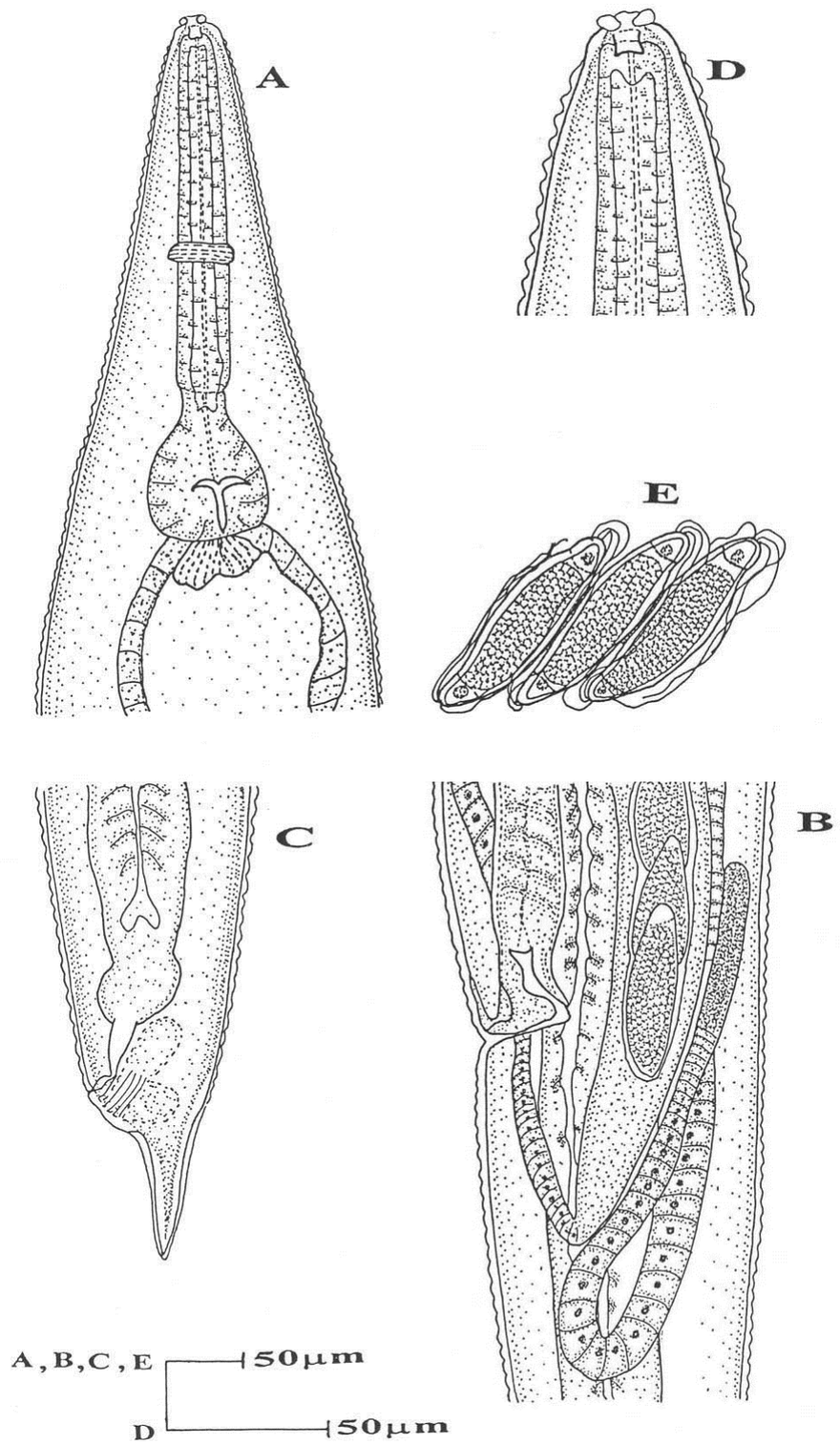

Fig. 1. *Cameronia triovata* Shah, 2007a: A-Female anterior end, B-Female vulval region, C-Female posterior end (lateral view), D-Female cephalic end, E-Eggs.

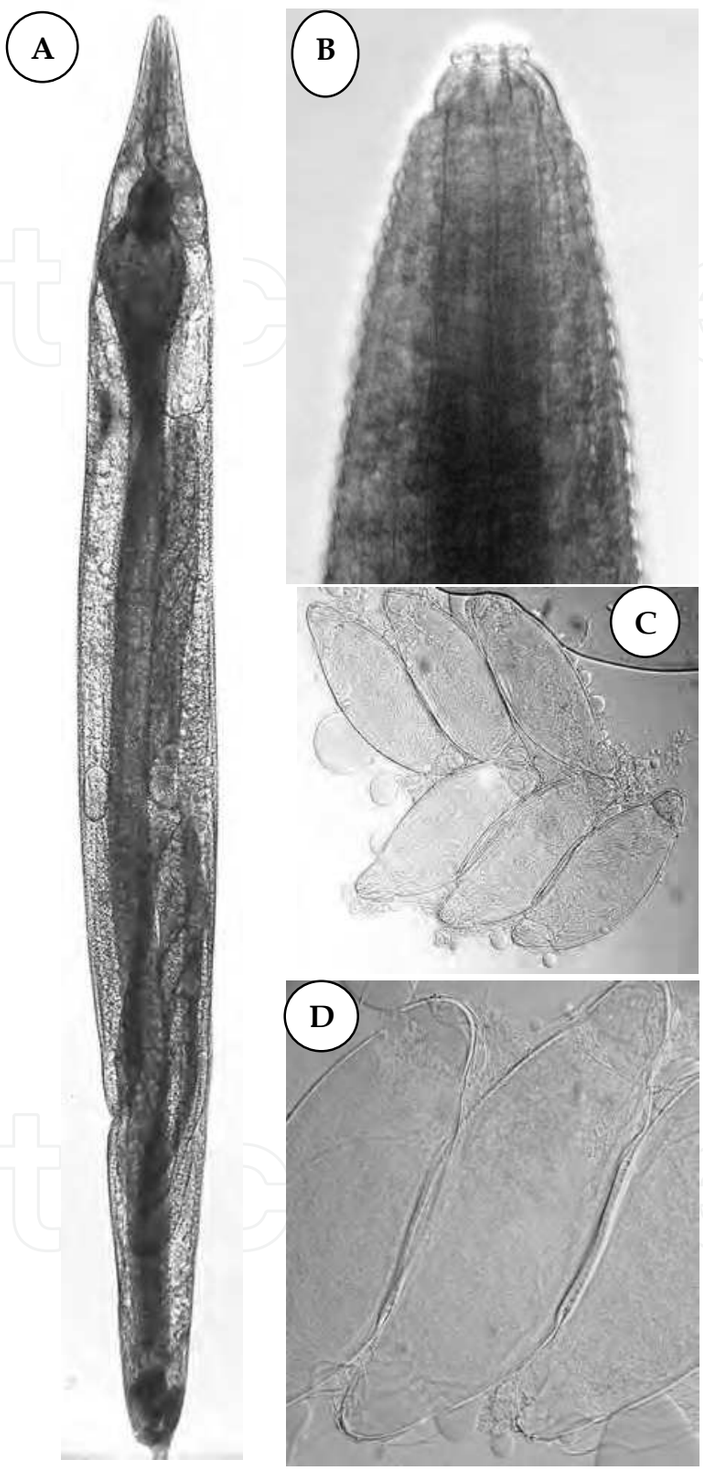

Fig. 2. Photomicrographs of *Cameronia triovata* Shah, 2007a: A-Female entire showing vulval opening, excretory pore and eggs within uterus (lateral view), B-Female cephalic end showing cephalic annule and buccal cavity, C-Eggs joining on lateral sides in three numbers, D-Eggs magnified showing polar filaments, ridges and furrows on lateral sides of attachment.

4.2.3 Species

Cameronia manipurensis Shah, 2007a (Figs.3 & 4); **Host***: Gryllotalpa africana* Beauvois **;** **Habitat:** Gut ; **Locality:** Imphal, Manipur, India

4.2.4 Key to species of *Cameronia* Basir, 1948a

1. Eggs laid fused……..2
- Eggs laid not fused……..5
2(1). 2 eggs fused……..3
- eggs fused……..*C. triovata* Shah,2007a
3(2). 2 eggs fused and not ridged..... *C. biovata* Basir,1948a
- 2 eggs fused and ridged……..4
4(3). Spicule 32µm long…….. *C. klossi* Parveen & Jairajpuri,1984
- Spicule 38-43µm long…….. *C. travassosi* Farooqui 1968a
5(1). Male=less than 2.160mm long; oesophagus=less than 564µm long in female……6
- Male=2.160–2.270mm long; oesophagus=564–644µm long in female……
……..……..……..…*C. laplatae* Reboredo & Camino, 2001
6(5). Spicule present……..7
- Spicule absent…….. *C. aspiculata*(Farooqui,1970)Adamson & Waerebeke,1992a
7(6). Female tail conical……..8
Female tail with a terminal spike…….
……*C. psilocephala* (Rao,1958) Adamson & Waerebeke,1992a
8(7). Lobed cardia present…….. *C. basiri* Rizvi & Jairajpuri,2002
- Lobed cardia absent……..9
9(8). Male tail with a thorn-like process on its ventral side……..
…….……..……..……*C. multiovata* Leibersperger,1960
- Male tail without a thorn like process on its ventral side……
……10
10(9). Egg=111-126 x 39-43µm; spicule=19-22µm……
.....*C. nisari* (Parveen & Jairajpuri,1985a) Adamson & Waerebeke, 1992a
- Egg = 102.06-109.35 x 32.80-38.88µm; spicule=10.36-13.18µm……
……*C. manipurensis* Shah,2007a

4.3 Genus: *Thelastoma* Leidy, 1849

4.3.1 Generic diagnosis

Female: Cephalic extremity formed by circumoral annule and enlarged second annule. Mouth surrounded by eight labial papillae. Amphids present. Lateral alae present or absent. Buccal cavity simple. Oesophagus consisting of an anterior cylindrical corpus, an isthmus and a posterior valvular bulb. Excretory pore pre- or post-oesophageal bulb or at the level of the base of the bulb. Tail long filiform about one-third to one-fourth of the total body-length. Vagina short, muscular and anteriorly directed with well developed vulval lip. Vulva at or posterior to mid-body. Eggs broadly oval.

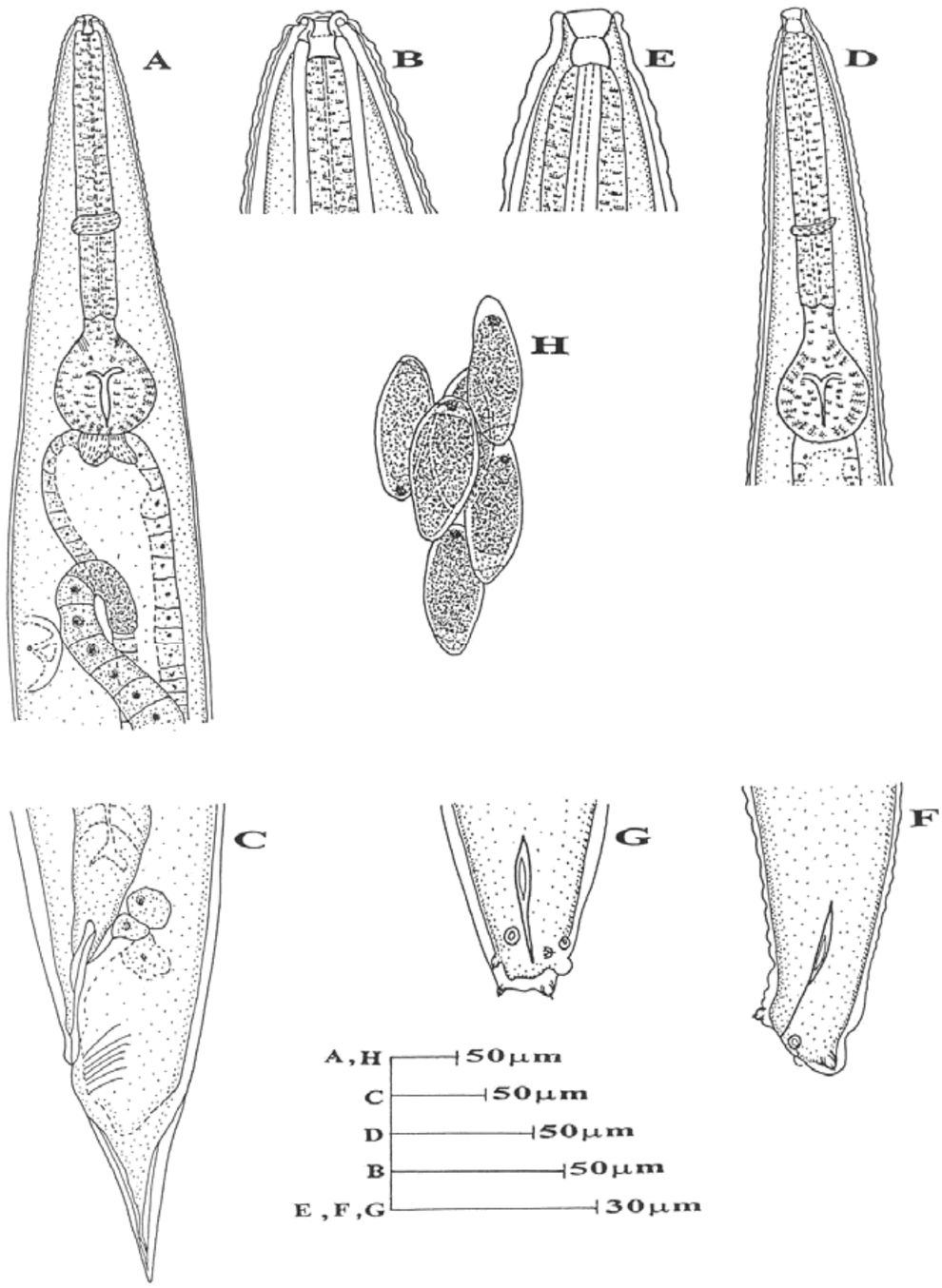

Fig. 3. *Cameronia manipurensis* Shah, 2007a: A-Female anterior end, B-Female cephalic end, C-Female posterior end (lateral view), D-Male anterior end, E-Male cephalic end, F-Male posterior end (lateral view), G-Male posterior end (ventral view), H-Eggs.

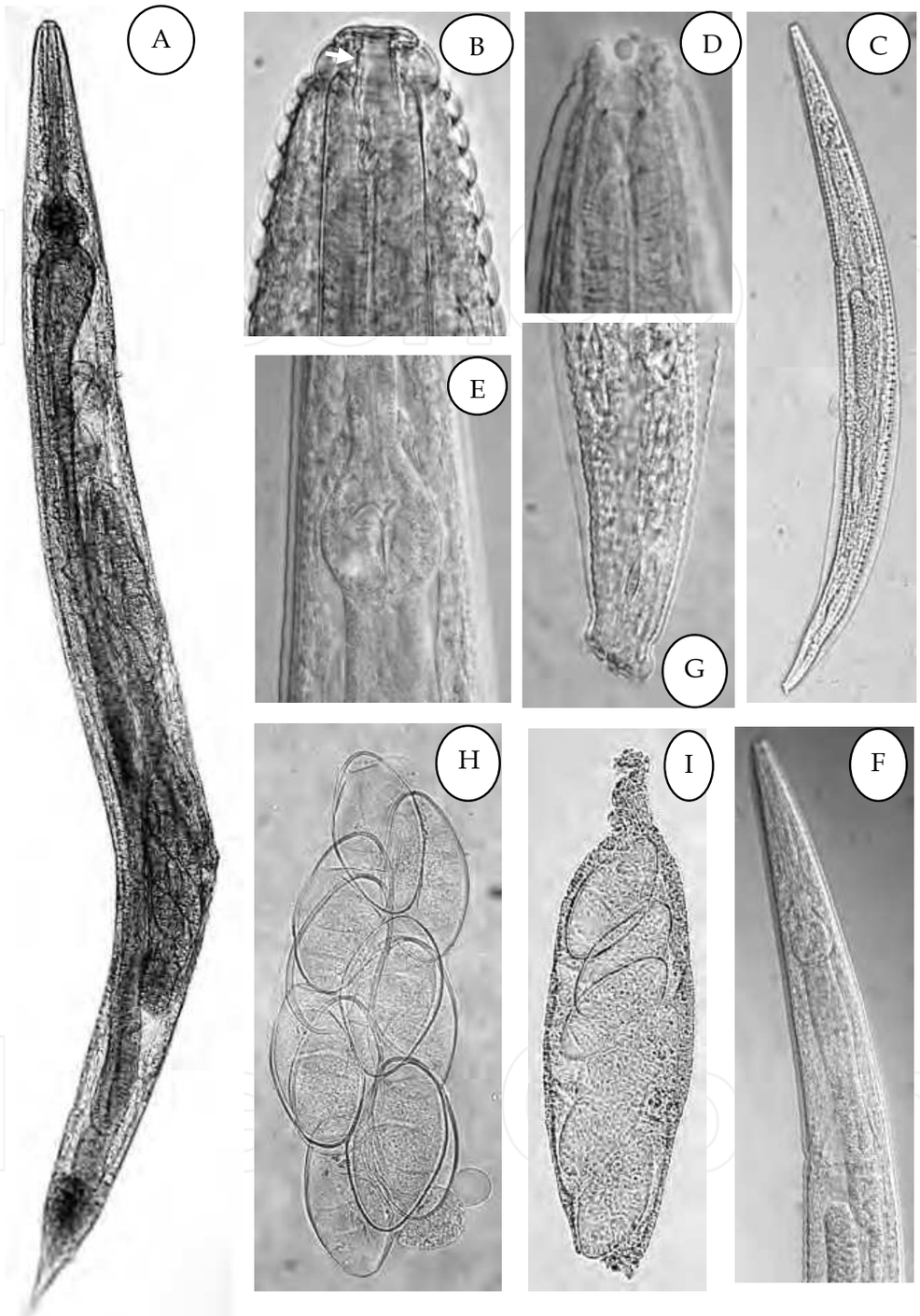

Fig. 4. Photomicrographs of *Cameronia manipurensis* Shah, 2007a: A-Female entire showing eggs (lateral view), B-Female anterior end showing buccal cavity (lateral view), C-Male entire (lateral view), D-Male anterior end showing buccal cavity (lateral view), E-Male cardia (lateral view), F-Portion of male anterior showing excretory pore (lateral view), G-Male posterior end showing spicule (lateral view), H-Eggs showing mode of attachment with one another, I-Eggs within uterus.

Male: Cephalic extremity formed by single expanded annule. Lateral alae present or absent. Tail elongated and filiform. Four pairs of caudal papillae, consisting one pair pre- anal, one pair ad-anal and one median duplex post anal papillae on genital cone. One pair of papillae on caudal appendage some distance away from the anus. Testis single. Spicule present or absent.

4.3.2 Species

Thelastoma periplaneticola Leibersperger, 1960 (Figs.5 & 6); **Host:** *Periplaneta americana* Linn.; **Habitat:** Gut; **Locality:** Imphal, Manipur, India

4.4 Genus: *Leidynema* Schwenk in Travassos, 1929

4.4.1 Generic diagnosis

Female: Cephalic extremity formed by two annules. Lateral alae present. Eggs large, elongate and crescent-shaped. Female tail long, filiform or attenuated. Oesophageal corpus divided into narrow anterior and broad posterior portions of roughly equal length, isthmus short, and bulb spherical. Intestine with blind diverticulum. Vulva near midbody.

Male: Cephalic extremity formed by single expanded annule. Lateral alae present or absent. Spicule present or absent. Caudal extremity in males abruptly truncate with or without short terminal spine (spine-like process on its ventral side) or with several protuberances. Caudal papillae 3-5 pairs.

4.4.2 Species

Leidynema appendiculatum (Leidy, 1850) Chitwood, 1932 (Figs. 7 & 8); Host : *Periplaneta americana* Linn.;Habitat: Gut ; Locality: Imphal, Manipur, India

4.4.3 Key to species of *Leidynema* Schwenk in Travassos, 1929

1. Males with several protuberances in posterior region……..……..…. ..…..……..……*L. portentosae* Van Waerebeke, 1978
- Males without protuberances in the posterior region….……...……2
2(1). Spicule=63µm long in male……...……..……..……... ……....……....*L. socialis* (Leidy,1850)Adamson & Waerebeke,1992a
- Spicule less than 63µm long in male…….…….……..……..…3
3(2). Lateral alae present in females only…….....……...……...4
- Lateral alae present in both sexes…..…….……...6
4(3). Lateral alae in female ends in backwardly pointed projection…….……..… …..……..…….....…..*L. schwencki* Farooqui,1967
- Lateral alae in female do not end in backwardly pointed projection……...……...5
5(4). Lateral alae in female extending along whole length of body without spinous process; cuticular bosses present……..….*L. delatorrei* Chitwood,1932
- Lateral alae in female start from mid-body and continuous upto tip of tail with spinous process; cuticular bosses absent…..…*L. stylopygi* Biswas&Chakravarty,1963
6(3). Female oesophagus 1/5th –1/6th of body length; males with five pairs of caudal papillae…..……...……..*L. periplaneti* Farooqui,1967
- Female oesophagus 1/8th of body length; males with 3-5 pairs of caudal papillae…..……...….*L. appendiculatum* (Leidy,1850) Chitwood,1932

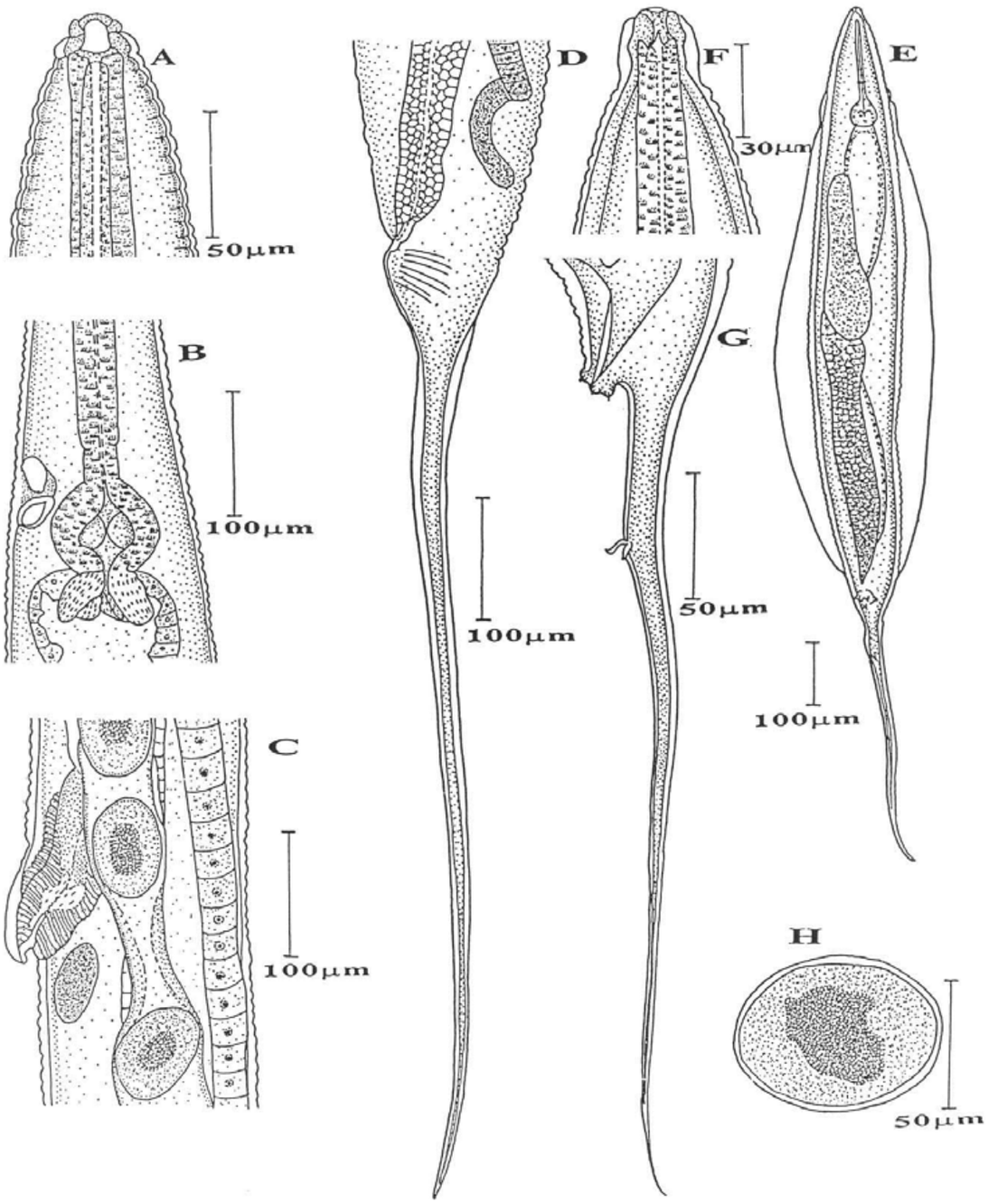

Fig. 5. *Thelastoma periplaneticola* Leibersperger, 1960: A-Female anterior end, B-Female oesophageal region, C-Female vulval region showing lip, D-Female posterior end (lateral view), E-Male entire, F-Male anterior end, G-Male posterior end (lateral view), H-Egg (Shah, 2007b)

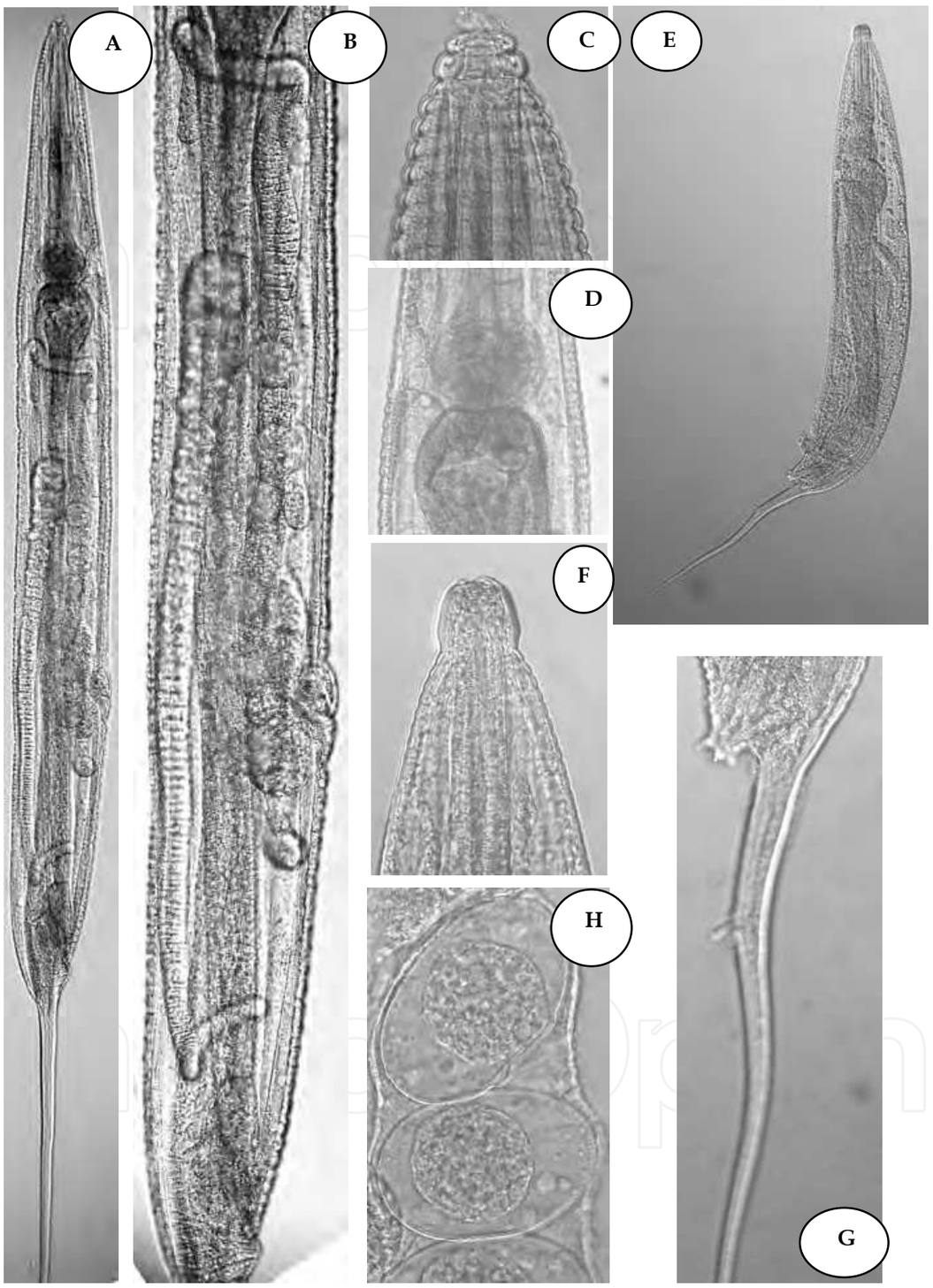

Fig. 6. Photomicrographs of *Thelastoma periplaneticola* Leibersperger, 1960: A-Female entire (lateral view), B-Female gonads, vulval lips and cloacal opening, C-Female cephalic end showing buccal cavity, D-Female excretory pore, E-Male entire (lateral view), F-Male cephalic end showing buccal cavity, G-Male posterior end showing papillae at genital cone and tail (lateral view), H-Eggs (Shah, 2007b).

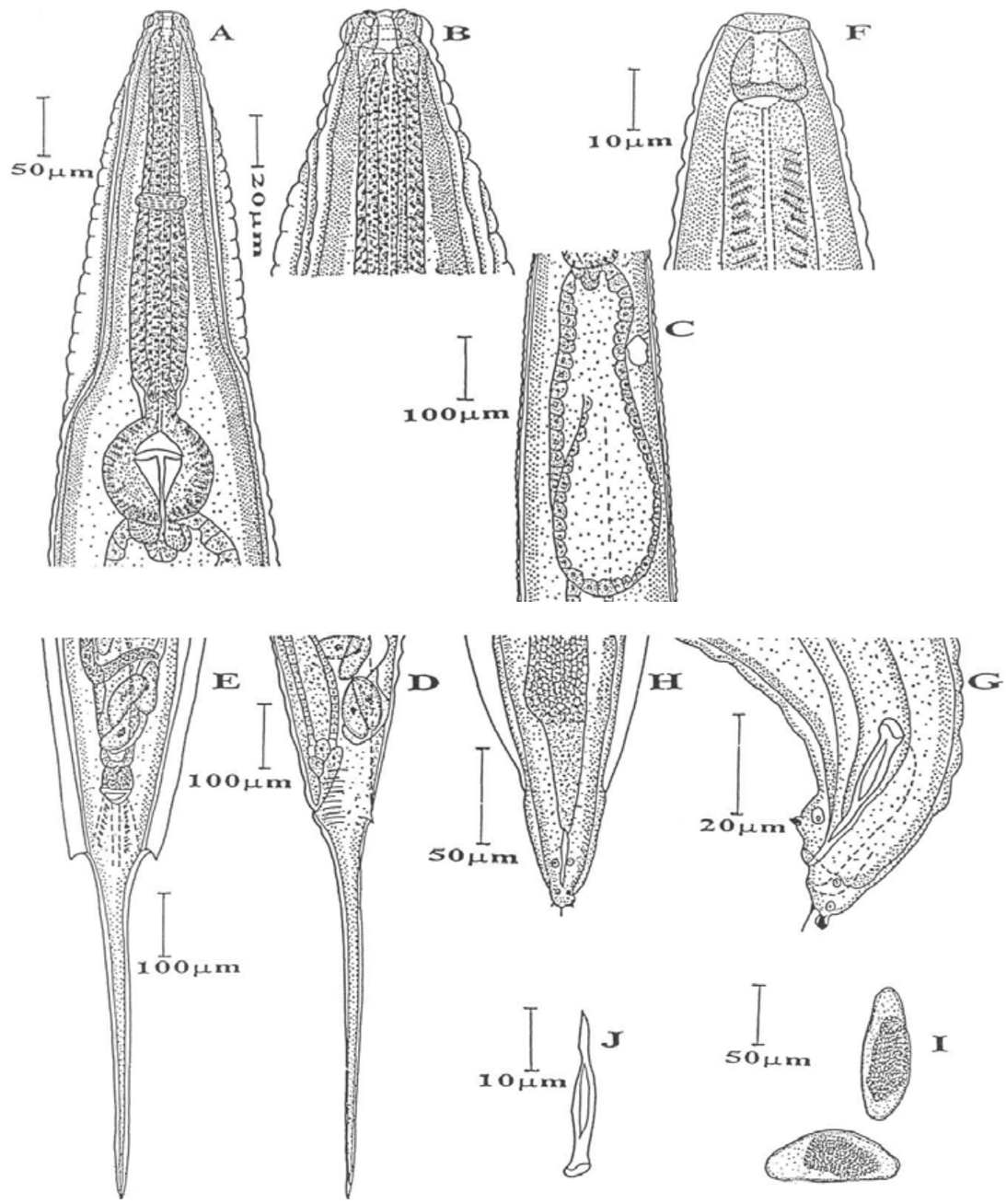

Fig. 7. *Leidynema appendiculatum* (Leidy, 1850) Chitwood, 1932: A-Female anterior end, B-Female cephalic end, C-Female showing intestinal diverticulum, D-Female posterior end (lateral view), E-Female posterior end (ventral view), F-Male cephalic end, G-Male posterior end (lateral view), H-Male posterior end (ventral view), I-Eggs, J-Spicule (Shah, 2007b).

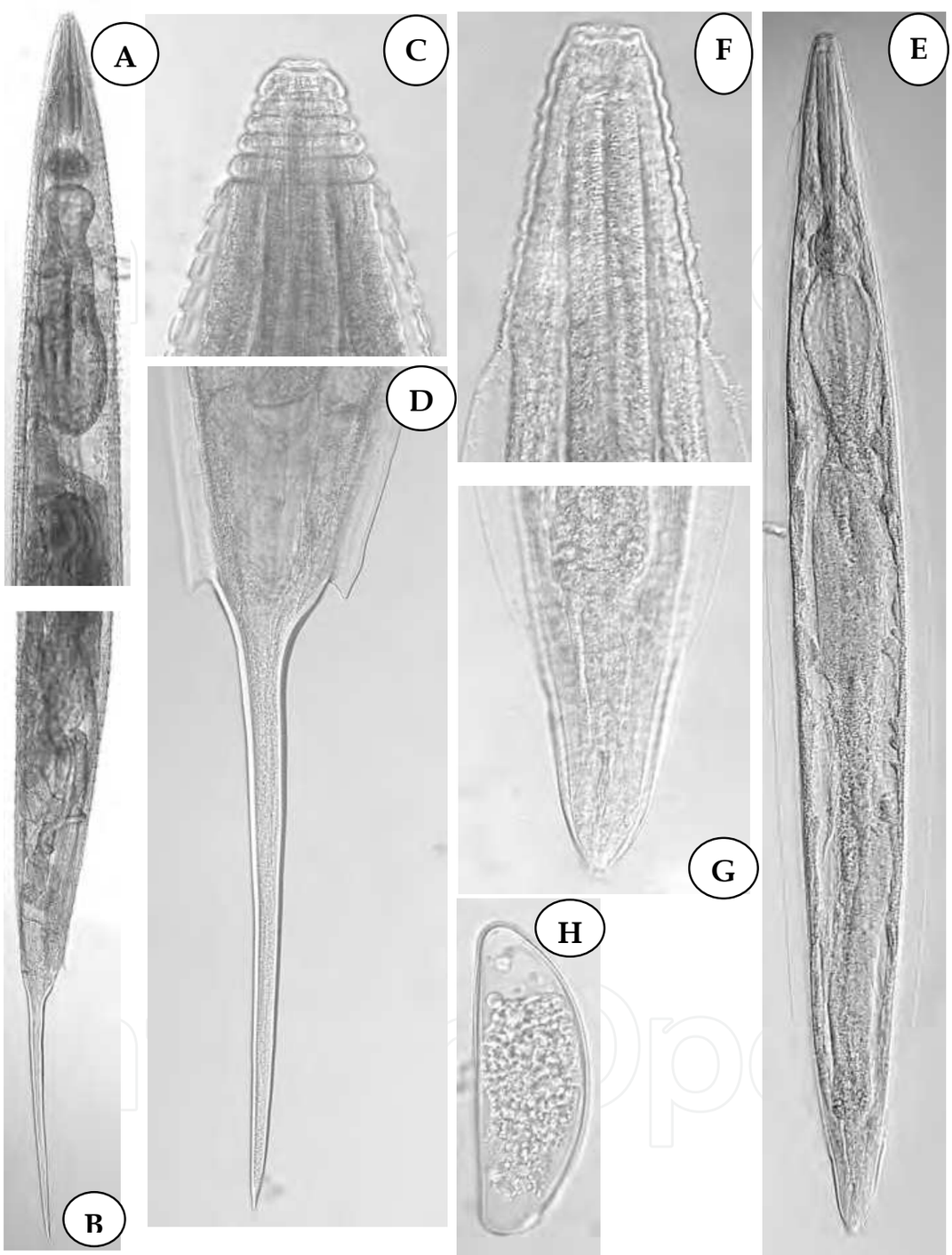

Fig. 8. Photomicrographs of *Leidynema appendiculatum* (Leidy, 1850) Chitwood, 1932: A-Female anterior half showing excretory pore and intestinal diverticulum (lateral view), B-Female posterior half (lateral view) showing coiled uterus, C-Female cephalic end showing buccal cavity and prominent cephalic annules, D-Female posterior end (ventral view) showing lateral alae, F-Male entire (ventral view) showing lateral alae, G-Male posterior end showing spicule (ventral view), H-egg (Shah, 2007b).

4.5 Genus: *Gryllophila* Basir, 1942a

4.5.1 Generic diagnosis

Female: Cephalic extremity formed by circumoral annule and posterior expanded annule. Mouth opening surrounded by eight labiopapillae and a pair of amphids. Oesophageal corpus cylindrical, isthmus cylindrical. Vulva in posterior quarter of the body. Vagina long and anteriorly directed. Uterus extending anteriorly and flexing posteriorly before dividing into two branches. Gonad amphidelphic. Eggs very large, with or without spine-like outgrowths, elongate, deposited in string held together by uterine secretions. Tail conical to attenuate.

Male: Cephalic extremity formed by single expanded annule. Caudal extremity with prominent genital cone. Caudal papillae 3-6 pairs, single median papilla present or absent. Spicule single. Caudal appendage, narrowing abruptly posterior to last pair of caudal papillae, rest of the papillae borne on genital cone.

4.5.2 Species

Gryllophila skrjabini (Sergiev, 1923) Basir, 1956 (Figs. 9 & 10); Host: *Gryllotalpa africana* Beauvois; Locality: Imphal, Manipur, India

4.5.3 Key to species of *Gryllophila* Basir, 1942a

1. Egg-shell with spine-like outgrowths……...…*G. skrjabini* (Sergiev, 1923) Basir,1956
- Egg-shell without spine-like outgrowths……...……...……...……..2
2(1). Caudal papillae three pairs with a single median papilla……. .....*G. nihali* Rizvi, Jairaipuri & Shah, 2002
- Caudal papillae 5-6 pairs without a single median papilla……..3
3(2). Caudal papillae in male five pairs……...…4
- Caudal papillae in male six pairs…….....……*G. basiri* Parveen & Jairajpuri, 1981
4(3). Presence of four lobules in the first ring and 14 lobules in the second in the cephalic region…….……..….*G. cephalobulata* Camino & Maiztegui, 2002
- Absence of lobules in the cephalic region……...…*G. gryllotalpae* Farooqui, 1970

4.6 Genus: *Hammerschmidtiella* Chitwood, 1932

4.6.1 Generic diagnosis

Female: Body spindle shaped. Cephalic extremity formed by two annules and cervical region with variable number and arrangement of enlarged annules. Oesophageal corpus with a pseudobulb, cylindrical isthmus. Vulva in anteriorthird of the body, vagina and uterus posteriorly directed. Didelphic, prodelphic. Eggs elongate, pear-shaped, oval/ovoid that are flattened on one side, tail attenuate to filiform.

Male: Cephalic extremity formed by single expanded annule. Oesophageal corpus clavate. Caudal extremity abruptly truncate, posterior to anus with spine-like appendage. Caudal papillae absent or if present consisting of one pair subv-entral preanal, one pair lateral adanal, one pair sub-ventral just posterior to anus and one duplex papilla at the base of the caudal appendage. Spicule present or absent.

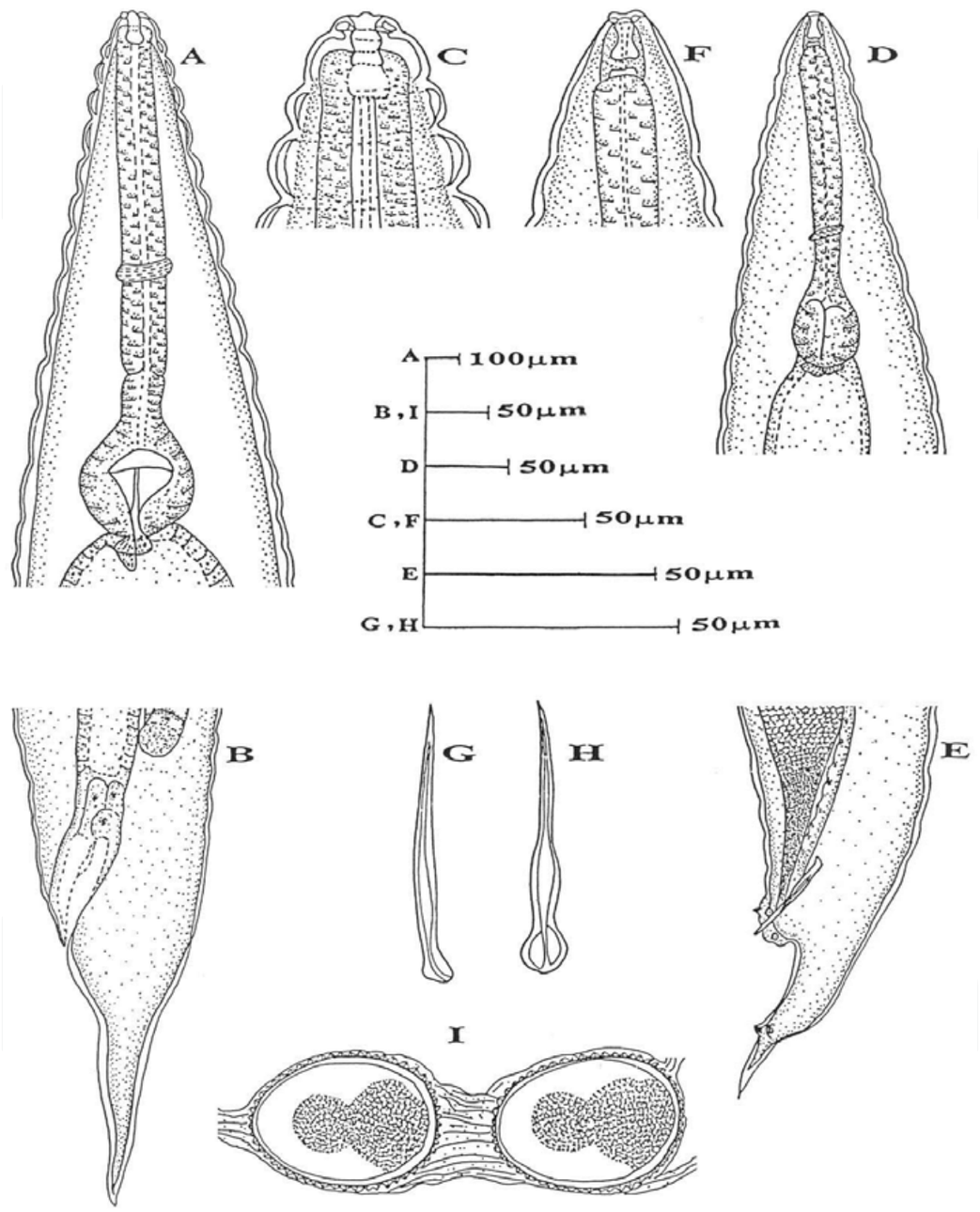

Fig. 9. *Gryllophila skrjabini* (Sergiev, 1923) Basir, 1956: A-Female anterior end, B-Female posterior end (lateral view), C-Female cephalic end, D-Male anterior end, E-Male posterior end (lateral view), F-Male cephalic end, G-Spicule (lateral view), H-Spicule (ventral view), I-Eggs (Shah, 2007b).

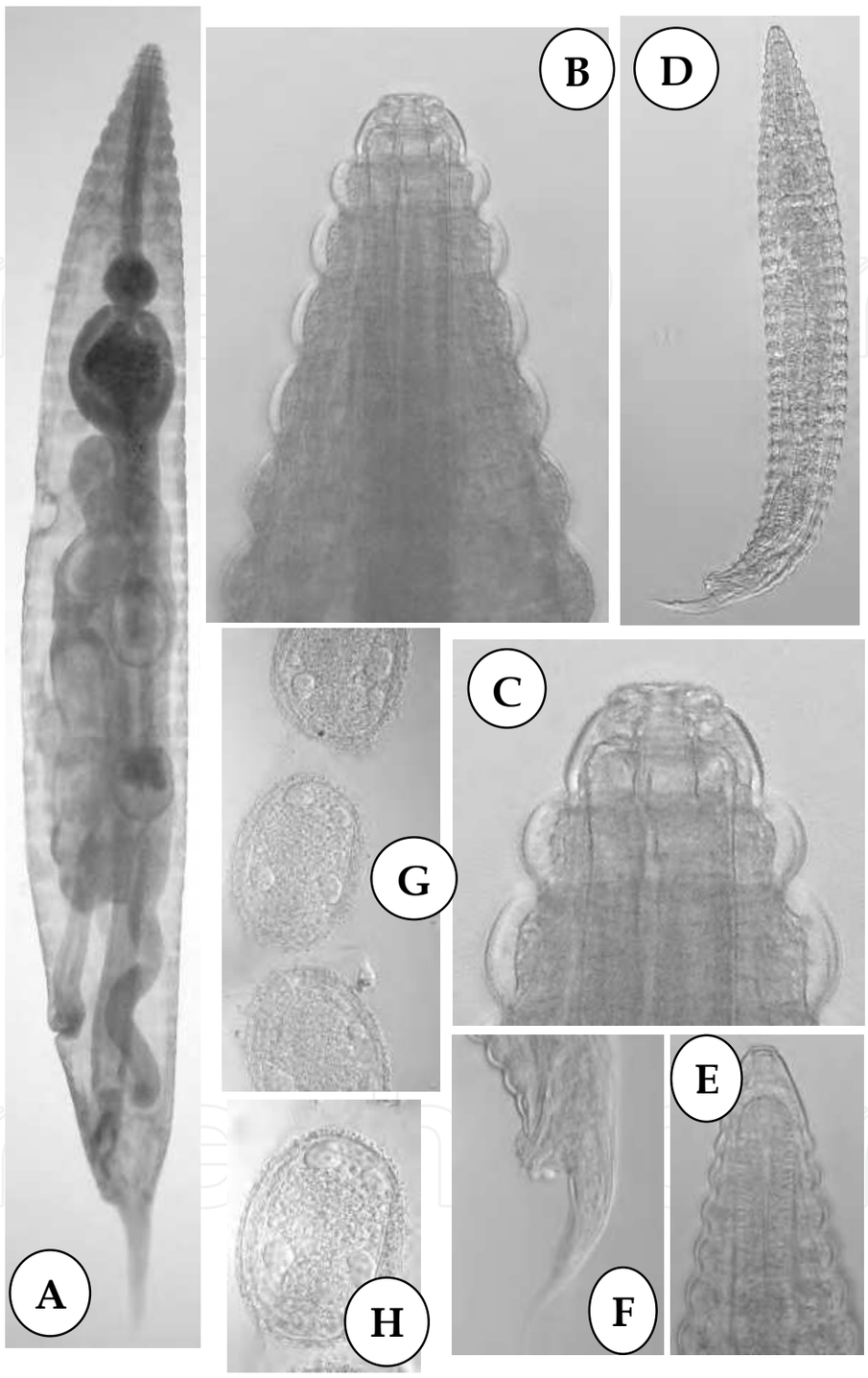

Fig. 10. Photomicrographs of *Gryllophila skrjabini* (Sergiev, 1923) Basir, 1956: A-Female entire (lateral view) showing uterus, excretory pore, vulva and anal opening, B-Female cephalic end with circumoral annule, C-Female cephalic end showing buccal cavity and annules, D-Male entire (lateral view), E-Male anterior end showing buccal cavity (lateral view), F-Male posterior end showing spicule (lateral view), G-Eggs, H-Egg showing spine-like outgrowths on the shell surface (Shah, 2007b).

4.6.2 Species

Hammerschmidtiella diesingi (Hammerschmidt, 1838) Chitwood, 1932 (Figs. 11 & 12); Host: *Periplaneta americana* Linn. ; Habitat: Gut; Locality: Imphal, Manipur, India

4.6.3 Key to species of *Hammerschmidtiella* Chitwood, 1932

1. Presence of pear-shaped eggs……..…*H. hochi* Jex, Schneider, Rose & Cribb, 2005
- Oval eggs or ovoid eggs that are flattened on one side……..…….……2
2(1). Male with multiple crest or ridges behind anus……....*H. cristata* Spiridonov,1984
- Multiple crest or ridges behind anus absent in male……..……..……...…..…….3
3(2). Presence of highly curved corpus over end bulb in female oesophagus……
……..…...……..……*H. poinari* Gupta & Kaur, 1978
- Corpus not curved in female oesophagus …...…….……..4
4(3). Vulva provided with three cuticularised plates …….*H. basiri* Singh & Kaur, 1988
- Vulva without plates..……...……....……5
5(4). Caudal papillae and spicule present in male.……..……6
- Caudal papillae and spicule absent in male…*H. aspiculus* Biswas & Chakravarty, 1963
6(5). Spicule=18µm long…….……..…….7
- Spicule more than 18µm long……...……...……..……9
7(6). Female=1.926-2.022mm long…..…….……...…*H. acreana* Kloss, 1966
- Female more than 2.022mm long ……..……..……..……..…..8
8(7). Female=2.20-3.77mm and tail=0.250-0.290mm; male=0.520-0.560mm……..…….
…….…....…*H. mackenziei* (Zervos, 1987a) Adamson & Waerebeke, 1992a
- Female=3.0-3.33mm and tail 0.78mm; male= 0.81-0.96 mm…...*H. manohari* Rao, 1958
9(6). Female=1.81mm long; spicule=20µm long……...*H. singhi* Rao & Rao, 1965
- Female=more than 1.81mm long; spicule=more than 20µm long……...10
10(9). Male=0.487-0.853mm long……...*H. diesingi* (Hammerschmidt, 1838) Chitwood, 1932
- Male = more than 0.853mm long…….…..……...…….……..…….11
11(10). Caudal papillae in male=5pairs, gubernaculums present …….……..…….
……...…….....*H. andersoni* Adamson & Nasher, 1987
- Caudal papillae = 3 pairs, gubernaculum absent.…*H. nayrai* Serrano Sanchez, 1945

5. Family Protrelloididae Chitwood, 1932

5.1 Diagnosis

Mouth with or without trilobed circumoral elevation. Cuticle without spines. Anterior region may or may not possess transverse striations. Oesophagus consisting of corpus which may be clavate or cylindrical, isthmus distinct or indistinct and a posterior valvular bulb. Vulva anterior to base of the oesophagus. Gonads amphidelphic. Eggs with or without cuticular crest or grooves. Tail of female attenuate to conical terminating in narrow spine or short and subconical or short and rounded with two cuticular wing like projections. Male caudal extremity tapering posterior to anus and ending in digitiform appendage or short and subconical or narrowing, with long appendage or short and bluntly rounded or subconical. Caudal papillae 3-8 pairs or completely absent. Spicule single or absent.

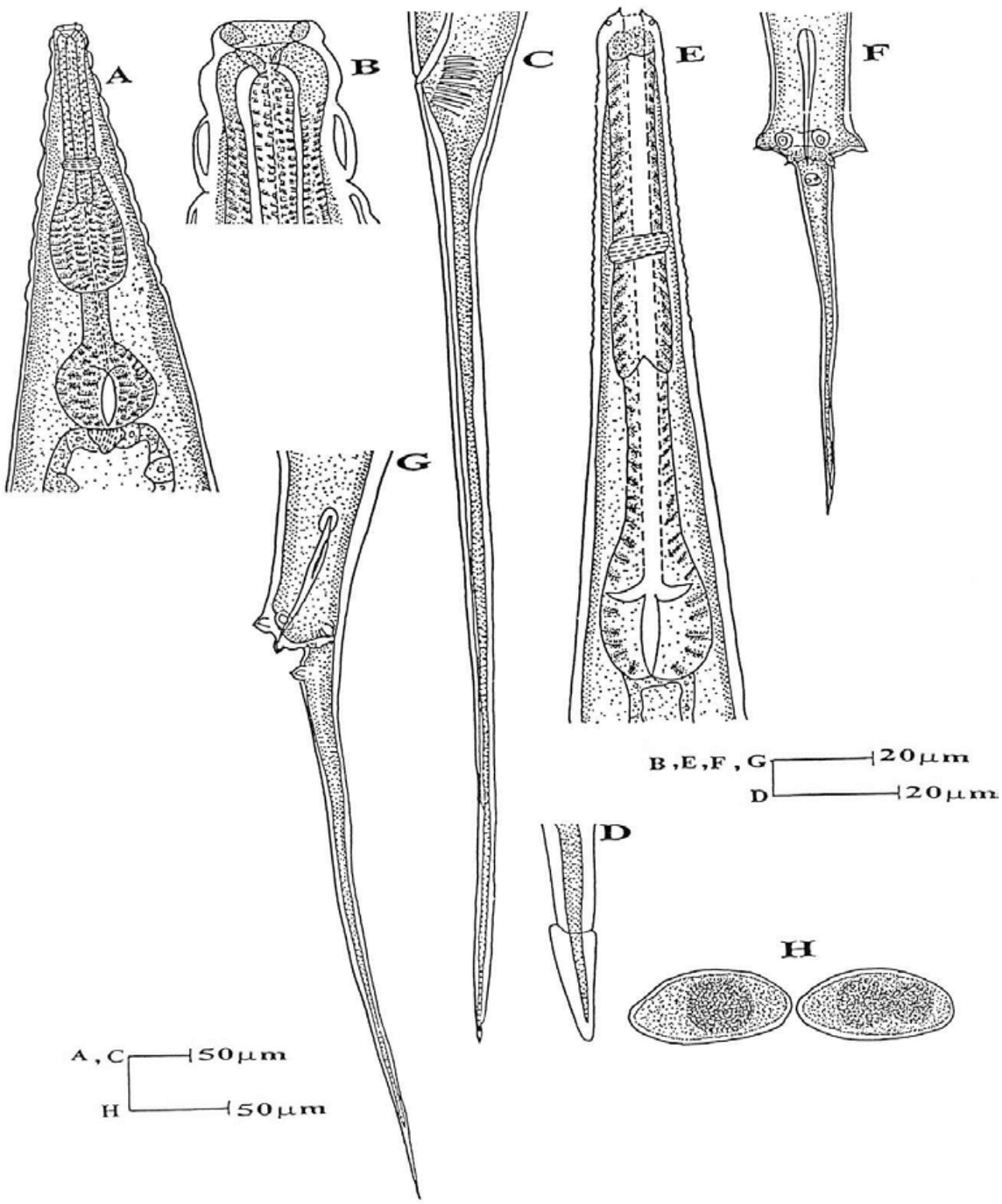

Fig. 11. *Hammerschmidtiella diesingi* (Hammerschmidt, 1838) Chitwood, 1932: A-Female anterior end, B-Female cephalic end, C-Female posterior end (lateral view), D-Female tail tip showing cap-like structure, E-Male anterior end, F-Male posterior end (ventral view), G-Male posterior end (lateral view), H-Eggs (Shah, 2007b).

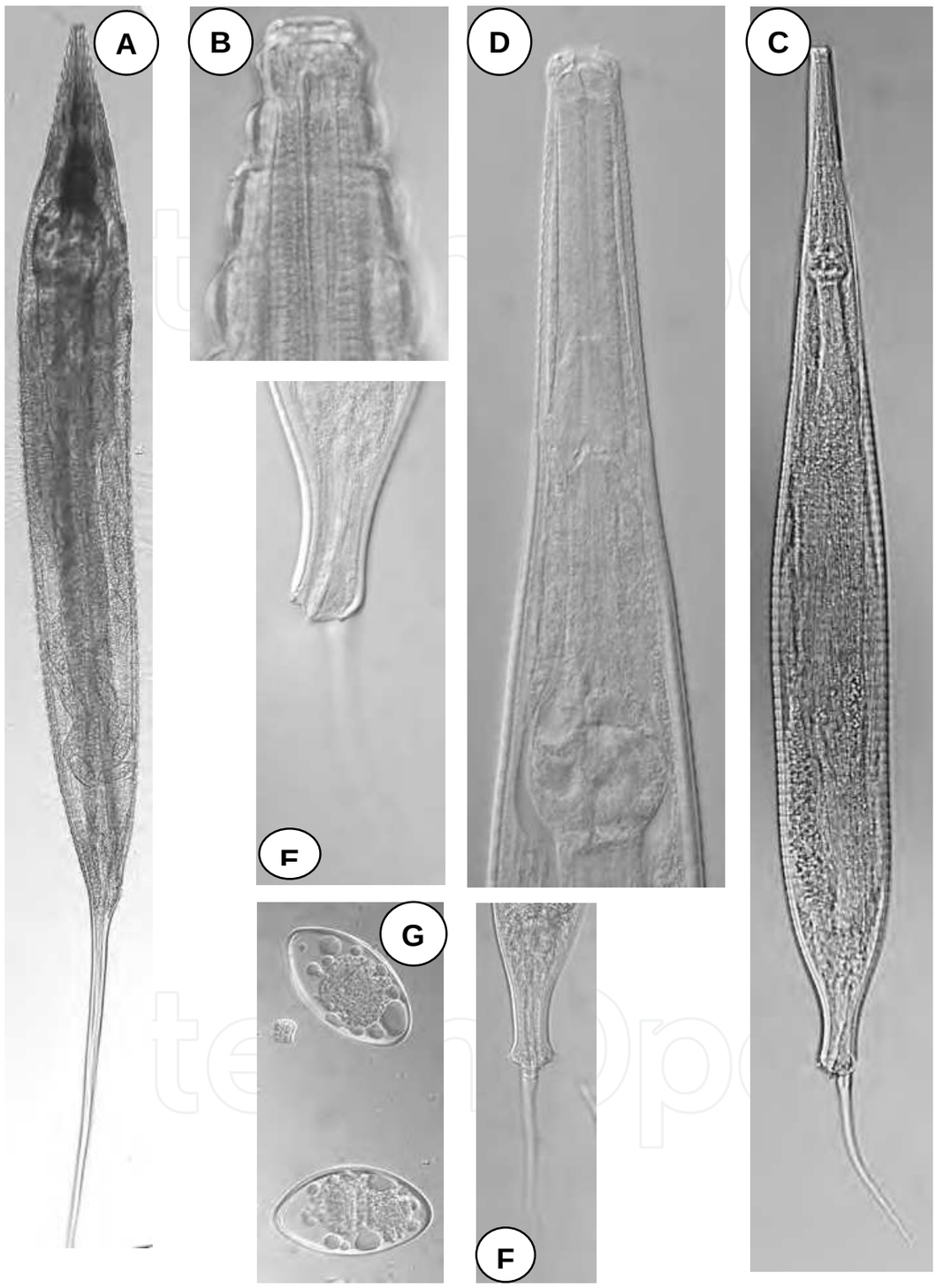

Fig. 12. Photomicrographs of *Hammerschmidtiella diesingi* (Hammerschmidt, 1838) Chitwood, 1932:A-Female entire (lateral view) showing excretory pore, vulva and anal opening, B-Female cephalic end showing buccal cavity, C-Male entire (ventral view), D-Male anterior end showing buccal cavity, E-Male posterior end showing spicule (ventral view), F-Male posterior end showing spicule and papillae (ventral view), G-Eggs. (Shah, 2007b).

5.2 Key to genera of Protrelloididae Chitwood, 1932

1. Cephalic extremity in female formed by lip cone and second annule large……..2
- Cephalic extremity in female simple, second annule normal……..……...……..…….. ……..……..……*Protrellatus* Farooqui, 1970

2(1). 4 pairs of caudal papillae in male……..……...…….3
- 3 pairs of caudal papillae in male……...……..…*Protrellus* Cobb,1920

3(2). Egg with cuticular modifications…..……...…….4
- Egg without cuticular modification…...……....*Protrellata* Chitwood, 1932

4(3). Female tail conically attenuated; male tail digitiform…...*Protrelloides* Chitwood,1932
- Female tail short, male tail not digitiform……..…..*Napolitana* Kloss,1959a

5.3 Genus: *Protrellus* Cobb, 1920

5.3.1 Generic diagnosis

Female: Cephalic extremity formed by lip cone and expanded second annule. Oesophageal corpus clavate. Isthmus short. Vulva anterior to base of oesophagus. Vagina and common uterus posteriorly directed, paired uteri opposed. Eggs elongate, oval or ellipsoidal, shell usually bearing longitudinal ridges or excrescences or a circular crest either laterally or towards one of the poles. Tail short, conical to attenuate.

Male: Corpus cylindrical. Caudal extremity subconical. Spicule present. Testis single. Caudal papillae 3-5 pairs.

5.3.2 Species

Protrellus shamimi Shah *et al*., 2005 (Fig.13);**Host :** *Periplaneta americana* Linn.

Habitat : Gut; **Locality:** Imphal, Manipur, India

5.3.3 Key to species of *Protrellus* Cobb, 1920

1. Female = less than 8.58 mm long……...……..……..……..……2
- Female = 8.58 - 10.37 mm long……..……..……*P. eurycotesi* Kloss, 1961

2(1). Female tail conical,with filiform projection…….....……...……..3
- Female tail short, no filiform projection……...……...……...…..4

3(2). Female=2.964-4.758mm; four pairs of caudal papillae in male…… ...…….…….…….. *P. dixoni* Zervos,1987b
- Female=5.6-7.66 mm; three pairs of caudal papillae in male……... ……..……...…….. *P. rasolefi* Van Waerebeke, 1969

4(2). Egg with crest or bosses……..……..……..……5
- Egg without crest or bosses …….……..……..……..9

5(4). Female oesophagus = 0.633 mm long……..……...…….… ……*P. kunckeli* (Galeb, 1877) Schwenk, 1926
- Female oesophagus less than 0.633 mm long……...……...……6

6(5). Excretory pore conspicuous……..……..……....7
- Excretory pore inconspicuous……...*P. ischnopterae*(Kloss,1966) Zervos,1987a

7(6). Length of egg=90-95µm .....…*P. manni* (Chitwood, 1932)Chitwood, 1933
- Length of egg less than 90µm ……..……...……..…8

8(7). Spicule = 17µm long, two pairs of caudal papillae in male……..…….. ……...…….……*P. aurifluus* (Chitwood, 1932) Basir, 1956
- Spicule = 36.45 - 38.88µm long, five pairs of caudal papillae in male……...……. ……..……...……...… *P. shamimi* Shah, Rizvi & Jairajpuri, 2005
9(4). Eggs with lateral grooves..…… …….*P. phyllodromi* (Basir, 1942b) Skrjabin, Schikhobalova & Lagodovskaya, 1966
- Eggs without lateral grooves……...……..……...…...…….10
10(9). Excretory pore with lip……...……...……...11
- Excretory pore without lip……..……..……12
11(10). Eggs larger than 77µm, oesophagus 180 mm and excretory pore to 0.290 mm from anterior end……..…….. *P. dalei* Zervos, 1987a
- Eggs less than 77µm, oesophagus 0.39-0.43 mm and excretory pore to 0 . 1 8 0 m m from anterior end .....……... *P. behorefi* Van Waerebeke, 1969
12(10). Female = 6 mm long, tail acutely pointed…..…..…….…. *P. aureus* Cobb, 1920
- Female = 5.029-5.147mm long, tail subulate..…..*P. ituana* (Kloss, 1966) Zervos, 1987a

6. Family Pseudonymidae Kloss, 1958

6.1 Diagnosis

The family Pseudonymidae is diagnosed by the presence of filaments coiled around egg shell and in the absence of polar egg filaments.

6.2 Key to the genera of Pseudonymidae Kloss, 1958

1. Cephalic extremity formed by circumoral annule and expanded second annule in female…..……...…….2
- Cephalic extremity formed by circumoral annule and simple second annule in female……..……3
2(1). Anterior cuticle in female with transverse rows of scales….*Stegonema* Travassos,1954
- Anterior cuticle in female without transverse rows of scales…….. ……..*Pseudonymus* Diesing,1857
3(1). Eggs broadly oval with filaments coiled around shell……....……...4
- Eggs elongate with filaments…..……...…*Itaguaiana* Kloss,1959a
4(3). Vulva with protruding anterior lip near posterior third of body; male tail conical, 7 pairs of caudal papillae ……....*Zonothrix* Todd,1942
- Vulva slightly posterior to midbody; male tail subconical, 5 pairs of caudal papillae …….……..…*Jarryella* Van Waerebeke & Remillet,1973

6.3 Genus: *Pseudonymus* Diesing, 1857

6.3.1 Generic diagnosis

Female: Cephalic extremity formed by circumoral annule and expanded second annule. Oesophageal corpus clavate. Isthmus a constriction between corpus and bulb. Vulva near posterior-third of the body. Vagina short, anteriorly directed. Gonads amphidelphic. Eggs broadly oval with filaments twisted around shell, polar egg filaments absent. Tail filiform or bluntly attenuated or conically attenuated or conical.

Male: Cephalic extremity formed by single annule. Corpus cylindrical. Caudal papillae 3-6 pairs. Spicule present or absent. Caudal appendage consists of one or two parts.

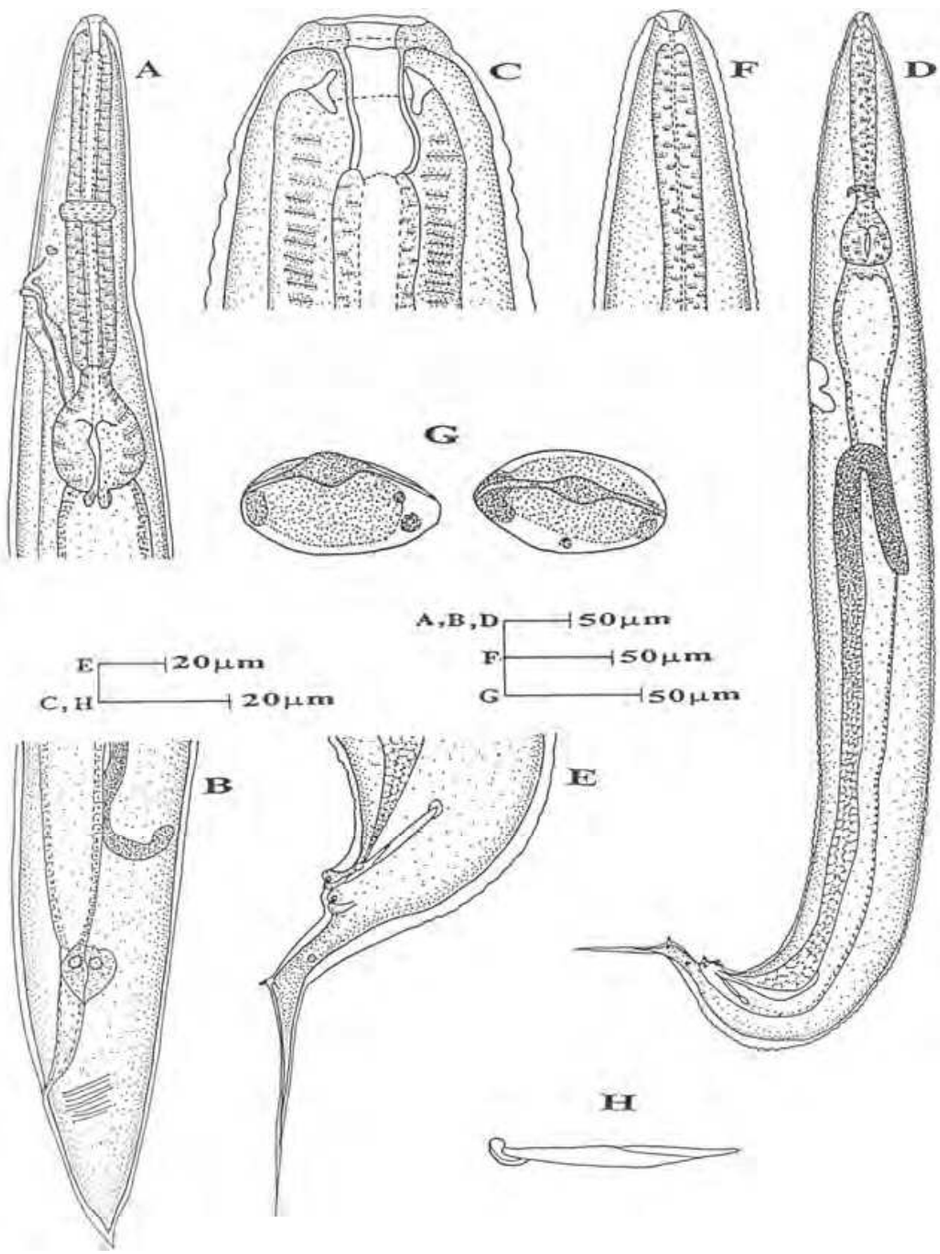

Fig. 13. *Protrellus shamimi* Shah, Rizvi & Jairajpuri,2005: A-Female anterior end, B-Female posterior end (lateral view), C-Female cephalic end, D-Male entire (lateral view), E-Male posterior end (lateral view), F-Male cephalic end, G- Eggs, H-spicule.

6.3.2 Species

Pseudonymus basiri Shah and Rizvi, 2004b (Fig.14)

Host: *Hydrophilus triangularis* Say; Habitat: **Gut ; Locality:** Imphal, Manipur, India

6.3.3 Key to species of *Pseudonymus* Diesing, 1857

1. Cephalic cuticular annule two……2
- Cephalic cuticular annule more than two……5
2(1). Female tail conical……3
- Female tail filiform……*P. leptocercus* Todd,1944
3(2). Eggs 78-88 µm in length……..……...…..…*P. brachycercus* Todd, 1944
- Eggs less than 78 µm in length……4
4(3). Caudal papillae three pairs……*P. hydrophili* (Galeb,1878) Basir, 1956
- Caudal papillae six pairs……...*P. basiri* Shah & Rizvi,2004b
5(1). Cephalic cuticular annule =6……*P. klossi* Farooqui, 1967
- Cephalic cuticular annule more than six……6
6 (5). Female tail filiform……7
- Female tail conical……8
7(6). Cephalic cuticular annules nine ….....*P. spirotheca* (Gyory,1856) Diesing,1857
- Cephalic cuticular annules 30 ……..……..… *P. multiannulata* Fotedar,1964
8(6). Cephalic cuticular annules less than 60 ….……..… 9
- Cephalic cuticular annules more than 60.....……..… *P. reuhmi* Gupta & Kaur, 1978
9(8). Oesophagus 0.45 mm in length.....…… *P. islamabadi* (Basir, 1941) Basir,1956
- Oesophagus less than 0.45 mm in length ……..…….....10
10(9). Caudal papillae three pairs ……..……...… *P. vazi* Travassos, 1954
- Caudal papillae five pairs……..*P. toddi* (Travassos, 1954) Kloss, 1959c

6.4 Genus: *Zonothrix* Todd, 1942

6.4.1 Generic diagnosis

Female: Cephalic extremity formed by circumoral annule and simple second annule. Oesophageal end bulb gently clavate with or without pseudobulb. Isthmus a constriction between corpus and bulb. Cardia may or may not be modified into a branch-like structure posteriorly. Vulva with protruding anterior lip near posterior-third of the body. Vagina short, anteriorly directed. Gonads amphidelphic. Eggs broadly oval with filaments coiled around shell. Tail conical

Male: Cephalic extremity formed by single annule. Corpus cylindrical. Caudal extremity conical. Spicule present. Caudal papillae consisting of one pair pre-anal sub-ventral, one pair adanal sub-lateral, three pairs circumanal of which one pair pre-anal, one pair adanal and one pair post-anal and two pairs on tail, of which one is sub-lateral and one sub-ventral.

6.4.2 Species

Zonothrix alata Shah & Rizvi, 2004b (Fig.15); **Host:** *Hydrophilus triangularis* Say

Habitat: Gut; **Locality:** Imphal, Manipur, India

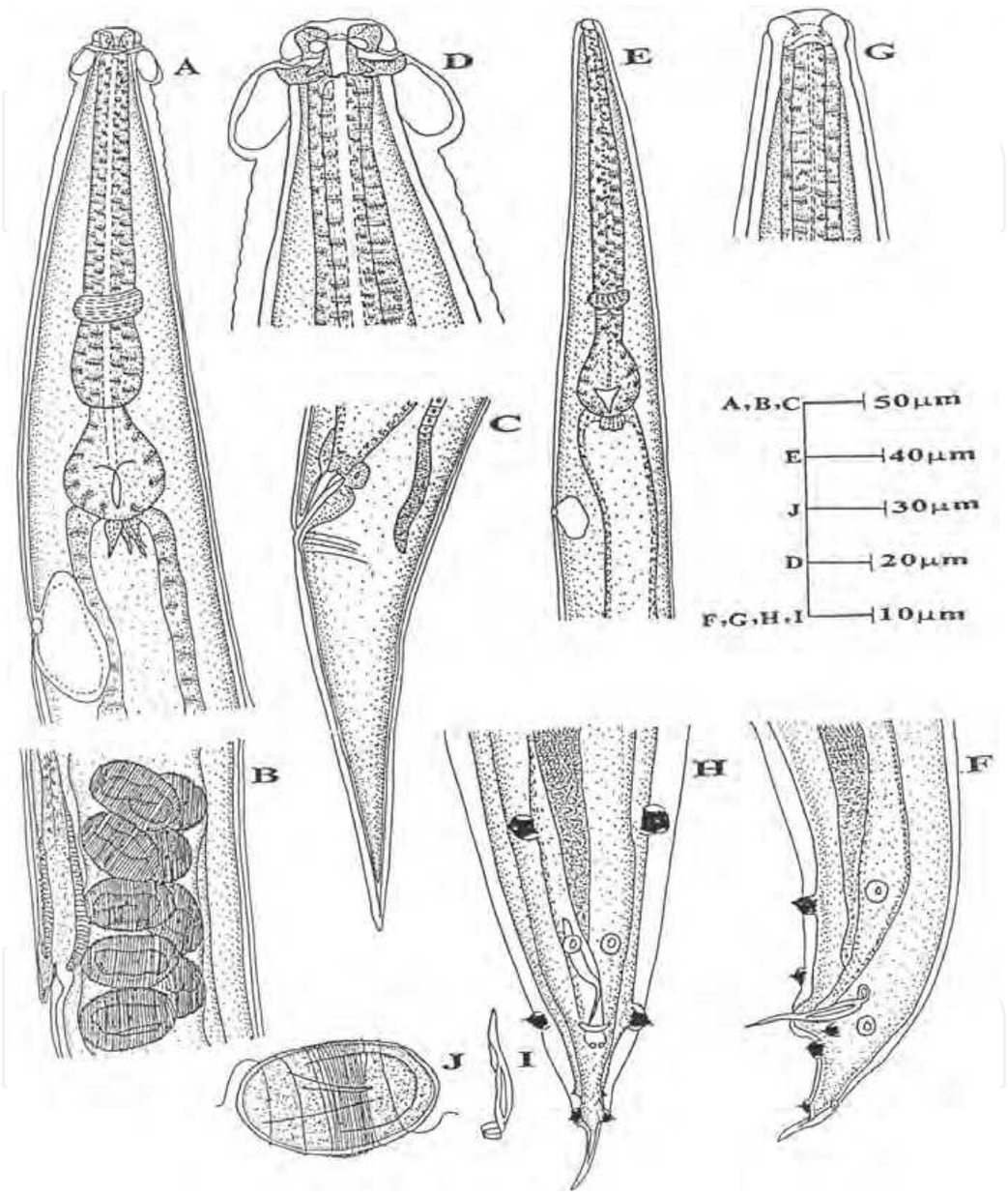

Fig. 14. *Pseudonymus basiri* Shah & Rizvi, 2004b: A-Oesophagus of female, B-Vulva region and eggs in uterus, C-Tail end of female, D-Head cephalic of female, E-Oesophagus of male, F-Tail end of male, lateral, G-Head cephalic end of male, H-Tail end of male (ventral), I-Spicule, J-An embryonated egg.

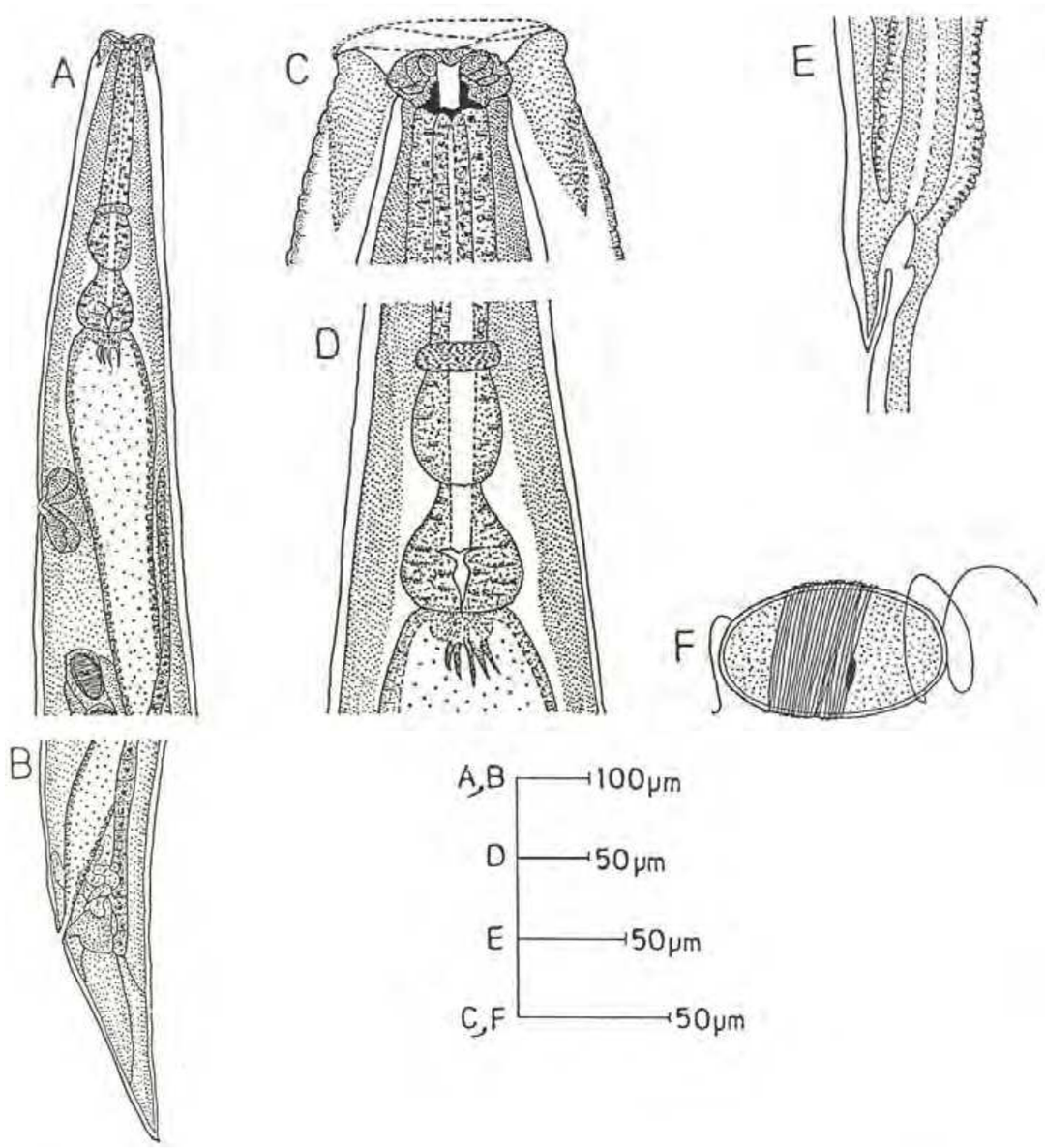

Fig. 15. *Zonothrix alata* Shah & Rizvi, 2004b: A-Anterior region of female, B-Tail end of female, C-Cephalic end of female, D-Basal region of oesophagus, E-Vulva region, F-An egg.

6.4.3 Key to species of *Zonothrix* Todd, 1942

1. Body of female C-shaped after fixation……..……...……2
- Body of female coiled after fixation…….……..…*Z. izecksohni* Kloss, 1959b
2(1). Posterior end of corpus in female narrower than oesophageal bulb……...…….. 3
- Posterior end of corpus in female almost as broad as oesophageal bulb……..... ……...…… *Z. hydroi* (Galeb, 1878) Todd, 1942
3(2). Mature female more than 2 mm and less than 5mm long ….……..……. 4
- Mature female less than 2 mm long ……..... *Z. helocharesae* Kloss, 1959c
4(3). Swollen annulation present in cephalic extremity of female …… 5
- Swollenannulation absent in cephalic extremity of female……. ……...…….……...…… *Z. tropisterna* Todd, 1942
5(4). Cephalic annule in female not inflated……...…..……..…6
Cephalic annule in female inflated …….……..…….. *Z. alata* Shah & Rizvi,2004b
6(5). Female tail narrowing behind anus and not continuing as a spine-like caudal extension……...……...……...…7
- Female tail not as above …..…….……..…..…… 8
7(6). Female tail conical ; Ex.=*Coleostoma luederwaldi*…..... *Z. gladius* Kloss, 1959c
- Female tail conically attenuated; Ex.= *Dytiscus marginicollis*..... ….……..……..*Z. mehdii* (Farooqui, 1967) Adamson & Waerebeke,1992b
8(6). Caudal extremity of female terminating in a short spine-like structure …….. 9
- Caudal extremity of female without spine-like appendage…..……..… 10
9(8). Caudal spine of female=26-35 µm long……...…..…*Z. galebi* Kloss, 1959c
- Caudal spine of female less than 10 µm long……..... *Z. paraense* Kloss, 1959
10(8). Distance between vulva and anus 20-28% total body length, tail of female 5-8% of body length; seven pairs of caudal papillae in male…….. ……...*Z. columbianus* Adamson & Buck, 1990
- Distance between vulva and anus less than 15% of total body length, tail of female 10% of body length; six pairs of caudal papillae in male…..… *Z. adversa* Kloss, 1958

7. Family Travasosinematidae Rao, 1958

7.1 Diagnosis

Cephalic extremity simple or formed by 6-12 hood-like expansion. Mouth surrounded by 3-8 labial papillae. Lateral alae present or absent. Oesophagus consisting of cylindrical or clavate corpus, isthmus distinct or just a constriction between corpus and a posterior endbulb. Vulva posterior to midbody. Gonads amphidelphic. Eggs with polar filaments and not twisted around shell. Males with single testes. Spicule single or absent. Caudal papillae 2-9 pairs or completely absent.

7.2 Key to genera of Travassosinematidae Rao, 1958

1. Spicule present…….……..……*Isobinema* Rao,1958
- Spicule absent……..……..……2
2(1). Buccal cavity annulated……..…..…..*Chitwoodiella* Basir,1948b
- Buccal cavity not annulated…….……...3
3(2). 2-5 pairs of caudal papillae in male……..……..4
- 9-10 pairs of caudal papillae in male…….*Pteronemella* Rao,1958

4(3). Vulva posterior to midbody……...……...……...….5
- Vulva at 2/3 of body length……..…..*Mirzaiella* Basir, 1942
5(4). Female tail with a spike-like caudal appendage…….…….…6
- Female tail without a spike-like caudal appendage…….. *Binema* Travassos,1925
6(5). Spines present on the body of female…….....……*Indiana* Chakravarty, 1943
- Spines absent on body of female …..…….……..….7
7(6). Cephalic extremity provided with 6-12 hood-like projections …...…….8
- Cephalic extremity simple, without hood-like projections...*Mohibiella* Farooqui,1970
8(7). Eggs with polar filaments…….…..9
- Eggs without polar filaments…….…...*Travassosinema* Rao,1958
9(8). Mouth with 6 lips, buccal cavity divided into 2 parts, a narrow and a broad posterior chamber occupied by leaf-like plates……*Singhiella* Rao,1958
- Mouth with 12 hood-like formations arranged in 2 circles of 6, in tandem, buccal cavity not divided into two parts…….*Pulchrocephala* Travassos,1925

7.3 Genus: *Binema* Travassos, 1925

7.3.1 Generic diagnosis

Cephalic extremity formed by a circumoral ring and short second annule. Lateral alae present or absent in both sexes. Isthmus distinct or it is a constriction between corpus and bulb with or without a ring-like sub-ganglion at its middle of isthmus. Buccal cavity absent or present in females. Vulva posterior to midbody. Gonads amphidelphic. Eggs broadly oval with polar filaments deposited in capsules containing 2-3 eggs or non-encapsulated and laid in pairs. Tail conical or rounded with short or long caudal appendage or flagella-like, with or without fine striations near its tips. Caudal extremity in male conical to subulate or filiform or spike-like. Caudal papillae 5-10 pairs. Single median papilla present or absent. Spicule single or absent.

7.3.2 Species

Binema ornata Travassos, 1925 (Figs. 16 & 18); Host : *Gryllotalpa africana* Beauvois ;**Habitat :** Gut ; **Locality :** Imphal, Manipur, India

7.3.3 Species

Binema korsakowi (Sergiev, 1923) Basir, 1956 (Figs. 17 & 18); **Host :** *Gryllotalpa africana* Beauvois ; **Habitat:** Gut; **Locality:** Imphal, Manipur, India

7.3.4 Species

Binema mirzaia (Basir, 1942a) Basir, 1956 (Figs. 19 & 21) ; **Host:** *Gryllotalpa africana* Beauvois ; **Habitat:** Gut ;**Locality:** Imphal, Manipur, India

7.3.5 Species

Binema anulinervus Shah & Rizvi, 2004a (Figs. 20 & 21); **Host :** *Gryllotalpa africana* Beauvois ; **Habitat :** Gut ; **Locality:** Imphal, Manipur, India

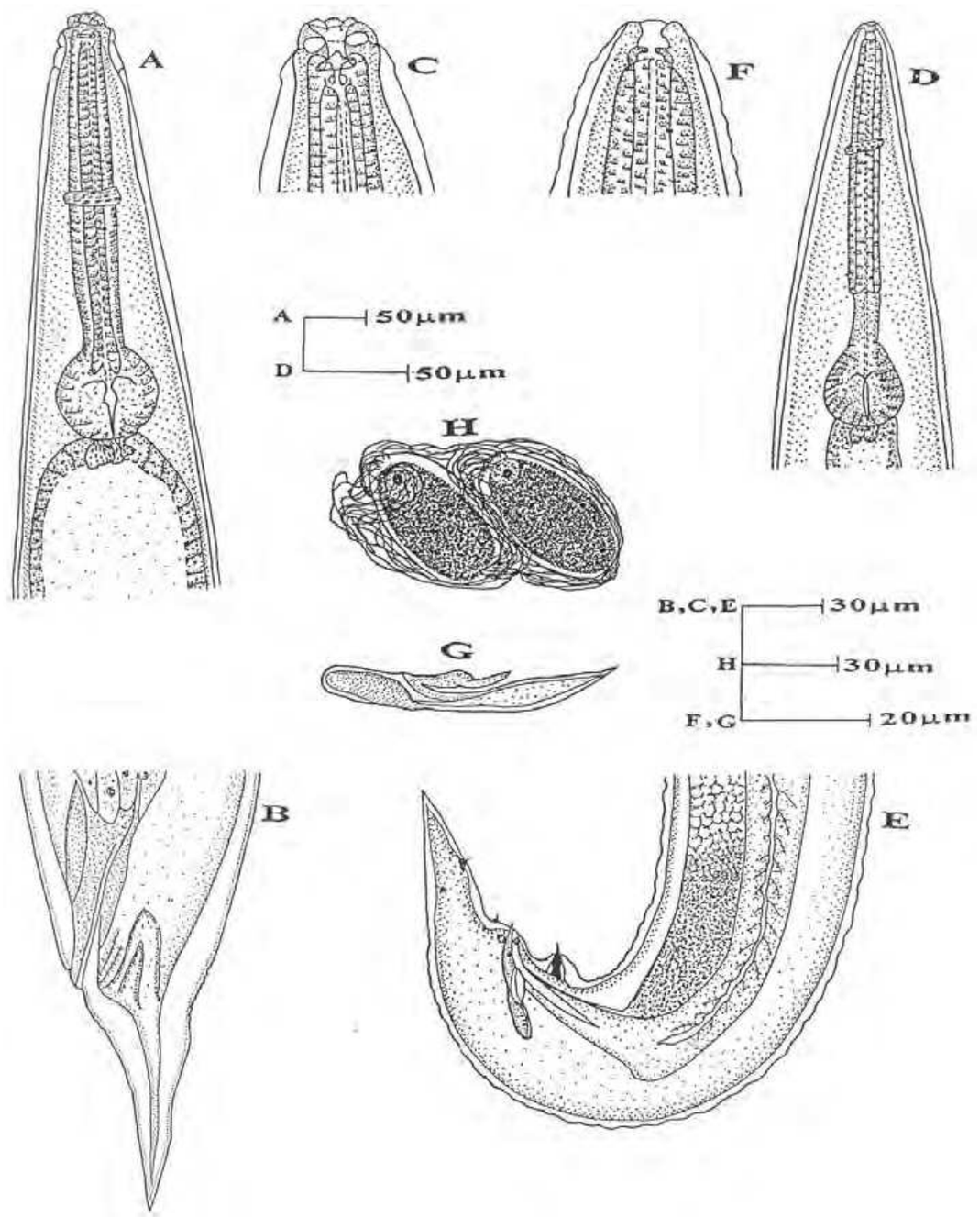

Fig. 16. *Binema ornata* Travassos, 1925: A-Female anterior end (lateral view), B-Female posterior end (lateral view), C-Female cephalic end (lateral view), D-Male anterior end (lateral view), E-Male posterior end (lateral view), F-Male cephalic end (lateral view), G-Spicule (lateral view), H-Eggs (Shah & Rizvi, 2004a).

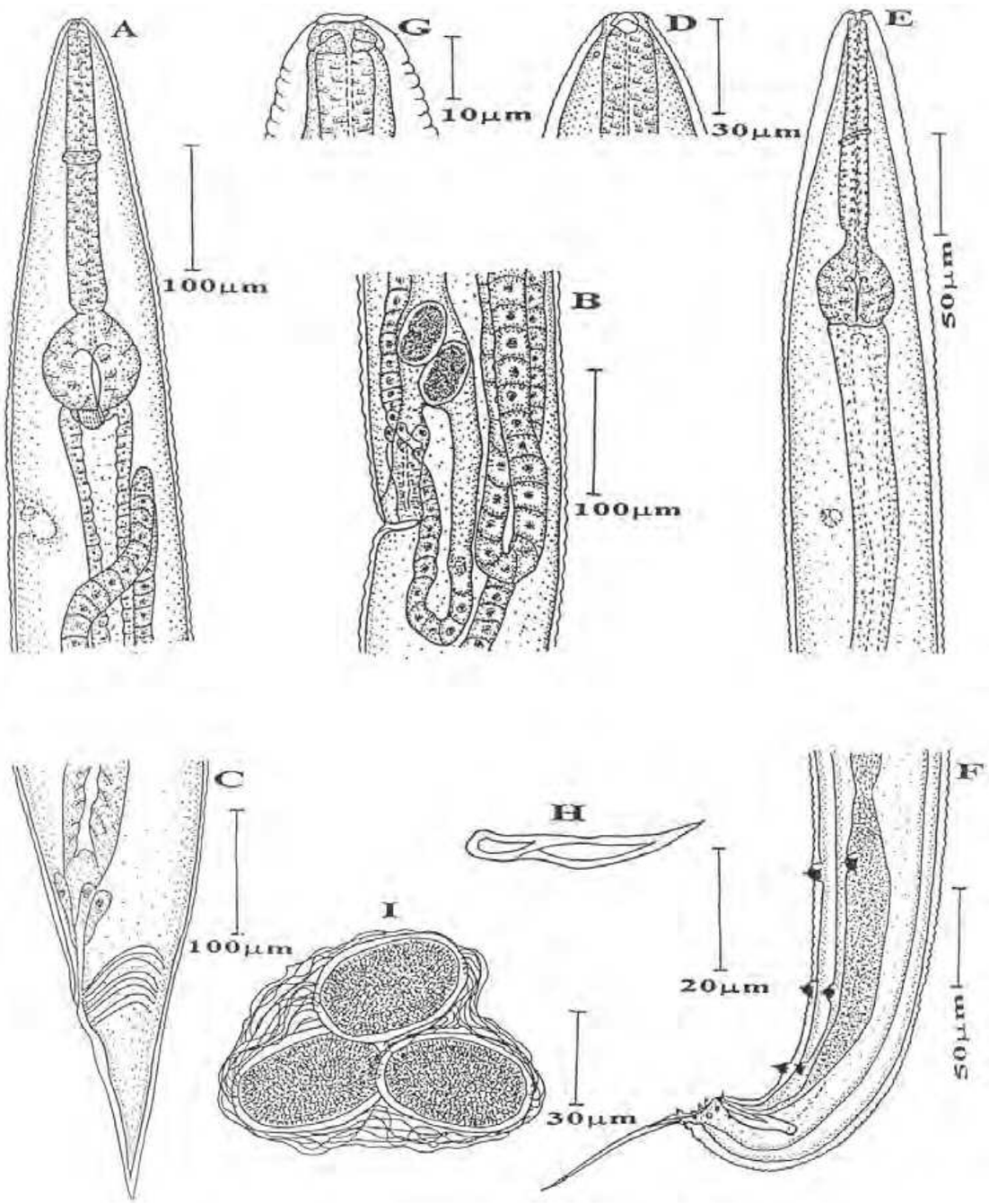

Fig. 17. *Binema korsakowi* Sergiev, 1923: A-Female anterior end (lateral view), B-Female vulval region (lateral view), C-Female posterior end (lateral view), D-Male cephalic end (lateral view), E-Male anterior end (lateral view), F-Male posterior end (lateral view), G-Female cephalic end (lateral view), H-Spicule (lateral view), I-Eggs (Shah & Rizvi, 2004a).

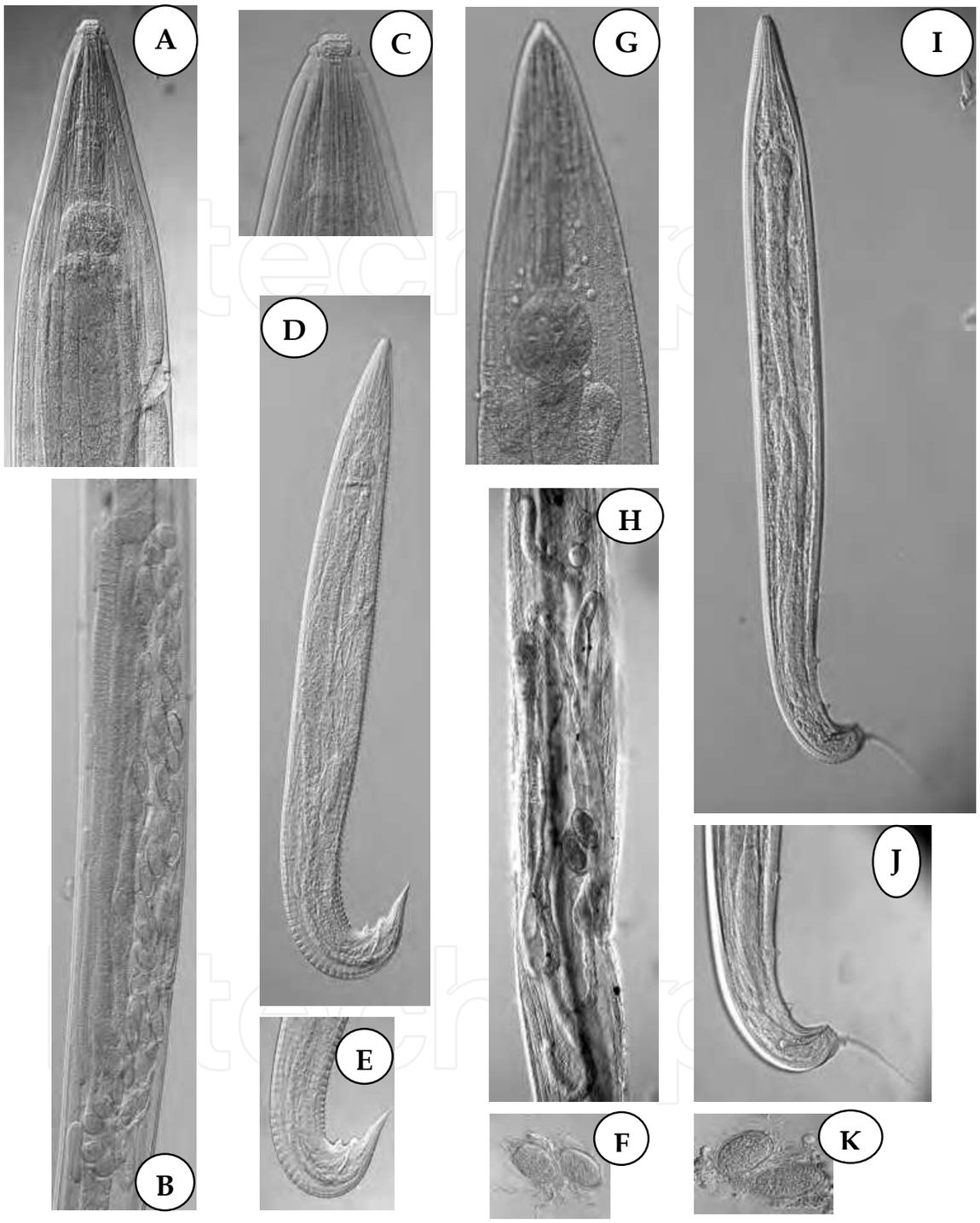

Fig. 18. Photomicrographs of *Binema ornata* Travassos, 1925 (A-F) and *Binema korsakowi* Sergiev, 1923 (G-K): A-Female anterior portion showing, excretory pore, B-Female gonads, C-Female cephalic structure, D-Entire male (lateral view), E-Male posterior end showing spicule and papillae, F-Eggs; G-Female excretory pore, H-Female gonads, I-Entire male (lateral view), J-Male posterior end showing spicule and papillae, K-Eggs (Shah & Rizvi, 2004a).

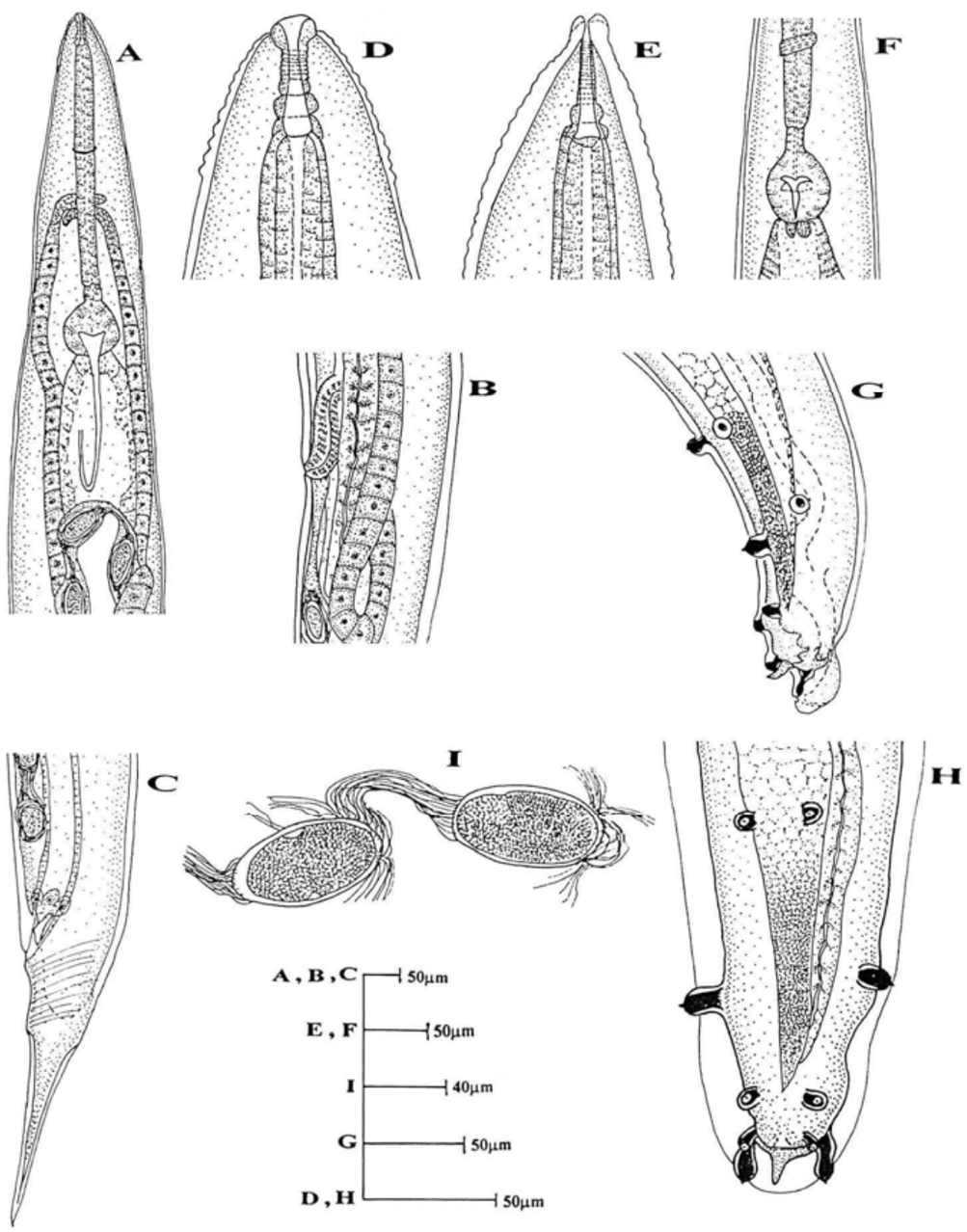

Fig. 19. *Binema mirzaia* Basir, 1942a: A-Female anterior end (lateral view), B-Female cephalic end (lateral view), C-Male cephalic end (lateral view), D-Male anterior end (lateral view), E-Female posterior end lateral view), F-Male posterior end (lateral view), G-Male posterior end (ventral view), H-Spicule, I-Eggs (Shah & Rizvi, 2004a).

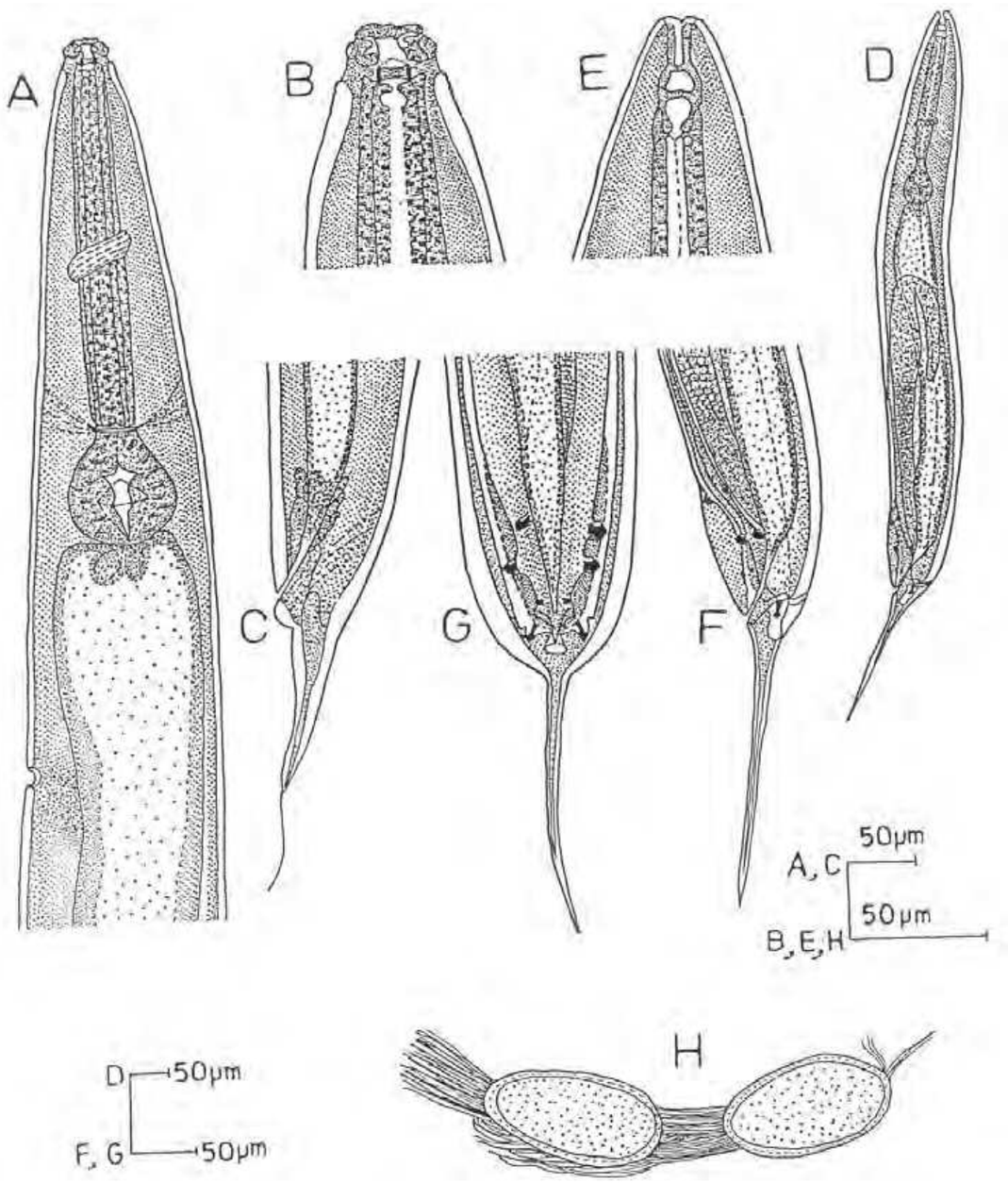

Fig. 20. *Binema anulinervus* Shah & Rizvi, 2004a: A-Female anterior end (lateral view), B-Female cephalic end (lateral view), C-Female posterior end (lateral view), D-Male entire (lateral view), E-Male cephalic end (lateral view), F-Male posterior end (lateral view), G-Male posterior end (ventral view), H-Eggs.

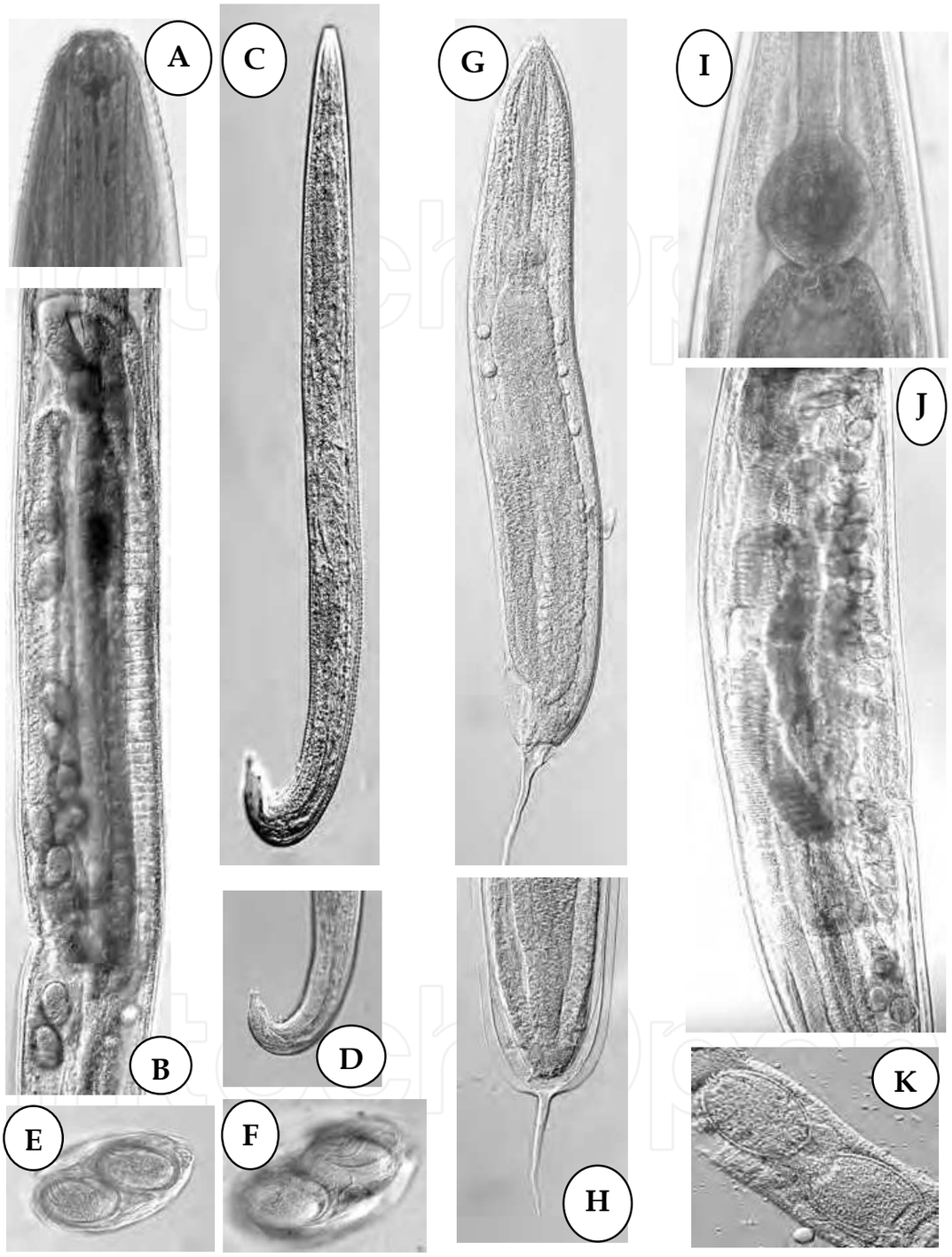

Fig. 21. Photomicrographs of *Binema mirzaia* Basir, 1942a (A-F) and *Binema anulinervus* Shah & Rizvi, 2004a (G-K): A-Female cephalic annulation, B-Female gonads, C-Entire male (Lateral view), D-Male posterior end showing spicule and papillae, E-Eggs (internal), F-Eggs (outer shell), G-Male entire (Lateral view), H-Male posterior end showing papillae (ventral view), Portion of female oesophagus showing ring like structure in the middle of Isthmus, J-Female gonads (Lateral view), K-Eggs.

7.3.6 Key to species of *Binema* Travassos, 1925

1. Female tail with flagellate caudal appendage……2
- Female tail without flagellate caudal appendage...……..3
2(1). Female length=2.423-3.273 mm, presence of a sub-ganglion at the middle of isthmus...…… *B. anulinervus* Shah & Rizvi,2004a
- Female length = 6.98 mm, absence of a subganglion at the middle of the isthmus…. ……..…… *B. pseudornatum* Leibersperger,1960
3(1). Buccal cavity present……..……4
- Buccal cavity absent…….…..…..... *B. korsakowi* (Sergiev, 1923) Basir,1956
4(3). Lateral alae in male present……...…….....5
- Lateral alae in male absent……..……6
5(4). Annulation prominent only in cervical region and female tail=0.068-0.088mm……. ……. *B. mirzaia* (Basir,1942a)Basir,1956
- Annulation absent in cervical region and female tail = 0.2-0.21 mm…….. ……..…..…….....*B. parva* Parveen & Jairajpuri,1985b
6(4). Male with five pairs of caudal papillae, buccal cavity with ornamentation……7
- Male with eight pairs of caudal papillae, buccal cavity without ornamentation…..... ……..……...……..……*B. striatum* Rizvi &Jairajpuri,2000
7(6). Female buccal cavity with three sclerotized arches and male tail conical…… ……...……...……..…… *B. bonaerensis* Camino &Reboredo,1999
- Female buccal cavity with projection; male tail forms a caudal spike…… ……..……...……..……*B. ornata* Travassos,1925

7.4 Genus: *Chitwoodiella* Basir,1948b

7.4.1 Generic diagnosis

Female: Cephalic extremity formed by single lip cone. Buccal capsule long, tubular with striated cuticular wall, posterior part of which may or may not possess three cuticularised tooth like structures. Oesophageal corpus cylindrical. Prominent cardia with or without modification into a long tubular structure. Vulva between middle and posterior-third of body. Vagina short and directed anteriorly. Gonads amphididelphic. Blind ends of ovaries reflexed and reaching the oesophageal region. Eggs attached to one another in strings by polar filaments. Tail conical or subulate.

Male: Buccal capsule long tubular with striated cuticular wall, posterior part do not possess cuticularised tooth-like structures. Lateral alae present. Tail very short, truncated with caudal alae. Spicule absent. Caudal papillae five to six pairs. A median ventral, rod-like, bluntly pointed projection, juts out backwardly just behind the cloaca.

7.4.2 Species

Chitwoodiella longicaridia Shah, 2008 (Figs. 22 & 23); **Host :** *Gryllotalpa africana* Beauvois ; **Site :** Gut ; **Locality:** Imphal, Manipur, India

7.4.3 Key to species of *Chitwoodiella* Basir, 1948b

1. Cardia modified into a long tube……..…..……..*C. longicardia* Shah,2008
- Cardia not modified into a long tube…….……..……..…..……2

2(1). Six pairs of caudal papillae in male; female buccal cavity with three tooth-like structures…..…..…..…..……..*C. tridentata* Rizvi, Jairajpuri & Shah,1998

- Five pairs of caudal papillae in male; female buccal cavity without three tooth-like structure……..……..…..……..…*C. ovofilamenta* Basir (1948b, 1949)

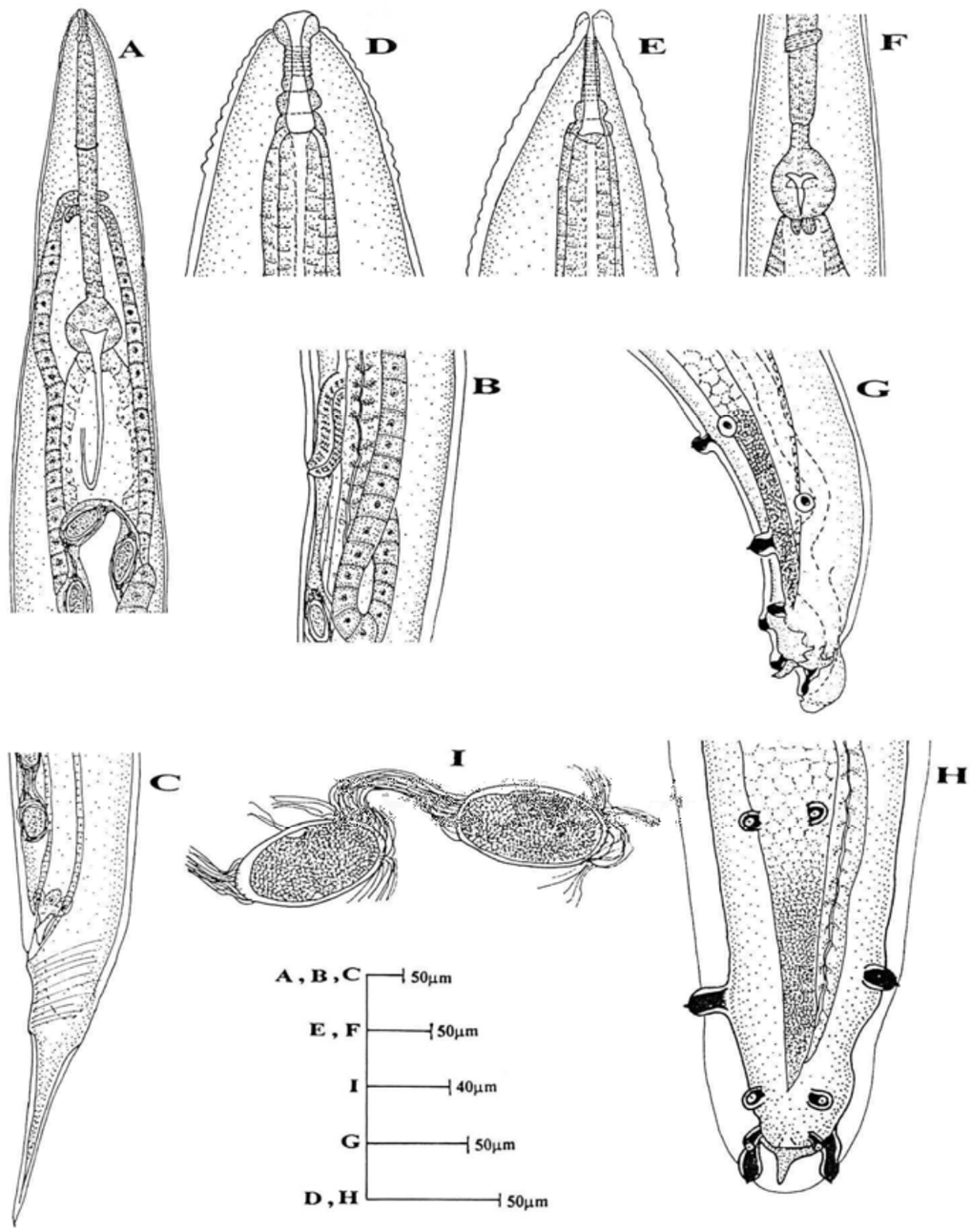

Fig. 22. *Chitwoodiella longicardia* Shah, 2008: A-Female anterior end, B-Female vulval region, C-Female posterior end (lateral view), D-Female cephalic end, E-Male cephalic end, F-Male oesophageal region, G- Male posterior end (lateral view under different focuses), H-Male posterior end (ventral view), I- Eggs.

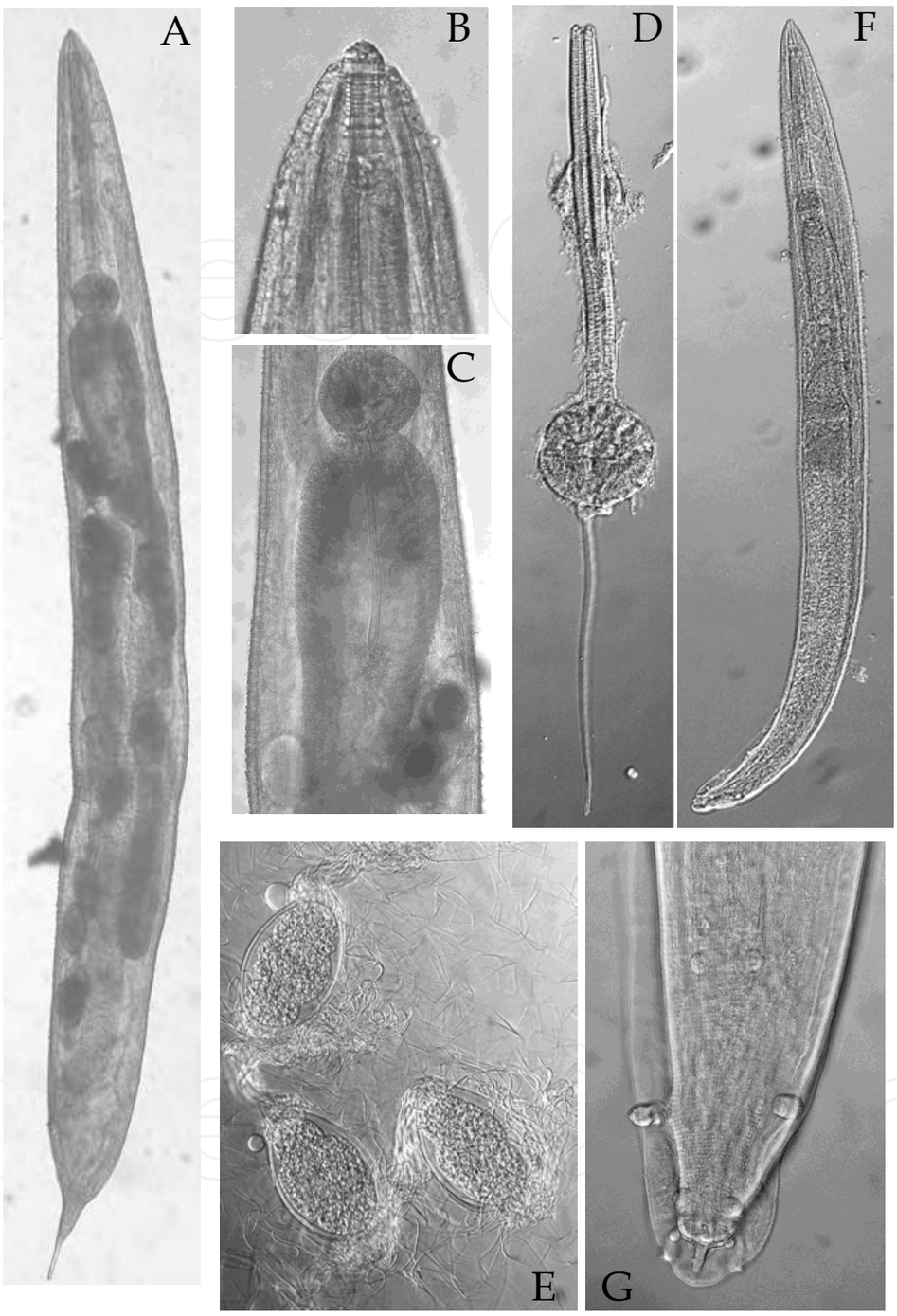

Fig. 23. Photomicrographs of *Chitwoodiella longicardia* Shah, 2008: A-Female entire (lateral view), B-Female anterior end showing prominent annulations in cervical region and in buccal cavity, C-Female oesophageal bulb and intestine showing modified cardia, D-Magnified and cut-open view of female oesophagus showing corpus, nerve ring, bulb and modified & elongated cardia, E-Eggs showing egg filaments joining one another, F-Male entire (lateral view), G-Male posterior end (ventral view).

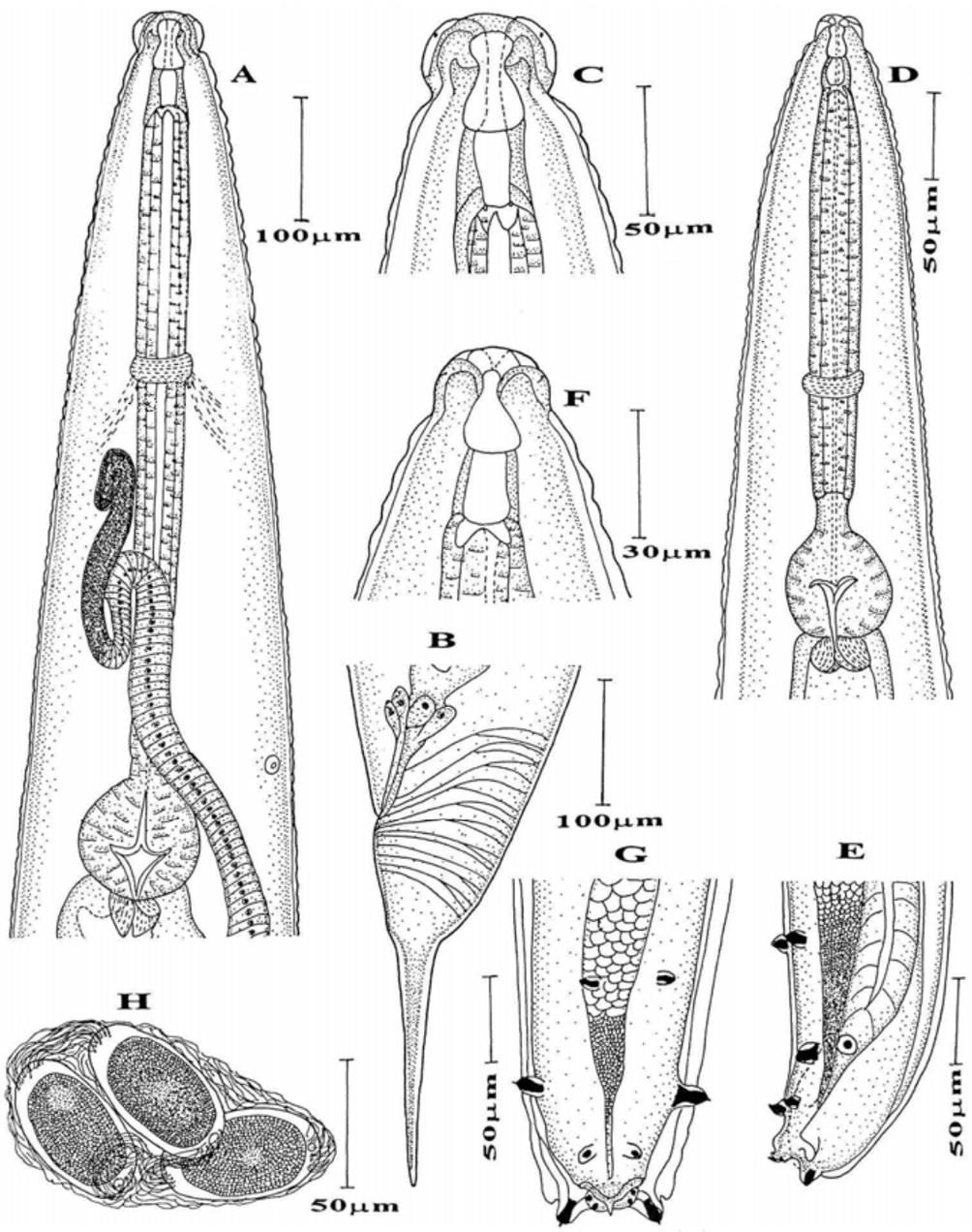

Fig. 24. *Mirzaiella asiatica* Basir, 1942: A-Female anterior end, B-Female posterior end (lateral view), C-Female cephalicd end, D-Male anterior end, E-Male posterior end (lateral view), F-Male cephalic end, G-Male posterior end (ventral view), H-Eggs (Shah, 2008).

7.5 Genus: *Mirzaiella* Basir, 1942a

7.5.1 Generic diagnosis

Cephalic extremity formed by prominent cephalic annule. Oral opening surrounded by three lips, one dorsal and two subventral. Buccal cavity long, tubular, formed by two distinct parts of almost equal length. Oesophageal corpus very long, widest at its anterior

end, shaped like an inverted club, isthmus short and bulb spherical. Excretory pore anterior to the base of the oesophagus. Vulva near posterior-third of body. Vagina short, muscular and anteriorly directed. Amphidelphic. Eggs oval shaped, attached to one another by polar filaments, laid in mucus capsules, each capsule containing two-five eggs. Tail short, blunt or rounded or subulate, with or without spine-like appendage. Lateral alae absent in female. Gonads two, ovaries reflexed at both ends, the anterior one extends upto the middle of the corpus and the posterior one a little above the anus. Caudal extremity in male rounded. Caudal papillae four to seven pairs. Spicule absent. Pointed cuticularized accessory piece present immediately behind the anus.

7.5.2 Species

Mirzaiella asiatica Basir, 1942a (Fig. 24); Host : *Gryllotalpa africana* Beauvois ; Site : Gut ;Locality: Imphal, Manipur, India

7.5.3 Key to species of *Mirzaiella* Basir, 1942a

1. Female tail with a distinct constriction in the middle……..…*M. alii* Farooqui,1967
- Female tail without distinct constriction in the middle…….…..……..……..2
2(2). Three chitinous teeth at the base of the buccal cavity present in female…..…..…… …..…….……*M. indicus* (Singh & Singh, 1955) Adamson & Waerebeke,1992b
- Female buccal cavity without teeth…….....3
3(2). Spicule present in male…..... ……..*M. gryllotalpae* (Singh & Singh,1955) Adamson & Waerebeke,1992b
- Spicule absent in male…….....……..….4
4(3). Caudal papillae five pairs, only caudal alae present...……..*M. asiatica* Basir, 1942a
- Caudal papillae seven pairs, caudal alae extend upto midbody……..……..…..…..... ...…….……*M. haroldi* Farooqui, 1968b

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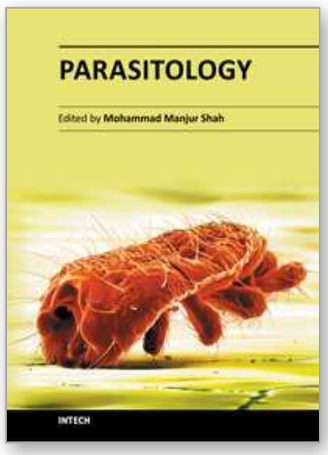

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Parasitology is an established discipline that covers a wide area of subjects, ranging from the basics (study of life cycle, ecology, epidemiology, taxonomy, biodiversity, etc) to the advanced and applied aspects (human and animal related, although control aspect remains the most important task). There is a great scarcity in the amount of available literature that is freely accessible to anyone interested in the subject. This book was conceptualized with this in mind. The entire book is based on the findings of various studies performed by different authors, comprising reviews and original scientific papers. I hope this book will be helpful to diverse audiences like biologists, zoologists, nematologists, parasitologists, microbiologists, medical doctors, pathologists as well as the molecular biologists, by providing them with a better understanding of the subject.

How to reference

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