PART - I
TAXONOMIC STUDIES
INTRODUCTION AND HISTORICAL REVIEW
PART - I TAXONOMIC STUDIES

INTRODUCTION AND HISTORICAL REVIEW

The nematodes or 'roundworms' make up a large assemblage of worms of relatively simple structure with widespread distribution. Nematodes are pseudocoelomate, bilateria with flexible cuticle and somatic longitudinal muscles for movement. The body tissues are believed to be permanently under pressure due to the presence of body fluids. Usually circular in cross-section. They have no appendages, but may have cuticular bristles or sensory setae. The nervous system consists of a circum-esophageal nerve ring and longitudinal nerves. The circulatory and respiratory systems are totally absent. The excretory system is primitive, it is devoid of protonephridial cilia or flame cells. The digestive system consists of a feeding apparatus (stoma), esophagus, intestine and rectum. The sexes are typically separate, the reproductive organs are tubular. The females have a separate genital pore and males having cloaca and copulatory apparatus. The females are oviparous or ovoviviparous and eggs pass through four larval stages before the adult stage is reached.

The nematodes have more varied habitat than other
group of animals, save the arthropods and even this group is foreshadowed by the immense number of nematode individuals. As Cobb (1915) so aptly described it "they occur in arid deserts and at the bottom of lakes and rivers, in the waters of hot springs and in the polar seas where the temperature is constantly below the freezing point of fresh water. They were thawed out alive from Antartica ice in the far South, by members of the Shackleton expedition. They occur at enormous depths in Alpine lakes and in the ocean. As parasites of fishes they traverse the seas, as parasites of birds they float across continents and over high mountain ranges. Man without wings flies in aeroplanes, nematodes without wings fly in birds, bats, bees, flies or fleas".

The nematodes exhibit a wide range of feeding habits, some are saprophytic, whereas others live on the plant or in soil around plants, sucking their juices, while others venture within the plants and animals, wander destructively through its tissues and organs.

Entomophilic or insect nematodes belong to some 27 families in nine major groups of nematodes, namely rhabditoid, tylenchoid, aphelenchoid, strongyloid, oxyuroid, ascaridoid, spiruroid, filarioid and
mermithoid. The first eight belong to the Secernentea and the ninth to the Adenophorea, the two primary taxonomic divisions of the Nematoda (Nickle and Welch, 1984). 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 host.

The economic importance of insect nematodes in general lies in the fact that entomophilic nematodes are a group of parasites that cause debilitation, sterility (partial or complete) or death of a large number of insects belonging to various orders and families. There have been some reports of detrimental effects of oxyurids on insects (orthopterans). Taylor (1968) reported that *Leidynema appendiculatum* (Thelastomatidae) caused lesions in the hindgut of *Leucophaea maderae* which apparently were initiated as tissue damage followed by a hemocytic response and melanization on the part of the host. Later, Majumdar (1970) reported that *L. appendiculatum* infection in larval and adult *Periplaneta americana* caused total lipid reduction. Besides this, the dietary intake of the insect host influences the type of nematode infection (Hominick and Davey, 1972 b) and it has been
observed that starved cockroaches show a lower burden of nematode infection (Peregrine, 1974 a, b).

Though Nematology has lately begun to receive proper attention, its history can be traced to ancient times. Ebers (1872), a German Egyptologist obtained a manuscript, "Papyrus Ebers" dated as far back as 1553-1550 B.C., mentioning Ascaris lumbricoides, Dracunculus medinensis and Ancylostoma duodenale. The guinea worm of the Israelites was referred to as the "fiery serpent" by Moses (1250 B.C.) in the Bible. Among the ancient European workers, the names of Hippocrates, Aristotle, Agathachides, Pliny, Celsus and Vegitius may be mentioned. Rudolphi began to study the parasitic worms and gave them scientific names calling the roundworms, Nematoidea. In his "Entozoorum synopsis" published in 1819, Rudolphi listed 11 genera and about 350 species of nematodes.

The life-cycle of various parasitic nematodes were worked out during the period 1820-1870. The taxonomy of different groups of nematodes was placed on a firm footing by Dujardin (1845) and Diesing (1850). During the later years of the 19th century, knowledge regarding various genera and species increased and contributions by a long list of taxonomists broadened our knowledge of nematodes, both free living and
parasitic, parasitizing plants and animals.

The work on insect nematodes started comparatively late. The group of insect nematodes studied in the present work belongs to the Thelastomatoidea, a superfamily of the order Oxyurida, one of the principal orders of parasitic nematodes. *Oxyuris gryllotalpae* was the first oxyurid nematode to be reported from an arthropod host, mole cricket by Dufour (1837), but his descriptions and illustrations were not sufficient enough to assign it to a definite group. Hammerschmidt (1838) gave first complete description of insect oxyurid, *Oxyuris diesingi* from the intestine of German cockroach, *Blatta orientalis*, a member of the family Blattidae. Another important taxonomist of the nineteenth century is Leidy (1849, 1850, 1853) who worked on the oxyurid nematodes of arthropods and erected a new genus *Thelastoma* and described several new species which were later placed in the family Thelastomatidae (Travassos, 1929).

At the turn of the twentieth century, a number of scientists in many countries became active in insect nematode research. Cobb (1920, 1929) provided extensive information on insect nematodes by describing several new genera and species of oxyurid nematodes. A long series of publications were provided by Travassos
(1920, 1925 a,b; 1929, 1953, 1954) who pursued detailed morphological and taxonomic studies on the oxyurid nematodes parasitizing various Arthropods, namely Diplopoda, Chilopoda and Insecta, besides this he modified earlier work. Sergiev (1923) and Schwenck (1926) worked on the taxonomy of various insect nematodes, erecting new genera and describing new species. Walton (1927) revised the nematodes of the Leidy collection. Christie (1931, 1938) reported many new genera and species and modified various genera and species of earlier workers. Chitwood (1932) published a synopsis of nematodes parasitic in insects of the family Blattidae reporting one new subfamily, seven new genera, nine new species and several new combinations. Chitwood and Chitwood (1934) reported nematode parasitism in Philippine cockroaches and described 5 new species. Chitwood and Chitwood's (1937, 1938, 1940) compilation, "Introduction to Nematology" published in three parts, has been of paramount importance in the field of Nematology. Todd (1941, 1943, 1944a,b) worked on the development and hatching of the eggs of Hammershmidtella diesingi and Leidynema appendiculatum, nematodes parasitic in roaches, besides reporting three new species of insect nematodes. Bozeman (1942) provided experimental investigation into
the life-history of *Blatticola blattae* found in *Blatella germanica* (German cockroach).

Notable work on the taxonomy of oxyurid nematodes were carried out by several workers, some of the important ones being Serrano Sanchez (1945, 1947) who reported some new species of insect oxyurids from Spain. Theodorides (1953, 1955, 1956) worked out the taxonomy of nematodes parasitizing Coleopterans and Diploponds. Travassos and Kloss (1957, 1958, 1965) erected new genera and described several new species of nematodes parasitizing Arthropods. Kloss (1957-1970) pursued the taxonomy of various insect nematodes, erected new families for the nematodes belonging to the superfamily Thelastomatoidea, besides describing several species of insect nematodes. Lee (1958 a, b; 1959, 1960, 1961, 1974) provided important informations regarding thelastomatid nematodes by reporting studies on morphology and osmoregulation in *Hammerschmidtilla diesingi*, digestion and nervous system in *Leidynema appendiculatum*, origin of sticky coat in eggs and occurrence of dimorphic males in *Thelastoma bulhoesi*. Leibersperger (1960) widened the knowledge of nematodes parasitizing insect and other Arthropods by redescribing 12 known genera, reporting 23 new species, 5 new subspecies and 10 known species
from France. Fay (1961) worked for the first time on
the ecology of L. appendiculatum. Jarry (1961, 1964)
and Jarry and Jarry (1961, 1963, 1968) reported several
species of nematodes parasitic in insects and other
Arthropods from France and also distinguished two
relative genera of thelastomatid nematodes namely
Thelastoma and Cephalobellus. Dale (1964 a, b; 1965,
1966 a, b) reported one new genus and seven new
species from New Zealand. Cali and Mai (1965)
reported studies on the development of Blatticola
blattae within its host Blatella germanica. Bain (1965)
described six species of oxyurid nematodes from
Gryllotalpa africana (mole cricket) in Madagascar.
Ahmad and Jabin (1966) reported two new species of
nematodes from the roach, Opisthoplatia orientalis from
Pakistan. Skrjabin et al., (1966) worked on the
systematics of oxyurids of invertebrates and also
modified the work of earlier scientists. Taylor (1968)
contributed to our knowledge on the detrimental effects
of oxyurids on their host. Gordon (1968, 1970) provided
information on the neuroendocrine relationship between
the nematode Hammerschmidtiella diesingi and its host,
Blatta orientalis. Kakulia (1968) reported oxyurid
nematodes from mole crickets in Georgia.

For the last twenty years, there have been a
phenomenal development in the area of insect Nematology. Waerebeke (1969, 1970, 1973, 1978, 1987) has done elaborate work on the taxonomy of nematodes parasitizing insects and other arthropods, reporting two new genera and ten new species of oxyurids and also modified the earlier works in this field. Hominick and Davey (1972a,b; 1973, 1975) worked out the behavioural aspect of these nematodes and their relationship with their host. Poinar (1973, 1977) carried out systematic studies on insect oxyurids and described two new species, published a key of oxyurid nematodes in the Commonwealth Agricultural Bureaux Series.

Besides these, there are other workers who have contributed to our knowledge in this field. Some of them need to be mentioned, such as, Peregrine (1974a, b) who reported the host-dietary changes and the hindgut fauna of cockroaches and the effect of host-diet on Thelastoma attenuatum; Khairul and Paran (1977) described one new species and two known species of thelastomatid nematodes; Clark (1978) reported one new species from diplopods; Wharton (1979b, 1980a,b; 1991) studied the structure and formation of egg-shell of Hammerschmidtella diesingi and other nematodes and provided freeze-substitution techniques for preparing for scanning electron microscopy; Trett and Lee (1981)
studied the cephalic sense organs of adult female, *H. diesingi*; Hunt (1981, 1983) made observations on the members of the family, Pulchrocephalidae Kloss, 1960 and cephalic structures of the genus, *Indiana* using scanning electron microscope; McCallister (1988) and McCallister and Schmidt (1981, 1983, 1984) provided information on the effect of oxyurid on host size and physiology of *Periplaneta americana*, diurnal migration, development and effect of temperature on the development of *Thelastoma bulhoesii*. Upton et al. (1983) described *Thelastoma collare*, provided a list of all the members of the genus till that time and also discussed the ecology and evolutionary relationship between parasite and its host. Zervos (1983, 1987a,b; 1988a,b,c) reported many new species of thelastomatid nematodes from New Zealand insects and also worked out their population regulation and dynamics. Spiridonov (1984 a, b) introduced some new taxonomic characters in oxyurid parasites of arthropods, besides describing several new species. Webster and Thong (1984) studied some aspects of nematode parasites of orthopterans including host-parasite relationship in Oxyuroidea. Yu and Crites (1985) performed scanning electron microscopic studies on the eggs of *Hammerschmidtiiella diesingii*. Bowie (1985) reported two new species of

During the last decade, one of the most important contributions in this field has been made by Adamson (1984 a, 1985, 1986, 1987 a, b; 1989). He needs special mention as he has covered several aspects on insect nematodes such as phylogenetic analysis, modes of transmission, cytogenetics, evolutionary biology, modification of old classification, besides reporting several new species. Adamson and Nasher (1987) reported a new species of the genus Hammerschmidtiiella from the diplopods in Saudi Arabia, and also worked out the karyotypy. Adamson and Waerebeke (1987) described a new species of oxyurid nematode from Madagascan gryllotalpoidea with comments on its cephalic structures. Adamson and Clease (1989) studied the morphological changes during development in the thelastomatid nematodes. Adamson & Noble (1992, 1993) reported studies on the interspecific and intraspecific
competition among thelastomatid nematodes.

One of the significant contribution in the area of insect Nematology has been made by Adamson and Waerebeke (1992 a, b, c) by revising the superfamily Thelastomatoidea, providing simpler classification, bringing together scattered information in this field and modifying the earlier works. The revision of the superfamily Thelastomatoidea is published in three parts covering all the five families, their genera and species from all over the world. Recently, Morand and Rivault (1992) studied the life-cycle of Blatticola blattae. Hunt (1993, 1996) described two new species of the genus Travassosinema namely T. morobecola and T. sulawesiense, in diplopods from Papua New Guinea and Sulawesi and provided the first scanning electron micrography of the structure of the cephalic umbraculum and reported another new species of the same genus along with scanning electron micrographs from millipede from Vietnam.

In India, the work on nematode parasites of Arthropods began very late and the contribution of Indian workers in this field has gained importance only during the last fifty-five years. Basir (1940-1956) may be regarded as a pioneer in this field in India. His monographic study provided detailed descriptions,
classification, host-parasite list and keys of almost all the species described at that time from all over the world and also modified the earlier work. He reported 9 new and 79 known species representing 30 genera. His contributions have been a stepping stone in this field in India and a rapid series of publications on Arthropod nematodes appeared in the literature. Singh (1955) and Singh and Singh (1955) reported several new species representing six genera of the oxyurid nematodes from North India. Rao (1958) studied a number of nematode parasites of insects and other arthropods from Hyderabad, South India, and reported 6 new genera 9 new and 14 known species representing 20 genera. Biswas and Chakravarty (1963) described three new species of oxyurid nematodes. Rao and Rao (1965a, b, c, d; 1966, 1981) reported seven new species from insects in South India.

Another important worker in this field has been Farooqui (1966-1970). He had performed elaborate work on the nematodes of insects and other arthropods from Aurangabad, Maharashtra and reported 21 new and 4 known species representing 17 genera of the family Thelastomatidae. Some other workers in this area of research include Majumdar (1970), who worked out the host-parasite relationships in these nematodes,
nematodes in insects in Bombay, (Maharashtra). Rizvi and Jairajpuri (1995) performed scanning electron microscopy on the nematode parasites of insects for the first time in India.

As, this part of the thesis deals with the taxonomy, its importance in the area of research must not be neglected. It is axiomatic that nematologists cannot carry out any research, teaching extension etc. without the proper identification of the organisms they are dealing with. Whether it is research on nematode morphology, biology, physiology or host-parasite relationship, disease complexes involving nematodes, quarantine or efficient field control of nematodes, all depend on correct and reliable identification of the nematode species involved, is an essential prerequisite. Recently, there has been increasingly close collaboration among taxonomists and workers in the field of immunology, comparative physiology etc.

The rapid development in the area of molecular biology have encouraged the taxonomists to adopt new and modern techniques for the study of organisms. One of these being, scanning electron microscopy which has been applied in the present study to achieve better results on the morphology of insect nematodes.

First part of the thesis deals with the taxonomy
of insect nematodes of the superfamily Thelastomatoidea (order: Oxyurida), with the aid of light microscopes (Nikon) and scanning electron microscope. The insects were collected from Aligarh and Siddarth Nagar, North India. Many species of insects were examined but only few species were found to harbour nematodes of the superfamily Thelastomatoidea. The nematodes recovered were found to represent three families viz. Thelastomatidae, Chitwoodiellidae and Protrelloididae. For the sake of convenience, this part of the thesis is divided into three chapters. The first chapter deals with the members of the family Thelastomatidae, the second chapter deals with the members of the family Chitwoodiellidae and the third chapter with the family Protrelloididae. Historical review of the superfamily, three families and 10 genera studied in the thesis, are provided separately at the beginning of each chapter. Identification keys of most of the genera and comparative measurement charts of new species are also provided. Host-parasite list has been given at the end of part I.

Total number of species described are 16, representing 3 families, 10 known genera, 5 new species and 11 known species. Out of the 11 known species, 4 species are reported for the first time from North
India. The range, mean, standard error of mean and De Man's ratio have been calculated and provided for all the species described. Scanning electron microscopy on the nematodes parasitic in *Blatta orientalis*, and *Periplaneta americana* have been performed for the first time in India.
MATERIALS AND METHODS
MATERIALS AND METHODS

1. Collection of the Host:

The insect hosts were collected regularly from February 1994 to December 1996, from different localities of Aligarh (West U.P.) and twice the year from SiddarthNagar (East U.P.) and brought to the laboratory in live condition.

2. Collection and Isolation of Nematodes:

The hosts were anaesthetized with chloroform and dissected immediately for parasites in normal saline. The gut was removed and transferred to petri-dish. The alimentary canal was teased out and the contents were mixed with saline. The petri-dish was kept undisturbed for a few minutes, allowing the contents to settle down at the bottom. The nematodes of insects are usually easily spotted by the naked eye, due to their size and movement. However, the small-sized nematodes were picked with the help of a needle under the low power stereoscopic binocular microscope.

The nematodes were then transferred to cavity blocks containing normal saline. A preliminary examination under the binocular microscope was carried out in order to study their activity, movement, colour
and certain morphological details which cannot be observed after fixation.

Normal saline (for invertebrates) was prepared as follows:

\[
\begin{align*}
\text{NaCl} & \quad - \quad 7.0 \text{ g} \\
\text{KCl} & \quad - \quad 0.3 \text{ g} \\
\text{CaCl}_2 & \quad - \quad 0.1 \text{ g} \\
\text{NaHCO}_3 & \quad - \quad 1.5 \text{ g} \\
\text{MgSO}_4 & \quad - \quad 0.3 \text{ g}
\end{align*}
\]

(dissolved in 1 litre of distilled water)

3. Killing and Fixation of Nematodes:

The nematodes in normal saline were allowed to relax at room temperature for two to three hours and then the saline was removed with the help of a dropper. The nematodes were then killed and fixed with hot TAF (Triethanolamine formalin) fixative (Courtney, Polly and Miller, 1955).

TAF was prepared by mixing the following:

\[
\begin{align*}
\text{Triethanolamine} & \quad - \quad 2 \text{ ml} \\
\text{Formalin} & \quad - \quad 7 \text{ ml} \\
\text{Distilled water} & \quad - \quad 91 \text{ ml}
\end{align*}
\]

TAF was boiled in a beaker and then poured over the nematodes kept in cavity blocks. The nematodes were then left in TAF for at least 24 hours.
4. Dehydration, Mounting and Sealing:

For gradual dehydration, fixed nematodes were transferred to glycerine-alcohol (5 parts glycerine and 95 parts 30% ethanol) and placed in dessicator containing anhydrous calcium chloride (CaCl$_2$) as a dehydrating medium, at room temperature for about two to three weeks. During this period the alcohol evaporated, leaving the nematodes in pure glycerine.

The dehydrated nematodes were then mounted in anhydrous glycerine on double coverslip aluminium slides or glass slides. Glass-wool of suitable thickness was used to prevent the flattening or crushing of the nematodes. Lactophenol was used as a quick clearing and temporary mounting medium. For permanent slides, the edges of coverslips were sealed with 'putty' or nail-polish.

Lactophenol was prepared by mixing the following:

- Phenol - 1 part
- Distilled water - 1 part
- Lactic acid - 1 part
- Glycerine - 2 parts

5. Measurements:

The dimensions of the nematodes were taken by using an ocular micrometer. Stage micrometer was used
to find out one ocular division which is calculated as follows:

\[ \text{1 Ocular division} = \frac{\text{No. of divisions on stage micrometer}}{\text{No. of divisions of ocular micrometer}} \times 0.01 \text{ mm} \]

De Man's (1884) formula was used to denote the dimension of the nematodes. The illustrations were drawn with the help of a drawing tube attached to Nikon Optiphot - 2 microscope.

6. Scanning Electron Microscopy:

Freshly isolated specimens were fixed in 3% glutaraldehyde solution for 90 minutes, washed in 0.05 M sodium phosphate buffer several times then post fixed in 2% osmium tetraoxide for 2 hours at room temperature and finally washed again in buffer. The specimens were then dehydrated in graded alcohol series and critical point dried using carbondioxide as the transitional fluid. Dried specimens were mounted on stubs using a double sided adhesive tape, coated with 30 nm gold and examined with a Hitachi S 2300 scanning electron microscope at an accelerating voltage of 15KV.

Abbreviations used in the text:

\n\begin{align*}
n &= \text{Number of specimen} \\
L &= \text{Total body length}
\end{align*}\n
\[ a = \text{Body length} \div \text{greatest body width} \]

\[ b = \text{Body length} \div \text{distance from anterior end to the esophagus.} \]

\[ c = \text{Body length} \div \text{tail length} \]

\[ V = \text{Distance of vulva from anterior end} \times 100 \div \text{body length}. \]

**Type Material:**

Type material has been labelled and deposited in the Nematode Collection of the Department of Zoology, Aligarh Muslim University.
RESULTS
CHAPTER - I
CHAPTER - I

SUPERFAMILY: THELASTOMATOIDEA

The Thelastomatoidea is a superfamily of the order Oxyurida, one of the principal order of parasitic nematodes. The members of the Thelastomatoidea are parasites of invertebrates, essentially Arthropods.

The Thelastomatoidea has been variously subdivided by Kloss (1960), Skrjabin et al., (1966) and Poinar (1977) into several families and various subfamilies, based on primitive characters. However, Adamson and Waerebeke (1992 a,b,c) provided a simple classification and divided the superfamily Thelastomatoidea into five families, viz., the Thelastomatidae, Protrelloididae, Hystrignathidae, Travassosinematidae and Pseudonymidae. The first three families are equivalent to the three subfamilies of Thelastomatidae of Chitwood (1932). The Travassosinematidae is equivalent to the two families Travassosinematidae of Rao (1958) and Chitwoodiellidae of Kloss (1960) and the Pseudonymidae is equivalent to the Gyoryiinae of Poinar (1977).

In the present study, the classification of Thelastomatoidea given by Adamson and Waerebeke (1992a,b,c) is not wholly accepted. Herein, the members

During the entire period of study, the worms collected from various insect hosts from Aligarh and SiddharthNagar (North India) were found to belong to three families of Thelastomatoidea namely
Thelastomatidae, Chitwoodiellidae and Protrellooididae.

The diagnosis of the family required modifications and hence emended diagnosis is provided.

Diagnosis (emended):

Cuticle with or without spines. Cephalic extremity simple or formed by 6 to 12 hood like expansions. Lateral alae present or absent. Mouth surrounded by three to eight labial papillae. Esophagus consisting of anterior corpus, cylindrical or clavate, which may or may not be modified; a short isthmus, distinct or just a constriction between corpus and bulb; posterior bulb with or without valve. Gonads monodelphic or didelphic amphidelphic. Eggs with or without filaments twisted around them and with or without tufts of polar filaments. Males with single testis. Spicule single or absent. Caudal papillae two to nine pairs or totally absent.

Key to the families of the superfamily Thelastomatoidea

1 - Vulva anterior to base of esophagus

- Vulva posterior to base of esophagus

2 - Cervical cuticle with transverse rows of spines

----- Protrellooididae

----- 2

----- Hystignathidae
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<th>Cervical cuticle</th>
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<td>without spines</td>
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<td>3 - Eggs with filaments</td>
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<tr>
<td>- Eggs without filaments</td>
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<td>Thelastomatidae</td>
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<td>4 - Egg filaments twisted around shell, polar egg</td>
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<td>- Egg filaments not twisted around shell, polar egg</td>
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<td>Chitwoodiellidae</td>
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FAMILY: THELASTOMATIDAE TRAVASSOS, 1929

In 1920, Travassos proposed two families Lepidonematidae and Isakidae to accommodate all the Oxyurid parasites of Arthropods and divided Lepidonematidae into two subfamilies Lepidonematinae and Hystrignathinae.

Later, Travassos (1929) revised his previous classification and proposed a new family Thelastomatidae and divided it into four subfamilies, viz., Thelastomatinae, Aorurinae, Oniscolinae and Ransomnematinae. However, Chitwood (1932) merged the family Lepidonematidae with the Thelastomatidae and divided it into three subfamilies namely Hystrignathinae Travassos, 1920, Thelastomatinae Travassos, 1929 and Protrelloidinae Chitwood, 1932. Though, Basir (1956) considered Thelastomatidae as a distinct natural group under Oxyuroidea, he did not agree with the division of the Thelastomatidae into subfamilies given by Chitwood (1932).

Herein, the Thelastomatidae is considered as a distinct family of the superfamily Thelastomatoidea without its division into subfamilies. At present the family Thelastomatidae includes 29 genera. During the present study, representatives of five genera of
Thelastomatidae were recovered. An emended diagnosis of the family is provided.

**Diagnosis (emended):**

Cuticle without spines. Cephalic extremity simple or formed by six hood like structures. Mouth surrounded by three or eight labial papillae. Lateral alae present or absent. Esophagus consisting of anterior corpus, cylindrical or clavate, which may or may not be modified into pseudobulb; a short isthmus distinct or indistinct; posterior bulb with or without valve. Gonads monodelphic or didelphic amphidelphic. Males with single testis. Spicule single or absent. Caudal papillae two to five pairs or completely absent.
GENUS:  **BLATTICOLA SCHWENCK, 1926**

**Synonyms:** Blattellicola Basir, 1940.


Schwenck (1926) proposed the genus *Blatticola* with *B. blatticola* (Galeb, 1877) as type species. Chitwood (1932) considered this species, a synonym of *B. blattae* (Graeffe, 1860). Rao and Rao (1965 d) reported *Blatticola supellaimeae* from South India. Ahmad and Jabin (1966) added *Blatticola opisthoplatia* from Pakistan, three species of the genus *Blatticola* are reported from New Zealand cockroaches by Dale (1966a) and Zervos (1983, 1987 a), viz., *B. tuapake*, *B. monandros* and *B. barryi* respectively. Duggal and Aulakh (1988) described *B. guptai* from India.

Basir (1940) proposed the genus *Blattellicola* with *B. blattellicola* as its type species. In 1956, he transferred *Thelastomum caucasicum* Skrjabin, 1923 to this genus as *B. caucasicum*.

Farooqui (1966) created a genus *Blatellicoloides* with *B. blatti* as the type species. While revising the family Thelastomatidae, Adamson and Waerebeke (1992 a) synonymised the genera *Blattellicola* Basir, 1940 and *Blatellicoloides* Farooqui, 1966 with the genus
Blatticola, on the basis of essential similarities between the three genera. Herein, the views of Adamson and Waerebeke (1992 a) are adopted. At present the genus includes 10 species. During the present work, few worms were collected from German cockroach, Blatella germanica which were found to belong to Blatticola blattae Chitwood, 1932.

Diagnosis (Adamson and Waerebeke, 1992 a):

Female: Cephalic extremity formed by circumoral ring and expanded annule. Esophageal corpus clavate, isthmus distinct or just a constriction between corpus and bulb. Vulva in posterior third of body. Monodelphic, prodelphic. Ovary doubly reflexed. Tail subconical.

Male: Testis single, reflexed or outstretched. Tail conical with or without constriction, 3-4 pairs of caudal papillae. Spicule single or absent.

BLATTICOLA BLATTAE (GRAEFFE, 1860) CHITWOOD, 1932
(Fig. 1 A-D)

Synonyms: Oxyuris blattae Graeffe, 1860
Oxyuris blatticola Galeb, 1878
Blatticola blatticola (Galeb, 1877) Schwenck, 1926.
Dimensions:

Females: (n=8): L = 1.95-2.43 (2.24 ± 0.067) mm; a = 9.28-11.61 (10.88 ±0.35); b = 7.3-8.11 (7.94±0.15); c = 12.7-16.2 (14.63 ± 0.47); V = 76.92-83.95 ( 80.02 ± 0.99); Esophagus = 0.267 - 0.292 (0.281)mm; Tail = 0.15-0.16 (0.152)mm; Egg = 106-124 x 40-49 μm.

Description:

Female: Body medium sized, slightly curved upon fixation. Cuticle annulated, anterior annules 5-9 μm apart, prominent upto esophagus then becomes very faint. Head, 28-31 μm long. Mouth sub-triangular, surrounded by eight sub-median labial papillae, amphids represented by small circular openings. Buccal cavity 10-15 μm long, cuticularized. Esophageal corpus club-shaped, 0.187-0.209 mm long, 31 μm wide anteriorly and 37-50 μm wide posteriorly. Isthmus distinct, 15-18 μm long, 25-30 μm wide. Endbulb ovate, 65-78 μm long, 75-80 μm wide. Cardia distinct. Nerve ring at 0.14-0.16 mm and excretory pore at 0.60-0.64 mm from anterior end.

Gonad monodelphic, prodelphic. Vulva at posterior third of body. Vagina highly muscular. Single uterus directed anteriorly, reflexed near the excretory pore and extending posteriorly to about the level of vulva where it is connected with short U-shaped oviduct.
Ovary directed anteriorly and reflexed, its blind end being directed posteriorly. Oocytes arranged in a single row. Eggs oval. Tail short and conical.

Male:
Not found but reported by Chitwood (1932)

Type host: Blatella germanica

Habitat: Posterior gut

Locality: Aligarh (North India)

Remarks: The present specimens closely conform with the measurements and description of Blatticola blattae Chitwood (1932), except in having a distinct isthmus, excretory pore slightly posterior and eggs smaller in size (isthmus indistinct, eggs = 114-136 μm).

Key to the species of the genus Blatticola

1 - Spicule present
   - Spicule absent

2 - Spicule less than 15 μm
   - Spicule more than 15 μm

3 - Spicule 18-26 μm
   - Spicule 34-50 μm

blatti (Farooqui 1966) Adamson & Waerebeke, 1992a
monandros Zervos, 1983
opisthoplatia Ahmad & Jabin, 1966
4 - Female esophagus
   less than 0.4 mm
   - Female esophagus more
   more than 0.4 mm
     caucasicum
     (Skrjabin, 1923)
     Adamson and
     Waerebeke,
     1992a

5 - Testis outstretched
   - Testis reflexed

6 - Eggs with operculum
   - Eggs without operculum

7 - Eggs small, 70-80 μm
   - Eggs larger than 80 μm

8 - Female small
   1.75-2.15 mm
   - Female, long
   3.42-3.58 mm
     guptai (Duggal
     & Aulakh,
     1988) Adamson
     and Waerebeke,
     1992a

9 - Eggs small, 162x72 μm
   - Eggs very large,
   230-245 x 75-90 μm
     supellaimae
     Rao, 1958
     tuapake, Dale,
     1966a
GENUS: CAMERONIA BASIR, 1948


The genus Cameronia was erected by Basir (1948b) based on only female specimens. Rao (1958) proposed the genus Psilocephala with P. psilocephala as its type species from South India, which is synonymised with the genus Cameronia by Adamson and Waerebeke (1992a). Leibersperger (1960) described C. multiovata from France. Later Farooqui (1968e, 1970) reported two species, C. travassosi and C. aspiculata respectively from Maharashtra, India. Parveen and Jairajpuri (1984b, 1985a) added two more species under this genus, viz. C. klossi and C. nisari respectively from North India.

During the investigation of insects for the present study, a large number of nematodes of this genus were recovered from Gryllotalpa africana. Few of them were found to belong to C. aspiculata, being reported for the first time from North India. However, some nematodes could not be accommodated in any of the existing species due to their some distinct characteristic, hence considered and described as a new species, C. basir n. sp. The diagnosis of the genus is
emended to accommodate the new species.

**Diagnosis (emended):**

**Female:** Cephalic extremity formed by circumoral annule and simple second annule. Esophagus consisting of cylindrical corpus, isthmus may be distinct or indistinct and a valvular bulb. Cardia lobed or simple. Vulva in posterior third of body, vagina anteriorly directed. Amphidelphic. Eggs elongate and flattened on one side, deposited singly or fused in a chain of two or more, along their flattened surface. Tail conical or with a terminal spike.

**Male:** Cephalic extremity formed by single annule. Esophageal corpus cylindrical, isthmus indistinct. Tail very short, rounded with tiny terminal spine. Spicule single or absent. Caudal papillae three to five pairs.

**CAMERONIA ASPICULATA (FAROOQUI, 1970) ADAMSON AND WAEREBEKE, 1992 a.**

(Fig. 1 E-H)

**Synonym:** *Psilocephala aspiculata* Farooqui, 1970

**Dimensions:**

**Females (n = 6):** $L = 1.77-2.14$ (2.015 ± 0.07) mm; $a = 8.35 - 9.07$ (8.61 ±0.14); $b = 5.65 - 6.53$ (6.15 ±0.16); $c = 14.75-15.77$ (15.28 ±0.18); $V = 60.6-62.14$ (61.23 ±
0.27); Esophagus = 0.313 - 0.328 (0.322 ± 0.002) mm; Tail = 0.12-0.14 (0.13 ± 0.003) mm; Egg = 105-110 x 40-49 μm.

**Description:**

**Female:** Small worms with attenuated anterior and posterior ends, straight upon fixation. Cuticle annulated, annules more prominent in the anterior half of the body, 4-8 μm apart. Mouth is surrounded by eight labial papillae and a pair of amphids. Buccal cavity short, 13-15 μm long. Esophageal corpus cylindrical, 0.218-0.230 mm long, 26-30 μm wide; isthmus distinct, 17-18 μm long, 19-22 μm wide; endbulb spherical, 78-80 μm long, 74-84 μm wide. Cardia distinct. Nerve ring at 0.18-0.19 mm from anterior end.


**Male:** Not found but reported by Farooqui, 1970

**Type host:** *Gryllotalpa africana*

**Habitat:** Midgut

**Locality:** Aligarh (North India)

**Remarks:** The measurements and description of the present specimens are in agreement with the range given
by Farooqui, 1970, except in having slightly longer eggs (Eggs = 102-105 μm in C. aspiculata Farooqui, 1970). This species is reported for the first time from North India.

**CAMERONIA BASIRI N.SP.**  
(Fig 2).

**Dimensions:**

**Holotype female:** L = 4.25 mm; a = 12.91; b = 9.44; c = 28.33; V = 77.17; Esophagus = 0.45 mm; Tail = 0.15 mm; Egg = 100 x 39 μm.

**Paratype females (n = 9):** L = 3.05-4.66 (3.54 ± 0.18) mm; a = 9.71-15.03 (11.08 ± 0.51); b = 7.27-10.32 (8.24 ± 0.36); c = 20.33-33.28 (24.26 ± 1.4); V = 75.5-79.58 (77.06 ± 0.56); Esophagus = 0.39-0.49 (0.42 ± 0.009) mm; Tail = 0.14-0.15 (0.145) mm; Egg = 100-112 x 39-48 μm.

**Paratype male (n = 1):** L = 0.975 mm; a = 10.83; b = 6.41; Esophagus = 0.152 mm; Spicule = 19 μm

**Description:**

**Female:** Body very long, almost straight to slightly curved upon fixation, tapering towards both extremities, more pronounced posteriorly. Cuticle annulated, 6-8 μm apart in the anterior region and 9-12
μm at midbody, become faint posteriorly. Mouth opening surrounded by circumoral elevation bearing eight labial papillae and a pair of amphids. Amphidial apertures circular. Buccal cavity short, 14-18 μm, consists of two parts, the outer part is cuticularized, wider and surrounds the inner part which is non-cuticularized and narrower. Esophageal corpus cylindrical, 0.305-0.389 mm long, 30-35 μm wide. Isthmus indistinct, just a constriction between corpus and endbulb. Endbulb spherical, 87-105 μm long, 87-102 μm wide. Nerve ring at 0.13-0.2 mm from anterior end. Excretory pore posterior to the esophageal bulb, 0.47-0.89 mm from anterior end. Cardia distinct and lobed, 20-30 μm wide.

Gonads amphidelphic. Vulva situated at about 75-80% of the body length, with prominent lips. Vagina muscular, cuticularized and directed anteriorly. Ovaries well developed, reflexed at the tip. Oocytes arranged in a single row. Eggs elliptical and deposited singly.

Male: Body medium sized, curved ventrally at the posterior end upon fixation. Cuticle annulated, 3-4 μm apart in the anterior region and 4-5 μm apart posteriorly. Cephalic extremity formed by single annule. Buccal cavity elongate, 7.5 μm wide. Esophageal
corpus broader in the middle, 0.117 mm long. Isthmus, a constriction between corpus and endbulb. Endbulb spherical, 35 μm wide. Nerve ring at 99 μm from anterior end.

Testis single, very long, reflexed anteriorly till 50% of its length. Tail truncated, anus subterminal. Caudal papillae three pairs: one pair preanal and two pairs postanal. Spicule single.

Type host: Gryllotalpa africana
Habitat: Midgut
Locality: Aligarh (North India)
Type Material: Holotype female on slide Cameronia basiri n.sp./1; paratype females on slides C. basiri n.sp./2-10; paratype male on slide C. basiri n.sp./11, deposited in the Nematode Collection of the Department of Zoology, Aligarh Muslim University, Aligarh.

Diagnosis and Relationships:

Cameronia basiri n. sp. is characterized by females with very long body, isthmus, a constriction between corpus and endbulb, buccal cavity very characteristic, prominent and lobed cardia, posteriorly situated vulva (V=75-80) and male with indistinct isthmus.

Cameronia basiri n.sp. comes close to C. travassosi
Farooqui, 1968e and C. multiovata Leibersperger, 1960 in the body length of females, but differs from them in the body width, position of vulva and the arrangement of eggs (width = 0.54 - 0.78 mm; vulva at 3.38 - 5.11 from anterior end, eggs fused with one another and distinctly ridged in C. travassosi; width = 0.26-0.47 mm; V = 36.5-37.2; eggs fused with one another in C. multiovata). The new species resembles C. klossi Parveen and Jairajpuri, 1984b and C. biovata Basir, 1948b in the position of vulva and shape of female tail, but differs from them in the dimensions of female, arrangement of eggs and the shape of male tail (female = 1.94 mm long, 0.27 mm wide, eggs fused with one another and distinctly ridged, male tail conically attenuated in C. klossi; whereas female = 2.3 - 2.9 mm long, 0.138-0.4 mm wide, eggs fused with one another in C. biovata).

and position of vulva (female = 1.6-2.09 mm long, 0.16-
0.26 mm wide, isthmus = 20-30 μm, V = 61.7, male =
0.86 mm long, 8 μm wide, isthmus = 8 μm in C.
aspiculata; female = 1.6-1.79 mm long, 0.16-0.165 mm
wide, isthmus = 18-25 μm, V = 62, male = 0.73-0.83 mm
long, 6-7 μm wide, isthmus = 11-12 μm wide in C.
nisari; female = 2.7-2.8 mm long, 0.3 μm wide, isthmus
= 24 μm , V = 61.7, male = 1.04 mm long, 11 μm wide,
isthmus = 11 μm in C. psilocephala).

Key to the species of the genus Cameronia

1 - Spicule present
   - Spicule absent  
     aspiculata (Farooqui, 1970)
     Adamson & Waerebeke 1992 a

2 - Spicule less than 30μm  
   - Spicule more than 30μm

3 - Female tail conical
   - Female tail with terminal spike

4 - Eggs fused in a chain of two or deposited singly
   - Eggs fused in a chain of more than two  
     multiovata Leibersperger, 1960.
5 - Eggs twice longer than wide

- Eggs thrice longer than wide

6 - Females 6 mm long

- Females 1.7 mm long

7 - Vulva, 60.67% of body length

- Vulva, 75-80% of body length
## TABLE - 1

**COMPARATIVE MEASUREMENT CHART OF THE SPECIES OF CAMERONIA**

<table>
<thead>
<tr>
<th>CHARACTER</th>
<th><em>C. birovata</em></th>
<th><em>C. multivata</em></th>
<th><em>C. travassosi</em></th>
<th><em>C. klossi</em></th>
<th><em>C. nisari</em></th>
<th><em>C. psilocephala</em></th>
<th><em>C. aspiculata</em></th>
<th><em>C. basiri</em> n.sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>2.3 - 2.9</td>
<td>2.93 - 4.59</td>
<td>4.51 - 6.66</td>
<td>1.94</td>
<td>1.6 - 1.79</td>
<td>2.74 - 2.80</td>
<td>1.6 - 2.09</td>
<td>3.05 - 4.66</td>
</tr>
<tr>
<td>Width</td>
<td>0.138 - 0.4</td>
<td>0.26 - 0.47</td>
<td>0.54 - 0.78</td>
<td>0.27</td>
<td>0.16 - 0.165</td>
<td>0.3 - 0.33</td>
<td>0.16 - 0.26</td>
<td>0.29 - 0.39</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.32 - 0.48</td>
<td>0.40 - 0.52</td>
<td>0.46 - 0.59</td>
<td>0.46</td>
<td>0.29 - 0.33</td>
<td>0.418</td>
<td>0.28 - 0.32</td>
<td>0.398 - 0.494</td>
</tr>
<tr>
<td>Lobed Cardia</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>20 - 30 μm</td>
</tr>
<tr>
<td>Tail</td>
<td>0.17 - 0.36</td>
<td>0.23 - 0.35</td>
<td>0.16 - 0.22</td>
<td>0.20</td>
<td>0.11 - 0.13</td>
<td>0.10</td>
<td>0.12 - 0.15</td>
<td>0.14 - 0.15</td>
</tr>
<tr>
<td>Vulva</td>
<td>1.3 - 2.06</td>
<td>1.07 - 1.71</td>
<td>3.3 - 5.1</td>
<td>1.36</td>
<td>1.0 - 1.11</td>
<td>1.72</td>
<td>0.99 - 1.29</td>
<td>2.4 - 3.53</td>
</tr>
<tr>
<td>Egg</td>
<td>71 - 136 μm</td>
<td>128 - 152 μm</td>
<td>-</td>
<td>133 - 147 μm</td>
<td>111 - 126 μm</td>
<td>102 - 108 μm</td>
<td>102 - 105 μm</td>
<td>100 - 112 μm</td>
</tr>
<tr>
<td>Arrangement of eggs</td>
<td>Two eggs attached end to end.</td>
<td>Two eggs attached and distinctly ridged.</td>
<td>Two eggs attached and distinctly ridged.</td>
<td>Egg laid singly</td>
<td>Egg laid singly</td>
<td>Egg laid singly</td>
<td>Egg laid singly</td>
<td>Egg laid singly</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>1.37 - 1.68</td>
<td>0.88 - 0.95</td>
<td>0.69</td>
<td>0.73 - 0.83</td>
<td>1.04</td>
<td>0.86</td>
<td>0.975</td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>0.10 - 0.14</td>
<td>0.094 - 0.99</td>
<td>0.06</td>
<td>0.06 - 0.07</td>
<td>0.11</td>
<td>0.08</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.193 - 0.24</td>
<td>0.14 - 0.16</td>
<td>0.144</td>
<td>0.134 - 0.143</td>
<td>0.14</td>
<td>0.22</td>
<td>0.152</td>
<td></td>
</tr>
<tr>
<td>Tail</td>
<td>-</td>
<td>0.078 - 0.08</td>
<td>0.052</td>
<td>0.011 - 0.015</td>
<td>-</td>
<td>0.015</td>
<td>Indistinct</td>
<td></td>
</tr>
<tr>
<td>Spicule</td>
<td>24 - 27 μm</td>
<td>38 - 43 μm</td>
<td>32 μm</td>
<td>19 - 22 μm</td>
<td>30 μm</td>
<td>absent</td>
<td>19 μm</td>
<td></td>
</tr>
<tr>
<td>Caudal papillae</td>
<td>3 pairs</td>
<td>5 pairs</td>
<td>4 pairs</td>
<td>3 pairs</td>
<td>3 pairs</td>
<td>3 pairs</td>
<td>3 pairs</td>
<td>3 pairs</td>
</tr>
</tbody>
</table>
GENUS: GRYLLOPHILA BASIR, 1942

Synonym: Neyraeiella Serrano Sanchez, 1947

The genus Gryllophila was proposed by Basir (1942) to accommodate worms collected from mole cricket, Gryllotalpa africana. The type species Gryllophila skrjabini (Sergiev, 1923) Basir, 1956 has been reported from U.S.S.R, Spain and India. Serrano Sanchez (1947) described the same worms from another species of Gryllotalpa from Spain and proposed new genus Neyraeiella for it, which was later synonymised with Gryllophila by Basir (1956). Farooqui (1970) reported another species G. gryllotalpae from Maharashtra, India and Parveen and Jairajpuri (1981) described G. basiri from North India.

Several worms were recovered during the present study representing this genus, however, they could not be fitted under the known species and therefore have been described as new species, G. nihali n.sp. (The species is named after late Mr. Nihal Ahmad Rizvi, father of the author) The diagnosis of the genus is emended to include the new species. With the addition of new species the genus consists of four species.
Diagnosis (emended):

**Female:** Cephalic extremity formed by circumoral annule and posterior expanded annule. Esophageal corpus cylindrical, isthmus cylindrical. Vulva in posterior quarter of body. Vagina long and anteriorly directed. Uterus extending anteriorly and flexing posteriorly before dividing into two branches. Amphidelphic. Eggs very large, elongate, deposited in strings 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 three to six pairs, single median papilla present or absent. Caudal appendage narrowing abruptly behind the last pair of caudal papillae, rest of the papillae are borne on genital cone.

**Gryllophila nihali** n. sp.

**(Fig. 3)**

Dimensions:

**Holotype female:** \( L = 2.44 \) mm; \( a = 8.15; b = 5.75; c = 10.18; V = 77.7; \) Esophagus = 0.425 mm; Tail = 0.24 mm; egg = 138 x 68 \( \mu \)m.

**Paratype females (n = 8):** \( L = 2.2-2.5 \) (2.36 ± 0.04) mm; \( a = 7.57-8.25 \) (8.04 ± 0.1); \( b = 5.23-5.81 \) (5.59 ±
c = 10.0-10.41 (10.21 ± 0.05); V = 77.27-78.00 (77.64 ± 0.1); Esophagus = 0.418-0.435 (0.422) mm; Tail = 0.22-0.24 mm; Egg = 135-138 x 56-68 μm.

**Holotype male:** L = 0.75 mm; a = 8.33; b = 4.49; c = 12.71; Esophagus = 0.167 mm; Tail = 75 μm.

**Paratype males (n = 2):** L = 0.72-0.97 mm; a = 7.57-9.75; b = 3.93-5.53; c = 8-13; Esophagus = 0.176-0.183 mm; Tail = 59-90 μm.

**Description:**

**Female:** Body medium sized, straight to slightly curved upon fixation, both the ends attenuated, the posterior being sharply pointed. Cuticle deeply annulated, 15-22 μm apart in the anterior region, 31-32 μm at midbody and 48-50 μm in the posterior region. Cephalic extremity formed by circumoral annule and posterior expanded annule. Mouth opening surrounded by eight submedian labial papillae and two lateral amphids. Buccal cavity, 17-25 μm. Esophageal corpus cylindrical, 0.290-0.307 mm long, 30-32 μm wide; isthmus cylindrical, 35-36 μm long, 26-28 μm wide; endbulb ovate, 93-95 μm long, 85-87 μm wide. Nerve ring at 0.22-0.24 mm from anterior end. Excretory pore post-esophageal, 0.83-0.85 mm from anterior end. Cardia distinct.

Gonads amphidelphic. Vulva in posterior quarter of body, vulval lips prominent. Vagina very long, highly
muscular, cuticularized and anteriorly directed. Uterus extending anteriorly and flexing posteriorly before dividing into two branches. Ovaries well-developed, oocytes arranged in a single row. Eggs large, elongate, deposited in strings held together by uterine secretions, laid in 4-8 cell stage. Tail conical.

**Male:** Body medium sized, slightly curved ventrally upon fixation. Both the ends attenuated. Cuticle deeply annulated, 11-15 \( \mu \text{m} \) apart in the anterior region, 11-19 \( \mu \text{m} \) apart posteriorly. Cephalic extremity formed by single expanded annule. Buccal cavity, 15-20 \( \mu \text{m} \). Esophageal corpus cylindrical, 0.124-0.146 mm long, 15-18 \( \mu \text{m} \) wide; isthmus distinct, 15-16 \( \mu \text{m} \); endbulb spherical, 37-43 \( \mu \text{m} \) long, 34-37 \( \mu \text{m} \) wide. Nerve ring at 80-90 \( \mu \text{m} \) from anterior end.

Testis single, reflexed at the anterior end. Caudal extremity with prominent genital cone. Caudal papillae three pairs and a single median papilla: one pair subventral preanal, one pair subventral postanal, single median papilla near the anus, one pair on caudal appendage. Caudal appendage narrowing abruptly behind the last pair of caudal papillae. Spicule single, 54-57 \( \mu \text{m} \) long.

**Type host:** *Gryllotalpa africana*

**Habitat:** Midgut
Locality: SiddharthNagar (North India)

Type Material: Holotype female on slide Gryllophila nihali n.sp./1; paratype females on slides G. nihali n.sp./2-9; holotype male on slide G. nihali n.sp./10; paratype males on slides G. nihali n.sp./11-12; deposited in the Nematode Collection of the Department of Zoology, Aligarh Muslim University, Aligarh.

Diagnosis and Relationships:

Gryllophila nihali n.sp. is characterized by the presence of deep annulations with progressive increase in the size of the annules in both the sexes and the presence of single median papilla along with three pairs of caudal papillae in males.

G. nihali n.sp. resembles G. skrjabini (Sergiev, 1923) Basir, 1956 in the size of female, but differs from it in the size of male, arrangement of annules in both the sexes, position of vulva, smaller eggs without spines, smaller spicule, number and arrangement of caudal papillae (male = 0.97-2.26 mm long, 80-190 μm, wide, anterior annules = 12-15 μm, at midbody = 36-40 μm, posterior region = 22 μm. In females, anterior annules = 12-50 μm, at midbody = 30-40 μm, posterior region = 10 μm, eggs with spines = 170-190 μm, V = 36.6 - 46.4, spicule = 52-64 μm, caudal papillae three
pairs: one preanal, one postanal, last pair at caudal appendage, single median papilla absent in *G. skrjabini*) The new species resembles *G. basiri* Parveen and Jairajpuri, 1981 in the position of vulva, but differs from it in the size and arrangement of annules in both sexes, larger egg size, smaller spicule and the number of caudal papillae (female = 1.45-1.68 mm long, 0.164 - 0.165 mm wide, anterior annules = 21.41 μm apart, rest of the annules = 21-25 μm apart; male 0.9 mm long, 0.1 mm wide, anterior annules = 45 μm apart, at midbody = 29 μm, eggs = 50-64 μm, spicule = 50 μm, caudal papillae six pairs, single median papilla absent in *G. basiri*).

*G. nihali* n.sp. resembles *G. gryllotalpae* Farooqui, 1970 in the size of esophagus in both the sexes, size of eggs and size of spicules, but differs from it in the size and arrangement of annules in both sexes, position of vulva and the number of caudal papillae in males (female = 2.6 - 3.15 mm long, 0.31-0.61 mm wide, anterior annules = 27-30 μm, rest of the annules = 40-43 μm apart, males = 1.12-1.14 mm long, 0.13-0.15 mm wide, anterior annules = 43-46 μm apart, rest of the annules = 20 μm, V = 21.92 - 25.07, caudal papillae five pairs, single median papilla absent in *G. gryllotalpae*).
**Key to the species of the genus Gryllophila**

1 - Egg shell with spine like outgrowths
    - Egg shell without spine like outgrowths

2 - Caudal papillae 3 pairs with a single median papillae
    - Caudal papillae 5-6 pairs without a single median papilla

3 - Caudal papillae 5 pairs
    - Caudal papillae 6 pairs

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Egg shell with spine like outgrowths</td>
<td><em>skrjabini</em> (Sergiev, 1923) Basir, 1956.</td>
</tr>
<tr>
<td>2</td>
<td>Egg shell without spine like outgrowths</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Caudal papillae 3 pairs with a single median papillae</td>
<td><em>nihali</em> n.sp.</td>
</tr>
<tr>
<td>3</td>
<td>Caudal papillae 5 pairs</td>
<td><em>gryllotalpae</em> Farooqui, 1970</td>
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<tr>
<td>3</td>
<td>Caudal papillae 6 pairs</td>
<td><em>basiri</em>, Parveen &amp; Jairajpuri, 1981</td>
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<tr>
<td>CHARACTERS</td>
<td>G. skrjabin</td>
<td>G. gryllotalpa</td>
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<tr>
<td><strong>FEMALE</strong></td>
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<tr>
<td>Length</td>
<td>2.1 - 4.93</td>
<td>2.6 - 3.15</td>
</tr>
<tr>
<td>Width</td>
<td>0.3 - 0.55</td>
<td>0.31 - 0.61</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.457 - 0.66</td>
<td>0.41 - 0.46</td>
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<tr>
<td>Tail</td>
<td>0.33 - 0.45</td>
<td>0.27 - 0.28</td>
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<tr>
<td>Vulva</td>
<td>0.77 - 2.25</td>
<td>0.57 - 0.79</td>
</tr>
<tr>
<td>Egg</td>
<td>170-190 × 100-110 µm</td>
<td>100-140 × 65-84 µm</td>
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<tr>
<td>Excretory pore</td>
<td>1.3 - 1.46</td>
<td>0.79 - 0.95</td>
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<tr>
<td><strong>MALE</strong></td>
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<tr>
<td>Length</td>
<td>0.97 - 2.26</td>
<td>1.12 - 1.14</td>
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<tr>
<td>Width</td>
<td>0.08 - 0.19</td>
<td>0.13 - 0.15</td>
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<tr>
<td>Esophagus</td>
<td>0.193 - 0.262</td>
<td>0.17 - 0.20</td>
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<tr>
<td>Tail</td>
<td>0.105 - 0.166</td>
<td>0.10 - 0.11</td>
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<tr>
<td>Spicule</td>
<td>52 - 64 µm</td>
<td>44 - 57 µm</td>
</tr>
<tr>
<td>Caudal papillae</td>
<td>3 - 4 pairs</td>
<td>5 pairs</td>
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</table>
GENUS: HAMMERSCHMIDTIELLA CHITWOOD, 1932


The genus Hammerschmidtiella was proposed by Chitwood (1932) to accommodate *Oxyuris diesingi* Hammerschmidt, 1838. The same species was described by Leidy (1850) as *Streptostoma gracile* and by Diesing (1851) as *Anguillula macrura*. The type species *H. diesingi* has been reported from all over the world in its domiciliated hosts, *Periplaneta americana* and *Blatta orientalis*.

Serrano Sanchez (1945) described another species *H. neyrai* from Spain. Rao (1958) and Rao and Rao (1965 c) reported *H. manohari* and *H. singhi* respectively from South India. Another species *H. acreana* was added by Kloss (1966) from Brazil. In 1978, Gupta and Kaur described a species *W. poinari* under the genus Welchiella which is considered a synonym of Hammerschmidtiella and transferred to this genus as *H. poinari* by Adamson and Waerebeke (1992 a). Spiridonov (1984 b) reported *H. cristata* from Diplopods of Cuba. *H. andersoni* was reported from Saudi Arabia by Adamson and Nasher (1987). Zervos (1987 a) described a new species under the genus Suifunema which was later
transferred to this genus as *H. mackenziei* by Adamson and Waerebeke (1992 a). Singh and Kaur (1988) reported *H. basiri* from India. At present the genus includes 11 species from all over the world. The type species *H. diesingi* were collected during the present study.

**Diagnosis** (Adamson and Waerebeke, 1992 a):


**Male:** Cephalic extremity formed by single expanded annule. Esophageal corpus clavate. Caudal extremity abruptly truncate, posterior to anus with spine like appendage. Caudal papillae consisting of one pair subventral preanal, one pair lateral adanal, one pair subventral just posterior to anus and one duplex papilla at the base of caudal appendage.

**Hammerschmidtella diesingi** (Hammerschmidt, 1838)

**Chitwood, 1932.**

(Figs. 4 & 5)

**Synonyms:** *Oxyuris diesingi* Hammerschmidt, 1838

*Oxyuris blattae orientalis* Hammerschmidt, 1847
Streptostoma gracile Leidy, 1850
Anguillula macrura Diesing, 1851
Aorurus (Streptostoma) diesingi (Ham., 1838), Walton, 1927
Aorurus (Streptostoma) blattae-orientalis (Ham., 1847), Walton, 1927
Aorurus diesingi (Hammerschmidt, 1838) Travassos, 1929
Leidynemella periplaneticolae Singh and Singh, 1955
H. aspiculus Biswas and Chakravarty, 1963
H. bareillyi Sharma and Gupta, 1983

Dimensions:

Females (n = 8): $L = 2.43-3.18 \, (2.82 \pm 0.09) \, \text{mm}$; $a = 8.45-10.23 \, (9.00 \pm 0.31); b = 7.91-9.67 \, (8.80 \pm 0.23)$; $c = 2.61-3.81 \, (3.17 \pm 0.15); V = 20.63-23.89 \, (22.24 \pm 0.44); \text{Esophagus} = 0.304-0.351 \, (0.320) \, \text{mm}; \text{Tail} = 0.66-1.03 \, (0.9 \pm 0.04) \, \text{mm}; \text{Egg} = 68-97 \times 31-34 \, \mu \text{m}.$

Male (n = 1): $L = 0.9 \, \text{mm}; a = 14.28; b = 6.66; c = 8.65; \text{Esophagus} = 0.135 \, \text{mm}; \text{Tail} = 0.104 \, \text{mm}; \text{Spicule} = 20 \, \mu \text{m}.$

Description:

Female: Body spindle shaped, straight upon fixation. Cuticle deeply annulated, anterior annules 11-15 $\mu \text{m}$
apart, 18-30 μm apart posteriorly. Lateral alae start from base of esophagus and reach upto anus, 21 μm wide. Esophageal corpus divided into anterior cylindrical part, 0.10-0.130 mm long, 20-30 μm wide and a posterior elongate ovoid pseudobulb, 0.70-0.95 mm long, 60-75 μm wide. Isthmus long, 40-45 μm, endbulb pyriform, 70-85 μm long, 70-90 μm wide. Nerve ring at 80-130 μm from anterior end. Cardia distinct. Excretory pore at 0.3-0.55 mm from anterior end.


Male: Body small and has a truncated appearance, slightly curved at the posterior end upon fixation. The tail shoots out like a spike from the posterior end of body. Cuticle annulated, 14-18 μm apart in the anterior region, 9 μm apart posteriorly. Lateral alae start at 99 μm from anterior end, reach upto the anus with a maximum width of 5-9 μm. Esophageal corpus devoid of pseudobulb, 65μm long, 11-17 μm wide; isthmus well developed, 40 μm long, 11 μm wide. Endbulb ovate, 30 μm long, 26 μm wide. Nerve ring at 45 μm from anterior end.
Testis single. Caudal papillae three pairs: one pair preanal, one pair adanal and 3rd pair postanal and ventral, a single median papilla present a little behind the postanal pair. Tail spicate.

**Type host:** *Periplaneta americana*

**Habitat:** Posterior gut

**Locality:** SiddarthaNagar (North India)

**Remarks:** The present specimens conform well with the description and measurements given by earlier workers.

Scanning electron microscopy on the females of *H. diesingi* has been performed for the first time in India. The SEM micrographs reveal the anterior annules, en face with eight labial papillae arranged around a wide mouth opening and a pair of laterally situated tiny amphids. Another micrographs include midbody annules and lateral alae. The vulval region shows transverse slit-like vulval opening.
GENUS: LEIDYNEMA SCHWENCK IN TRAVASSOS, 1929

The genus *Leidynema* was established by Schwenck in Travassos, 1929. Chitwood (1932) described its type species *L. appendiculatum* and another species *L. delatorrei* from Cuba. Basir (1956) transferred *Oxyuris socialis* (Leidy, 1850) to *Leidynemella* (Chitwood and Chitwood, 1934), which is now transferred to the genus *Leidynema* by Adamson and Waerebeke (1992a). Farooqui (1967) reported two species from South India, viz., *L. periplaneti* and *L. schwenki* from *Periplaneta americana* and *Blatta orientalis* respectively. Another very interesting species *L. portentosae* possessing several protuberances in the posterior region of male was described by Waerebeke (1978) from Madagascar. The type species is cosmopolitan and reported from *P. americana*, *P. australasiae*, *Blaberus atropos* and *Blatta orientalis*. At present the genus includes six species. Collection of nematodes from various insect hosts revealed two species of this genus, viz., *L. appendiculatum* and *L. periplaneti* from *B. orientalis* and *P. americana* respectively. These two species are reported for the first time from Aligarh, North India.
Diagnosis (Adamson and Waerebeke, 1992a):

**Female:** Cephalic extremity formed by two annules. Esophageal corpus divided into narrow anterior and broad posterior portions of roughly equal length, isthmus short. Intestine with blind diverticulum. Vulva near midbody. Amphidelphic. Eggs large and elongate. Tail attenuate.

**Male:** Cephalic extremity formed by single expanded annule. Caudal extremity abruptly truncate with short terminal spine. Caudal papillae consisting of one large subventral preanal and one to three tiny subventral and one sublateral postanal pairs.

**LEIDYNEMA PERIPLANETI FAROOQUI, 1967**
(Fig. 6)

**Dimensions:**

**Females (n = 6):**
- $L = 2.34-2.7$ (2.48 ± 0.07) mm; $a = 8.42-10.58$ (9.58 ± 0.39); $b = 6.07-6.80$ (6.42 ± 0.21);
- $c = 4.25-4.90$ (4.61 ± 0.12); $V = 47.5-48.7$ (47.81 ± 0.28); Esophagus = 0.375-0.397 (0.385) mm; Tail = 0.51-0.55 (0.530) mm; Intestinal diverticulum = 0.22-0.435 mm; Egg = 102-106 x 41-46 μm.

**Male (n = 1):**
- $L = 0.75$ mm; $a = 10.00$; $b = 4.09$;
- Esophagus = 0.183 mm; Spicule = 34 μm; Tail = 0.02 mm.
Description:

Female: Small worms with attenuated anterior and posterior ends. Cuticle annulated, the anterior being more markedly annular. Anterior five annules very deep, 9-12 μm. Lateral alae present, terminating posteriorly in a spine like projection. Mouth surrounded by four pairs of lips. Four submedian lips have a pair of papillae arranged in two circles of four papillae each. Esophageal corpus divided into anterior cylindrical part, 0.131-0.140 mm long, 28-31 μm wide and posterior broader part, 0.131-0.140 mm long, 51-52 μm wide; isthmus short, 13-15 μm long, 30 μm wide. Endbulb spherical, 90-102 μm long, 90 μm wide. Cardia distinct. From a little behind the cardia starts the intestinal diverticulum. Nerve ring at 0.14 - 0.16 mm and excretory pore at 0.57 - 0.60 from anterior end.


Male: Body small, slightly curved at the posterior end upon fixation. The cuticle is annulated throughout the length. The anterior five annules are deep, 3-5 μm. Mouth opens into a small buccal cavity. Esophagus
divisible into corpus, isthmus and endbulb. Nerve ring at 50 μm from the anterior end.

Testis single, reflexed anteriorly. The body ends in a sharply pointed caudal appendage. Caudal papillae five pairs. one pair preanal, one pair adanal and three pairs postanal. A single spicule present.

**Type host:** *Periplaneta americana*

**Habitat:** Posterior gut

**Locality:** Aligarh (North India)

**Remarks:** Measurements and description are in agreement with the range given by Farooqui (1967) except in having slightly longer, esophagus and spicule in male (esophagus = 0.12 mm; spicule = 30 μm) and a smaller intestinal diverticulum in females (intestinal diverticulum = 0.4 -0.6 mm).

This species is reported for the first time from North India (Aligarh).

**LEIDYNEMA APPENDICULATUM (LEIDY, 1850) CHITWOOD, 1932**

(Figs. 7 & 8)

**Synonyms:** *Thelastoma appendiculatum* Leidy, 1850;

*Oxyuris blattae* Hammerschmidt, 1847, of Galeb, 1878;

*O. blattae-orientalis* Hammerschmidt, 1847 of Butschli, 1871;
O. blattae-orientalis Hammerschmidt, 1847 of Magalhaes, 1900;
Aorurus appendiculatus (Leidy) Walton, 1927;
L. blattae orientalis (Hammerschmidt, 1847) of Schwenck, in Travassos, 1929;
L. appendiculata americana Serrano Sanchez, 1947;
L. appendiculata hispana Serrano Sanchez, 1947;
L. appendiculata indiana Serrano Sanchez, 1947.

Dimension:

Female (n = 6): L = 3.12-4.02 (3.62 ±0.16) mm; a = 8.00-9.57 (8.74 ± 0.28); b = 7.85- 9.66 (8.88 ± 0.33); 
c = 5.67-7.88 (6.69 ±0.4); V = 54.72-55.44 (55.08 ±0.13); Esophagus = 0.385-0.45 (0.41 ±0.01) mm;
Intestinal diverticulum = 0.48-0.7 (0.02) mm; Tail = 0.51-0.57 (0.54 ± 0.01) mm; Egg = 100-109 x 37-54 µm.

Males (n = 2): L = 1.05-1.065 mm; a = 11.66-11.83; b = 6.06-6.12; Esophagus = 0.173-0.174 mm; Spicule = 38-40 µm.

Description:

Female: Body cylindrical, tapering at both ends, straight upon fixation. Cuticle annulated throughout
the length, 10-15 μm apart anteriorly and 20-21 μm apart at midbody. Lateral alae prominent, each terminating posteriorly in a spine-like projection. Mouth surrounded by eight labial papillae. Buccal cavity small, 15-18 μm. Esophageal corpus divided into anterior cylindrical part, 0.140-0.165 mm long, 30-34 μm wide and posterior broader part, 0.140-0.152 mm long, 51-59 μm wide. Isthmus distinct, 15-21 μm long; endbulb, 90-102 μm wide. Anterior part of intestine enlarged and provided with a posteriorly directed intestinal diverticulum. Nerve ring at 0.11-0.15 mm and excretory pore at 0.65-0.75 mm from anterior end.


**Male:** Body small, slightly curved ventrally at the posterior end upon fixation. The cuticle is annulated throughout the length, 4-6 μm. Lateral alae present. Mouth opens into a small buccal cavity, 10-12 μm. Esophagus divisible into corpus of uniform diameter, 118-120 μm; a short isthmus, 15-18 μm and endbulb, 33-37 μm. Nerve ring at 70-150 μm from anterior end.

Testis single, reflexed at the tip. Tail very
small. Caudal papillae three pairs: one pair large subventral preanal, one pair subventral postanal and one pair small subdorsal postanal.

**Type host:** *Blatta orientalis*

**Habitat:** Posterior gut

**Locality:** Aligarh (North India)

**Remarks:** The present specimens are in agreement with the description and range given by earlier workers except in having slightly smaller intestinal diverticulum (0.68-0.8 mm). *L. appendiculatum* is reported for the first time from North India (Aligarh).

The scanning electron microscopy on the females of *L. appendiculatum* has been performed for the first time. The SEM micrographs reveal the anterior region with anterior annules, *en face* shows eight labial papillae arranged like a disc around a sub-triangular mouth opening and a pair of laterally situated tiny amphids. The vulval region shows transverse slit-like vulval pore. Posterior region reveals the anal region and the tail.

**Key to the species of the genus Leidynema**

1. Spicule more than 40 μm ------------ 2
2. Spicule less than 40 μm ------------ 3
2 - Spicule 42 μm, several protuberances present in the posterior region of males

- Spicule 63 μm; males without protuberance

3 - Lateral alae present in females only

- Lateral alae present in both sexes

4 - Lateral alae in female ends in backwardly pointed projection

- Lateral alae in female do not end in backwardly pointed projection

5 - Female esophagus, 1/6-1/5th of body length; males with five pairs of caudal papillae

- Female esophagus, 1/8th of body length; males with three to five pairs of caudal papillae

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portentosae
Waerebeke, 1978

socialis (Leidy, 1850) Adamson & Waerebeke, 1992a

schwenki
Farooqui, 1967

delatorrei
Chitwood, 1932

periplaneti
Farooqui, 1967

appendiculatum
(Leidy, 1850)
Chitwood, 1932.
CHAPTER - II
CHAPTER - II

FAMILY: CHITWOODIELLIDAE KLOSS, 1960

Rao (1958) proposed the family Travassosinematidae to accommodate three genera, viz., Pulchrocephala Travassos, 1925a, Indiana Chakravarty, 1943 and Travassosinema Rao, 1958. Later, Kloss (1960) proposed two families namely, Pulchrocephalidae and Chitwoodiellidae. The family Pulchrocephalidae included three genera: Pulchrocephala, Indiana and Ptercnemella Rao, 1958. Whereas the family Chitwoodiellidae included Mirzaiella Basir, 1942 Chitwoodiella Basir, 1948 a and Singhiella, Rao, 1958. However, Skrjabin et al. (1966) and Poinar (1977) did not recognize the family Travassosinematidae, but accepted the two families Pulchrocephalidae and Chitwoodiellidae of Kloss (1960) as two distinct families and transferred the type genus Travassosinema of the family Travassosinematidae to the family Thelastomatidae. The decision was based on the presence of a spicule in Travassosinema which was lacking in the other two genera of Travassosinematidae.

Adamson and Waerebeke (1992 b) revived the family Travassosinematidae and combined it with Chitwoodiellidae and Pulchrocephalidae of Kloss (1960)
adding two more genera Binema Travassos, 1925b and Isobinema Rao, 1958.

In the present study, the views of Adamson and Waerebeke (1992b) regarding the family Travassosinematidae is not accepted wholly. Herein the family Chitwoodiellidae is considered a distinct family and combined with the members of the family Pulchrocephalidae and three genera of the family Thelastomatidae, viz., Binema, Isobinema and Mohibiella Farooqui (1970). The basis for the combination of these genera in the family Chitwoodiellidae lies in, the presence of polar egg filaments and their parasitism in the mole cricket (Gryllotalpoidea : Orthoptera), whereas the genus Travassosinema lacks polar egg filaments and it is parasitic in diplopods, in this respect it differs from the above members but resembles the members of the family Thelastomatidae and therefore transferred to the same.

The family Chitwoodiellidae now includes nine genera namely Chitwoodiella, Mirzaella, Singhiella, Pulchrocephala, Indiana, Pteronemella, Mohibiella, Binema and Isobinema. The diagnosis of the family required certain modifications and therefore emended diagnosis is provided.
During the present study, investigations of various insects revealed that they were parasitized by some members of this family, viz. Binema, Isobinema, Chitwoodiella and Mirzaella.

**Diagnosis (emended):**

Cephalic extremity simple or formed by 6-12 hood like expansions. Mouth surrounded by three to eight labial papillae. Lateral alae present or absent. Esophagus consisting of cylindrical or clavate corpus, isthmus distinct or just a constriction between corpus and a posterior valvular endbulb. Vulva posterior to midbody. Gonads amphidelphic. Eggs with polar filaments. Males with single testis. Spicule single or absent. Caudal papillae two to nine pairs or completely absent.
The genus *Binema* was proposed by Travassos (1925b) and provisionally placed in the Oxyuroidea. Travassos (1929) later placed this genus in the family, Thelastomatidae proposed by him. However, Basir (1956) revised the genus and redescribed all the three valid species, viz., *B. korsakowi* (type species), *B. ornata* and *B. mirzaia*. Later, Rao (1958) reported these species from South India and described the males of *B. korsakowi* and *B. mirzaia* for the first time. Leibersperger (1960) reported *B. pseudornatum* from France. Farooqui (1968b) concluded that the male of *B. ornata* described by Travassos were in fact the males of *B. korsakowi* because he collected the males as many as eight times along with females of the type species from *Gryllotalpa africana*.

Parveen and Jairajpuri (1985b) reported a species, *B. parva*, besides describing other known species, from North India. Adamson and Waerebeke (1992b) while revising the superfamily
Thelastomatoidea transferred *Binema* from the family Thelastomatidae to the family Travassosinematidae Rao, 1958. However, in the present study the genus *Binema* is placed under the family Chitwoodiellidae Kloss, 1960 on the basis of the presence of polar egg filaments and their parasitism in mole crickets (*Gryllotalpa africana*).

During the present study, several worms representing this genus were collected from *G. africana*. Some of them were found to belong to *B. mirzaia*, but some were quite different and could not be accommodated in any of the known species and hence regarded as a new species and described as *B. adamsii* n. sp. (Named after Prof. M.L. Adamson for his significant contribution in this field). At present the genus includes six species from all over the world.

The diagnosis of the genus required certain modifications to accommodate the new species and hence emended.

*Diagnosis (emended):*

**Female:** Cephalic extremity formed by circum-oral ring and short second annule. Lateral alae present or absent. Esophageal corpus cylindrical. Isthmus distinct or it is a constriction between corpus and bulb. Vulva
pósterior to midbody. Amphidelphic. Eggs broadly oval with polar filaments, deposited in capsules containing 2-3 eggs. Tail conical or rounded with short or long caudal appendage, with or without fine striations near its tip.

**Male:** Caudal extremity conical to subulate. Caudal papillae five to nine pairs. Tail small to a long caudal appendage. Spicule single.

**BINEMA MIRZAIA (BASIR, 1940) BASIR, 1956.**
(Fig. 9)

**Synonyms:** Periplaneticola mirzaia Basir 1940

Periplaneticola periplaneticola Basir, 1942

**Dimensions:**

**Females** (*n* = 8): *L* = 2.34-3.32 (2.86 ± 0.13) mm; *a* = 10.09-10.68 (10.4 ± 0.09); *b* = 5.57-7.21 (6.49 ± 0.2); *c* = 31.2 - 40.26 (34.47 ± 1.13); *V* = 64.25 - 72.29 (68.71 ± 1.21); Esophagus = 0.414 - 0.46 (0.431 ± 0.01) mm; Tail = 0.075 - 0.095 (0.083) mm, Egg = 51 - 56 x 31 -34 μm.

**Male** (*n* = 1): *L* = 0.75; *a* = 10.71; *b* = 5.43; *c* = 9.03; Esophagus = 0.138 mm; Tail = 83 μm; Spicule = 33 μm.
Description:

Female: Body medium sized, cylindrical in shape, attenuated at both ends. Lateral alae present from head to tail. Cuticle annulated, annulations prominent upto esophageal region, 3-6 µm apart. Cephalic extremity formed by circum-oral ring and short second annule. Mouth surrounded by eight labial papillae and a pair of amphids. Buccal cavity small, 12-18 µm. Esophageal corpus cylindrical, 0.31-0.35 mm long, 30-35 µm wide; isthmus distinct, 9-15 µm long, 23-27 µm wide; endbulb spherical, 78-95 µm long, 82-91 µm wide. Nerve ring at 0.165 - 0.195 mm from anterior end. Excretory pore post-esophageal, 0.67 -0.80 mm from anterior end. Cardia distinct.

Gonads amphidelphic, vulva posterior to midbody, vagina muscular and anteriorly directed. Eggs broadly oval with polar filaments, deposited in capsules containing 2-3 eggs. Tail with spine like ending.

Male: Body small, curved ventrally upon fixation cuticle annulated, annules, 1 - 2 µm apart. Mouth surrounded by eight labial papillae and a pair of amphids. Buccal cavity very small, 3 µm. Esophageal corpus, 85 µm long; isthmus distinct, 12 µm; endbulb ovate, 41 µm.

Testis single, reflexed at the tip. Caudal
extremity conical ending in a flagellate appendage. Caudal papillae nine pairs: five pairs preanal, two pairs postanal, two pairs adanal with single median papilla at the base of caudal appendage. Spicule single.

**Type host:** Gryllotalpa africana  
**Habitat:** Midgut  
**Locality:** SiddharthNagar (North India)  
**Remarks:** All the measurements and descriptions are in conformity with the range given by earlier workers except for slightly longer male with slightly longer spicule (males = 0.57 - 0.65 mm long, spicule = 26-31 μm).

**BINEMA ADAMSII** *N. SP.*  
(Fig. 10)

**Dimensions:**

**Holotype female:** L = 2.9 mm; a = 8.81; b = 7.19; c = 10.00; V = 57.58; Esophagus = 0.403 mm; Tail - 0.29 mm; Egg = 51 μm.

**Paratype females (n = 7):** L = 1.9-2.95 (2.42 ± 0.17) mm; a = 8.07 - 9.42 (8.88 ± 0.18); b = 4.66 - 7.62 (6.15 ± 0.4); c = 8.65 - 12.15 (10.2 ± 0.74); V = 57.58 - 68.07 (60.85 ± 1.31); Esophagus = 0.341 - 0.409 (0.393 ± 0.01) mm; Tail = 0.176 - 0.320 (0.24 ± 0.02)
mm; Egg = 51 - 56 x 28 - 35 μm.

**Paratype male** \( (n = 1) \): \( L = 0.84 \) mm; \( a = 11.2 \); \( b = 6.61 \); \( c = 24.7 \); Esophagus = 0.126 mm; Tail = 36 μm; Spicule = 36 μm.

**Description:**

**Female:** Body more or less spindle shaped, almost straight upon fixation, tapering towards both extremities, more pronounced posteriorly. Cuticle annulated, annulations prominent till esophageal region, 4-6 μm apart, rest of the body with faint striations, few striations become distinct near the tip of the tail. Lateral alae present from head to tail. Cephalic extremity formed by circum-oral ring and short second annule. Mouth surrounded by eight labial papillae and a pair of amphids. Mouth opens into a short buccal cavity, 12-15 μm, partly surrounded by esophagus and provided with cuticularized wing-like margins. Esophageal corpus cylindrical, 0.254 - 0.33 mm long, 25-31 μm wide; isthmus indistinct, just a constriction between corpus and endbulb; endbulb ovate, 79-105 μm long, 79-105 μm wide. Nerve ring at 0.13 - 0.17 mm from anterior end. Excretory pore, posterior to esophagus, 0.50 - 0.67 mm from anterior end. Cardia distinct.
Gonads amphidelphic. Vulva posterior to midbody, vagina muscular, cuticularized and anteriorly directed. Ovaries well developed and reflexed at their tips. Oocytes arranged in a single row. Eggs broadly oval with polar filaments, deposited in capsules containing 2-3 eggs. Tail conical with few striations near the tip.

**Male:** Body small, almost straight anteriorly, curved ventrally at the posterior region upon fixation. Cuticle annulated. Mouth surrounded by eight labial papillae and a pair of amphids. Buccal cavity small, funnel shaped, 7 μm. Esophageal corpus cylindrical, 90 μm long, 18 μm wide; isthmus indistinct, just a constriction between corpus and bulb; endbulb ovate, 36 μm long, 30 μm wide. Nerve ring at 70 μm from anterior end.

Testis single, small and reflexed at the tip. Tail abruptly narrows behind the anus to form a caudal spike. Caudal papillae eight pairs: four pairs preanal, one pair adanal, two pairs postanal and one pair at the base of caudal appendage. Spicule single.

**Type host:** Gryllotalpa africana
**Habitat:** Midgut
**Locality:** Aligarh (North India)
**Type material:** Holotype female on slide Binema adamsii
n. sp./1; paratype females on slides B. adamsii n. sp./2-8; paratype male on slide B. adamsii n.sp./9, deposited in the Nematode Collection of the Department of Zoology, Aligarh Muslim University, Aligarh.

**Diagnosis and Relationships:**

*Binema adamsii* n. sp. is characterized by indistinct isthmus, buccal cavity with cuticularized wing-like margins and few distinct striations near the tip of the tail in females; funnel shaped buccal cavity and eight pairs of caudal papillae in male.

The new species comes close to *B. korsakowi* (Sergiev, 1923) Basir, 1956 in the body measurements and shape of the tail in females, but differs from it in the presence of buccal cavity, few striations near the tip of the tail in females, long male with funnel shaped buccal cavity, small esophagus, small tail, eight pairs of caudal papillae, presence of lateral alae and indistinct isthmus in both the sexes (*buccal cavity and striations near the tip of the tail absent in females; male = 0.78 mm long, buccal cavity simple, esophagus = 0.132, tail = 40 \( \mu m \), caudal papillae nine pairs, lateral alae absent and isthmus distinct in both the sexes in *B. korsakowi*). *B. adamsii* n. sp. resembles *B. parva* Parveen and Jairajpuri, (1985b) in the presence of lateral alae and buccal cavity in
females, but differs from it in the body measurements, structure of buccal cavity and presence of striations near the tip of tail in females; long male with small tail, funnel shaped buccal cavity and eight pairs of caudal papillae and indistinct isthmus in both the sexes (female = 1.54 - 1.77 mm long, 0.14-0.15 mm wide, buccal cavity simple, striations near the tip of the tail absent; male = 0.6 - 0.73 mm long, tail = 50 - 70 \mu m, buccal cavity simple, nine pairs of caudal papillae, isthmus distinct in both the sexes in \textit{B. parva}).

The new species resembles \textit{B. ornata} Travassos, 1925b in the presence of lateral alae, position of excretory pore and vulva in females; similar dimensions of male, but differs from it in long tail with few striations near the tip of the tail and small eggs in females; male with funnel shaped buccal cavity, small tail, small esophagus, number and arrangement of caudal papillae and indistinct isthmus in both the sexes. (tail = 0.11 - 0.14 mm long, striations near its tip absent and eggs = 54-62 \mu m in females; male buccal cavity simple, tail = 40 - 70 \mu m, esophagus = 0.140 mm long, caudal papillae 5 to 8 pairs; with 8 pairs arranged as 4 pairs preanal and 4 pairs postanal and isthmus distinct in both the sexes in \textit{B. ornata}).
B. adamsii n. sp. resembles B. mirzaia (Basir, 1940), Basir, 1956 in the presence of lateral alae in both the sexes and presence of buccal cavity in females, but differs from it in the length of tail in both the sexes, smaller modified buccal cavity in females and male with longer spicule and eight pairs of caudal papillae (female tail = 0.06-0.11 mm; male tail = 0.089-0.13 mm, females with simple buccal cavity, 11 - 22 μm; males with nine pairs of caudal papillae and spicule = 26-31 μm in B. mirzaia).

Key to the species of the genus Binema

1 - Female tail with flagellate caudal appendage
   - Female tail without flagellate caudal appendage

2 - Female tail conical
   - Female tail with spine like ending

3 - Lateral alae and buccal cavity present
   - Lateral alae and buccal cavity absent

--------- pseudornatum
         Leibersperger, 1960

--------- 2

--------- 3

--------- 4

--------- 5

--------- korsakowi
         (Sergiev, 1923)
         Basir, 1956
4 - Male with 9 pairs of caudal papillae and a single median papilla

- Male with 5 pairs of caudal papillae, median papilla absent

5 - Male with 8 pairs of caudal papillae. Female tail with fine striations near its tip

- Male with 9 pairs of caudal papillae. Female tail without striations

--- mirzaia (Basir, 1942) Basir, 1956.

--- ornata Travassos, 1925a

--- adamsii n. sp.

--- parva Parveen and Jairajpuri, 1985b
### TABLE - 3

COMPARATIVE MEASUREMENT CHART OF THE SPECIES OF *BINEMA*.

<table>
<thead>
<tr>
<th>CHARACTERS</th>
<th><em>B. ornata</em></th>
<th><em>B. pseudornatum</em></th>
<th><em>B. korsakowi</em></th>
<th><em>B. mirzaia</em></th>
<th><em>B. parva</em></th>
<th><em>B. adamsii n. sp.</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>2.5 - 3.5</td>
<td>6.98</td>
<td>1.8 - 4.1</td>
<td>2.3 - 4.9</td>
<td>1.54 - 1.77</td>
<td>1.9 - 2.95</td>
</tr>
<tr>
<td>Width</td>
<td>0.22 - 0.27</td>
<td>0.49</td>
<td>0.21 - 0.5</td>
<td>0.2 - 0.42</td>
<td>0.14 - 0.15</td>
<td>0.22 - 0.32</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.30 - 0.35</td>
<td>0.56</td>
<td>0.35 - 0.43</td>
<td>0.43 - 0.54</td>
<td>0.32 - 0.36</td>
<td>0.34 - 0.40</td>
</tr>
<tr>
<td>Tail</td>
<td>0.11 - 0.14</td>
<td>0.38</td>
<td>0.2 - 0.58</td>
<td>0.06 - 0.11</td>
<td>0.2 - 0.21</td>
<td>0.176 - 0.32</td>
</tr>
<tr>
<td>Vulva</td>
<td>1.47 - 1.80</td>
<td>3.35</td>
<td>1.1 - 1.71</td>
<td>1.6 - 2.21</td>
<td>0.9 - 1.04</td>
<td>1.1 - 1.75</td>
</tr>
<tr>
<td>Buccal cavity</td>
<td>20 x 10 μm</td>
<td>-</td>
<td>absent</td>
<td>11 - 22 μm</td>
<td>15 - 20 μm</td>
<td>9 - 12 μm</td>
</tr>
<tr>
<td>Lateral alae</td>
<td>present</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Egg</td>
<td>54 - 62 μm</td>
<td>65 - 68 μm</td>
<td>55 - 64 μm</td>
<td>50 - 66 μm</td>
<td>55 - 61 μm</td>
<td>51 - 56 μm</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>0.64 - 0.82</td>
<td></td>
<td>0.78</td>
<td>0.57 - 0.65</td>
<td>0.6 - 0.73</td>
<td>0.84</td>
</tr>
<tr>
<td>Width</td>
<td>0.05 - 0.07</td>
<td>Unknown</td>
<td>0.11</td>
<td>0.05 - 0.085</td>
<td>0.054 - 0.063</td>
<td>0.075</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.140</td>
<td></td>
<td>0.132</td>
<td>0.12 - 0.13</td>
<td>0.11 - 0.14</td>
<td>0.127</td>
</tr>
<tr>
<td>Tail</td>
<td>0.04 - 0.07</td>
<td></td>
<td>0.048</td>
<td>0.089 - 0.13</td>
<td>0.05 - 0.07</td>
<td>0.034</td>
</tr>
<tr>
<td>Lateral alae</td>
<td>absent</td>
<td></td>
<td>present</td>
<td>present</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Spicule</td>
<td>20 - 30 μm</td>
<td></td>
<td>37 μm</td>
<td>26 - 31 μm</td>
<td>36 μm</td>
<td>36 μm</td>
</tr>
<tr>
<td>Caudal papillae</td>
<td>5 - 8 pairs</td>
<td>9 pairs</td>
<td>9 pairs</td>
<td>9 pairs</td>
<td>9 pairs</td>
<td>8 pairs</td>
</tr>
</tbody>
</table>

Basir (1948a) established the genus *Chitwoodiella* with its type species *C. ovofilamenta*, based only on the female worms recovered from *Gryllotalpa africana* and placed this genus in the family Thelastomatidae, as he observed eight cephalic papillae. However, in 1949, he obtained some material of the type species from British West Indies consisting of both the males and females from the host *Scapteriscus vicinus* of the family Gryllidae and observed only four cephalic papillae in the males, as well as in the females and transferred this genus to the family Oxyuridae. Later, Rao (1958) reported the same species from South India. Parveen and Jairajpuri (1984a) reported the type species and another species, *C. neoformis* from North India. Adamson and Waerebeke (1992b) while revising the superfamily Thelastomatoidea, transferred this genus to the family Travassosinematidae Rao, 1958. However, in the present study this genus is placed under the family Chitwoodiellidae Kloss, 1960 due to the similarities between the members of the family and the genus *Chitwoodiella*, viz., the presence of polar egg filaments and their parasitism in mole cricket (*Gryllotalpa africana*).
During the present investigations, several worms collected from G. africana were found to represent this genus. Few of them were found to belong to the type species, C. ovofilamenta, but few worms consisting of both males and females could not be fitted in either of the two known species, hence regarded as a new species and described as C. tridentata n. sp. At present the genus includes only three species. The diagnosis of the genus is emended to accommodate the new species.

Diagnosis (emended):

**Female:** Cephalic extremity formed by simple lip cone. Buccal capsule long, tubular and annulated, posterior part of which may or may not possess three cuticularized tooth like structures. Esophageal corpus cylindrical. Vulva between middle and posterior third of body. Vagina short, directed anteriorly. Amphidelphic. Ovaries reflexed and reach the esophageal region. Eggs attached to one another in strings by polar filaments. Tail conical.

**Male:** Buccal capsule as in females but do not possess tooth like structures. Lateral alae present or absent. Tail very short. Spicule absent. A median ventral rod like, bluntly pointed projection located posteriorly behind the anus. Caudal papillae five to six pairs.
CHITWOODIELLA OVOFILAMENTA BASIR, 1948a
(Fig. 11)

Dimensions:

**Females (n = 4):** $L = 1.9 - 2.1$ (2.02 ± 0.04) mm; $a = 8.4 - 10.38$ (9.09 ± 0.45); $b = 4.56 - 5.03$ (5.05 ± 0.28); $c = 5.5 - 6.36$ (5.96 ± 0.18); $V = 53.37 - 59.25$ (57.07 ± 1.3); Buccal cavity = 46 - 49 (46.73 ± 1.43) μm; Esophagus = 0.40 - 0.44 (0.42 ± 0.01) mm; Tail = 0.330 - 0.360 (0.347) mm; Egg = 72 - 83 x 43 - 49 μm.

**Male (n = 1):** $L = 1.27$ mm; $a = 14.16$; $b = 4.67$; Buccal cavity = 35 μm; Esophagus = 0.273 mm.

Description:

**Female:** Body medium sized, almost straight to slightly curved upon fixation. Cuticle annulated, annules prominent in the cervical region, 4-10 μm apart, rest of the body with indistinct striations. Lateral alae absent. Mouth opening subtriangular, surrounded by circumoral elevation bearing three distinct but very small lips, the dorsal lip with two minute subdorsal papillae and each venterolateral lip with one subventral papilla and one amphid. Buccal cavity long and tubular with striated cuticular wall, its anterior half being narrower and finely striated and posterior half wider with comparatively few striae farther apart. Esophageal corpus cylindrical, 0.318 - 0.339 mm long, 30 - 33 μm.
wide; isthmus distinct, 12 - 15 μm long, 24 - 25 μm wide. Endbulb ovate, 71- 90 μm long, 71-93 μm wide. Nerve ring at 0.10 - 0.19 mm from anterior end. Cardia distinct.


Male: Worms small, posterior end ventrally curved upon fixation. Cuticle annulated, annules distinct in the cervical region, 3 μm apart. Lateral alae present. Mouth opening subtriangular with three small lips. Buccal cavity long and tubular with striated cuticular wall. Esophageal corpus 0.202 mm long, 31 μm wide; isthmus distinct 15 μm long; endbulb ovate, 56 μm long. Nerve ring at 0.15 mm from anterior end.

Testis single, reflexed anteriorly. Tail very short. Caudal papillae five pairs: three pairs preanal and two pairs postanal. One of the three preanal is ventral in position, second pair is lateral and third ventral. Spicule absent. Rod like projection 15 μm long present.

Type host: Gryllotalpa africana
Habitat: Midgut
Locality: Aligarh (North India)
Remarks: All the body measurements and descriptions are in agreement with the range given by earlier workers except for the slightly smaller buccal cavity and esophagus in females (buccal cavity = 40 - 61 μm long, esophagus = 0.3 - 0.47 mm).

**CHITWOODIELLA TRIDENTATA N. SP.**
(Fig. 12)

Dimensions:

**Holotype female:** L = 2.22 mm; a = 7.04; b = 4.92; c = 5.69; V = 48.64; Buccal cavity = 47 μm; Esophagus = 0.451 mm; Tail = 0.39 mm; Egg = 71 x 41 μm.

**Paratype females (n = 3):** L = 2.07 - 2.88 (2.35 ± 0.26) mm; a = 8.4 - 9.29 (8.6 ± 0.35); b = 4.79 - 6.02 (5.2 ± 0.41); c = 5.75 - 6.85 (6.1 ± 0.36); V = 53.43 - 57.89 (56.19 ± 1.3); Buccal cavity = 46 - 50 (47.3 ± 1.3) μm; Esophagus = 0.432 - 0.478 (0.45 ± 0.01) mm; Tail = 0.36 - 0.42 (0.38 ± 0.01) mm; Egg = 69 - 71 x 34 - 50 μm.

**Holotype male:** L = 1.53 mm; a = 9.27; b = 5.38; Buccal cavity = 41 μm; Esophagus = 0.284 mm;

**Paratype males (n = 3):** L = 1.5 - 1.59 (1.53 ± 0.03)
mm; \( a = 10.6 - 12.5 \ (11.86 \pm 0.63) \); \( b = 5.24 - 5.28 \ (5.25 \pm 0.01) \); Buccal cavity = 40 - 45 \ (41.5 \pm 0.72) \ \mu\text{m}; \) Esophagus = 0.286 - 0.30 \ (0.291 \pm 0.005) \ \text{mm}.

**Description:**

**Female:** Body medium sized, straight upon fixation. Cuticle annulated, annules prominent in the cervical region, 5-10 \( \mu\text{m} \) apart. Mouth opening subtriangular surrounded by circumoral elevation, bearing three distinct lips, four small labial papillae and a pair of amphids. Buccal cavity very characteristic, long and tubular with striated cuticular wall, its anterior being narrower and finely striated, posterior half wider with comparatively few striae farther apart. Posterior part of the buccal cavity leading to the esophagus possesses three well developed cuticularized tooth-like structures, 10-12 \( \mu\text{m} \) long. Esophageal corpus cylindrical, 0.330 - 0.376 \ \text{mm} \) long, 31-34 \( \mu\text{m} \) wide; isthmus short, 12-15 \( \mu\text{m} \) long; endbulb spherical 78-87 \( \mu\text{m} \) long, 87-90 \( \mu\text{m} \) wide. Nerve ring at 0.20 - 0.24 mm from anterior end. Cardia distinct.

Gonads amphidelphic. Vulva posterior to midbody with prominent vulval lips. Vagina cuticularized, muscular and anteriorly directed. Ovaries well developed, oocytes arranged in a single row. Ovaries
reflexed and reach the esophageal corpus. Eggs elliptical, attached to one another in strings by polar filaments. Tail attenuated filiform.

**Male:** Body fairly long, almost straight to slightly curved posteriorly upon fixation. Cuticle annulated, annules prominent in the cervical region, 3-5 \( \mu m \) apart. Lateral alae distinct, 12-15 \( \mu m \) and reach 1/3rd of the body length. Circumoral elevation distinct. Mouth opening subtriangular with three small lips. Buccal cavity very long and tubular with finely striated cuticular wall. Esophageal corpus 0.212-0.227 mm long, 18-25 \( \mu m \) wide; isthmus distinct, 15-18 \( \mu m \) long; endbulb spherical, 54-56 \( \mu m \) long, 54-56 \( \mu m \) wide. Nerve ring at 0.15-0.17 mm from anterior end.

Testis single, reflexed at the tip. Tail very short. Caudal papillae six pairs: three pairs preanal and three pairs adanal. Among the three preanal pairs, first and third are small, second is large, and among the three adanal, one is large and pedunculated, 2nd pair is small and sessile and third pair is small and pedunculated. Spicule absent. Rod like projection 12.5-15 \( \mu m \) long present.

**Type host:** Gryllotalpa africana

**Habitat:** Midgut

**Locality:** Aligarh (North India)
**Type material:** Holotype female on slide *Chitwoodiella tridentata* n. sp./1, paratype females on slides *C. tridentata* n.sp./2-4; holotype male slide *C. tridentata* n. sp./5; paratype males on slides *C. tridentata* n.sp./6-8, deposited in the Nematode Collection of the Department of Zoology, Aligarh Muslim University, Aligarh.

**Diagnosis and relationships:**

*Chitwoodiella tridentata* n.sp. is characterized by the presence of three well developed cuticularized tooth-like structures in the posterior part of the buccal cavity leading to the esophagus and long tail in females, longer males with fairly long buccal cavity and six pairs of caudal papillae.

*C. tridentata* n. sp. resembles *C. ovofilamenta* Basir, 1948a in the presence of striated buccal cavity in both the sexes and cervical annulations in females, but differs from it in having three well developed cuticularized tooth-like structures in the posterior part of buccal cavity, short isthmus, small eggs and slightly smaller buccal cavity in females, longer males with longer buccal cavity, presence of lateral alae and six pairs of caudal papillae. (tooth-like structures absent, isthmus = 20-25 μm; egg = 70-80 μm;
buccal cavity = 50-60 μm in females; males = 1.1-1.45 mm long, buccal cavity = 30-34 μm, lateral alae absent and five pairs of caudal papillae in *C. ovofilamenta*).

The new species resembles *C. neoformis* Parveen and Jairajpuri, 1984a in the presence of striated buccal cavity in both the sexes, lateral alae in males, body size of females and position of vulva, but differs from it in the presence of three well developed cuticularized tooth-like structures in the posterior part of buccal cavity in females and smaller eggs. It differs in all the body measurements of males, longer buccal cavity and six pairs of caudal papillae (tooth-like structures absent, egg = 75-83 μm, males = 0.96 mm long, 86 μm wide, buccal cavity = 26 μm and five pairs of caudal papillae in *C. neoformis*).

**Key to the species of the genus Chitwoodiella**

1 - Lateral alae present
- Lateral alae absent

2 - Female buccal cavity with three tooth-like structures; caudal papillae six pairs
- Female buccal cavity without tooth like structures; caudal
papillae five pair ------- neoformis
Parveen and Jairajpuri, 1984a
### TABLE - 4

**COMPARATIVE MEASUREMENT CHART OF THE SPECIES OF CHITWOODIELLA.**

<table>
<thead>
<tr>
<th>CHARACTERS</th>
<th>C. ovafilementa</th>
<th>C. neoformis</th>
<th>C. tridentata n. sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Length</td>
<td>1.1 - 2.95</td>
<td>1.9 - 2.0</td>
<td>2.07 - 2.88</td>
</tr>
<tr>
<td>Width</td>
<td>0.2 - 0.26</td>
<td>0.16 - 0.17</td>
<td>0.25 - 0.31</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.30 - 0.517</td>
<td>0.46 - 0.47</td>
<td>0.432 - 0.478</td>
</tr>
<tr>
<td>Tail</td>
<td>0.15 - 0.35</td>
<td>0.33 - 0.36</td>
<td>0.36 - 0.42</td>
</tr>
<tr>
<td>Vulva</td>
<td>1.05 - 1.7</td>
<td>1.1 - 1.2</td>
<td>1.08 - 1.54</td>
</tr>
<tr>
<td>Buccal cavity (B.C)</td>
<td>50 - 60 µm</td>
<td>43 - 48 µm</td>
<td>46 - 50 µm</td>
</tr>
<tr>
<td>Teeth like structure at the base of B.C.</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>Egg</td>
<td>70 - 80 µm</td>
<td>75 - 83 µm</td>
<td>69 - 71 µm</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>1.1 - 1.45</td>
<td>0.96</td>
<td>1.5 - 1.59</td>
</tr>
<tr>
<td>Width</td>
<td>0.08 - 0.11</td>
<td>0.086</td>
<td>0.12 - 0.16</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.25 - 0.38</td>
<td>0.26</td>
<td>0.28 - 0.30</td>
</tr>
<tr>
<td>Tail</td>
<td>0.02 - 0.026</td>
<td>0.015</td>
<td>0.014</td>
</tr>
<tr>
<td>Buccal cavity</td>
<td>30 - 40 µm</td>
<td>26 µm</td>
<td>40 - 43 µm</td>
</tr>
<tr>
<td>Rod-like structure</td>
<td>15 - 18 µm</td>
<td>15 µm</td>
<td>12.5 - 15 µm</td>
</tr>
<tr>
<td>Caudal papillae</td>
<td>5 pairs</td>
<td>5 pairs</td>
<td>6 pairs</td>
</tr>
<tr>
<td>Lateral alae</td>
<td>absent</td>
<td>14-18 µm</td>
<td>12.5 - 15 µm</td>
</tr>
</tbody>
</table>

Rao (1958) reported a genus from Southern part of India and named it *Isobinema* with its type species *I. flagellocerca* under the family Thelastomatidae. Another species *I. dimorphicauda* was reported by Parveen and Jairajpuri (1982) from Aligarh, North India. Adamson and Waerebeke (1992b) while revising the superfamily Thelastomatoidea, transferred this genus to the family Travassosinematidae Rao, 1958. However, in the present study this genus is transferred to the family Chitwoodiellidae Kloss, 1960, on the basis of the presence of polar egg filaments and their parasitism in mole crickets, a characteristic of the family Chitwoodiellidae. At present the genus comprises of only two species. The type species *I. flagellocerca* were recovered during the present study and described herein.

**Diagnosis (emended):**

**Female:** Cephalic extremity simple or modified into knob like structure. Cuticle smooth or annulated in the anteriormost region. Esophageal corpus cylindrical. Isthmus distinct. Vulva posterior to midbody. Amphidelphic. Eggs oval, with polar tufts and are
released in a chain of two. Tail with or without flagellate caudal appendage. **Male:** Cephalic extremity modified into a knob like structure. Caudal extremity tapering from anus and ending in a thread-like appendage. Caudal papillae six pairs, four pairs preanal and two pairs postanal. Spicule single.

**ISOBINEMA FLAGELLOCERCA** RAO, 1958.  
(Fig. 13 A - D)

**Dimensions:**

**Females (n = 10):**  
$L = 2.72 - 3.58 (3.27 \pm 0.082) \text{ mm}$;  
$a = 10.06 - 13.22 (11.71 \pm 0.26)$;  
$b = 9.06 - 11.67 (10.27 \pm 0.26)$;  
$c = 13.94 - 21.19 (18.87 \pm 0.69)$;  
$V = 44.67 - 56.61 (48.57 \pm 2.81)$;  
$\text{Esophagus} = 0.30 - 0.349 (0.319 \pm 0.004) \text{ mm}$;  
$\text{Tail} = 0.16 - 0.2 (0.179 \pm 0.004) \text{ mm}$;  
$\text{Egg} = 60 - 66 \times 33 - 35 \ \mu\text{m}$.

**Description:**

**Female:** Body straight upon fixation and maintain almost a uniform diameter in its middle third, but tapers anteriorly and posteriorly. Annules 5-7 $\mu\text{m}$ apart are present only in the anteriormost region upto 10-18 $\mu\text{m}$ from anterior end, rest of the cuticle smooth without annules or striations. Head distinct 15-22 $\mu\text{m}$ wide. Mouth surrounded by eight labial papillae, opens into a
cuticularized buccal cavity, 15-25 μm long, partly enclosed by corpus. Esophageal corpus cylindrical, 0.22 - 0.26 mm long; 30 - 33 μm wide; isthmus short, 7-8 μm long, endbulb ovate, 78-84 μm long, 78-84 μm wide. Nerve ring at 0.13 - 0.17 mm and excretory pore at 0.4 - 0.65 mm from anterior end. Cardia distinct.

Gonads amphidelphic. Vulval opening transverse with well developed lips. Vagina muscular, cuticularized and anteriorly directed. The common uterus is connected to the ovaries by short oviduct. Ovaries reflexed at their tips, oocytes arranged in a single row. Eggs broadly oval, provided with polar tufts and released in a chain of two. Tail terminates in a flagellated caudal appendage.

**Male:** Not found but reported by Rao (1958)

**Type host:** Gryllotalpa africana

**Habitat:** Midgut

**Locality:** Aligarh (North India)

**Remarks:** The present specimens conform well with the original description except in having short isthmus, slightly smaller tail and few annulations in anteriormost region of the body (isthmus = 10-20 μm; tail = 0.186-0.256 mm and cuticle smooth in the specimens described by Rao, 1958).
Key to the species of the genus *Isobinema*

1 - Female tail with flagellate caudal appendage. Anterior extremity of male provided with knob-like structure

---------- *flagellocerca*

Rao, 1958

- Female tail without flagellate caudal appendage. Anterior extremity of both the sexes provided with knob-like structure

---------- *dimorphicauda*

Parveen & Jairajpuri, 1982
GENUS: MIRZAIELLA BASIR, 1942.

The genus *Mirzaiella* was described by Basir (1942) in the family Thelastomatidae, but in 1956, he observed four cephalic papillae in females and accordingly transferred it to the family Oxyuridae. The type species *Mirzaiella asiatica* Basir, 1942 was reported by Rao (1958) from South India.

Singh and Singh (1955) described *M. gryllotalpae* and *M. indicus* under the genus *Gryllocola*, these species were transferred to *Mirzaiella* by Adamson and Waerebeke (1992b) along with the transfer of the genus *Mirzaiella* to the family Travassosinematidae Rao, 1958. Farooqui (1967, 1968a) reported *M. alii* and *M. haroldi* respectively from Aurangabad, India.

In the present study, the genus *Mirzaiella* is placed under the family Chitwoodiellidae Kloss, 1960, due to the similarities between *Mirzaiella* and other members of Chitwoodiellidae, viz., the presence of polar eggs filaments and their parasitism in mole cricket. The total number of species in the genus is five.

During the present study, several worms collected from *Gryllotalpa africana* were found to belong to three species of *Mirzaiella* namely, *M. haroldi*, *M. alii* and
M. asiatica. M. haroldi is reported for the first time from Aligarh, North India.

**Diagnosis:**

**Female:** Cephalic extremity formed by prominent cephalic annule. Oral opening surrounded by three lips. Buccal cavity long and formed of two distinct parts of almost equal length. Esophageal corpus very long. Vulva near posterior third of body. Vagina short. Amphidelphic. Eggs oval, attached to one another by polar filaments, laid in mucous capsules containing 3-5 eggs. Tail rounded with or without spine-like appendage.


**MIRZAIELLA ASIATICA** BASIR, 1942.
(Fig. 13 E-H)

**Dimensions:**

**Females (n = 2):** L = 2.01 - 2.55 mm; a = 7.88 - 8.5; b = 3.71 - 4.61; c = 11.16 - 12.75; V = 59.7 - 61.5; Esophagus = 0.541 - 0.552 mm; Tail = 0.18 - 0.20 mm; Egg = 60 - 65 x 23-46 μm.
Description:

Female: Worms slender, straight upon fixation, cuticle annulated, annules prominent till the esophageal region, 9-10 μm apart. Head distinct, 43-45 μm wide. Mouth opening subtriangular, surrounded by three well developed lips, one dorsal and two subventral. Buccal cavity very long, divided in two portions of almost equal length, 68 - 70 μm. Esophageal corpus broad anteriorly, narrower posteriorly, 0.430 - 0.435 mm long, 35-40 μm wide anteriorly, 20-25 μm wide posteriorly. Isthmus distinct, 21 - 22 μm long; endbulb spherical, 90-95 μm wide. Nerve ring at 0.19 - 0.20 mm and excretory pore at 0.58 - 0.60 mm from anterior end. Cardia distinct.

Gonads amphidelphic. Vulva transverse with well developed lips, vagina sclerotized, muscular and anteriorly directed. Ovaries reflexed at their tips, oocytes arranged in a single row. Ovaries reach the esophageal region. Eggs oval, attached to one another by polar filaments and deposited in capsules containing 3-4 eggs. Tail short and attenuated.

Male: Not found but described by Basir (1942)

Type host: Gryllotalpa africana

Habitat: Midgut

Locality: Aligarh (North India)
Remarks: The present specimens conform well with the measurements and description of *M. asiatica* given by earlier workers, except in having slightly anteriorly located nerve ring (nerve ring = 0.21 - 0.30 mm from anterior end).

*MIRZAIELLA ALII FAROOQUI, 1967* (Fig. 14)

Dimensions:

**Females: (n = 8)** L = 2.01 - 3.00 (2.45 ± 0.16) mm; a = 7.10 - 8.82 (7.96 ± 0.31); b = 3.24 - 4.28 (3.75 ± 0.19); c = 8.61 - 11.53 (10.12 ± 0.51); V = 43.33 - 54.32 (48.45 ± 1.54); Esophagus = 0.619 - 0.70 (0.649 ± 0.01) mm; Tail = 0.225 - 0.26 (0.241 ± 0.01) mm; Egg = 62-65 x 30-35 μm.

**Males (n = 6)**: L = 1.18 - 1.60 (1.44 ± 0.06) mm; a = 7.9 - 9.6 (9.02 ± 0.25); b = 4.67 - 5.59 (5.27 ± 0.22); Esophagus = 0.242 - 0.297 (0.275 ± 0.02) mm; Tail = 0.16-0.18 mm.

Description:

**Female**: Worms slender, straight upon fixation. Cuticle annulated, 12-14 μm apart anteriorly and 21 μm at midbody. Head distinct, 50-52 μm wide. Mouth opening small, subtriangular and surrounded by three well
developed lips, one dorsal and two subventral. Buccal cavity simple, very long, 60-65 \( \mu m \). Esophageal corpus cylindrical, isthmus short, endbulb ovate. Nerve ring at 0.22 - 0.26 mm and excretory pore at 0.52 - 0.54 from anterior end. Cardia distinct.

Gonads amphidelphic. Vulva transverse with well developed lips, vagina heavily sclerotized, muscular and anteriorly directed. Ovaries reflexed at their tips, oocytes arranged in a single row. Eggs elongate, attached to one another by polar filaments and deposited in capsules containing 3-5 eggs. Tail divisible into broader anterior part and spike-like posterior part.

**Male:** Worms small, straight upon fixation. Cuticle faintly annulated, anterior annules, 6-9 \( \mu m \) apart. Lateral alae start from the middle of corpus and end with the caudal alae, 20-30 \( \mu m \) apart. Mouth is surrounded by two pairs of papillae and a pair of amphids. Buccal cavity long, 24-30 \( \mu m \). Esophageal corpus cylindrical, 0.171 - 0.219 mm long, 21-25 \( \mu m \) wide; isthmus distinct, 15-19 \( \mu m \) long; endbulb ovate, 54-59 \( \mu m \) long, 50-53 \( \mu m \) wide. Nerve ring at 0.14 - 0.18 mm and excretory pore at 0.4 - 0.5 mm from anterior end.

Testis single, reflexed at the tip. Spicule
absent, pointed cuticularized accessory piece, 22-27 μm present immediately posterior to anus. Caudal papillae six pairs, of which two pairs are lateral in position, bigger and pedunculated. Two pairs are sessile and ventral in position. Two pairs are small, sessile, one pair being preanal and the other postanal, these two pairs are close together but distinctly separated.

Type host: Gryllotalpa africana
Habitat: Midgut
Locality: SiddharthNagar (North India).
Remarks: The present specimens closely conform with the measurements and description of MirzaieLLa alii given by Farooqui (1967) except in having slightly longer tail in females (0.14 - 0.19 mm) and slightly longer buccal cavity in males (23-25 μm).

**MIRZAIELLA HAROLDI** FAROOQUI, 1968

(Fig. 15)

Dimensions:
Females (n = 7): L = 2.26 - 3.04 (2.59 ± 0.121) mm; a = 7.58 - 9.62 (8.70 ± 0.27); b = 3.36 - 4.33 (3.82 ±
0.13); \( c = 10.26 - 12.66 \ (11.35 \pm 0.39) \); \( V = 60.4 - 61.5 \ (60.8 \pm 0.15) \); Esophagus = 0.540 - 0.670 (0.617 \pm 0.01) \ mm; \ Tail = 0.22 - 0.24 (0.227) \ mm; Egg = 60 - 65 \times 33 - 38 \ \mu m.

**Males \ (n = 6):** \( L = 1.06 - 1.50 \ (1.25 \pm 0.08) \) mm; \( a = 9.09 - 11.83 \ (10.30 \pm 0.5) \); \( b = 4.12 - 5.74 \ (4.83 \pm 0.29) \); Esophagus = 0.235 - 0.261 (0.259) mm.

**Description:**

**Female:** Worms long and spindle shaped. The body is almost cylindrical throughout its length, except the posterior end which is abruptly attenuated. The cuticle is annulated throughout the length, but the annules are more prominent at the anterior region, 10-12 \( \mu m \) apart.

Head distinct, 30-47 \( \mu m \) wide. Mouth surrounded by three large and conspicuous lips. Buccal cavity very long, 65-78 \( \mu m \). Esophageal corpus broader at the anterior end and narrows towards posterior end, 0.42 - 0.56 mm long; isthmus distinct, 14 - 18 \( \mu m \) long; endbulb spherical, 81-97 \( \mu m \) wide. Nerve ring at 0.25 - 0.32 mm and excretory pore at 0.50 - 0.60 mm from anterior end.

Gonads amphidelphic. Vulva transverse with well developed lips. Vagina sclerotized, muscular and anteriorly directed. Ovaries reach the corpus, oocytes
arranged in a single row. Eggs oval with polar tufts and deposited in capsules containing 3-5 eggs. Tail short tapering abruptly into a spine.

**Male:** Worms small, slightly bent upon fixation. Cuticle striated throughout the length. Lateral alae start from midbody and join the caudal alae. Head distinct, 13-16 μm wide. Mouth is surrounded by two pairs of papillae and a pair of amphids. Buccal cavity 34-39 μm. Esophageal corpus cylindrical, 174-193 μm long, 22-25 μm wide, isthmus distinct, 11-13 μm long; endbulb spherical, 50-62 μm wide. Nerve ring at 0.17 - 0.23 mm from anterior end. Cardia distinct.

Testis single, reaches upto midbody, reflexed at the tip. Spicule absent, pointed cuticularized accessory piece present. Caudal papillae seven pairs: four pairs are preanal and three pairs adanal. The first preanal pair is asymmetrical, ventral in position, the second pair is subventral and larger, the third pair is smaller, ventral, fourth pair is smaller and subventral; A pair of minute sessile adanal papillae is located adjacent to the anus, the second and the third pair of adanal papillae are pedunculated.

**Type host:** *Gryllotalpa africana*

**Habitat:** Midgut

**Locality:** Aligarh (North India).
Remarks: The present specimens conform well with the description of *Mirzaiella haroldi* given by Farooqui (1968a) except in having slightly smaller esophagus and buccal cavity in females (esophagus = 0.66 - 0.78 mm; buccal cavity = 80 μm).

His descriptions were based on a single male, however, during the present study several males were collected, hence a new range of measurement is provided. This species is reported for the first time from North India and after 28 years of its original description (Farooqui, 1968a).

Key to the species of the genus *Mirzaiella*

1 - Female tail with a distinct constriction in the middle
   
   -------- *alii* Farooqui, 1967

   - Female tail without any constriction
     
     -------- 2

2 - Caudal papillae four pairs

   -------- 3

   - Caudal papillae more than four pairs
     
     -------- 4

3 - Female esophagus long about 0.58 - 0.657 mm and vulva about 63 - 67% of body length

   -------- *indicus* (Singh & Singh, 1955)

   Adamson & Waerebeke, 1992b
- Female esophagus 0.119
  - 0.124 mm and vulva about 58-62% of body length

  \[ \text{----} \text{gryllotalpae} \]
  (Singh & Singh, 1955) Adamson & Waerebeke, 1992b

4 - Caudal papillae 5 pairs,
caudal alae present
slightly above the anus \[ \text{-- asiatica} \]
Basir, 1942

- Caudal papillae 7 pairs,
caudal alae extend up
to the midbody \[ \text{---- haroldi} \]
Farooqui, 1968a
CHAPTER - III

FAMILY: PROTRELLOIDIDAE CHITWOOD, 1932

Chitwood (1932) proposed subfamily Protrelloidinae under the family Thelastomatidae to accommodate worms with anteriorly situated vulva. However, Basir (1956) remarked that the position of vulva is greatly variable and did not regard this subfamily as valid, but Farooqui (1970) agreed with Chitwood (1932) and revived the subfamily Protrelloidinae and added a genus Protrellatus to this group. Later, Adamson (1989) raised this subfamily to the rank of family Protrelloididae. Adamson and Waerebeke (1992b) revised the family Protrelloididae and included five genera under this family namely, Protrellus Cobb, 1920; Protrelloides Chitwood, 1932; Protrellata Chitwood, 1932; Napolitana Kloss, 1959a and Protrellatus Farooqui, 1970.

In the present study, Protrelloididae is accepted as a distinct family under the superfamily Thelastomatoidea. During the present investigation of insects, several worms were collected from the house cricket, Gryllus domesticus from SiddharthNagar (North India). The worms were found to represent the genus
Protrellatus, but could not be fitted in the known species of Protrellatus and hence regarded as a new species and described as *P. siddharthi* n. sp. Due to the addition of this species, the diagnosis of the family as well as the genus required certain modifications and therefore emended diagnosis is provided.

**Diagnosis (emended):**

Cuticle without spines. Mouth may or may not be surrounded by trilobed circumoral elevation. Anterior region may or may not possess fine transverse striations. Esophagus consisting of corpus which is clavate or cylindrical, isthmus distinct or indistinct and a posterior valvular bulb. Vulva anterior to base of esophagus. 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 posterior to anus with long appendage or short and bluntly rounded or subconical. Caudal papillae three to eight pairs or completely absent. Spicule single or absent.
GENUS: PROTRELLATUS FAROOQUI, 1970

The genus Protrellatus with the type species P. alii was established by Farooqui (1970) to accommodate worms recovered from common house cricket, Gryllus domesticus from Maharashtra, India. Another species was described under this genus by Sharma and Gupta (1983 a) namely, P. striati from Bareilly, India. During the present investigations of insects for parasitic infections, several nematodes were recovered with quite distinct characteristics and hence regarded as a new species and described as P. siddharthi n. sp. The total number of species in this genus is three. The diagnosis of the genus is emended to accommodate the new species.

Diagnosis (emended):


Male: Cephalic extremity formed by single annule.
Corpus clavate, isthmus indistinct. Caudal extremity narrowing posterior to anus with a long caudal appendage. Spicule single. Caudal papillae four to eight pairs.

**PROTRELLATUS SIDDHARTHI N. SP.**

**Dimensions:**

**Holotype female:** $L = 7.8 \text{ mm}$; $a = 20$; $b = 11.62$; $c = 18.13$; $V = 2.11$; Esophagus = 0.671 mm; Tail = 0.43 mm; Egg = 118 x 44 µm.

**Paratype females (n = 10):** $L = 5.4 - 8.3$ (7.13 ± 0.29) mm; $a = 16.36 - 21.11$ (19.18 ± 0.52); $b = 8.54 - 13.22$ (11.29 ± 0.5); $c = 15.83 - 22.63$ (18.61 ± 0.9); $V = 1.6 - 2.77$ (2.13 ± 0.12); Esophagus = 0.591 - 0.671 (0.64 ± 0.03) mm; Tail = 0.33 - 0.48 (0.40 ± 0.02) mm; Egg = 115 - 118 x 40 - 48 µm.

**Paratype male (n = 1):** $L = 1.20$ mm; $a = 20$, $b = 9.05$, $c = 6.15$; Esophagus = 0.133 mm; Tail = 0.195 mm; Spicule = 25 µm.

**Description:**

**Female:** The females very long compared to males and exhibit a marked sexual dimorphism. Slightly curved
upon fixation. The head end is markedly expanded at the opening of the vulva, just behind the vulva, a constriction marks off the head distinctly from the rest of the esophageal region. The body gradually expands and reaches its maximum width in the posterior third of body. Cuticle finely striated in the anterior region, striae, 4-8 μm apart, rest of the cuticle is smooth. Mouth surrounded by four pairs of papillae and a pair of laterally situated amphids. Mouth leads into a small buccal cavity, 14-21 μm. Esophageal corpus cylindrical, 0.514 - 0.577 mm long, 40 - 46 μm wide; isthmus is a constriction between corpus and bulb. Endbulb ovate, 90 - 99 μm. Nerve ring at 0.107 - 0.110 mm and excretory pore at 0.114 - 0.130 mm from anterior end. Cardia distinct.

Vulva opens at the level of nerve ring and surrounded by thick protruding lips. Eggs elliptical, more broad at one side and possess longitudinal crest. Tail tapering slowly to a rounded tip and possess two small triangular cuticular projections.

**Male:** Worm small, ventrally curved upon fixation. The head is not marked off, both the ends are attenuated, the posterior being more sharply conical and pointed. Mouth surrounded by four pairs of papillae and a pair of laterally situated amphids. Buccal cavity small, 7
μm wide. Esophageal corpus not uniform in diameter, being broader in the middle, 0.100 mm long, 12 - 20 μm wide in the middle and 10-15 μm wide at anterior and posterior ends. Isthmus indistinct. Endbulb ovate, 33 μm long. Nerve ring at 52 μm from anterior end.

Testis single, reflexed at the tip, lies in the posterior third of body. Tail, long and filiform. Spicule single. Caudal papillae four pairs: two pairs preanal and two pairs postanal.

**Type host:** Gryllus domesticus (House cricket)

**Habitat:** Midgut

**Locality:** SiddharthNagar (North India)

**Type material:** Holotype female on slide Protrellatus siddharthi n.sp./1; paratype females on slides P. siddharthi n.sp./ 2-11; paratype male on slide P. siddharthi n. sp./12, deposited in the Nematode Collection of the Department of Zoology, Aligarh Muslim University, Aligarh.

**Diagnosis and Relationships:**

*Protrellatus siddharthi* n. sp. is characterized by the presence of finely striated cuticle in the anterior most region, smaller head and buccal cavity, tail slowly tapering to a rounded tip in females; longer male with small spicule, four pairs of caudal
papillae and filiform tail. It is closely related to *P. alii* Farooqui, 1970 in having anterior end including vulva, set-off from the body, indistinct isthmus, vulva very close to the head end, eggs with longitudinal crest, worms showing sexual dimorphism, but differs from it in the size of male, size of spicule, shape of the tail, number and arrangement of caudal papillae, females with striations in the anterior region, smaller head and eggs, shape of the tail (male = 0.79-1.18 mm, spicule = 26-29 μm, tail attenuated, caudal papillae eight pairs; female cuticle smooth, head = 30-60 μm, eggs = 124 μm, tail abruptly rounded in *P. alii*). It resembles, *P. striati* Sharma and Gupta, 1983a in the presence of striations in the anterior region and length of females. However, it differs from it in the size of eggs and the values of a, b, c and position of vulva (eggs = 125 - 127 x 70 - 72 μm, a = 17.7 - 19.04; b = 12.0 - 12.7, c = 22.3 - 25.6; V = 1.5 - 1.8 in *P. striati*).

**Key to the species of the genus *Protrellatus***

1 - Female cuticle smooth

-------- alii Farooqui, 1970

2 - Female cuticle finely striated in the anterior region

-------- 2

111
2 - Vulval % 1.5-1.8.
Eggs = 125-127 \mu m

\textit{striati} Sharma & Gupta 1983a

- Vulval % 1.6-2.77.
Eggs = 115-118 \mu m

\textit{siddharthi} n. sp.
### TABLE 5

**COMPARATIVE MEASUREMENT CHART OF THE SPECIES OF PROTRELLATUS.**

<table>
<thead>
<tr>
<th>CHARACTERS</th>
<th><em>P. alii</em> (mm)</th>
<th><em>P. striati</em> (mm)</th>
<th><em>P. siddharthi</em> n. sp. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>5.49 - 9.52</td>
<td>8.4 - 8.5</td>
<td>5.4 - 8.3</td>
</tr>
<tr>
<td>Width</td>
<td>0.34 - 0.53</td>
<td>0.44 - 0.48</td>
<td>0.28 - 0.42</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.61 - 0.66</td>
<td>-</td>
<td>0.591 - 0.676</td>
</tr>
<tr>
<td>Tail</td>
<td>-</td>
<td>0.33 - 0.38</td>
<td>0.33 - 0.48</td>
</tr>
<tr>
<td>Vulva</td>
<td>0.11 - 0.25</td>
<td>0.12 - 0.15</td>
<td>0.12 - 0.18</td>
</tr>
<tr>
<td>Egg</td>
<td>124 - 64 μm</td>
<td>125 - 127 μm</td>
<td>115 - 118 μm</td>
</tr>
<tr>
<td>a</td>
<td>-</td>
<td>17.7 - 19.04</td>
<td>16.36 - 21.11</td>
</tr>
<tr>
<td>b</td>
<td>-</td>
<td>12.0 - 12.7</td>
<td>8.54 - 13.22</td>
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<tr>
<td>c</td>
<td>-</td>
<td>22.3 - 25.6</td>
<td>15.83 - 22.6</td>
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<tr>
<td>V</td>
<td>-</td>
<td>1.5 - 1.8</td>
<td>1.6 - 2.7</td>
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<tr>
<td><strong>MALE</strong></td>
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<td></td>
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</tr>
<tr>
<td>Length</td>
<td>0.79 - 1.18</td>
<td>Unknown</td>
<td>1.2</td>
</tr>
<tr>
<td>Width</td>
<td>0.06</td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>Esophagus</td>
<td>0.14 - 0.2</td>
<td></td>
<td>0.133</td>
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<tr>
<td>Tail</td>
<td>0.17 - 0.23</td>
<td></td>
<td>0.195</td>
</tr>
<tr>
<td>Spicule</td>
<td>26 - 29 μm</td>
<td></td>
<td>25 μm</td>
</tr>
<tr>
<td>Caudal papillae</td>
<td>8 pairs</td>
<td></td>
<td>4 pairs</td>
</tr>
</tbody>
</table>
**LIST OF INSECT HOSTS FOUND INFESTED WITH NEMATODE PARASITES**

<table>
<thead>
<tr>
<th>Class</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>Parasite described</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecta</td>
<td>Gryllidae</td>
<td>Gryllotalpa</td>
<td>africana</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1. Binema mirzaia</td>
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<td></td>
<td></td>
<td></td>
<td>2. B. adamsii n. sp.</td>
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<td>3. Cameronia aspiculata</td>
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<td>4. C. basiri n.sp.</td>
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<td></td>
<td></td>
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<td>5. Chitwoodiella ovofilamenta</td>
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<td>6. C. tridentata n. sp.</td>
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<td>7. Gryllophila nihali n. sp.</td>
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<td></td>
<td></td>
<td></td>
<td>8. Isobinema flagellocerca</td>
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<td></td>
<td></td>
<td></td>
<td>9. Mirzaiella alii</td>
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<td></td>
<td></td>
<td></td>
<td>10. M. haroldi</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>11. M. asiatica</td>
</tr>
</tbody>
</table>

**Genus** : Gryllus  
**Species** : domesticus  
**Family** : Blattidae  
**Genus** : Periplaneta
Species : *americana*  
Genus : *Blatta*

Species : *orientalis*  
Genus : *Blatella*

Species : *germanica*  
Genus : *Blatticola blattae*
CONCLUSIONS
CONCLUSIONS

During the investigations of various insect hosts from February, 1994 to December, 1996, for the parasitic infection by the members of the superfamily Thelastomatoidea, following conclusions were drawn:

1 - The investigation of parasitic infection in various insect hosts revealed that they are generally parasitized by three families of the superfamily Thelastomatoidea, viz. Thelastomatidae, Chitwoodiellidae and Protrelloididae.

2 - The members of the above three families are parasitic in five species of insects, viz. Gryllotalpa africana, Periplaneta americana, Blatta orientalis, Blatella germanica and Gryllus domesticus, in the Northern part of India viz. Aligarh (West U.P.) and Siddharth Nagar (East U.P.).

3 - The rate of infection was highest in mole cricket, Gryllotalpa africana (Gryllidae). It harboured species of nematodes representing 6 genera and 11 species out of which 7 species are known and 4 are new to science. American cockroach, Periplaneta americana harboured two species of
nematodes representing two genera. Lowest rate of infection were found in German cockroaches, *Blatta orientalis* and *Blatella germanica*, which were infected with single species. *Gryllus domesticus* was to found to harbour single new species.

4 - The members of the family Thelastomatidae have the wide host distribution. They occur in *Gryllotalpa africana*, *Periplaneta americana*, *Blatta orientalis* and *Blatella germanica*. The members of the family Chitwoodiellidae are highly host-specific and were found in single host species viz. *Gryllotalpa africana*. The members of the family Protrelloididae though reported from three species of insects, were found to occur only in *Gryllus domesticus*, during the present study.

5 - The worm burden of various species of insects were different and as follows: Single specimen of *Gryllotalpa africana* was found to harbour about 10-20 nematodes and most of the time, with mixed population. Single specimen of *Periplaneta americana* harboured about 5-10 nematodes representing single genus. Whereas single specimen of *Blatella germanica* was found to harbour 5-15 nematodes belonging to single genus.
Blatta orientalis (single specimen) harboured, 5 - 10 nematode representing single genus, however the worm burden of Gryllus domesticus was very low i.e. not exceeding 4 in number representing single genus.

6 - The worm burden in various insects was found to be regulated by environmental temperature and humidity. At extreme temperatures (severe cold or severe heat and low humidity) the worm burden was low as compared to normal temperatures and the activity of the nematodes were also low at extreme temperatures.

7 - Total number of species recovered are 16 representing 10 known genera, 5 new species and 11 known species. Among the known species, 4 are reported for the first time from North India.

8 - Lastly, it may be concluded that the incidence of nematode parasitism is low in insects of Aligarh and SiddharthNagar (Uttar Pradesh), North India.
FIGURES
Fig. 1 (A-D) : *Blatticola blattae*

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.

Fig. 1 (E-H) : *Cameronia aspiculata*

E - Female Anterior end.
F - Female Head end
G - Female Posterior end.
H - Egg.
Fig. 1.
Fig. 2: *Cameronia basiri* n. sp.

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
Fig. 2.
Fig. 3: *Gryllophila nihali* n. sp.

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
H - Spicule.
Fig. 3
Fig. 4: *Hammerschmidtella diesingi*

A - Female Anterior end.
B - Female Head end
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Posterior end.
Fig. 4.
Fig. 5: SEM Micrographs of Female *H. diesingi*

A - Anterior end.
B - *En face*
C - Lateral alae
D - Vulval region
Fig. 5.
Fig. 6: *Leidynema periplaneti*

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
Fig. 7: *Leidynema appendiculatum*

A - Female Anterior end.
B - Female Head end.
C - Vulval region.
D - Female Posterior end.
E - Egg.
F - Male Anterior end.
G - Male Head end.
H - Male Posterior end.
I - Spicule.
Fig. 7.
Fig. 8: SEM Micrographs of Female *L. appendiculatum*

A - Anterior end.
B - *En face*
C - Vulval region.
D - Posterior end.
Fig. 8.
Fig. 9: *Binema mirzaia*

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
H - Spicule.
Fig. 10: *Binema adamsii* n. sp.

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
H - Spicule.
Fig. 11: *Chitwoodiella ovofilamenta*

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
Fig. 11.
Fig. 12: *Chitwoodiella tridentata* n. sp.

A - Female Anterior end.
B - Female Head end.
C - Female Buccal cavity (Posterior Part).
D - Vulval region.
E - Female Posterior end.
F - Egg.
G - Male Anterior end.
H - Male Head end.
I - Male Posterior end.
Fig. 13 (A-D): *Isobinema flagellocerca*

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.

Fig. 13 (E-H): *Mirziella asiatica*

E - Female Anterior end.
F - Female Head end.
G - Female Posterior end.
H - Egg.
Fig. 14: *Mirzaiella alii*

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
Fig. 14.
Fig. 15: *Mirzaiella haroldi*.

A - Female Anterior end.
B - Female Head end.
C - Female Posterior end.
D - Egg.
E - Male Anterior end.
F - Male Head end.
G - Male Posterior end.
Fig. 16: *Protrellatus siddharthi* n. sp.

A - Female Anterior end.
B - Female Head end.
C - Vulval region
D - Female Posterior end.
E - Egg.
F - Male Anterior end.
G - Male Head end.
H - Male Posterior end.
I - Male Anal region.
J - Spicule.