

STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA

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By

SANTHOSH. P. P

Under the Guidance of

Dr. MARY ANITHALATHA SADANANDAN



**PG & RESEARCH DEPARTMENT OF ZOOLOGY
MALABAR CHRISTIAN COLLEGE
CALICUT
UNIVERSITY OF CALICUT
JUNE 2017**

**PG & RESEARCH DEPARTMENT OF ZOOLOGY
MALABAR CHRISTIAN COLLEGE
CALICUT, KERALA**

Dr. Mary Anithalatha Sadanandan
Associate Professor & Head (Rtd.)



33/4176 "Leyah"
East Malaparamba,
Malaparamba. PO,
Kozhikode.09
Kerala

Phone off: 0495 2765679
Res : 0495 2370264
Mob : 09495 890076
e-mail: manithals@yahoo.co.in

Date: 15.06.2017

CERTIFICATE

This is to certify that this thesis entitled "**STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA**" is an authentic record of the work done by **Mr. SANTHOSH.P.P**, under my supervision and guidance in partial fulfillment of requirements of the Degree of Doctor of Philosophy in Zoology, under the Faculty of Science of the University of Calicut. No part of this thesis has been presented before for the award of any other degree.

Dr. Mary Anithalatha Sadanandan

**PG & RESEARCH DEPARTMENT OF ZOOLOGY
MALABAR CHRISTIAN COLLEGE
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Dr. Mary Anithalatha Sadanandan
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Kerala

Phone off: 0495 2765679
Res : 0495 2370264
Mob : 09495 890076
e-mail: manithals@yahoo.co.in

Date: 29.06.2018

CERTIFICATE

This is to certify that all the corrections /suggestions from the adjudicators have been incorporated in the copies of the Ph.D thesis submitted by **Mr. Santhosh .P.P** entitled "**STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA**"

Calicut

Dr. Mary Anithalatha Sadanandan

DECLARATION

I, **SANTHOSH.P.P.**, hereby declare that this thesis entitled “**STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA**” is an authentic record of the work carried out by me under the supervision and guidance of **Dr. Mary Anithalatha Sadanandan**, Associate Professor & Head (Rtd.), P G & Research Department of Zoology, Malabar Christian College, Calicut and that no part of this has been published previously or submitted for the award of any degree, diploma, title or recognition before.

Calicut

SANTHOSH. P.P

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PART I

TAXONOMY

INTRODUCTION

Mites are tiny microscopic organisms belonging to the class Arachnida of the phylum Arthropoda. They are biologically the most diverse and dominant groups which are worldwide in distribution (Chillar *et al.*, 2007). There are about 50,000 mite species known today, but estimations of its real number will be 20 times higher (Krantz and Walter, 2009). Because of their minute size and obscure nature, generally they are overlooked and the damage symptoms induced by them are assessed based on their feeding response. They possess a supreme adaptability to survive in totally diverse ecological conditions like benthic zones of oceans, freezing temperatures of arctic, warm waters of thermal springs and even hostile conditions of caves. Many of them have complex symbiotic relationships with other organisms on which they live. Mites may be classified as phytophagous, predatory, parasitic, saprophytic or mycophagous based on their feeding behavior. A large number of mites have been recognized as serious pests of medicinal plants, agricultural crops, stored products and even cause diseases to man and his livestock.

The important phytophagous groups of mites recognized so far generally belong to the families Tetranychidae, Tenuipalpidae, Tarsonemidae and Eriophyidae which are of great economic importance by virtue of the various types of damages caused by them leading to heavy yield loss. Phytophagous mites suck the plant sap with the help of their needle like

cheliceral stylets, modify the developing tissues and inject toxins to induce galls. Their feeding habits results in speckling, stippling, bronzing or blotching of leaves which leads to leaf fall, premature flower and fruit drops, thus affecting quality and quantity of products (Jeppson *et al.*, 1975; Evans,1992).

An understanding of the positive role of mites in areas of research like the maintenance of soil fertility, biological control of pests and bioindication of environmental conditions marked a turning point in the history of Acarology. Predatory mites deserve special mention in an agricultural country like India, where agriculture is always under the threat of constant pest attack.

Predatory mites constitute a highly significant beneficial group on account of their vital role in the maintenance of pests below economic injury level. Predatory mites have received considerable recognition globally owing to their potential as biocontrol agents of phytophagous mites, and more recently of insect pests like thrips, aphids, scale insects and mealy bug etc. The predatory role has been attributed to various mite families like Phytoseiidae, Ascidae, Blattisociidae, Bdellidae, Cunaxidae, Cheyletidae, Stigmaeidae, Erythraeidae, Tydeidae, Anystidae and so on. Predatory mites are a natural and common component of all healthy gardens often named as body guards of plants (Dicke and Sabelis, 1988).

Predatory mites of the family Hemisarcoptidae are well known for the control of armoured scale insects. Water mites, *Piona nodata* and *Thyas barbigera* are known to control mosquito larvae. Members of families

Podopodidae and Trombidiidae are predators of grass hoppers and locusts. Mites belonging to suborders Astigmata, Cryptostigmata, Mesostigmata and Prostigmata feed on nematode pests thereby exerting an effective control on their population density. A galumnoid mite, *Orthogalumna terrebrantis* is used to control the notorious aquatic weed *Eichhornia crassipes*.

Among the predatory mites, the species of Phytoseiidae are potentially important as a biotic factor in the control of phytophagous mites (McMurtry and Croft, 1997). They are efficient predators than other predatory mite families because of their shorter life cycles than the prey they feed upon, high range of reproductive potentiality, good searching capacity, ability to survive on a low prey density and their capacity to survive by feeding on alternate food like plant saps, nectar and honey dew. Mass multiplication methods have been developed to use these predators in commercial scale on a variety of crops (Lo *et al.*, 1979; Krishnamoorthy, 1982). *Pytoseiulus persimilis* is a specialist mite that controls webspining mites such as the two spotted spider mites, *Tetranychus urticae* Koch. Nowadays many species of predatory mites are commercially available. *Galendromus occidentalis*, *Neoseiulus californicus* and *Amblyseius fallacis* are some examples.

The present work is mainly focused on the taxonomy of predatory mites inhabiting medicinal plants. Medicinal plants which once grew in the wild are now being cultivated, so that they can be utilized in the pharmaceutical industry. The flora of the world contributes in a major way to the maintenance of human health. Plants and plant extracts are used for medicinal purposes by 75% of the people all over the world. Twenty five percentage of the total drugs in a developed country like USA are plant based

and in developing countries like India and China the number of drugs made from plant resources goes up to 80% of the total drugs. There are 2, 50,000 higher plant species on the earth. Out of these the number of medicinal plants is more than 80,000 of which, 15,000-20,000 plants are of high medicinal value. Traditional systems of medicine in India like Unani and Ayurveda have been using drugs of herbal origin for thousands of years. Hence India is a rich repository of medicinal plants. The utilization of medicinal plants is a facet of the local culture of a region. The cultivation and preservation of medicinal plants goes a long way towards safeguarding the biodiversity of a land.

However, like other crops, medicinal plants too are prone to the attacks of pest mites. Primary method used to control pest is by the application of synthetic pesticides. Nowadays the issue of pest control is becoming more and more problematic in various ways. One of these is the development of pesticide resistance in pests. Consequently the growers tend to increase the usage of pesticides. This results in pesticide contamination in the harvested medicinal plants. Therefore, it is in the interest of all that the different plant species are protected using natural methods with biological agents like predatory mites instead of chemical pesticides so as to promote healthy medicinal practices.

Despite the rich diversity of predatory mites in the Indian subcontinent, very little work has been carried out on the biosystematics of these mites in South India especially in Kerala. Hence the present study includes a detailed survey of predatory mites of different families inhabiting medicinal plants

from various localities in 6 districts of North Kerala, their systematic aspects and also the feeding and breeding biology of a representative species.

Objectives of the study

- To study species diversity of acarine predators inhabiting medicinal plants of North Kerala.
- To record the systematics of the recovered acarine predators of different families with keys.
- To elucidate the feeding potential and breeding biology of some of the species under natural and experimental conditions.
- To observe the predatory potential of some of the selected species under experimental condition.
- To record observation regarding host plants and site specificity of predatory mites.

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REVIEW OF LITERATURE

Family: ASCIDAE Voigts and Oudemans, 1905

Ascid mites are generally found to inhabit soil, leaf litter, green plants, bee-hives, and are often associated with other animals. They found on various biocenoses and microhabitat, constitute an important group of predators, but can also feed on fungal mycelium. The taxonomy of ascid mites passed through great transformation in the last century. The most known representatives of this family viz., *Asca aphidioides* (Linnaeus, 1758a) and *Asca bicornis* (Canestirini and Fanzago, 1878) were reported in 19th century. The family Ascidae was erected by Voigts and Oudemans (1905). They proposed the subfamily Ascinae and included the genus *Asca* in it without giving any diagnosis of the group. Oudemans (1905) also described some species mainly under the genera *Arctoseius*, *Cheiroseius*, *Leioseius* and *Platyseius*. Willmann (1938) reported the first information on ascid mites from Slovakia. Baker and Wharton (1952) erected and established a new family, Aceosejidae for the former erected representatives of Ascidae. A revision of the British Aceosejinae was done by Evans (1958).

Bregetova (1977) elaborated the taxonomy and prepared the identification keys of Aceosejidae from the former Soviet Union. Walter *et al.*, (1993) reviewed the genus *Asca* from Australia, with descriptions of 3 new leaf-inhabiting species. Karg (1965, 1993) and Walter and Lindquist (1997) contributed many species from different parts of the countries. Lindquist and Evans (1965) made the first morphological analysis of Ascidae, divided it into 3 subfamilies viz., Arctoseiinae, Ascinae and

Melicharini. Karg (1965) not agreed the classification proposed by Lindquist and Evans (1965). The same author (1993) classified the families and superfamilies of the order Mesostigmata based on the synapomorphies as proposed by Henning (1950). Halliday *et al.* (1998) revised the Australian species of Ascidae, suggested a complex family level classification based on the information on leg chaetotaxy of Evans (1963) and wider sets of other characters. Chinniah and Mohanasundaram (1995) recorded some new species of ascid mites infesting insects from Tamil Nadu. Bhattacharyya (1966) described 4 species of ascid mites under the genus *Asca*. The same author (1968) contributed descriptions of 9 new species and 6 new records.

Yi-Hsiung Tseng (1981) described and illustrated 12 species under the genus *Asca* from Taiwan including 5 new species. Later Bhattacharyya *et al.*, (1997, 1998) Bhattacharyya and Sanyal (2003), Bhattacharyya and Bhattacharyya (2004) described many species under the genera *Antennoseius*, *Cheiroseius*, *Lasioseius* and *Asca* from different regions of North India under different habitat. Walter (2003) described 3 new species under the genus *Gamaselloides* from Australia. Kaluz and Fenda (2005) published an elaborated study on ascid mites of Slovakia, recorded 35 species from the Slovak territory under the genera *Arctoseius*, *Asca*, *Cheiroseius*, *Iphidozercon*, *Leioseius*, *Platyseius*, *Plesioseius* and *Zerconopsis*. Christian and Karg (2008) prepared a revised nomenclature based on ontogenetic and phylogenetic characters universally applicable to the idiosoma of Gamasina. Fenda and Kaluz (2009) studied the distribution and ecology of the ascid mites in Slovakia.

Until the year 2009, all the ascid mites described were actually included in a single family called Ascidae. A major change in the taxonomy of Ascidae was done by Lindquist *et al.* (2009). They classified Ascidae into

3 families, viz., Ascidae Voigts and Oudemans, Blattisociidae Garman and Melicharidae Hirschmann. The family Ascidae included following genera viz., *Anephiasca* Athias-Henriot, *Antennoseius* Berlese, *Anystipalpus* Berlese, *Arctoseiodes* Willmann, *Arctoseius* Thor, *Asca* von Heyden, *Athiashenriotis* Özdikmen, *Ectoantennoseius* Walter, *Gamasellodes* Athias-Henriot, *Iphidonopsis* Gwiazdowicz, *Iphidozercon* Berlese, *Leioseius* Berlese, *Maxinia* Lindquist and Makarova, *Neojordensia* Evans, *Protogamasellus* Karg, *Xenoseius* Lindquist and Evans and *Zerconopsis* Hull. Lindquist and Makarova (2012) redefined the subfamily Arctoseiinae of the family Ascidae and described a new genus, *Maxinia* based on a new species, *Maxinia arctomontana*. Kazemi and Rajaei (2013) published an annotated checklist of Iranian species. Moraes *et al.* (2016) published a catalogue containing 372 valid species of ascid mites under 17 genera.

Family: BLATTISOCIIDAE Garman, 1948

Works on the taxonomy of Blattisociidae is scattered over hundreds of publications and the concepts of genera and families have been revised many times based on the morphological features. Baker and Wharton (1952) provided an important contribution for the understanding of ascid complex by the establishment of the family Aceosejidae with *Aceosejus* Sellnick as the type genus. Evans (1957) modified the concept of Mesostigmata and placed the genus *Blattisocius* in the family Aceosejidae. Evans (1958), Evans and Hyatt (1960) divided the family Aceosejidae into 2 subfamilies viz., Blattisociinae and Platyseiiinae and keyed the genera that included in each. Chant (1963) studied the genera and species of the subfamily Blattisociinae occur in North America with description of many new species.

Until 2009, the family Blattisociidae was included in the family Ascidae because of their many external morphological similarities (Lindquist

and Chant 1964). Lindquist and Evans (1965) made the first attempt to revise the family Ascidae based on the detailed morphological analysis. They recognized 22 genera and 3 tribes under 3 subfamilies viz., Arctoseiinae, Ascinae and Platyseiinae. Athias- Henriot (1968) proposed the importance of the spermathecal structures in the classification of mesostigmatid mites. Karg (1965, 1971, 1993) proposed an alternative system for the classification of Mesostigmata that was radically differed from the system used by majority of the workers. Halliday *et al.*, (1998) updated the supraspecific classification system of Lindquist and Evans, 1965 and provided a key to the genera of the family Ascidae. Through a series of papers, Bhattacharyya (1968, 1969a, 1972, and 1978), Bhattacharyya *et al.* (2000), Bhattacharyya and Bhattacharyya (2001) Bhattacharyya and Sanyal (2002) contributed more information to the knowledge of Blattisociidae from India. Gupta (2003) in his monograph reported many species under the genera *Blattisocius*, *Gamasellodes*, *Lasioseius*, *Melichares* and *Proctolaelaps*.

Until recently, Lindquist *et al.* (2009) made a major change in the suprageneric level of the family Ascidae proposed 3 separate families viz., Ascidae Voigts and Oudemans, Blattisociidae Garman and Melicharidae Hirschmann under the superfamily Phytoseioidea and Ascoidea based on the spermathecal structures (Alberti 2002, Alberti and Di Palma, 2002) as well as the reconsideration of their external morphology. They also modified the concepts of superfamilies Ascoidea and Phytoseioidea given by Krantz (1978) by placing the Ascidae and Melicharidae into the Ascoidea and the Blattisociidae to the Phytoseioidea.

According to Lindquist *et al.*, (2009) the family Blattisociidae included the following genera viz., *Aceodromus* Muma, *Adhaerenseius* Loots and Theron, *Arrhenoseius* Walter and Lindquist, *Blattisocius* Keegan,

Cheiroseius Evans and Baker, *Cheiroseius* Berlese, *Discoseius* Lindquist and Moraza, *Fungiseius* Moraza and Lindquist, *Hoploseius* Berlese, *Krantzoseius* Seeman, *Lasioseius* Berlese, *Opilloseius* Lindquist and Moraza, *Platyseius* Berlese and *Zercoeseius* Berlese. Britto *et al.* (2011, 2012) made comprehensive study by preparing key to the world species and new species from Brazil. Lindquist and Moraza (2010, 2012) revised the diagnosis of Blattisociidae, provided an updated key to the genera, subfamilies and also added description of two genera viz., *Opilloseius* and *Discoseius*. Nemati *et al.*, (2012) published a catalogue of Iranian blattisociid mites including 6 genera and 29 species. Lindquist and Moraza (2016) described a new genus *Calyptoseius* of the subfamily Platyseiinae from lowland rain forests of Costa Rica. Moraes *et al.* (2016) made an excellent contribution by preparing a worldwide catalogue of Blattisociidae, reported 367 species distributed under 14 genera.

Family: PHYTOSEIIDAE Berlese, 1952

Phytoseiid mites are main predators of plant feeding mites and small soft bodied insects like scales, thrips, aphids, whiteflies and their eggs. The earliest phytoseiid mite was described by Koch in 1839 (Chant, 1989) viz., *Zercon obtusus* as the type species. Berlese (1913) erected the family Phytoseiidae. Later, he (1914) designated *Zercon obtusus* Koch as the type species of *Amblyseius*, based on the material collected by him in 1882. Berlese (1916) proposed the subfamily Phytoseiinae under the family Laelaptidae including five genera viz., *Podocinum*, *Ameroseius*, *Amblyseius*, *Epicroseiopsis*, and *Iphidozercon*. Vitzthum (1941) revised the family Laelaptidae into subfamily Laelaptidae by including 7 genera under this subfamily. Garman (1948) provided the diagnostic features for the identification of the family based on the type, number and distribution of

setae on the dorsal shield, size and shape of female anal plate etc. First critical review of the subfamily Laelaptidae was done by Nesbitt (1951), and he revised the subfamily into family Laelaptidae. Based on the review, 7 genera were recognised viz., *Amblyseius* Berlese, *Typhlodromus* Scheuten, *Blattisocius* Keegan, *Klemania* Oudemans, *Phytoseius* Ribaga, *Kampimodromous* Nesbitt and *Garmania* Nesbitt. Since then the taxonomy of phytoseiids have advanced relatively fast with several additions, various opinions and disagreements on the system of classification. Baker and Wharton (1952) divided family Laelaptidae in to two subfamilies viz., Phytoseiinae including 12 genera and Podoscinae comprising 10 genera.

Chant (1959a) made taxonomic review of the family Phytoseiidae with descriptions of 38 new species, based on the chaetotaxy of dorsal shield, shape of ventrianal shield etc. The same author (1959b) classified Phytoseiidae and proposed two subfamilies viz., Macroseiinae with one genus *Macroseius* and Phytoseiinae with 8 genera viz., *Phytoseius*, *Phytoseiulus*, *Typhlodromus*, *Iphiseius*, *Asperoseius*, *Seiulus*, *Proprioseius* and *Typhloseius*. Athias –Henriot (1960), Karg (1961), Muma (1961), Hirschmann (1962), Schuster and Pritchard (1963) made remarkable contributions to the taxonomy of family Phytoseiidae. Muma and Denmark (1962) discussed the systematic problem of intraspecific variation. Chant (1965) identified three subfamilies viz., Amblyseiinae, Phytoseiinae and Macroseiinae with a total of 28 genera under this family from Florida. Ehara (1966) published a tentative catalogue of predatory mites of Phytoseiidae known from Asia with descriptions of 5 new species from Japan. While reviewing some works on mites of economic importance, Ghai (1964) listed 17 species of phytoseiid mites from India. Later she (1965) again recorded 35 species of phytoseiid mites from India under 10 genera.

A key for Indian Phytoseiidae was first made by Ghai and Menon (1967). They described 16 species of phytoseiid mites under the genus *Amblyseius* including 7 new species. The same authors (1969) erected two genera viz., *Indoseiulus* and *Indodromus*. Gupta (1969a, 1969b, 1969c, 1970a, 1970b, 1978, 1980a, 1980b, 1981, 1986) through a series of papers contributed many new species and new records from India and neighbouring countries. Two new species of phytoseiid mites under the genera, *Amblyseius* and *Phytoseius* were made by Battacharya (1969b). Wainstein (1972), Prasad (1974), Chaudhari (1974) contributed several new species. Chant *et al.* (1978) proposed a new classification based on the numerical taxonomy of the family recognized 2 subfamilies, Otopheidomeninae with 4 genera and Phytoseiinae with 5 tribes viz., Phytoseiini, Typhlodromini, Amblyseiini, Macroseiini and Chantiini. Rowell *et al.* (1978) proposed a widely acceptable diagnostic characters for the family Phytoseiidae based on the setal homologies and setal pattern of dorsal shield. Chaudhari *et al.* (1979) erected the subfamily Gnoriminae viz., *Demarkia*, *Ansaria*, *Amathia* and *Kashmerius*.

Moraes *et al.* (1986) published a catalogue of the mite family Phytoseiidae with reference to taxonomy, synonymy, distribution and habitat. Denmark and Muma (1989) made a revision of the genus *Amblyseius*. Chant and Yoshida-Shaul (1992) revised the tribe phytoseiini and added the adult ventral and idiosomal setal patterns for better identification. Denmark (1992) revised the genus *Typhlodromus*. Chant and McMurtry (1994) recognized 3 subfamilies in the family Phytoseiidae viz., Phytoseiinae, Amblyseiinae and Typhlodrominae, 15 tribes, 9 subtribes, 84 genera and 8 subgenera. Ehara and Amano (1998) revised the family Phytoseiidae with 77 species under 3 subfamilies, 5 tribes, 9 genera, and 11 subgenera from Japan.

Gupta and Arun Gupta (1999), Gupta (2003), Gupta *et al.* (2004) continued his contributions to Indian Phytoseiidae through several publications, reviews and monographs. Chinniah and Mohanasundaram (2001a) reported 5 new species of predatory mites from Kerala. Denmark and Welbourn (2002) revised the genera *Amblydromella* and *Anthoseius*. The work of Chant and McMurtry (2003, 2004) is of particular significance as these include several revisionary works on the subfamily Amblyseiinae. They recorded 1499 normal species, almost all of them were exclusively plant inhabiting from different parts of the world. They proposed 61 genera under 9 subtribes in 9 tribes, of which Afroseiulini, Euseiini, Neoseiulini, Phytoseiulini and Typhlodromipsini were newly erected. Several subgenera were raised to genera and new combinations were recommended for the species under them. They also provided diagnosis and key to the constituent tribes. Moraes *et al.* (2004) published a revised catalogue of the family Phytoseiidae which includes 2250 species. Mary Anitha (2005, 2006a, 2006b) and Mary Anitha and Ramani (2007) made significant contributions to the phytoseiid fauna of Kerala. Chant and McMurtry (2005) reviewed the subfamily Amblyseiinae recommended the tribe Euseiini, subtribes Typhlodromalina, Euseiina and Ricoseiina. Chant and McMurtry (2006 a, 2006b,) made a critical review of the subfamily Amblyseiinae and recognized 9 tribes. Moraes *et al.* (2006) reported 24 phytoseiid species under the subtribe Typhlodromalina from sub-Saharan Africa. Chant and McMurtry (2007) published the illustrated keys and diagnostic characters for the genera and subgenera of the family Phytoseiidae of the world and listed about 2,300 species under 84 genera. Roy *et al.* (2008) described a new species and a new record of phytoseiid mite infesting medicinal plants from West Bengal. Kreiter *et al.* (2010) published a catalogue, biogeography and

key for the identification of Tunisian phytoseiid mite population, reported 27 species belonging to 14 genera. Wu *et al.* (2010) reviewed the research on the systematics of the family Phytoseiidae from china and provided an updated checklist of 304 species.

Gupta and Karmakar (2011) published a paper on diversity of mites (Acari) on medicinal and aromatic plants from India reported 56 species of predatory mites under 24 genera. Ryu and Seo (2011) made a taxonomic review of the subfamily Typhlodrominae from Korea reported 8 new species under 4 genera viz., *Kuzinellus*, *Paraseiulus*, *Galendromus* and *Typhlodromus*. Prasad (2012) published a checklist of Phytoseiidae of the world with 2,692 species distributed over 102 genera and 3 subfamilies including synonyms. Sajna and Mary Anitha (2013) made a survey on economically important plants of North Kerala reported 15 species of phytoseiid mites belonging to 6 genera viz., *Amblyseius*, *Euseius*, *Typhlodromips*, *Neoseiulus*, *Phytoseius* and *Paraphytoseius*. Demite *et al.* (2014) published an updated version of the Phytoseiidae database presented detailed information about the taxonomy and distribution of each species. According to this database, a total of 2,709 species were described of which 2,436 were valid species under 91 genera, 3 subfamilies viz. Amblyseiinae, Phytoseiinae and Typhlodrominae. Suresh *et al.* (2014) described a new predatory mite, *Euseius coimbatorensis* from coconut ecosystem of Tamil Nadu. Gupta and Karmakar (2015) published an updated checklist of Indian phytoseiid mites reported a total of 211 species under 21 genera, 8 tribes and 3 subfamilies. Haneef and Mary Anitha (2015) published a new species of phytoseiid mite viz., *Phytoseius alathurensis* from Kerala. Doker *et al.* (2016) published a revised key for the identification of Turkish phytoseiid mites including 12 new records and redescription of some known species. Rahul *et al.* (2016) described a new species of phytoseiid

mite *Amblyseius dioscoreae* from Kerala. Santhosh and Mary Anithalatha (2016) reported a new species of predatory mite, *Amblyseius velayudhani* from Kerala.

Family: BDELLIDAE Duges, 1834

Bdellids are active and fast running pale yellow to orange red or green mites often called snout mites. These mites are found in various habitats viz., soil, plants, caverns and intertidal zones of sea shores that found predaceous on small arthropods and other mites.

Linnaeus (1758b) in the 10th edition of ‘*Systema Naturae*’ had described 31 species of mites under the genus *Acarus*, in which two species were later included within Bdellidae viz., *Bdella longicornis* and *Neomolgus littoralis*. Latreille (1795) erected the type genus *Bdella* and designated as type species of *Bdella longicornis*. Von Heyden (1826) erected the genus *Cyta* for the mites having stocky bodies, massive chelicerae and unpaired fifth eye. Duges (1834) erected the family Bdellidae for two genera: *Bdella* Latreille, 1795 and *Scirus* Hermann, 1804. The first systematic representation and excellent historical account of the family Bdellidae was done by Thor (1902, 1931). Berlese (1923) erected the genus *Trachymolgus* and renamed *Bdella nigerrima* Canestrini and Fanzago, 1876 as *Trachymolgus niggerimus*. Grandjean (1938) grouped *Cyta* and *Trachymolgus* into a new subfamily Cytinae based on the number of subcapitular setae and leg trichobothria, presence of pseudotracheae and normal chelicerae. Atyeo (1960) revised the members of the family Bdellidae from North and Central America. Wallace and Mahon (1972) studied the taxonomy and biology of Australian Bdellidae of the following subfamilies viz., Bdellinae, Spinibdellinae and Cytinae. The same authors (1976) published a work on the taxonomy and biology of

Australian Bdellidae, subfamily Odontoscirinae. Wainstein *et al.* (1978) prepared an identification key for the soil inhabiting mites including family Bdellidae. Tseng (1978) reported an account of mites of the family Bdellidae from Taiwan.

Gupta and Ghosh (1980) reported *Dactyloscirus nicobarensis* from Andaman and Nicobar Islands. Den Heyer (1981a) provided a key to the Afrotropical fauna of *Cyta* and described two new species, viz., *Cyta magdalenae* and *C. murrayi*. He also enumerated the diagnostic characteristics of the genus *Cyta*. Kuznetsov and Barilo (1984) described 4 new species of the family Bdellidae from middle Asia. Gupta and Paul (1985) studied some mites associated with bird's nests in West Bengal, reported two new species viz., *Spinibdella atyeoi* and *Bdella bakeri*. Gupta (1991) reported 3 new species from Northeast India under the genus *Bdella* viz., *B. khasyana*, *B. atro* and *B. angustifolius* and 2 new species under the genus *Bdellodes* viz., *B. manipurensis* and *B. grandiflora*. Ostovan and Kamali (1995) recorded 8 species under 4 genera from Iran and a key for their identification.

Gupta (2002) in his monograph on plant inhabiting predatory mites of India described 14 species of bdellid mites under 6 genera. Mary Anitha (2002) reported two new species from Kerala viz., *Bdella kottakkalensis* and *Bdella radhikae*. Omukunda *et al.* (2007) illustrated and described 6 new species under the genus *Biscirus* from South Africa. Hernandez *et al.*, (2008) described two new species from Brazil. Walter *et al.* (2009) reviewed a total of 135 species under 15 genera, 5 subfamilies. Lin and Zhang (2010) reviewed the systematics and biology of the superfamily Bdelloidea from China with an updated checklist of 26 species belonging to 9 genera. Fisher (2011) described a new species, *Trachymolgus purpureus* from the Ozark

highlands of North America. Maslov and Khaustov (2013) described a new species under the genus *Bdella* from Ukraine. Saeed *et al.* (2014) described and illustrated a new species viz., *Hexabdella persiaensis* from Iran. Eghbalian *et al.* (2014) reported two new species viz., *Cyta leliae* and *Cyta kurdistanicus* from Iran. They also provided a key to identify the adult female *Cyta* of the world. Arun Gupta *et al.* (2014) reported 4 new species of the genus *Bdellodes* and *Bdella* from India. Saeed *et al.*, (2015) described a new species *Spinibdella tabarii* from Iran. He also provided the worldwide distributions and differential characters of all *Spinibdella*. Hernandez *et al.* (2016) published a world catalogue containing 278 valid species under 5 subfamilies of Bdellidae.

Family: CUNAXIDAE Thor, 1902

Cunaxids are common predatory mites found in forest ecosystems, grasslands, agricultural fields, etc. In the early history, until the erection of family Bdellidae by Duges the cunaxid mites were treated together with *Bdella* and *Cyta* under the genus *Scirus* by Hermann (1804). The genus *Cunaxa* was erected by Von Heyden (1826). Koch (1838) first described a cunaxid mite with 3 jointed palps instead of 5 jointed palps as *Cunaxa setirostris* Hermann. He named this group as *Eupalus*. Trouessart (1892) erected the subfamily Scirinae, placed *Cunaxa* to the family Trombidiidae from Bdellidae. Oudemans (1902) used the name Cunaxiinae similar to subfamily Scirinae that is for those mites having pedipalp with a curved terminal segment and movable chela only. Thor (1902) erected the family Cunaxidae, those mites having 4 palpal segments. Meanwhile, Berlese (1904, 1910) again used the name *Scirus* for two undescribed cunaxid mites. Atyeo (1958) described the first cunaxid taxon and placed the Cunaxidae under the superfamily Bdelloidea. Schruft (1971) erected a new species under the

genus *Haleupalus* viz., *H. oliveri* on grape vine from Germany. The superfamily Cunaxoidea was erected by Van der Hammen (1972) based on the palpal morphology and number of segments, kinds of setae, and location of dorsal shield, etc. Den Heyer (1975) erected a new genus *Cunabdella* from Ethiopia. Smiley (1975) revised the generic classification reported 4 new genera viz., *Parabonzia*, *Pseudobonzia*, *Neocunaxoides* and *Pseudocunaxa*. Den Heyer (1977) erected the subfamily Bonziinae for *Bonzia* and *Parabonzia*. He again (1978) added a new subfamily Coleoscirinae and described two new species under the genus *Coleoscirus*. Gupta and Chattopadhyay (1978) reported *Neocunaxoides biswasi* from the nest of birds. Den Heyer (1979a) continued his contribution by adding the description of a new genus *Rubrioscirus* and 3 new species viz., *R. africanus*, *R. vestus* and *R. rarus* from Ethiopian region. He again (1979b, 1979c) added two genera viz., *Scutopalpus* and *Pulaeus*. The same author (1980, 1981b) published a new classification system for the family Cunaxidae. Sepasgosarian (1984) compiled the earlier papers on biology, taxonomy, systematics and published a list with 124 species belonging to 4 subfamilies, 6 tribes and 17 genera. Gupta and Paul (1985) described a new species viz., *Cunaxa prinia* associated with bird nests from West Bengal. Inayathullah and Shahid (1989) described two new species under the genus *Neocunaxoides* from Pakistan.

Gupta (1991, 1992) reported many new species and new records from India. Smiley (1992) divided the family Cunaxidae into following 9 subfamilies viz., Bonziinae, Neobonzinae, Coleoscirinae, Cunaxiinae, Cunaxoidinae, Paracunaxoidinae, Denheyernaxoidinae, Orangescirulinae and Scirulinae and also provided new classification. Muhammed and Chaudhari (1993) described *Rubroscirus rasile* and *Rubroscirus otiosus* from Pakistan.

From Philippines, Corpuz-Raros and Gracia (1995) described 5 species of Philippine cunaxid mites. Swift (1996) reported two new species of *Dactyloscirus* from Hawaiian Island. Hu (1997) reported 28 species of Cunaxidae from China.

Chinniah and Mohanasundaram (2001b) reported a new species of cunaxid mite viz., *Cunaxa eupatoria* from Tamil Nadu. Lin *et al.* (2001) reported 3 new species from Fujian, China. Mary Anitha (2002) described 3 species of cunaxid mites from Kerala. Sionti and Papadoulis (2003) done a national wide survey of cunaxid mites of Greece reported 14 species. Bashir *et al.* (2005) described a new cunaxid mites *Cunaxa reticulates* from Pakistan. Bashir and Afzal (2006) described two new species under the genus *Dactyloscirus* from Punjab and Pakistan. Sergeyenko (2006) described a new species and new record of the genus *Rubroscirus*. Bashir *et al.* (2008) reported a new species viz., *Cunaxoides sargodhaensis* on debris from Pakistan. Den Heyer and Castro (2009) described 4 new genera viz., *Bunaxella*, *Dunaxeus*, *Funaxopsis* and *Qunaxella* under the subfamily Cunaxoidinae from South Africa.

Lin and Zhang (2010) published a review article on Bdelloidea of China. Skvarla and Dowling (2012) described some new *Armascirine* from United States. Den Heyer (2013) prepared a database on Bdelloidea consists of 5 subfamilies, 6 tribes, 27 genera and 329 species. Bashir *et al.* (2014) summarized the subfamily Coleoscirinae from Pakistan and also described one new species. A review on Cunaxidae was done by Skvarla *et al.* (2014) which provide comprehensive keys to world subfamilies, genera and species. Rocha *et al.* (2015) described 3 new species viz., *Neocunaxoides promatae*, *Bonzia flechtmanni* and *Dactyloscirus multiscutus* from Southern Brazil. Bagheri *et al.* (2016) reported a new species of *Cunaxoides*, from soil, humus and moss

and also provided a key to the Cunaxoides species of Iran. Paktinat-saeij *et al.* (2016) described a new species viz., *Odontoscirus mazandaranensis* from Iran.

Family: CHEYLETIDAE Leach, 1815

Cheyletids are either associated with parasitism in mammals and birds or are free-ranging predators found in forest litter, soil, tree bark, foliage, bird-nests, animals and in house dust. Leach (1815) erected the family Cheyletidae. The genus *Cheyletomorpha* was erected by Oudemans (1904) with *Acarus lepidopterorum* as type species. Baker (1949) published the first taxonomic review of the family in which he included 19 genera. Dubinin (1957) reported a new classification of mites of the superfamilies Cheyletoidea and Demodicoidea. Volgin (1960, 1961 and 1969) recognized 10 tribes under 54 genera in this family. Zaheer and Soliman (1967) identified 4 new species under the genus *Ker* from Egypt. Summers and Price (1970) revised the family Cheyletidae and elaborated the species list to about 186 species under 51 genera. Attiah (1973) described *Chelacaropsis bakeri* a new genus and species associated with stored food mites in Egypt. A new genus *Acaropsellina* was erected by Summers (1976) with *A. sollers* as type species. Soliman (1977) reported 3 new species of cheyletid mite from Egypt with a key to genera. Fain (1979) published a notes on the genera *Cheletoides* Oudemans and *Metacheletoides* Fain with description of 3 new species. Smiley and Whitaker (1981) studied the idiosomal and leg chaetotaxy of the Cheyletidae with descriptions of a new genus viz., *Camincheyletus* and 4 new species viz., *Camincheyletus glaucomys*, *Acaropsellina sumwersi*, *Eucheyletia oregonensis* and *Cheletopkyes indiacus*.

Aheer *et al.* (1991) reported 2 new species under the genus *Acaropsis* from Pakistan. Same authors (1992) again described 3 new species under the

genus *Cheletogenes*. Aheer *et al.* (1994) reported the genus *Cheletomimus*. Fain *et al.* (1997) studied the chaetotaxy and solenidiotaxy of cheyletid mites. Fain (1979a, 1979b) through a series of papers added a number of new species and erected new genera viz., *Apodicheles* and *Galagochet*. The same author (1979c) reported 3 new species viz., *M. crinifer*, *M. gisagarensis* and *C. chirunduensis* under the genera *Matacheletoids* and *Cheletoides*. Corpuz – Raros (1998) described 12 new species and one new record from Philippines. Gerson *et al.* (1999) provided a key to 76 genera of Cheyletinae and listed more than 400 species. Fain and Ardeshtir (2000) published a notes on the genus *Neoeucheyla* Radford with description of a new species from Iran.

Bochkov and Fain (2001) established the intrafamilial relationship of 13 tribes which perfectly corresponded to the tribes proposed by Volgin 1969. This study considered the first phylogenetic analysis of the family Cheyletidae. Fain and Bochkov (2001) redefined and revised, the genus *Cheyletus* and provided key to its 29 valid species. Mary Anitha (2002) in her Ph.D thesis, described 6 cheyletid mites from Kerala, out of which 3 were new species. Bochkov (2004) studied the phylogeny, distribution, evolution and analysis of host-parasite relationships of Cheyletidae. Bochkov and Saboori (2005) reviewed the Iranian cheyletid mites and provided a key to 18 genera and 28 species. Ramaraju and Mohanasundaram (2009) described two new cheyletid mites associated with carpenter bees from Tamil Nadu. Bochkov and Otto (2010) described 5 new species and one new genus viz., *Oconnoricheylus* from USA.

According to Zhang *et al.* (2011) the family Cheyletidae presently includes over 440 species under 75 genera. An updated checklist of cheyletid mites of Egypt was prepared by Negam and Mesbah (2014) and provided a

key to the Egyptian cheyletid mites. Bochkov and Abramov (2016) recorded 7 species of cheyletid mites from Russia.

Family: STIGMAEIDAE Oudemans, 1931

Stigmaeids are small prostigmatid mites that occur in many habitats and form an important component of the acarine fauna of soil, litter and plants. The family Stigmaeidae was erected by Oudemans (1931) with *Stigmaeus* Koch as its type genus. Summers (1962) made an attempt to revise the genus *Stigmaeus*. Ehara (1962) published notes on some predatory mites (Phytoseiidae and Stigmaeidae) from Japan. Wood (1964) erected a new genus viz., *Mullederia*, from New Zealand. Gonzalez- Rodriguez (1965) presented a comprehensive key and described 13 genera under this family. Summers (1966) provided a key to the family Stigmaeidae described 14 genera. Chaudhri (1968) described 3 new mites of the genus *Ledermuelleria* from Pakistan. Wood (1967, 1970, 1971, and 1973) made an excellent contribution to the advancement of the family Stigmaeidae. Meyer (1969) described some stigmaeid mites from South Africa. Kuznetsov (1977) contributed an account to the fauna of the family Stigmaeidae from Russia. Later, (1978) he revised the genus *Stigmaeus*. Gupta and Ghosh (1980) described distribution of 30 species of prostigmatid mites belonging to 20 genera and 8 families from Andaman and Nicobar islands.

Tseng (1982) studied Stigmaeidae of Taiwan, provided a key to 18 genera and 25 species. Sepasgosarian (1985, 1990) enumerated more than 20 genera with 300 species in his major work on superfamily Raphignathoidea. Gupta (1985) described 4 stigmaeid mites under the genera *Agistemus* and *Indostigmaeus* from India. Vacante and Gerson (1988) described 3 species of *Eryngiopus* (Acari: Stigmaeidae) from Italy, with key to species.

Gutpa (1991, 1992) done an outstanding work on prostigmatid mites of various habitat from India. Zhang (1993) revised the superfamily Raphignathoidea and included a key to world families and genera from New Zealand. Kapaxidi and Papadoulis (1999) published new records of stigmatid mites from Greece with description of a new species. Zhu *et al.* (2001) published a checklist for the superfamily Raphignathoidea from China. Gupta (2002) published a monograph of plant inhabiting predatory mites of India, described 25 species of stigmatid mite under 6 genera. Mary Anitha (2002) reported two stigmatid species under the genus *Apostigmaeus* and *Agistemus* from Kerala. Putatunda *et al.* (2002) studied the mites associated with some fruit trees in Hisar, Hariyana reported *Agistemus fleschneri*. Faraji and Ueckermann (2005, 2006) provided a key to *Stigmaeus* species known from Iran and Europe respectively. Koc (2005) published two new species of the genus *Stigmaeus* from Turkey. Dogan (2007) prepared a checklist of raphignathoid mites of Turkey. Akyol and Koc (2007) described 4 new species of the genus *Stigmaeus* from Turkey. Cheng and Fan (2008) published a catalogue of the Chinese Raphignathoidea and provided an annotated checklist of 112 valid species from China.

Kuznetsov *et al.* (2010) reported the first record of mites of the family Stigmatidae from Rovno amber with description of a new species of the genus *Mediolata*. Donel and Dogan (2011) described 9 new species and 4 newly recorded species of stigmatids under 6 genera from Turkey. Khanjani *et al.* (2012) described two new species of the genus *Stigmaeus* from Iran. Hajizadeh *et al.* (2013) published a tabulated checklist for stigmatid species from Iran. Khaustov (2014) described 3 new species of the genus *Stigmaeus* from various habitats in Crimea and provided a key to the species. Dogan *et al.* (2015) described a new species of the genus *Stigmaeus* from Turkey and

published a list of described species of the world. Fan and Flechtmann (2015) summarized the research on the taxonomy, biology and ecology of this family and recorded 534 species in 33 genera. Khaustov (2015) described a new species and a new record of the genus *Stigmaeus* from Western Siberia. Fan *et al.* (2016) published an annotated catalogue of Stigmaeidae of the world with 577 species under 34 genera. The catalogue contains pictorial key to genera included nomenclature, synonymies, type localities, type depositories, host/habitat, feeding habits and distribution.

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MATERIALS AND METHODS

The predatory mites fauna harbouring various species of medicinal plants were collected by making extensive survey in North Kerala.

3.1 Sampling localities

The districts covered during the period of survey included Kasaragod, Kannur, Wayanad, Kozhikode, Malappuram and Palakkad (plate I). In Kasaragod district the sampling sites were Panathur, Nileschwaram, Uppala and Kumbla (Plate 02, Figs. 1-4). The study areas in Kannur district were Pariyaram, Payyannur, Herbal Garden of Ayurveda College Pariyaram and Valapattanam (Plate 02, Figs. 5-8). From Wayanad district, collections were taken from various herbal gardens which were naturally protected by tribal people. The sites were Mananthavady, Thekkumthara, Pulpally and Ambalavayal (Plate 03, Figs. 1- 4). In Kozhikode district, 13 localities were surveyed for the occurrence of predatory mites *viz.*, Pantheerankavu, Kadalundy, Herbal Garden of Malabar Christian College Calicut, Ashokapuram, Kunduparamba, Mankavu, Kurachundu, Kavumvattam, Pazhur, Kakkadampoyil, Vengeri, Balussery and Kakkodi (Plate 03, Figs. 5 - 8). The collection sites in Malappuram district were Chelembra, Chenakkal, Botanical Garden of Calicut University, Herbal garden of Arya vaidhyasala Kottakkal, Parapangadi, Ponnani and Cherukara. The sampling sites in Palakkad district were Pattambi, Koppam, Vilayur, Ottapalam, Cherpulassery and Alathur (Plate 04, Figs. 5 -8).

3.2 Plants Surveyed

Survey was conducted during the year 2013-15 on a wide range of medicinal plants which were in high demand at the current national and international market for pharmaceutical, cosmetic and nutritional application. Mites were collected mainly from creepers, shrubs, herbs and trees either cultivated or naturally grown. A total of 53 species of medicinal plants belonging to 47 genera and 28 families were surveyed (Table I). Each locality was surveyed two to three times for the recovery of predatory mites during the study period.

TABLE I
LIST OF MEDICINAL PLANTS SURVEYED
FOR THE COLLECTION OF PREDATORY MITES

Sl. no.	Scientific name	Local name	Family
1	<i>Abelmoschus moschatus</i> (L.)	Kasthurivenda	Malvaceae
2	<i>Achyranthus aspera</i> L.	Kadaladi	Amaranthaceae
3	<i>Aegle marmelos</i> (L.)	Koovalam	Rutaceae
4	<i>Argeria nervosa</i> (Burm.f.)	Samudra pacha	Convolvulaceae
5	<i>Averrhoa bilimbi</i> L.	Irumbampuli	Oxalidaceae
6	<i>Baliospermum montanum</i> (willd)	Katalavanakku	Euphorbiaceae
7	<i>Bauhinia acuminata</i> L.	Vella mantharam	Fabaceae
8	<i>Bauhinia racemosa</i> Lam.	Manjha mantharam	Fabaceae
9	<i>Benincasa hispida</i> (Thunb.)	Elavan	Cucurbitaceae
10	<i>Canavalia ensiformis</i> (L.)	Val payer	Fabaceae
11	<i>Carica papaya</i> L.	Papaya	Caricaceae
12	<i>Citrus medica</i> L.	Narakam	Rutaceae

Sl. no.	Scientific name	Local name	Family
13	<i>Clerodendrum paniculatum</i> L.	Krishna kireedam	Verbenaceae
14	<i>Clitoria ternatea</i> L.	Neela - sanghupushpam	Fabaceae
15	<i>Coffea arabica</i> L.	Kappi	Rubiaceae
16	<i>Cucurbita maxima</i> Duch.	Mathenga	Cucurbitaceae
17	<i>Curcuma longa</i> L.	Manjhal	Zingiberaceae
18	<i>Datura metel</i> L.	Ummam	Solanaceae
19	<i>Elaeocarpus tuberculatus</i> Roxb.	Bhadraksham	Elaeocarpaceae
20	<i>Gmelina arborea</i> Roxb	Kumizhu	Verbenaceae
21	<i>Gymnema sylvestre</i> R.Br.	Chakkarakolli	Asclepiadaceae
22	<i>Helicterus isora</i> L.	Valampiri	Sterculiaceae
23	<i>Hibiscus rosa-sinensis</i> L.	Chembarathy	Malvaceae
24	<i>Ipomoea maxima</i> (L.f.)	Cheruthiruthali	Convolvulaceae.
25	<i>Ipomoea sepiaria</i> Roxb.	Thiruthali	Convolvulaceae
26	<i>Ixora coccinea</i> L.	Thechi	Rubiaceae
27	<i>Jatropha curcas</i> L.	Kottathari	Euphorbiaceae
28	<i>Justicia adhatoda</i> (L.)	Adalodakam	Acanthaceae
29	<i>Justicia gendarussa</i> Burm.f.	Vatham kolli	Acanthaceae
30	<i>Magnolia chempaka</i> (L.)	Chempakam	Magnoliaceae
31	<i>Morinda citrifolia</i> L.	Nonni	Rubiaceae
32	<i>Morus alba</i> L.	Mulberry	Moraceae
33	<i>Murraya koenigii</i> (L.)	Kariveppu	Rutaceae
34	<i>Myristica fragrans</i> Houtt.	Jadi	Myristicaceae
35	<i>Ocimum basilicum</i> L.	Ramathulasi	Lamiaceae
36	<i>Ocimum sanctum</i> L.	Thulasi	Lamiaceae
37	<i>Ophiorrhiza mungos</i> L.	Avilpuri	Rubiaceae

Sl. no.	Scientific name	Local name	Family
38	<i>Persea macrantha</i> (Nees)	Kulirmavu	Lauraceae
39	<i>Piper betle</i> L.	Vettila	Piperaceae
40	<i>Plumbago indica</i> L.	Chethikoduveli	Plumbaginaceae
41	<i>Psidium guajava</i> L.	Pera	Myrtaceae
42	<i>Pseudarthra vasicida</i> (L.)	Moovila	Fabaceae
43	<i>Salacia reticulata</i> Wight.	Eakanayakam	Celastraceae
44	<i>Saraca indica</i> L.	Ashokam	Fabaceae
45	<i>Sida rhombifolia</i> L.	kurunthotti	Malvaceae
46	<i>Solanum anguivi</i> Lam.	Putharichunda	Solanaceae
47	<i>Solanum melongena</i> L.	Vazhuthana	Solanaceae
48	<i>Solanum virginianum</i> L.	Chunda	Solanaceae
49	<i>Syzygium samarangense</i> (Blume.)	Champakka	Myrtaceae
50	<i>Theobroma cacao</i> L.	Cocoa	Malvaceae
51	<i>Vitis venifera</i> L.	Munthiri	Vitaceae
52	<i>Wrightia tinctoria</i> (Roxb.)	Denthapala	Apocynaceae
53	<i>Zingiber zerumbet</i> (L.)	Malayinji	Zingiberaceae

3.3 Methods of collection

Mites were randomly collected from leaves, twigs, buds and petioles of medicinal plants. The plant materials having predatory mites were collected in a polyethylene cover and the mouth of the cover was fastened with an elastic band. The covers were labeled with details of habitat, locality, date of collection, etc. and brought to the laboratory for further examination and extraction of the mites. Usually morning and evening hours were used to collect samples from the sites. Details of collection were recorded by giving

an accession number to the collection, date of collection, local/scientific name of host plant, number of predatory mites, presence or absence of prey mites, feeding habits etc. The various methods adopted for extracting the mites from the collected samples were:

3.3.1 Hand picking

The direct method of collection in which the infested leaves or plant parts were examined under a 10 X lens in the field itself and the mites can be picked up by a moistened fine hair brush which were transferred to a vial having 70% alcohol. This method was suitable for the collection of fairly large sized, fast moving and brightly coloured mites. In the case of small mites, the infested plant materials were collected in a polyethylene bag with proper labeling and screened in the laboratory under a stereozoom-binocular microscope. When they could not be processed the same day, they were stored in a refrigerator at 5 to 15° C for 4-7 days.

3.3.2 Beating

Leaf beating method was generally used for the collection of mites directly from the field. The mite infested plant parts were beaten over a white enamel tray or on a dark coloured rexin sheet. The dislodged mites were picked up using a camel hair brush and stored in 70% alcohol.

3.3.3 Aspirator

An aspirator filled with 70% alcohol was used to pick up small mites directly from the habitat without touching them.

3.4 Clearing and mounting

Collected specimens were preserved in 70% alcohol and were then run through a series of alcohol concentrations for dehydration. After this procedure, the samples were transferred from absolute alcohol to a clearing medium containing lactic acid and alcohol in 1:1 ratio for 5-7 minutes.

3.4.1 Preparation of mounting medium

Hoyer's medium was prepared by mixing the following chemicals in the required proportion at room temperature. It was then filtered through cotton wool.

Distilled water	-	50 ml
Gum arabic crystals	-	30 g
Chloral hydrate	-	200 g
Glycerine	-	20 ml

3.4.2 Preparation of permanent slides

Since the Hoyer's medium act as clearing agent, mites can be directly mounted in the medium without any pre-treatment either in live condition or in preserved form. Usually 2-4 specimens were mounted on a slide. Mites were pressed to the bottom of the slide and legs were spread to the lateral positions. Large sized mites required a small body puncture to remove the internal gut contents for easy clearing.

The slides were labeled and numbered serially for identification. Data on locality, host plant, collector's name and slide number with date were given on the label apart from species name. The slides so prepared were dried

under 60W electric bulb at least 2 or 3 days or in hot air oven at 40°C temperature for one or two weeks till the required clarity of the specimen was obtained. After drying, the mounted slides were sealed with a light coloured nail polish to avoid shrinkage and fungal deterioration. All mounted slides were stored in a cool place in a slide box.

3.5 Remounting

Sometimes remounting were needed for species level identification. For remounting, slides were dipped in petridish containing distilled water for 2-5 minutes. Then sealing were removed with the help of needle, coverslips were removed carefully without damaging the specimens. Then the specimens were transferred into medium containing lactic acid and alcohol in a ratio 1: 1 for 3-5 minutes. After this process specimens were directly mounted in Hoyer's medium.

3.6 Identification of mites

Morphological characters were studied using Olympus CX 31 microscope. Observations on dorsal and ventral shield, peritreme, chelicera, spermatheca in female, spermatophoral process in male, leg IV etc. were studied and figures were drawn using a mirror type camera lucida attached to the microscope. All measurements were made with an ocular micro meter in microns. Microphotographs were taken using phase contrast system of Olympus Research Microscope. Taxonomic keys were prepared for the respective genus and species. Systematic position of individual species was done by referring following literature of Gupta (1986, 2002, 2003), Chant and McMurtry (1994, 2004, 2005, 2006a, 2007) and also seeking opinion from experts.

The setal nomenclature proposed by Rowell *et al.* (1978), the dorsal and caudoventral setal patterns of Chant and Yoshida-Shaul (1989, 1991), the idiosomal setal patterns of Chant and Yoshida-Shaul (1992), Smiley (1992) as well as the leg chaetotaxy of Evans (1963) were followed in this study for the family Phytoseiidae. For the family Ascidae and Blattisociidae majority of taxonomic characters were taken mainly from Evans (1958), Karg (1993) and Bregetova (1977), setal pattern and arrangements were similar to that of Phytoseiidae except the number. For Bdellidae, the setal nomenclature used this study follows Kethley (1990) and for propodosomal setae, which follows the notation given by Fischer *et al.* 2011. The morphology and terminology used for Cunaxidae are that of Smiley (1975), setal notation for anal setae follows Kethley (1990) and ventral hypostomal abbreviations are adopted from Den Heyer (1978).

For cheyletids the terminology used for the body setae follows Fain (1979c) and Gerson (1994). Morphological terms are adopted from Volgin (1969) and Summers and Price (1970). The setal nomenclature follows that of Grandjean's (1944), with modifications and additions made by Summers (1962), Gonzalez (1965) and Meyer (1969) were used for the family Stigmaeidae.

The following abbreviations were used in the illustrations to denote the morphological and taxonomical characters of the various structures present in the study.

Cf	- Chelicera of female
Cm	- Chelicera of male
DD	- Dorsal view of Deutonymph

DF	- Dorsal view of Female
DL	- Dorsal view of Larva
DM	- Dorsal view of Male
DP	- Dorsal view of Protonymph
DS	- Dorsal body Seta
Hf	- Hypostome female
L I to L IV	- Legs I to IV showing setation
Mp	- Metapodal plate
Sp	- Spermatheca
Pf	- Pedipalp of female
T	- Tectum
VD	- Ventral view of Deutonymph
VF	- Ventral view of Female
VL	- Ventral view of Larva
VM	- Ventral view of Male
VP	- Ventral view of Protonymph
VG	- Ventral view of gnathosoma

The abbreviations and symbols used in the text are as follows:

°C	- Degree Celsius
L	- Length
RH	- Relative Humidity
W	- Width
♀	- Female
♂	- Male

The slides of all type specimens have been deposited in the P G and Research Department of Zoology, Malabar Christian College, Kozhikode, Kerala, India.

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OBSERVATION

During the present study, a total of 82 species of predatory mites inhabiting 53 species of medicinal plants belonging to 47 genera and 28 families (Table1) were surveyed and examined for studying their taxonomic characters. Table 2 supplements the details of predatory mites recovered from the respective medicinal plants surveyed from various localities in North Kerala. A total of 82 species belonging to 23 different genera, 11 subfamilies and 7 families were recovered under the suborder Prostigmata and order Mesostigmata, of these 48 species belonging to 23 genera were new to science. The predatory mite families recorded during the study were Ascidae, Blattisociidae, Phytoseiidae, Bdellidae, Cunaxidae, Cheyletidae and Stigmaeidae (Plate 05). Plate 06 gives the details of percentage of diversity of various families, Ascidae included 5 species (6%), Blattisociidae –10 species (12%) Phytoseiidae – 38 species (46%), Bdellidae – 6 species (7%), Cunaxidae – 12 species (15%), Cheyletidae – 9 species (11%) and Stigmaeidae – 2 species (3%).

The mesostigmatid mites recovered during the present study could be identified under 3 families viz., Ascidae, Blattisociidae and Phytoseiidae. Plate 07 gives the generic diversity of the mesostigmatid mites. Under the family Ascidae, 5 species were identified, of which 3 were new to science. Out of the 2 known species *Asca spicata* Hurlbutt was a new record from India and *Asca garmani* Hurlbutt from Kerala. The family Blattisociidae represented by 10 species, all coming under the genus *Lasioseius*, of which 9

were identified as new to science and one known species viz, *Lasioseius plumatus* Karg was a new record from India.

Under Phytoseiidae, a total of 38 species were recovered that could be categorized under 3 subfamilies viz., Amblyseiinae, Phytoseiinae and Typhlodrominae. When compared to the families Ascidae and Blattisociidae, Phytoseiidae exhibited maximum diversity with respect to genera and species. (Plate 09) This was evidenced by the recovery of 38 species out of the 82 collected comes under the family Phytoseiidae, of which 18 were appeared as new taxa, of which one species viz., *Amblyseius velayudhani* Santhosh and Mary Anitha, 2016 has been already published. Plate 10 indicates the percentage of distribution of various genera under the family Phytoseiidae.

The genus *Amblyseius* belonging to the subfamily Amblyseiinae was the dominant one represented by 13 species which were the most abundant genus of predatory mites surveyed during the present study. The other genera identified under the subfamily Amblyseiinae were *Euseius*, *Neoseiulus*, *Paraphytoseius*, *Proprioseiopsis*, *Typhlodromips*, *Scapulaseius* and *Gynaeseius* (= *Indoseiulus*) represented by 9, 2, 2, 1, 2, 2 and 1 species respectively. The subfamily Phytoseiinae represented by 5 species under the genus *Phytoseius* and a single species was recovered from the subfamily Typhlodrominae under the genus *Typhlodromus*. Plate 06 gives the details of percentage of diversity of various genera under the suborder Mesostigmata.

In the present study, 4 families of prostigmatid mites viz., Cheyletidae, Cunaxidae, Bdellidae and Stigmaeidae were recovered from different medicinal plants (Plate 11). Among this, family Cunaxidae represented the maximum species and generic diversity followed by Cheylitidae, Bdellidae

and stigmatidae. The family Cunaxidae was found represented by 12 species categorized under the genera viz., *Cunaxa*, *Dactyloscirus* and *Neocunaxoides* comprising 8, 1 and 3 species respectively under a single subfamily Cunaxinae, of which 8 species were new to science. The family Cheyletidae formed the second with respect to species diversity accommodating 9 species under the genera *Cheyletus*, *Cheletomimus* and *Hemicheyletia*, of which 5 were new to science and 2 species viz., *Hemicheyletia cordovens* (De Leon) and *Hemicheyletia serrula* Schuster and Summers were new report from India. The family Bdellidae was found represented by 6 species categorized under 3 subfamilies viz., Bdellinae, Odontoscirinae and Cytinae. The genera identified were *Bdella*, *Bdellodes*, *Thoribdella* and *Cyta*. Out of the 6 species, 5 were recognized as new to science. The family Stigmeidae was found represented by only 2 known species under the genus *Agistemus*. Plate 12 gives the percentage of distribution of various genera under the suborder Prostigmata.

All the predatory mites were noted to occupy the lower surface of the leaves. During the hot weather season, rich populations of both predatory as well as pest mites were noticed. The preference to lower surface was seen as a general trend irrespective of leaf texture variations. The density of populations of these predatory mites on their respective host plants showed variations with respect to the age of plant, season of the year, distribution of prey mites, etc.

During the present survey, *Amblyseius channabasavannai* was recognized as the species with maximum diversity in distribution by colonizing different species of plants followed by *Neoseiulus longispinosus* and *Paraphytoseius orientalis* (Table 2). A similar diversity was found in the

case of host plants also, where the maximum species complexity was seen on Fabaceae which supports 5 species of predatory mites followed by Solanaceae, Malvaceae, Rubiaceae , 4 species each (Plate. 13).

This study explored many new species (48) and new records of predatory mites. As far as the works on predatory mites concerned, only a few works were reported from Kerala, particularly family Ascidae and Blattisociidae.

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SYSTEMATIC ACCOUNT OF THE SPECIES STUDIED

SYSTEMATIC POSITION

SUPER ORDER: PARASITIFORMES

ORDER : MESOSTIGMATA

Superfamily: Ascoidea

- Family : **I. ASCIDAE** Voigts and Oudemans, 1905
- Subfamily : **A. ASCINAE** Voigts and Oudemans, 1905
- Genus : **1. *Asca*** Von Heydon, 1826
- Species : 1. *Asca devadasi* sp.nov.
2. *Asca garmani* Hurlburt , 1963
3. *Asca indirae* sp.nov.
4. *Asca sashikalae* sp.nov.
5. *Asca spicata* Hurlbutt, 1963

Superfamily: Phytoseioidea

- Family : **II. BLATTISOCIDAE** Garman, 1948
- Subfamily: **B. BLATTISOCINAE** Garman 1948
- Genus : **2. *Lasioseius*** Berlese, 1916
- Species : 1. *Lasioseius adhathodae* sp.nov.
2. *Lasioseius gangadharani* sp.nov.
3. *Lasioseius gokuldasi* sp.nov.
4. *Lasioseius guptai* sp.nov.

5. *Lasioseius pavani* sp.nov.
6. *Lasioseius pazhurensis* sp.nov.
7. *Lasioseius plumatus* Karg, 1980
8. *Lasioseius kurachundensis* sp.nov.
9. *Lasioseius soudhaminia* sp.nov.
10. *Lasioseius wayanadensis* sp.nov.

- Family : **III. PHYTOSEIIDAE** Berlese, 1952.
- Subfamily : **C. AMBLYSEIINAE** Muma, 1961.
- Tribe : i. NEOSEIULINI Chant and McMurtry, 2003.
- Genus : **3. Neoseiulus** Hughes, 1948.
- Species : 1. *Neoseiulus longispinosus* (Evans), 1952.
2. *Neoseiulus radhamaniae* sp. nov.
- Tribe : ii. KAMPIMODROMINI Kolodochka, 1998.
- Subtribe : a. PARAPHYTOSEIINA Chant and McMurtry, 2003.
- Genus : **4. Paraphytoseius** Swirski and Schechter, 1961.
- Species : 1. *Paraphytoseius bhadrakaliensis* Gupta, 1969
2. *Paraphytoseius orientalis* Narayanan, Kaur and Ghai, 1960.
- Tribe : iii. TYPHLODROMIPSINI Chant and McMurtry, 2005.
- Genus : **5. Typhlodromips** De Leon, 1965
- Species : 1 *Typhlodromips mathaii* sp.nov.
2. *Typhlodromips syzygii* Gupta, 1975.
- Genus : **6. Scapulaseius** Karg and Oomen - Kalsbeek, 1987.
- Species : 1. *Scapulaseius mohanasundarami* sp.nov.
2. *Scapulaseius suknaensis* Gupta, 1970
- Tribe : iv. AMBLYSEIINI Muma, 1961.

- Subtribe : b . AMBLYSEIINA Muma, 1961.
- Genus : **7. *Amblyseius*** Berlese, 1914.
- Species : 1. *Amblyseius aerialis* (Muma), 1955
 2. *Amblyseius cucurbitae* Rather, 1985
 3. *Amblyseius channabasavannai* Gupta and Daniel, 1978.
 4. *Amblyseius devakiae* sp.nov.
 5. *Amblyseius kadalundiensis* sp.nov.
 6. *Amblyseius kavumvattamsis* sp.nov.
 7. *Amblyseius largoensis* (Muma), 1955.
 8. *Amblyseius melongenae* sp.nov.
 9. *Amblyseius neorykei* Gupta, 1977.
 10. *Amblyseius ramaniae* sp.nov.
 11. *Amblyseius thejessi* sp.nov.
 12. *Amblyseius velayudhani* Santhosh and Mary Anitha, 2016
 13. *Amblyseius zoansi* sp.nov.
- Subtribe : c. PROPRIOSEIOPSINA Chant and McMurtry, 2004.
- Genus : **8. *Proprioseiopsis*** Muma, 1961.
- Species : 1. *Proprioseiopsis peltatus* Van der Merwe, 1968.
- Tribe : v. INDOSEIULINI Ehara and Amano, 1998
- Genus : **9. *Gynaeseius*** Wainstein, 1962.
- Species : 1. *Gynaeseius mumai* sp.nov.
- Tribe : vi. EUSEIINI Chant and McMurtry, 2005.
- Subtribe : d. EUSEIINA Chant and McMurtry, 2005.
- Genus : **10. *Euseius*** Wainstein, 1962.

- Species : 1. *Euseius alstoniae* Gupta, 1975
 2. *Euseius curcasae* sp.nov.
 3. *Euseius faisali* sp.nov.
 4. *Euseius finlandicus* (Oudemans), 1915
 5. *Eusieus macrospatulatus* Gupta, 1986.
 6. *Euseius moosai* sp.nov.
 7. *Euseius ovalis* (Evans), 1953
 8. *Euseius pariyarensis* sp.nov.
 9. *Euseius rhododendronis* Gupta, 1970
- Subfamily : **D. PHYTOSEIINAE** Berlese, 1913.
- Genus : **11. *Phytoseius*** Ribaga, 1904.
- Species : 1. *Phytoseius asperae* sp. nov.
 2. *Phytoseius intermedius* Evans and Macfarlane, 1962
 3. *Phytoseius macropilus* (Bank), 1909
 4. *Phytoseius prakasani* sp. nov.
 5. *Phytoseius rachelae* Swirski and Shechter, 1961
- Subfamily : **E. TYPHLODROMINAE** Wainstein, 1962.
- Tribe : vii. Typhlodromini Wainstein, 1962.
- Genus : **12. *Typhlodromus*** Scheuten, 1857
- Subgenus : **1. *Anthoseius*** De Leon, 1959.
- Species : 1. *Typhlodromus (Anthoseius) bambusicolus* Gupta, 1977

SUPER ORDER: ACARIFORMES

ORDER: TROMBIDIFORMES

Suborder: PROSTIGMATA

Superfamily: Bdelloidea

Family : **IV. BDELLIDAE** Duges, 1834

Subfamily : **F. BDELLINAE** Grandjean

Genus : **13. *Bdella*** Latreille 1795

Species : 1. *Bdella aniyammae* sp.nov.
2. *Bdella khasyana* Gupta ,1991
3. *Bdella vincenti* sp.nov.

Subfamily : **G. ODONTOSCIRINAE**, Grandjean

Genus : **14. *Bdellodes*** Oudemans, 1938

Species 1. *Bdellodes thankamaluae* sp.nov.

Genus : **15. *Thoribdella*** Grandjean 1938

Species 1. *Thoribdella citrifoliae* sp.nov.

Subfamily : **H. CYTINAE** Grandjean, 1938

Genus : **16. *Cyta*** Von Heyden , 1826

Species 1. *Cyta troglodyte* Hernandes, 2011

Family : **V. CUNAXIDAE** Thor, 1902

Subfamily : **I. CUNAXIINAE** Oudemans, 1902

Genus : **17. *Cunaxa*** Von Heyden , 1902

Species 1. *Cunaxa jayasreeae* sp. nov.
2. *Cunaxa justiciae* sp. nov.
3. *Cunaxa medicae* sp. nov.
4. *Cunaxa myristicae* sp. nov.

5. *Cunaxa rahuli* sp. nov.

6. *Cunaxa vilayurensis* sp. nov.

7. *Cunaxa vinodi* sp. nov.

8. *Cunaxa womersleyi* Baker and Hoffmann, 1948

Genus : **18. *Dactyloscirus*** Berlese 1916

Species 1. *Dactyloscirus vanajae* sp. nov.

Subfamily : **J. CUNAXOIDINAE** Den Heyer, 1979

Genus : **19. *Neocunaxoides*** smiley, 1975

Species 1. *Neocunaxoides anithae* sp. nov.

2. *Neocunaxoides kottakkalensis* sp. nov.

3. *Neocunaxoides raghavani* sp. nov.

Superfamily: Cheyletoidea

Family : **VI. CHEYLETIDAE** Leach, 1815

Subfamily : **K. CHEYLETINAE** Leach, 1815

Tribe : Cheyletini Leach, 1815

Genus : **20. *Cheyletus*** Latreille, 1796

Species 1. *Cheyletus kunduparambensis* sp. nov.

Genus : **21. *Cheletomimus*** Oudemans, 1904

Species 1. *Cheletomimus melongenae* sp. nov.

Genus : **22. *Hemicheyletia*** Volgin, 1969

Species 1. *Hemicheyletia aswini* sp. nov.

2. *Hemicheyletia congensis* (Cunliffe), 1962

3. *Hemicheyletia cordovens* (De Leon) 1962.

4. *Hemicheyletia parvathiae* sp. nov.

5. *Hemicheyletia serrula* Summers and Price, 1970.

6. *Hemicheyletia volgini* (Cunliffe), 1962.

7. *Hemicheyletia wellsi* (Baker), 1949.

Superfamily: Raphignathoidea

Family : **VII. STIGMAEIDAE** Oudemans, 1931

Genus : **23. *Agistemus*** Summers, 1960

Species 1. *Agistemus fleschneri* Summers, 1960

2. *Agistemus terminalis* (Quayle), 1912

SANTHOSH. P. P. "STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA". THESIS. DEPARTMENT OF ZOOLOGY, MALABAR CHRISTIAN COLLEGE, UNIVERSITY OF CALICUT, 2017.

DESCRIPTION OF SPECIES STUDIED

6.1 ORDER: MESOSTIGMATA

Key to the families of order Mesostigmata

1. Third pair of sternal lyrifissures off sternal shield , usually inserted on metasternal plates together with sternal setae ST₄; peritremal shield broadly connected or not connected to exopodal shield; fixed digits of chelicera with setiform *pilus dentilis*; movable cheliceral digits variable, often tridentate 2
- Third pair of sternal lyrifissures on posteriolateral corners of sternal shield and ST₄ usually on metasternal plates; peritremal shield broadly connected exopodal to shield; fixed digit of chelicera with setiform *pilus dentilis*; movable cheliceral digit usually bidentate.....
.....Ascidae
2. Corniculi with pointed tips, generally well separated from each other and subparallel; podonotal region with 15-25 pairs of setae and opisthonotal region with 8-16 pairs of setaeBlattisociidae
- Corniculi deeply separated, slender, proximal, parallel and bladder like; a maximum of 14 pairs of setae on the podonotum and opisthonotum region Phytoseiidae

6.1.1 Superfamily: Ascoidea

6.1.1.1 Family : ASCIDAE Voigts and Oudemans , 1905

1905. Ascidae: Voigts and Oudemans, *Abh. herausg. Naturwiss. Ver. Bremen.*, **18**:199 – 253.
1910. Ascidae : Berlese, *Brevi diag. generie specie nuovi. Acari, Redia*, **6**: 346 – 388.
1914. Ascidae: Banks, Acarians from Brazil, *Psyche.*, **21**: 159–163.
1916. Ascidae: Berlese, Centuria prima di Acari nuovi, *Redia*, **12**: 19–67.
1930. Ascidae: Thor, *Skr. Svalbard Ishavet, Oslo.*, **27**: 1 – 156.
1952. Ascidae: Baker and Wharton, *An Introduction to Acarology. Mc Millan., New York*, p.465.
1958. Ascidae: Evans, *Proc. Zool. Soc. London*, **131**: 177 – 229.
1960. Ascidae: Evans and Hyatt, *Bull. Brit. Mus. (Nat. Hist.) Zool.*, **6** (2): 25.
1960. Ascidae : Sansinak, *Parasitol.*, **7**: 297 – 307.
1962. Ascidae: Krantz, *Parc. National. Garamba., Mission H. Saeger*, **34**: 3 – 29.
1963. Ascidae: Bernhard, *Beitr. Syst. Okol. Mitteleur.*, **3**: 177.
1963. Ascidae: Hurlbutt, *Acarologia*, **5**: 481.
1963. Ascidae: Chant, *Can. J. Zool.*, **41**: 243.
1965. Ascidae: Wood, *N. Z. J. Sci.*, **8**(1): 129.
1965. Ascidae: Lindquist and Evans, *Mem. Ent. Soc. Can.*, **47**: 1 – 64
1966. Ascidae: Bhattacharyya, *Proc. Zool. Soc. Calcutta.*, **19**: 31–37.
1967. Ascidae: De Leon, *Some mites of the Caribbean Area: Part II*. Allen Press, Inc. Lawrence, Kansas. p. 47–66.

1968. Ascidae: Bhattacharyya, *Acarologia*, **10**: 528.
1968. Ascidae: Aoki, *Bull. Nat. Sci. Mus.*, Tokyo, **11**: 149 – 152.
1969. Ascidae: Athias – Henriot, *Acarologia*, **11**: 609–628.
1969. Ascidae: Loots and Ryke, *Separ. N. 81 Publi. Cult. Compa. Diam. Angola*, p. 85.
1976. Ascidae: Hughes, *Min. Agri. Fish Food Lond. Tee/I. Bull.*, **9** (3): 3.
1971. Ascidae: Karg, *Gustav Fisher Verlag Jena.*, 1 – 475.
1971. Ascidae: Sansinak and Dusbabek, *Ceskoslov. Akad. Ved.*, p. 313 – 352.
1977. Ascidae: Bregetova *et al.*, *Izd. Nauk., Moscow* , p.1 – 716.
1977. Ascidae: Bregetova, *Key to the Soil – Inhabiting Mites. Mesostigmata. Nauk., Leningrad*, p. 169–226.
1979. Ascidae: Evans and Till, *Trans. Zool. Soc. Lond.*, p.189.
1979. Ascidae: Karg, *Mitt. Zool. Mils. Berl.*, **55** : 242.
1985. Ascidae: Gupta, *Handbook, Plant mites of India*, p.329.
1993. Ascidae: Walter *et al.*, *Invert. Taxonomy*, **7**: 1327.
1993. Ascidae: Karg, *Gustav Fisher Verlag Jena.*, 1 – 523.
1994. Ascidae: Karg, *Mitt. Zool. Mils. Berl.*, **70** : 113.
1994. Ascidae: Papadoulis, *Internat. J. Acarol.*, **20**: 183.
1996. Ascidae: Karg. *Mitt. Zool. Mus. Berl.*, **72**: 157.
1998. Ascidae: Halliday, Walter and Lindquist, *Invert. Taxon*, **12**: 1 – 54.
2000. Ascidae: Basha Yousef , *Acarologia*, **41**: 395–402.
2002. Ascidae: De Leon – Facundo and Corpuz – Raros, *Philip. Agrl.Sci.*, **85**: 39–46.
2003. Ascidae: Gupta, *Memoirs, Zool. Surv. India*, **20**: 1–185.

2003. Ascidae: Gwiazdowicz, *Biol. Brat.*, **58**: 151–154.
2004. Ascidae: De Leon – Facundo and Corpuz – Raros, *Philip. Agrl.Sci.*, **87**: 196–228.
2005. Ascidae: De Leon – Facundo, *Asia Life Sciences*, **14**: 111–131.
2005. Ascidae: Kaluz and Fenda, *Institute of Zoology, Slov. Acad. Sci, Bratislava*, p.168.
2007. Ascidae: Gwiazdowicz, *Wyd . Akad. Roln. Im. Aug. Cie., Poznan*, p. 248.
2008. Ascidae : Gwiazdowicz and Halliday, *Zootaxa*, **1921**: 47–68.
2008. Ascidae: Christian and Karg, *Soil Organisms*, **80**: 45–79.
2008. Ascidae: Beaulieu *et al.*, *Zootaxa*, **1961**: 37–57.
2009. Ascidae: Fenda and Kaluz , *Proceedings of the 9th Central European Workshop on Soil Zoology, Contribution to Soil Zoology in Central Europe III*, p. 33–40.
2011. Ascidae: Çakmak *et al.*, *Turk. Entomol. Derg.*, **35**: 575–586.
2012. Ascidae: Britto *et al.*, *Zootaxa*, **3479**: 33–51.
2012. Ascidae: Nemati *et al.*, *Int. J. Agri .Crop Sci.*, **4** (14):1005 – 1011.
2013. Ascidae: Bai and Ma, *Acta Arachnologica Sinica*, **22**: 86–88.
2014. Ascidae: Bai and Ma, *Acta Arachnologica Sinica*, **23**: 32–36.
2016. Ascidae: Moraes *et al.*, *Zootaxa*, **4112** (1):1 – 299.

Diagnosis: Small or middle sized body. Dorsal shield of adults with solid margins or with distinct shallow incisions. Adults with distinct podonotal or opisthonotal shields frequently without setae S₂. More than 21 pairs of setae on dorsal shield (usually 23 – 26 pairs), setae mostly nude or slightly hairy,

sometimes indented, seldom broadened. Tectum with various shapes, gnathosomal setae usually equal and nude, however rostral setae sometimes whip shaped. Tritosternum present. Conrniculi horn – like, strongly sclerotised, acuminated terminally. Peritremes and peritremal shields narrow or wide. Peritremes sometimes exceed beyond stigmatum and coxae IV. Fixed digit of chelicera of female chelate, dentate with several teeth. Movable digit mostly with two teeth. Hypostome grooved in both sexes with 5 – 7 transverse rows of denticles. Sternal shield with 3 pairs of sternal setae. Genital shield usually reaches behind coxae IV with a single pair of genital setae. Ventral shield frequently confluent with anal shield, enlarged, with several pairs of ventrianal setae. In some species, anal shield with 3 anal setae. Small sclerites nearly 1 – 3 pairs between genital and ventrianal or anal shields. Metapodal shields small, oval 1 – 2 pairs. In females 1 – 2 pairs of endopodal shields present. In males, chelicera with spermatophoral process present, usually two shields visible on ventral side; genitosternal and ventrianal, the shields are confluent together very seldom. Anal, ventrianal, hologastric or holovenral shields in adults not fused with dorsal shield. Tarsi IV in several species with two long and apically curved dorso medial setae.

Type species: *Asca* Von Heyden, 1826

Subfamily: Ascinae Voigts and Oudemans, 1905

1905. Ascinae Voigts and Oudemans, *Abh. herausg. Naturwiss. Ver. Bremen.*, **18**:199 – 253.

1939. Ascinae, Oudemans, *Neu Funde auf dem Gebiete der Systematik. Nomen. Acari. III. Zool. Anzeiger*, **126** (1-2): 20-24

1952. Ascinae, Baker and Wharton, *An Introduction to Acarology*. Mc Millan., New York, p.465.

1965. Ascinae, Lindquist and Evans, *Mem. Ent. Soc. Can.*, **47**: 1 – 64

Diagnosis: Anterior margin of epistome variable, usually with 2-3 projections, distally denticulate or not. Seta *h2* usually shorter than *h1*, *h3* and *pc* setae, all of which similar lengths. Deutosternum from narrow to wide. Cheliceral digits similar in length. Fixed digit usually with 4-6 teeth, movable digit usually with two teeth in addition to apical tooth.

6.1.1.1 Morphology and Terminology (Plate :14 A,B)

Dorsal shield of adults divisible into podosomal and opisthosomal region by solid margins or with distinct shallow incisions. Fixed digit of chelicera multidentate, movable digit of chelicera mostly with two teeth, opisthosomal part of dorsal shield frequently without setae *S*₂. More than 21 pairs of setae on dorsal shield, setae mostly nude or slightly hairy, sometimes indented, seldom broadened. Sternal shield with 3 pairs of sternal setae, metasternal shield small, oval, rhomboid or triangular, with one pair of setae. A pair of genital setae closed to lateral margins of genital shield. Ventrianal shield enlarged, with several pairs of setae, anal shield with 3 anal setae. Maximum number of setae on genu I–II–III–IV is 12-10-8-7 and on tibiae-12-9-7-7 respectively.

The majority of taxonomic characters were taken mainly from Evans (1958), Karg (1993) and Bregetova (1977). Setal pattern and arrangements were similar to that of Phytoseiidae except the number. The setae present on the dorsal surface of the podosoma were designated by lower case alphabets

and those on the dorsal opisthosoma are designated by upper case alphabets. The following were the sets of setae present on the dorsal shield.

6.1.1.2 Dorsal setae

- a) *Dorsocentral setae* (j-J):** A row of paired setae present on the central region of the dorsal shield.

j₁ – j₆ – Vertical setae

J₁ – J₅ – Clunal setae

- b) *Mediolateral setae* (z-Z):** Setae present between dorsocentral and dorsolateral setae.

z₁ – z₆ – Podosomal mediolateral setae

Z₁ – Z₅ – Opisthosomal mediolateral setae

- c) *Dorsolateral setae* (s-S):** Setae present between mediolateral and sublateral setae.

s₁ – s₆ – Podosomal dorsolateral setae

S₁ – S₅ – Opisthosomal dorsolateral setae

- d) *Marginal setae* (r₃ and R₁):** Setae present on the lateral integument of the dorsal shield.

r₁ – r₆ – Podosomal marginal setae

R₁ – R₆ – Opisthosomal marginal setae

6.1.1.3 Ventral setae

ST₁ – ST₃ – Sternal setae

ST₄ – Metasternal setae

ST ₅	– Genital setae
ZV ₁ –ZV ₅ , JV ₁ –JV ₄	– Preanal setae
a ₁ –a ₃	– Anal setae
JV ₅	– Caudal setae

Genus : *Asca* Von Heydon, 1826

1963. *Asca*: Hurlbutt, *Acarologia*, **3**: 480 – 518.
1965. *Asca*: Wood, *N.Z. J. I. Sci.*, **8**: 127 – 135.
1966. *Asca*: Bhattacharyya, *Proc. Zool. Soc., Calcutta*, **19**: 31–37.
1969. *Asca*: Genis *et al.*, *Publ. Cult. Comp. Diam., Angola*, **81**: 85–105.
1981. *Asca* : Yi – Hsiung Tseng, *Chin. J. Entomol.* **2**: 7 – 15.
1993. *Asca*: Walter *et al.*, *Invert. Taxon.*, **7**: 1327 – 1347.
1997. *Asca* : Bhattacharyya, *Ann. Entomol.*, **15** (2) : 11–15.
2000. *Asca* : Bhattacharyya *et al.*, *Rec. Zool. Surv. India*, **98**: 93–99.
2002. *Asca* : Bhattacharyya and Sanyal, *Acarina*, **10**: 167–173.
2004. *Asca* : De Leon – Facundo and Corpuz – Raros, *The Philip. Agri. Scientist*, **87**: 196–228.
2005. *Asca* : De Leon , *Asia Life Sciences*, **14**: 111–131.
2011. *Asca*: Beard *et al.*, *Sys. Appl. Acarol.*, **16**: 7–20.
2017. *Asca*: Britto *et al.*, *Internat. J. Acarol.*, p.1 – 5

Diagnosis: Dorsal shield divided into podonotal shield (Anterior dorsal shield) and opisthonotal shield (posterior dorsal shield). Opisthonotal shield with 15 pairs of setae and a prominent posteriolateral tubercles upon which setae Z₄ and S₅ inserted together. Some species Z₄ absent. Podonotal shield

lacking setae z_1 , and with j_2 well behind level of j_1 . Peritrematal shields of adults broad, truncate posteriorly; genu I with 12 setae (*av2* absent). All legs with pretasi. Chaetotaxy of leg I-IV, genu: 12, 11, 8, 9; tibia: 13 or 12, 10, 8, 10 or 9. Leg II not distinctly thickened.

Key to the Species of genus *Asca* included in the present study

1. Dorsal idiosomal setae thick and serrated..... 2
 - Dorsal idiosomal setae not like above, mostly simple..... 4
2. Dorsal idiosomal setae more than 30 pairs 3
 - Dorsal idiosomal setae 30 pairs.....*Asca garmani* Hurlbutt, 1963
3. Dorsal idiosomal setae 33 pairs.....*Asca devadasi* sp.nov
 - Dorsal idiosomal setae 32 pairs..... *Asca indirae* sp.nov.
4. Leg chaetotactic formula; genu III $2 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{2}{1} \frac{2}{0} 1$
 -*Asca sashikalae* sp.nov.
 - Leg chaetotactic formula; genu III $2 \frac{2}{1} \frac{2}{1} 1$ tibia III $1 \frac{2}{1} \frac{1}{1} 1$
 -*Asca spicata* Hurlbutt, 1963

Asca devadasi sp.nov.

PLATE 15

Female

Dorsum: Body 330 long, 180 wide. Dorsal shield with 33 pairs of setae of which 18 pairs on anterior shield and 15 pairs on posterior shield. Anterio-dorsal shield heavily sclerotised with polygonal scales in which a pair of large flat scale present on the posterior-lateral side of the dorsal shield. Posterior-dorsal shield densely sclerotised of which antero-lateral scales look like wings

of butterfly. Anterio-dorsal setae spine like and almost equal size except j_6 , z_4 , z_5 and s_6 , they are plumose. Posterio-dorsal shield with a pair of prominent postero-lateral tubercles on which Z_4 and S_5 present. Each seta on posterior-dorsal shield plumose. Series j with 6 pairs of setae, series z and s each with 5 pairs setae. Setae $j_1 - 13$, j_2 , j_3 , j_4 , j_5 and $j_6 - 22$ long. Setae z_1 , $z_2 - 22$, $z_3 - 19$, $z_5 - 18$ and $z_5 - 20$ long. Setae $s_1 - 11$, $s_2 - 12$, $s_3 - 19$, s_4 , $s_5 - 20$ and $s_6 - 22$ long. Setae $r_3 - 19$ long, R series with 5 pairs of setae, 15 long. On posterior dorsal side, series J, Z and S with 5 pairs of setae. Setae $J_1 - 22$, J_2 , $J_3 - 24$, $J_4 - 26$ and $J_5 - 22$ long. Setae $Z_1 - 22$, Z_2 , $Z_5 - 24$ and Z_3 , $Z_4 - 22$ long. Setae S_1 , $S_4 - 22$, S_2 , $S_3 - 24$ and $S_5 - 19$ long. Peritreme extends up to the base of j_1 . Spermatheca not visible.

Venter: Sternal shield smooth, 63 long and 55 wide, length and width ratio 1. Sternal setae $ST_1 - 19$, ST_2 , $ST_3 - 17$ and ST_4 on metasternal shield 13 long. Genital shield 44 long and 35 wide with setae $ST_5 - 11$ long. Two pairs of pores present near the genital shield. Ventrianal shield 105 long and 132 wide, length and width ratio 0.8. Shape and reticulation of ventrianal shield as shown in the figure. Six pairs of setae present on the shield, of which a pair of setae 25 long and spine like where as all others minute. Four pairs of small pores present around the ventrianal shield. Two pairs of metapodal plates present, primary one 15 long and accessory one 6 long. A continuous septum present between the genital shield and ventrianal shield. Chelicera 22 long, fixed digit of chelicera with 1 tooth and movable digit with 3 teeth. Tectum minutely denticulated. Length of leg I – IV: 556, 354, 240 and 607 respectively. Macrosetae present on leg IV basitarsus – 15 long and tarsus – 17.

Leg chaetotaxy: genu II $2 \frac{2}{2} \frac{1}{1} 1$ tibia II $2 \frac{2}{1} \frac{2}{1} 1$;
genu III $2 \frac{2}{1} \frac{1}{0} 1$ tibia III $1 \frac{2}{1} \frac{1}{0} 1$.

Male: Sternogenital shield smooth, 101 long, 50 wide. ST₁, ST₂, ST₃, ST₄ and ST₅ – 15 each. Ventrianal shield with 113 long, 121 wide, reticulated, semi-circular with 7 pairs of setae other than anal setae. Spermatophoral process present on the movable digit, 22 long. Dorsal setal pattern same as female.

Habitat: *Cucurbita maxima* Duch.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Chelembra (Malappuram district), 1.xii.2015, ex. *Cucurbita maxima* Duch., coll. Santhosh (No.C 1002/1). Five paratype slides with 4 ♀♀ and 1 ♂ (No.C 685 /3, 682/4, 687/5, 1003/6), collection details same as holotype.

Remarks: This species resembles *Asca flabellifera* Tseng, 1981 in general appearance but can be clearly differentiated by the following characters:

1. In the new species, fixed digit of chelicera with 1 tooth and movable digit with 3 teeth where as in *A. flabellifera*, it is 2 and 5 respectively.
2. In the new species tectum is minutely denticulated whereas in *A. flabellifera*, tectum is with 3 tines.
3. In the new species, setae j₆, z₄, z₅ and s₆ plumose whereas in *A. flabellifera* these setae smooth.
4. In the new species, posteriodorsal setae are plumose whereas in *A. flabellifera*, they are leaf shaped with midrib.

Asca garmani Hurlbutt, 1963

PLATE 16

1963. *Asca garmani* Hurlbutt, *Acarologia*, **5**: 491-492.
1966. *Asca garmani* , Bhattacharya , *Pro. Zool. Soc. Calcutta*, **19**: 31-37
1981. *Asca garmani*, Yi-Hsing Tseng, *Chin. J. Entomol.*, **2**: 7-25.
1993. *Asca garmani*, Walter *et al.*, *Invertebrate Taxonomy*, **7**: 1339.
1997. *Asca garmani*, Lee *et al.*, *Kore. J. Sys. Zool.*, **13**:38.
2001. *Asca garmani*, Halliday, *Aust. J. Entomol.*, **40**: 300.
2004. *Asca garmani*, De Leon- Fecundo and Corpuz-Raros, *Phil. Agr. Scientist*.**87**:209.
2005. *Asca garmani*, De Leon- Fecundo, *Asia Life Sciences*, **14**:128.
2009. *Asca garmani*, Mineiro *et al.*, *zootaxa*, **2024**: 2

Female

Dorsum: Body 350 long, 200 wide. Dorsal shield with 32 pairs of setae of which setae S₅ form a rudiment on postriolateral tubercles. In dorsal shield, 17 pairs of setae present on anterior shield and 15 pairs on posterior shield. Anteriodorsal shield is not reticulated on dorsocentral region and weakly sclerotised on antriolateral side. Posteriodorsal shield bears scale shaped ornamentation on its anteriolateral margin . This ornamentation is lacking between J setae series. In anteriodorsal region each setae plumose and almost equal in size whereas on posteriodorsal region, series Z₃, Z₄ and Z₅ setae are spine like. Series j with 6 pairs of setae, series z and s with 5 pairs setae present. Setae j₁ – 13, j₂ , j₃ – 17 , j₄ , j₅ and j₆ – 22 long . Setae z₁ – 17, z₂ – 18, z₃, z₄ and z₅ – 22 long. Setae s₁ – 13, s₂, s₃ – 17, s₄ and s₅ – 22 long. Series r with 2 pairs of setae, r₃ – 17 long and R series with 5 pairs of setae of which R₅

– 35 long. On posterior dorsal side, a pair of prominent posteriolateral tubercles on which Z_4 present but S_5 rudiments. Series J, Z and S with 5 pairs of setae. Setae J_1 – 22, J_2 – 24, J_3 – 28, J_4 – 33 and J_5 minute. Setae Z_1 – 11, Z_2 – 12, Z_3 – 20, Z_4 – 15 and Z_5 – 25 long. Setae S_1 – 22, S_2 , S_3 , S_4 – 26 each. Peritreme extend up to the base of j_1 . Spermatheca not visible.

Venter: Sternal shield smooth, 77 long and 66 wide, length and width ratio 1.2. Sternal setae ST_1 – 19, ST_2 , ST_3 – 13 and ST_4 on metasternal shield 13 long. Genital shield 66 long and 48 wide with setae ST_5 – 13 long. Two pairs of pore present near the posteriolateral side of genital shield. Ventrianal shield measuring 110 long and 196 wide. Length and width ratio 0.56. Ventrianal shield semi-circular with cross running parallel pattern in proximal part with 5 pairs of setae of which a pair of setae long (22). Two pairs of small pores present around ventrianal shield of which a pair is near to setae JV_5 . Two pairs of metapodal plates present. Primary metapodal plate 15 long and accessory plate 6 long. A discontinuous septum present between the genital shield and ventrianal shield. Chelicerae 22 long, fixed digit of chelicera with 4 teeth and movable digit with 2 teeth. Tectum with a central point without dentacles. Length of leg I – IV: 270, 240, 220 and 270 respectively. Macrosetae present on leg IV basitarsus – 26 long. No macrosetae on genu and tibia.

Leg chaetotaxy:

genu	II	$2 \frac{3}{3}$	$\frac{2}{1}$	1	tibia	II	$2 \frac{3}{2}$	$\frac{2}{1}$	1;
genu	III	$2 \frac{2}{2}$	$\frac{2}{0}$	1	tibia	III	$2 \frac{3}{2}$	$\frac{1}{1}$	1.

Male: Unknown

Habitat: *Justicia gendarussa* Burm.f

Known Habitat: Apple orchard, *Pinus* sp.

Material examined: Female marked on the slide, INDIA: KERALA: Pariyaram (Kannur district), 8.xii.2015, ex. *Justicia gendarussa* Burm.f., coll. Santhosh (No.P 812/1), with 4 ♀♀, (No. P 812/3, 812/4, 812/5) from the same habitat.

Distribution: INDIA: West Bengal. OUTSIDE INDIA: Chinshan, Taiwan

Remarks: This species examined resembles *Asca garmani* Hurlbutt, 1963 in almost all characters and hence fixed so. This is a new report from Kerala.

***Asca indirae* sp.nov.**

PLATE 17

Female

Dorsum: Body 330 long, 200 wide. Dorsal shield with 32 pairs of setae of which setae S₅ form a rudiment on postriolateral tubercles. Anterior dorsal shield with 17 pairs of setae and posterior shield with 15 pairs of setae. Anteriodorsal shield obliquely sclerotised on lateral side and weakly sclerotised on central. Lateral shield shows semiconcentric patterns of sclerotisation on lateral ends. Posteriodorsal shield with anteriolateral scale shaped ornamentation which looks like wings of butterfly. This ornamentation is lacking between J setae series. Each setae plumose and almost equal size on anteriodorsal region whereas on posteriodorsal region series Z and S with spine like setae and J series plumose. Series j with 6 pairs of setae, series z and s with 5 pairs setae. Setae j₁ – 15, j₂ – 22, j₃ – 24, j₄ – 15, j₅ and j₆ – 17 long, setae z₁, z₂, z₃, z₄ and z₅ – 22 long. Setae s₁, s₂, s₃, s₄ and s₅ – 22 each and s₆ – absent. Setae r₃ – 22 long, series r with 2

pairs of setae and R series with 5 pairs of setae. On the posteriodorsal side, a pair of prominent posteriolateral tubercles on which Z_4 is present but S_5 is rudimentary. Series J, Z and S with 5 pairs. Setae J_1, J_2, J_3 – 22 each, J_4 – 24 and J_5 minute. Setae Z_1 – 22, Z_2 – 24, Z_3 – 44, Z_4 – 28 and Z_5 – 26 long. Setae S_1 – 22, S_2, S_3, S_4 – 24 each. Peritreme extends up to the base of j_1 . Spermatheca not visible.

Venter: Sternal shield smooth, 77 long and 55 wide, length and width ratio 1.4. Sternal setae ST_1 – 22, ST_2 – 11, ST_3 – 12 and ST_4 on metasternal shield 12 long. Genital shield 66 long, 48 wide with ST_5 – 12 long. Two pairs of pores present near the posteriolateral side of the genital shield. Ventrianal shield measuring 260 long and 110 wide. Length and width ratio 2.3. Ventrianal shield sub triangular with cross running parallel patterns on proximal part with 5 pairs of setae of which a pair is long (22) and all others are minute. Two pairs of small pores present around ventrianal shield. Two pairs of metapodal plates present, primary one 13 long and accessory one 11 long. A discontinuous septum present between the genital shield and ventrianal shield. Chelicerae 26 long, fixed digit of chelicera with 2 teeth and movable digit with single tooth. Tectum minutely denticulated at centre with two lateral points. Length of leg I – IV: 280, 200, 200 and 280 respectively. Macrosetae present on leg IV basitarsus – 24 long.

Leg chaetotaxy:

genu II	$2 \frac{3}{2} \frac{2}{1} 1$	tibia II	$2 \frac{2}{2} \frac{1}{0} 1;$
genu III	$2 \frac{2}{1} \frac{1}{0} 1$	tibia III	$1 \frac{2}{1} \frac{1}{0} 1.$

Male: Unknown

Habitat: *Clerodendrum paniculatum* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Calicut University Campus (Malappuram district), 27.vii.2015, ex. *Clerodendrum paniculatum* L., coll. Santhosh (No.C 59/1). Five paratype slides with 5 ♀ ♀, (No. 59/3, 59/4, 59/5, 59/6, 59/7) from the same habitat.

Remarks: This species resembles *Asca aphidiodes* Vitzthum, 1926 in dorsal chaetotaxy but differs in the following characters:

1. In new species, dorsal shield is sclerotised with oblique reticulations on anteriolateral side whereas in *A. aphidiodes*, dorsal shield sclerotised with polygonal reticulation with minute protuberance.
2. All setae plumose in *A. aphidiodes* whereas in the new species, posteriodorsal setae Z and S series spine like.
3. In the new species, tectum minutely denticulate at centre with two lateral points whereas in *A. aphidiodes* tectum with 3 tines.
4. In the new species, posterior tubercle bears Z_4 and a rudiment of S_5 where as in *A. aphidiodes*, it bears Z_4 only.
5. In *A. aphidiodes* setae Z_4 plumose whereas in the new species it is spine like.
6. In new species, lateral shield shows semi-concentric patterns of sclerotisation on anteriordorsal region whereas it is absent in *A. aphidiodes*.

***Asca sashikalae* sp.nov.**

PLATE 18

Female

Dorsum: Body 380 long, 210 wide. Dorsal shield with 32 pairs of setae of which 17 pairs on anterior shield and 15 pairs on posterior shield. Anteriodorsal shield densely sclerotised with polygonal scales. A prominent ornamentation present between setae j_6 . Posteriodorsal shield with anteriolateral scale shaped ornamentation which looks like wings of a butterfly. These ornamentations are lacking between J setae series. Each setae spine like and almost equal except J_5 . Posterior dorsal shield with a pair of prominent posteriolateral tubercles on which Z_4 and S_5 arising. A thick band of rectangular ornamentation measuring 37 long and 151 wide, formed of polygonal scales are present between the tubercles. A pair of prominent rounded scales present in the centre of the band which is peculiar to this species. Series j with 6 pairs of setae, series z and s with 5 pairs setae. Setae j_1 –9, j_2 , j_3 and j_5 –15 long, j_4 and j_6 –16 long. Setae z_1 , z_2 , z_3 , z_4 –15 long and z_5 –20 long. Setae s_1 –11, s_2 –8, s_3 –15, s_4 –17 and s_5 –20 and s_6 –absent. Setae r_3 –15 long. R series with 5 pairs of setae measuring 13–22 long. On posteriodorsal side, series J, Z and S are with 5 pairs of setae. Setae J_1 –15, J_2 –22 long, J_3 –24, J_4 –33 and J_5 –11 long. Setae Z_1 –22, Z_2 –28, Z_3 –35, Z_4 –24 and Z_5 –33 long. Setae S_1 –22, S_2 –28, S_3 , S_4 –33, S_5 –15 long. Peritreme extends up to the base of j_1 . Tectum and spermatheca not visible.

Venter: Sternal shield smooth, 77 long and 70 wide; length and width ratio 1. Sternal shield smooth with setae ST_1 , ST_2 , ST_3 and ST_4 13 each. Genital shield 44 long and 44 wide with setae ST_5 –13 long. Two pairs of pores

present near the posteriolateral side of genital shield. Ventrianal shield measuring 121 long and 176 wide. Length and width ratio 0.7. Ventrianal shield semi-circular with cross running parallel patterns on proximal part with 5 pairs of setae of which setae ZV₃ 25 long and another pair of setae short and thorn like. Five pairs of small pores and 3 pairs of small setae present around ventrianal shield of which lateral pair is thorn like. Post anal setae remarkably long (37). Two pairs of metapodal plates present. Fine striations present on the lateral margin of venter. Primary metapodal plate 12 long and accessory plate not visible. A discontinuous septum present between the genital shield and ventrianal shield. Chelicerae 28 long, fixed digit of chelicera with 3 teeth, movable digit with a large prominent tooth and two simple teeth. Length of leg I – IV: 270, 250, 240 and 300 respectively. Setae on dorsal and ventral sides are simple, lateral setae thorn like arising from tubercles. Macrosetae present on leg IV, basitarsus – 22 long and tarsus – 26.

Leg chaetotaxy: genu II $2 \frac{2}{1} \frac{2}{0} 1$ tibia II $2 \frac{3}{1} \frac{2}{0} 1$;
genu III $2 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{2}{1} \frac{2}{0} 1$.

Male: Unknown

Habitat: *Ixora coccinea* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kadalundi (Malappuram district), 31.xi.2015, ex. *Ixora coccinea* L., coll. Santhosh (No. K 608/1). Three paratype slides with 4 ♀♀, (No. K 608/3, 608/4, 608/5) from the same habitat.

Remarks: This species resembles *Asca tricornicula* Tseng, 1981 in general appearance, chaetotaxy etc., but can be clearly distinguished by the following characters:

1. In the new species, fixed and movable digit of chelicerae with 3 teeth instead of 2.
2. In *A. tricornicula*, setae on anteriodorsal shield set on tubercles and setae j_1 pilose whereas in the new species, tubercles absent and setae j_1 is simple, spine like.
3. In the new species, all setae on posteriodorsal shield spiny in nature whereas in *A. tricornicula*, posteriodorsal setae pilose and leaf shaped.
4. In the new species, sternal shield 77 long and 70 wide but in *A. tricornicula*, it is 96 and 72 respectively.
5. Ventrianal shield with 5 pairs of setae in the new species instead of 6 pairs.
6. Setae ZV_3 – 35 long, slightly clavated and minutely barbed in *A. tricornicula*, whereas in the new species, it is spiny, 25 long.
7. In the new species, the posterior tubercles are connected with a thick band of polygonal sclerites whereas in *A. tricornicula*, this band is absent.

Asca spicata Hurlbutt, 1963

PLATE 19

1963. *Asca spicata* Hurlbutt, *Acarologia*, **5**: 514-515.

1981. *Asca spicata*, Yi-Hsing Tseng, *Chin. J. Entomol.*, **2**: 7-25

1993. *Asca spicata*, Farrier and Hennessey, *Soil inhabiting and free-living Mesostigmata (Acari-Parasitiformes) from North America, An annotated checklist with bibliography and index. Tech. Bull.*, North Carolina State University, Raleigh, **302**:29.
2004. *Asca spicata*, De Leon- Fecundo and Corpuz-Raros, *Phil. Agr. Scientist*, **87**:221.
2005. *Asca spicata*, De Leon- Fecundo, *Asia Life science*, **14**: 129.
2006. *Asca spicata*, Karg, *Zoologische Reihe*, **82**: 162.

Female

Dorsum: Body 300 long, 180 wide. Dorsal shield with 31 pairs of setae of which 16 pairs on anterior shield and 15 pairs on posterior shield. Anterior dorsal shield weakly sclerotised. Posteriodorsal shield with prominent scale shaped ornamentation present, but lacking in the area between J setae series. Each setae spine like and almost equal size except J₄ and S₅. Posterior dorsal shield with a pair of prominent posteriolateral tubercles with Z₄ and S₅ setae. Series j, z and s with 6 pairs of setae. Setae j₁ – 13, j₂ and j₄ – 17, j₃ – 22 and j₅ – 19 long and setae j₆ absent. Setae z₁, z₂, z₃, z₄, z₅ and z₆ – 22 each. Setae s₁ – 13, s₂ – 17, s₃, s₄ and s₅ – 22 and s₆ – absent. Setae r₃ – 17 long. Series r with 3 pairs of setae measuring 20 long and R series with 5 pairs of setae measuring 24 long. In posteriodorsal side, series J, Z and S with 5 pairs of setae. Setae J₁, J₂ – 22 long, J₃ – 26, J₄ – 41 and J₅ – 25 long. Setae Z₁ – 22, Z₂ – 24, Z₃ – 37, Z₄ – 13 and Z₅ – 37 long. Setae S₁ – 22, S₂, S₃ – 24, S₄ – 28, S₅ – 25 long. Peritreme extends up to the base of j₁. Spermatheca not visible.

Venter: Sternal shield smooth, 77 long and 61 wide, length and width ratio 1. Sternal setae ST₁ – 19, ST₂, ST₃ – 17 and ST₄ on metasternal shield 13 long.

A pair of pore present near the posteriolateral side of sternal shield. Genital shield 44 long and wide with setae ST_5 –13 long. Ventrianal shield measuring 97 long, 154 wide; length and width ratio 0.6. Ventrianal shield smooth and sub triangular with 5 pairs of setae. A pair of small pores present on lateral side of ventrianal shield. Ventrianal shield strongly ornamented with linear striations. Setae JV_5 – 33 long. Two pairs of metapodal plates present. Primary one 10 long and accessory one minute. A septum present between the genital shield and ventrianal shield. Two pairs of pores and a pair of setae present below the septum. Chelicera 28 long, fixed digit of chelicera with 2 teeth and movable digit with a large prominent teeth and two simple teeth present. Tectum minutely denticulated. Length of leg I – IV: 250, 220, 200 and 260 respectively. Setae on all legs are spiny almost equal size. No macrosetae present on leg IV.

Leg chaetotaxy: genu II $2\frac{3}{1}\frac{2}{1}2$ tibia II $2\frac{2}{1}\frac{2}{1}1$;
genu III $2\frac{2}{1}\frac{2}{1}1$ tibia III $1\frac{2}{1}\frac{1}{1}1$.

Male: Unknown

Habitat: *Bauhinia acuminata* L.

Known Habitat: Rice leaf sheath, *Metrosideros collina*

Material examined: Female marked on the slide, INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex. *Bauhinia acuminata* L., coll. Santhosh (No.V 326/1), another slides with three ♀♀ (No.V 326/3, 326/4, 326/5) collection details same.

Distribution: Chinshan, Taiwan

Remarks: This species resembles *Asca spicata* Hurlbutt, 1963 in general appearance, dorsal chaetotaxy and hence fixed so. It is the first report from India. In the present survey it was recovered from a new host plant *Bauhinia acuminata* (L.),

6.1.2 FAMILY: BLATTISOCIIDAE Garman, 1948.

1948. Blattisociidae: Garman, *Conn. Agr. Exp. St. Bull.*, **520**:5-27.

1964. Blattisociidae: Lindquist, *A revision of Mites of Subfamily Blattisociinae (Acarina: Blattisociidae) in America North of Mexico. University of California, Berkeley*, p. 68.

1973. Blattisociidae: Athias-Henriot, *Bull. Soc. Ento. France*, p. 227.

2009. Blattisociidae: Lindquist *et al.*, *A Manual of Acarology*, 3rd Edition, Texas Tech University Press, Lubbock, p.164.

2010. Blattisociidae: Lindquist and Moraza, *Zootaxa*, **2243**:2

Diagnosis: Dorsum with podonotal and opisthonotal shield fused, smooth or ornamented. Podonotal shield usually with 11 pairs of setae, including r₃ opisthonotal shield with 7-10 pairs of setae. Unsclerotised lateral cuticle with six pairs of setae. Anterior region of epistome variously shaped, smooth or denticulate. Deutosternum moderately wide to distinctly wide with delimiting lateral lines. Presternal platelets indistinct. Corniculi 1-4 times as long as their basal width. Palp tarsal apotele two – tined. Chelicera stout, elongate, digits of similar lengths. Peritreme extending from stigma to j₂. Fixed digits of chelicera with 4-20 teeth in addition to apical tooth, movable digit with 0-4 teeth. Leg chaetotaxy I-IV, genu: 13, 10, 8, 9; tibia; 13,

10,8,10. Leg IV with one or more distinct macrosetae. Phytoseiid-type spermathecal apparatus.

Type species: *Aceodromus* Muma, 1961.

Subfamily: **B. BLATTISOCIINAE** Garman, 1948

1948. Blattisociinae Garman, *Conn. Agr. Exp. St. Bull.*, **520**:5-27.

1963. Blattisociinae, Chant, *Can. J. Zool.*, **41**:243-305

1964. Blattisociinae, Lindquist, *A revision of Mites of Subfamily Blattisociinae (Acarina: Blattisociidae) in America North of Mexico. University of California, Berkeley*, p. 74.

1965. Blattisociinae, Lindquist and Evans, *Memoirs. Ent. Soc. Canada*, p. 45

1965. Blattisociinae, Karg, *Mitt.Zool.Mus., Berlin*, **41**:307.

1971. Blattisociinae, Karg, *Die Tierwelt Deutschlands, New York*, **59**:81.

1993. Blattisociinae, Karg, *Die Tierwelt Deutschlands, New York*, p.171.

Diagnosis: Dorsal shield entire with more than 21 pairs of setae; sternal shield with 2 or 3 pairs of setae; genital shield generally truncate posteriorly with or without a pair of setae; female with an anal plate or ventrianal shield, posteroventral integument with not more than 15 pairs of setae; lateral integuments frequently with a number of setae; tectum smooth, minutely denticulate or with 2 or 3 process; chelicerae small, short with varied dentition. Rostral setae present and internal setae on palp trochanter never long, whip like; tarsi II to IV without specialized setae, peritremal plate and peritreme not developed behind posterior margin of coxa IV; para-anal setae anterior to posterior margin of anus.

Type species: *Aceodromus* Muma, 1961.

6.1.2.1 Morphology and terminology (Plate:20 A,B)

Anterior region of epistome variously shaped, smooth or denticulate. Corniculi 1–4 times as long as their basal width, with pointed tips, generally well separated from each other and subparallel. Movable digit with 0–4 teeth, fixed digit usually with 4–20 teeth, up to 40 teeth in some *Lasioseius*. Idiosoma elongated or hemispherical, podonotal and opisthonotal shields fused, smooth or ornamented, usually without distinct lateral incisions at line of fusion; without transverse and nearly straight lines or posterior tubercles; usually without delineated strip along lateral margins. Podonotal region of shield usually with 15–25 pairs of setae, opisthonotal region of shield with 8–16 pairs of setae, unsclerotised lateral cuticle with 0–16 pairs of setae, venter with 0–3 pairs of presternal plates or with sclerotised presternal area consolidated or confluent with sternal shield. Sternal shield usually with three pairs of setae (ST₁–ST₃) only 1–2 pairs in *Blattisocius*. Opisthogaster with 5–10 pairs of setae; with an anal shield bearing only circumanal setae, or with a ventrianal shield bearing additionally up to 7 pairs of setae; para-anal setae usually inserted between levels of anterior and posterior margins of anal opening. Pritreme commonly extending from stigma at least to level of s₂. Usual setation of legs I–IV, genu: 13 (12), 11 (10), 9 (8), 10 (8,9); tibia: 13(12), 10 (9), 8 (9), 10 (9). Spermathecal apparatus phytoseiid-type (except in *Zercoseius*). In male fixed digit of chelicerae with 1–12 teeth in addition to apical tooth; movable digit usually with one tooth in addition to apical tooth, spermatodactyl twice as long as movable digit, ventrianal shield including 4–7 pairs of setae in addition to circumanal setae. Legs similar to female.

Taxonomic characters were taken mainly from Evans (1958), Karg (1993) and Bregetova(1977). Setal pattern and arrangements are similar to that of Ascidae except the number.

Genus : *Lasioseius* Berlese, 1916

1916. *Lasioseius* Berlese, *Redia*, **12**: 34.
1941. *Aceosejus* Sellnick, *Zool. Anz.*, **133**: 149.
1946. *Lasioseius*, Borinquolaelaps Fox, *J. Parasitol.*, **32**: 450.
1958. *Lasioseius*, Evans, *Proc. Zool. Soc. Lond.*, **131**: 189.
1960. *Lasioseius*, Evans and Hyatt, *Bull. Bit. Mus. (Nat. Hist.) Zool.*, **6**: 29.
1961. *Lasioseius*, Athias – Henriot, *Acarologia*, **3** : 458.
1963. *Lasioseius*, Chant, *Can. J. Zool.*, **41** : 249.
1965. *Lasioseius*, Lindquist and Evans, *Mem. Ent. Soc. Canada*, **47**: 21.
1972. *Lasioseius*, H.urlbutt, *Acarologia*, **13** : 289.
1979. *Lasioseius*, Evans and Till, *Trans. Zool. Soc. Lond.*, **35**: 182.
1985. *Lasioseius*, Gupta, *Handbook. Plant mites of India*, p. 330.
1994. *Lasioseius*, Gu and Guo , *Acta Arachnologica Sinica*, **3**: 86–90.
1995. *Lasioseius*, Bai *et al.*, *Entomotaxonomia*, **17**: 59–62.
1995. *Lasioseius*, Bei and Yin, *Entomotaxonomia*, **17**: 152–154.
1997. *Lasioseius*, Walter and Lindquist, *Invert. Taxon.*, **11**: 525 – 547.
2001. *Lasioseius*, Bhattacharyya and Bhattacharyya *Rec. Zool.Surv. India*, **99**: 23–26.
2001. *Lasioseius*, Gwiazdowicz, *Biol. Brat.*, **56**: 469–471.
2002. *Lasioseius*, Bhattacharyya and Sanyal, *Acarina*, **10**: 51–56.
2002. *Lasioseius*, De Leon – Facundo and Corpuz – Raros, *Philip. Agrl.Sci.*, **85**: 39–46.
2003. *Lasioseius*, Bhattacharyya, *Zootaxa*, **189**: 1–10.
2003. *Lasioseius*, Gwiazdowicz , *Biol. Brat.*, **58**: 147–150.
2005. *Lasioseius*, Faraji and Karg *Internat.J. Acarol.*, **31**: 113–117.

2006. *Lasioseius*, Christian and Karg, *Abha. Berich. Nat.mus.,Gorlitz*, **77** (2): 99–250.

2011. *Lasioseius*, Britto *et al.*, *Zootaxa*, **2905**: 1–15.

2014. *Lasioseius*, Bai *et al.*, *Acta Arachnologica Sinica*, **23**: 32–36.

Diagnosis: Adults with holodorsal shield; dorsal setae mostly conspicuously trispinate, partly acicular; however, caudal dorsal setae frequently pectinate, posterior half of dorsum with a maximum of 15 pairs of setae. 1 –12 pairs of setae on the membrane lateral to the holodorsal shield (r and R setae), however marginal seta r_3 (humeral seta) conspicuous and situated on the dorsal shield. Females with ventrianal shield with 5 – 7 pairs of setae, exceptionally 1 – 3 pairs. Adanal setae inserted anteriorly behind the margin of the anus; tectum mostly with 3 branches or 3 groups of points, sometimes irregularly denticulate. Corniculi strong, sometimes split; 8 hypognathal rows, first row smooth, 7 rows multidenticulate; movable digit of chelicera in most subgenera with 3 teeth; fixed digit of chelicera with a setiform *pilus dentilis* and with a saw like dental row of teeth, spermatodactyl of males finger shaped. Legs II – IV with median lobes, pulvilli rounded; genu III with 8 or 9 setae; femora I and II with 12 and 11 setae, respectively.

Type species: *Seius muricatus* Berlese and Koch, 1887

Key to the Species of genus *Lasioseius* included in the present study

1. Dorsolateral setae very strong mostly placed on tubercles and setae j1 leaf like, serrate and palmate.....*Lasioseius wayanadensis* sp.nov.
- Not like above..... 2
2. Dorsal idiosomal setae thick, serrated, elongated leaf like..... 3
- Setae mostly smooth 8

3. Dorsal shield with 30 pairs of setae 4
 - Dorsal shield with 31 pairs of setae 5
4. Ratio of length and width of sternal shield is more than 1
 - *Lasioseius kurachundensis* sp.nov.
 - Ratio of length and width of sternal shield less than 1
 - *Lasioseius adhatodae* sp.nov.
5. Prodorsal shield with 16 pairs of setae 6
 - Prodorsal shield with more than 16 pairs of setae 7
6. Movable digit of chelicerae with 3 teeth, median tooth much larger than other 2 teeth *Lasioseius gangadharani* sp.nov.
 - Movable digit of chelicerae with 4 teeth, all of same size.....
 - *Lasioseius gokuldasi* sp.nov.
7. Propodosomal shield with 17 pairs of setae, ratio of length and width of sternal shield and ventrianal shield both equal to 1
 - *Lasioseius soudhaminiaie* sp.nov.
 - Prodorsal shield with 18 pairs of setae, ratio of length and width of sternal shield more than 1 and that of ventrianal shield less than 1
 - *Lasioseius pazhurensis* sp.nov.
8. Ventrianal shield triangular 9
 - Ventrianal shield pentagonal *Lasioseius plumatus* Karg
9. Ratio of length and width of ventrianal shield is equal to 1.28 and that of sternal shield equal to 1.21 *Lasioseius guptai* sp.nov.
 - Ratio of length and width of ventrianal shield and sternal shield equal to 0.93 and 1.17 respectively..... *Lasioseius pavani* sp.nov.

Lasioseius adhatodae* sp.nov.*PLATE 21****Female**

Dorsum: Body 306 long, 210 wide. Dorsal shield with small polygonal reticulations present on the entire shield. Dorsal shield with 30 pairs of setae, of which 16 pairs are on anterior shield. All setae finely plumose and almost equal size except Z_5 . Setae j , z and s series with 5 pairs each. Setae $j_1 - 13$, $j_2 - 19$, $j_3 - 22$, $j_4 - 13$, $j_5 - 24$ and $j_6 - 22$ long. Setae $z_1 - 19$, z_2 , $z_5 - 13$ each, $z_6 -$ absent. Setae $s_1 - s_4$ 13 long, $s_5 -$ absent and $r_3 - 13$ long. In posteriodorsal side, series J and, Z each with 5 pairs of setae. Series S with 4 pairs of setae. Setae $J_1 - 44$, $J_2 - 46$, $J_3 - 47$, $J_4 -$ absent and $J_5 - 5$ long. Setae $Z_1 - 14$, $Z_2 - 22$ long, $Z_3 - 24$, $Z_4 - 39$ and $Z_5 - 22$ long, more plumose than other sets of setae. Setae $S_1 - 22$, $S_2 - 35$ and S_3 , $S_4 - 37$, $S_5 - 39$ long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 . Spermatheca as shown in the figure.

Venter: Sternal shield articulated with peculiar reticulations, 66 long and 67 wide, length and width ratio 0.98. Sternal setae $ST_1 - 11$, ST_2 not found, $ST_3 - 11$ and ST_4 on metasternal shield 15 long. Genital shield 61 long and 50 wide with setae $ST_5 - 13$ long. Ventrianal shield measuring 99 long and 98 wide. Length and width ratio 1. Ventrianal shield sub quadrate with densely reticulated and curved on posterior part. Setae $JV_1 - 11$, $JV_2 - 12$, $JV_4 -$ minute and $JV_5 - 44$ long. Setae $ZV_1 - 13$, $ZV_2 - 12$ and $ZV_3 -$ minute. Two pairs of metapodal plates present. Primary one 33 long and accessory one 12 long, found attached to the primary plate. A continuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulations. Chelicera 22 long, fixed digit of chelicera with 4

teeth posterior to *pilus dentilis* and no tooth anterior to it. Movable digit with no tooth. Tectum minutely denticulated at central points, no dentacle present on lateral points. Length of leg I – IV: 420, 380, 350 and 556 respectively. Leg IV with no macrosetae present.

Leg chaetotaxy: genu II $2 \frac{3}{1} \frac{2}{1} 2$ tibia II $1 \frac{2}{1} \frac{2}{1} 1$;
genu III $2 \frac{2}{1} \frac{2}{1} 2$ tibia III $1 \frac{2}{1} \frac{2}{1} 1$.

Male : Unknown.

Habitat : *Justicia adhatoda* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Herbal garden, Malabar Christian College, Calicut (Kozhikode district), 18.viii.2015, ex. *Justicia adhatoda* (L.), coll. Santhosh (No.M 306/2). Three paratype slides with 3 ♀ ♀ (No. M 306/3, 306/4, 306/5) from the same habitat.

Remarks: This species resembles *Lasioseius pellitus* Karg, 1994 but can be clearly differentiated by the following features:

1. In the new species, dorsal shield is 340 long with 30 pairs of setae whereas in *L. pellitus*, it is 370 long with 31 pairs of setae.
2. In the new species, dorsal shield entirely reticulated but in *L. pellitus*, it is smooth.
3. In the new species, ventrianal shield sub quadrate with densely reticulated and curved posterior part whereas in *L. pellitus*, it is triangular.
4. In *L. pellitus*, the central part of sternal shield is smooth whereas in the new species, the central part of sternal shield is sculptured with an arch shaped sclerite.

5. In the new species, tectum is variable with 4 points whereas in *L. pellitus*, tectum is rounded with margins minutely denticulate.
6. In the new species, Z_5 – 22 long instead of 45.

***Lasioseius gangadharani* sp.nov.**

PLATE 22

Female

Dorsum: Body 380 long, 230 wide. Dorsal shield densely reticulated with 31 pairs of setae, of which 15 pairs on posterior dorsal shield. A pair of sclerites as shown in the figure present in between the setae j_5 and J_1 . All setae on dorsal shield swollen distally and serrated. On anteriodorsal shield, the series j, z and s each with 5 pairs of setae and a pair of r_3 present on lateral margin. On posteriodorsal shield, the series J, Z and S each with 5 pairs of setae. Setae j_1, j_2 and j_3 measuring 26 each, j_4 – 24, j_5 – 22 and j_6 – 24. Setae z_1 – 17, z_2, z_3, z_5, z_6 – 22 each and z_4 – 28 long. Setae s_1, s_3, s_6 – 24 each, s_2 – 22, s_4 – 26 and r_3 – 26. Series r and R with two pairs of setae. Setae J_1 – 26, J_2 – 28, J_3 – 33, J_4 – 46 and J_5 – 6. Setae Z_1 – 22, Z_2 – 24, Z_3 – 33, Z_4 – 39 and Z_5 – 50 long. Setae Z_4 and Z_5 more pectinate at the tip. Setae S_1 – 22, S_2 – 24, S_3 – 26, S_4 – 28 and S_5 – 39 long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 . Tectum with 3 spines, minutely denticulate at area between each lateral and central points.

Venter: Sternal shield 95 long, 100 wide; length and width ratio 0.95, finely granulated and reticulated on lateral sides. Sternal setae ST_1, ST_2, ST_3 – 22 long and ST_4 on metasternal shield, 11 long. Genital shield 80 long, 70 wide with reticulation on lateral sides. Genital setae ST_5 measuring 13 long. Ventrianal shield triangular, measuring 120 long, 130 wide with broader

anterior and narrow posterior part. Length and width ratio 0.92. Setae JV_1 , JV_2 , JV_4 – 8 each, JV_5 – 24 long. Setae ZV_1 , ZV_2 – 11 and ZV_3 – 8 long. Two pairs of metapodal plates present. Primary metapodal plate 25 and accessory one 13 long. A discontinuous septum present between the genital and ventrianal shield. Anal region well marked with plate like reticulation. Chelicera 33 long, fixed digit of chelicera multidentate, movable digit with 4 teeth. Length of leg I – IV: 340, 310, 290 and 420 long respectively. Leg IV with macrosetae on tibia – 100 long and basitarsus – 110 long.

Leg chaetotaxy:

genu	II	2	$\frac{4}{1}$	$\frac{1}{1}$	1	tibia	II	2	$\frac{3}{0}$	$\frac{1}{2}$	1;
genu	III	2	$\frac{2}{2}$	$\frac{1}{0}$	1	tibia	III	2	$\frac{1}{1}$	$\frac{1}{1}$	1.

Male: Unknown

Habitat: *Psidium guajava* L., *Magnolia chempaka* (L.).

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Botanical garden, Calicut University (Malappuram district), 25.ix.2015, ex. *Psidium guajava* L., coll. Santhosh (No.K 25/2, 25/3). Three paratype slides with 3 ♀♀, ex. *Magnolia chempaka* (L.), (No. P 25/4, 144/5, 144/6), other details similar to holotype.

Remarks: This species resembles *Lasioseius matthysei* Chant, 1963 in general appearance, structure of setae etc, but differs in the following characters.

1. In the new species, the size of the body is smaller when compared to *L. matthysei*.
2. In the new species, dorsal shield densely reticulated over entire surface with 31 pairs of setae whereas in *L. matthysei* dorsal shield smooth with 30 pairs of setae.

3. In the new species, sternal shield has reticulations on lateral margin and granulation on central region where as it is smooth in *L. matthysssei*.
4. In the new species, ventrianal shield is smaller (120 long and 130 wide) whereas in *L. matthysssei* it is 130 long 155 wide.
5. In the new species, movable digit with 4 teeth instead of 2 or 3 teeth in *L. matthysssei*
6. Macrosetae present on Leg IV genu in *L. matthysssei* whereas it is absent in the new species.

***Lasioseius gokuldasi* sp.nov.**

PLATE 23

Female

Dorsum: Body 400 long, 210 wide. Dorsal shield loosely reticulated on the center and finely reticulated on lateral margin with 31 pairs of setae, of which 16 pairs on anterior dorsal shield. All setae plumose, series j, z and s each with 5 pairs of setae, series J, Z and S each with 5 pairs of setae. Setae j_1, j_3, j_4 – 22 long, j_2 – 26, j_5 – 24, j_6 – absent. Setae z_1, z_2 – 19, z_3 – 26, z_4, z_5 – 24, z_6 – absent. Setae s_1 – 22, s_2, s_3 – 23, s_4 – 26, s_5 – 17 and r_3 – 33. Series R with three pairs of setae, Setae J_1, J_2, J_3 – 28, J_4, J_5 – 26. Setae Z_1 – 23, Z_2, Z_3 – 26 each, Z_4 – 48 and Z_5 – 55 long. Setae Z_4 and Z_5 long and more plumose than other sets of setae. Setae S_1 – 22, S_2 – 26, S_3 – 28, S_4 – 32 and S_5 – 33 long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 .

Venter: Sternal shield 100 long, 80 wide; length and width ratio 1.25, densely granulated on entire shield and slightly reticulated on lateral side.

Sternal setae ST₁, ST₂, ST₃ – 20 long, ST₄ on metasternal shield 11 long. Genital shield 74 long and 66 wide with setae ST₅ –13 long. Ventrianal shield triangular, densely reticulated with broader anterior and narrow posterior part measuring 121 long, 110 wide; length and width ratio 1.1. Setae JV₁, JV₂, JV₄ – 8 each, JV₅ – 24 long. Setae ZV₁, ZV₂ and ZV₃ – 8 long. Two pairs of metapodal plates present. Primary one 22 long, 5 wide and accessory one 13 long. A discontinuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulations. Chelicera 33 long, fixed digit of chelicera multidentate with no *pilus dentilis*, movable digit with 4 teeth. Tectum minutely denticulated. Length of leg I –IV: 350, 320, 290 and 400 respectively. Leg IV with no macrosetae on genu and tibia, basitarsus 22 long.

Leg chaetotaxy: genu II $2 \frac{3}{0} \frac{2}{1} 2$ tibia II $2 \frac{2}{1} \frac{2}{1} 1$;
genu III $2 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{2}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Murraya koenigii* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex. *Murraya koenigii* (L.), coll. Santhosh (No.K 1004/2). Three paratype slides with 5 ♀♀, (No. K 1004/4, 1004/5, 1004/6), collection details same as holotype.

Remarks: This species resembles *Lasioseius meridionalis* Chant, 1963 in general appearance but can be clearly differentiated by the following characters:

1. In the new species, dorsal shield is 400 long, 210 wide with 31 pairs of setae whereas in *L. meridionalis*, it is 470 long and 230 wide with 36 pairs of setae.
2. In the new species, all setae plumose, whereas in *L. meridionalis*, all setae slightly thickened and Z_5 serrated.
3. In the new species, ventrianal shield 121 long, 110 wide whereas in *L. meridionalis*, it is 160 long and 190 wide.
4. In the new species, sternal shield reticulated on lateral margin and granulated on centre instead of smooth nature.
5. In the new species, tectum minutely denticulate whereas in *L. meridionalis*, it is trispinate.
6. In the new species, movable digit of chelicera with 4 teeth instead of 3.

***Lasioseius guptai* sp.nov.**

PLATE 24

Female

Dorsum: Body 370 long, 210 wide. Dorsal shield reticulated only on the anteriolateral margin of prodorsum. Dorsal shield with 31 pairs of setae of which 16 pairs on anterior shield. All setae spine like almost equal in size. j, z and s series with 5 pairs of setae. Setae $j_1 - 31$, $j_2 - 33$, j_3 , $j_4 - 28$ and $j_5 - 26$ long, $j_6 -$ absent. Setae z_1 , z_2 , z_4 and $z_5 - 22$ each and $z_3 - 33$, $z_6 -$ absent. Setae $s_1 - 30$, s_2 , s_3 , s_4 , $s_5 - 28$ and $r_3 - 46$ long. Series R with two pairs of setae. In posteriodorsal side, series J, Z and S each with 5 pairs of setae. Setae $J_1 - 24$, J_2 , $J_3 - 28$ and $J_4 - 26$, $J_5 - 8$ long. Setae Z_1 , $Z_2 - 28$ long, $Z_3 - 30$, $Z_4 - 39$ and $Z_5 - 61$ long. Setae Z_5 predominantly longer than other sets of setae. Setae $S_1 - 26$, S_2 and S_3 , $S_4 - 28$, $S_5 - 37$ long. Peritremal exopodal shield fused anteriorly

to podonotal shield. Peritreme extends anteriorly upto the base of j_1 . Spermatheca having vesicular cervix, 8.8 long with undifferentiated atrium.

Venter: Sternal shield smooth, 88 long and 72 wide, length and width ratio 1.2. Sternal setae $ST_1 - ST_3 - 22$ and ST_4 on metasternal shield 18 long. Genital shield 61 long and 57 wide with setae $ST_5 - 18$ long. Ventrianal shield longer than wider, measuring 107 long and 83 wide; length and width ratio 1.2. Ventrianal shield triangular densely reticulated with broader anterior and narrow posterior part. Setae $JV_1 - 11$, JV_2 and $JV_4 - 13$, $JV_5 - 59$ long. Setae ZV_1 , ZV_2 and $ZV_3 - 13$ long. Two pairs of metapodal plates present. Primary one 22 long, 3 wide and accessory one 11 long. A continuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulations. Chelicera 44 long, fixed digit of chelicera multidentate with no *pilus dentilis*, movable digit with 4 teeth. Tectum not visible. Length of leg I – IV: 400, 350, 330 and 450 respectively. Leg IV with macrosetae on basitarsus 40 long, absent on genu and tibia.

Leg chaetotaxy:

genu II	$2 \frac{3}{2} \frac{3}{1} 1$	tibia II	$1 \frac{3}{1} \frac{2}{2} 1;$
genu III	$1 \frac{2}{1} \frac{2}{1} 1$	tibia III	$1 \frac{1}{2} \frac{2}{1} 1.$

Male: Sternogenital shield 132 long and reticulated. ST_1 , ST_2 , ST_3 , ST_4 and $ST_5 - 5$ each. Ventrianal shield triangular, 115 long and 113 wide, densely reticulated. Movable digit of chelicera 15 long, spermatophoral process 22 long.

Habitat: *Coffea arabica* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Mananthavady (Wayanad district), 1.xii.2015, ex. *Coffea arabica* (L.), coll. Santhosh (No.M 892/2). Three paratype slides with 1 ♀ and 2 ♂♂ (No. M 890/3, 891/4, 889/5) collection details same as above.

Remarks: This species resembles *Lasioseius bispinosis* Evans, 1958 in general appearance but differs in the following characters:

1. In the new species, dorsal shield reticulated only on antero – lateral side with 31 pairs of setae whereas in *L. bispinosis*, dorsal shield smooth with 36 pairs of setae.
2. Sternal shield excavated posteriorly with only 2 pairs of setae in which anterior pair thick and thorn like in *L. bispinosis* but in the new species, sternal shield with 3 pairs of setae in which anterior pair (ST₁) long and simple.
3. In the new species, genital shield is smooth but in *L. bispinosis*, it is unusually sculptured.
4. In the new species, ventrianal shield triangular with 4 pairs of preanal setae but in *L. bispinosis*, it is rectangular with 2 pairs of setae.
5. In the new species, 4 pairs of setae present on the membrane surrounding ventrianal shield whereas in *L. bispinosis*, 7 pairs of setae present.
6. In the new species, movable digit of chelicera with 4 teeth instead of 3.
7. Macrosetae present on leg IV basitarsus and tarsus.

***Lasioseius pavani* sp.nov.**

PLATE 25

Female:

Dorsum: Body 341 long, 177 wide. Dorsal shield lightly reticulate over entire surface with 31 pairs of setae, of which 16 pairs on antero – dorsal shield. A pair of oval shaped sclerites present in between the setae z₁ and j₂.

All setae simple with pointed tips except setae r_3 and Z_5 , both are long and serrated. Series j , z and s each with 5 pairs of setae, series J , Z and S each with 5 pairs of setae. Setae j_1 – 25 long, j_2 , j_3 , j_4 and j_5 – measuring 22 each, j_6 – absent. Setae z_1 – 12, z_2 – 13, z_3 , z_4 – 15, z_5 – 10, z_6 – absent. Setae s_1 – 25, s_2 – 22, s_3 – 12, s_4 , s_5 – 20 each, Series r and R with 3 pairs of setae, r_3 – 27, R_1 – 17, R_7 – 25. Setae J_1 – 13, J_2 – 12, J_3 – 12, J_4 – 14 and J_5 – 7. Setae Z_1 – 17, Z_2 , Z_3 – 25, Z_4 – 30 and Z_5 – 50 long. Setae Z_5 long and serrated. Setae Z_4 , Z_5 , S_2 and S_5 originates from a small basal tubercle. Setae S_1 – 22, S_2 , S_3 – 25, S_4 and S_5 – 30 long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 . Spermatheca with long tubular cervix, 229 long with bifid atrium and heart shaped vesicle.

Venter: Sternal shield 88 long, 75 wide, length and width ratio 1.17, reticulated on lateral sides. Sternal setae ST_1 , ST_2 , ST_3 – 12 long, ST_4 on metasternal shield, 8 long. Genital shield 75 long and 60 wide with setae ST_5 – 8 long. Ventrianal shield triangular, reticulated with broader anterior and narrow posterior part measuring 113 long, 121 wide, length and width ratio 0.9. Setae JV_1 , JV_2 , JV_4 – 4 each, JV_5 – 50 long. Setae ZV_1 , ZV_2 – 11 and ZV_3 – 8 long. Two pairs of metapodal plates present, primary one 12 and accessory one 7 long. A continuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulation. Chelicera 27 long, fixed digit with 6 teeth posterior to *pilus dentilis* and 3 teeth anterior to it. Movable digit with 4 teeth. Tectum not visible. Length of leg I–IV: 340, 300, 260 and 360 respectively. Leg IV

with macrosetae on tibia – 40, basitarsus 38 long but no macrosetae on genu.

Leg chaetotaxy: genu II $2 \frac{3}{1} \frac{2}{0} 2$ tibia II $1 \frac{3}{1} \frac{2}{1} 2$;
 genu III $2 \frac{2}{1} \frac{2}{1} 1$ tibia III $1 \frac{2}{1} \frac{1}{1} 1$.

Male: Unknown

Habitat: *Murraya koenigii* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex. *Murraya koenigii* (L.) coll. Santhosh (No.K 1004/2). Four paratype slides with 4 ♀♀, (No. K 1004/4, 1004/5, 1004/6) from the same habitat.

Remarks: This species resembles *Lasioseius quadrisetosus* Chant, 1960 in dorsal chaetotaxy, number of setae etc., but distinguished by the following characters.

1. Small size of the body than *L. quadrisetosus*.
2. In the new species, all setae simple and spiny except setae r_3 and Z_5 (serrated) whereas in *L. quadrisetosus*, all setae pectinate.
3. In the new species, Z_5 double the length of j_4 whereas in *L. quadrisetosus*, Z_5 – 3 times longer than j_4 .
4. In the new species, movable digit of chelicera with 4 teeth instead of 2 or 3.
5. Spermatheca differs in both species.
6. In the new species anal region well marked with plate like reticulation.

Lasioseius pazhurensis* sp.nov.*PLATE 26****Female**

Dorsum: Body 420 long, 240 wide. Dorsal shield densely reticulated on entire shield with 30 pairs of setae, of which 17 pairs on anterior dorsal shield. Three pairs of pores are present on dorsal shield. All setae plumose; j, z and s series each with 5 pairs of setae. Setae j_1 – 30, j_2, j_4 and j_5 – 40 long, j_3 – 42 long, j_6 – absent. Setae z_1, z_2 – 11 long and z_3, z_4, z_5 – 30 long, z_6 – absent. Setae s_1, s_2 – 4 and s_3 – 35 long, s_4 and s_5 – 30 long and r_3 – 40 long. Series R with 3 pairs of setae. Posterior dorsal setae, J series with 4 pairs of setae, Z and S series each with 5 pairs of setae. Setae J_1 – absent, J_2 – 35, J_3, J_4 – 40 long, J_5 – minute. Setae Z_1, Z_2, Z_3 – 30 long, Z_4 – 46 and Z_5 – 50 long and more plumose than other sets of setae. Setae S_1 – absent, S_2 – 30, S_3, S_4 and S_5 – 32 long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 .

Venter: Sternal shield smooth, 100 long and 90 wide, length and width ratio 1.1. Sternal setae ST_1, ST_2, ST_3 – 22 long, ST_4 on metasternal shield, 22 long. Genital shield 60 long and 70 wide with setae ST_5 – 19 long. Ventrianal shield wider than longer, triangular, densely reticulated with broader anterior and narrow posterior part measuring 140 long and 150 wide; length and width ratio 0.9. Setae JV_1, JV_2 – 13 long, JV_4 – 6, JV_5 – 24 long. Setae ZV_1 – 13, ZV_2 – 8 and ZV_3 – 9 long. Two pairs of metapodal plates present. Primary one 19 long and 5 wide, accessory one 8 long. A discontinuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulations. Chelicera 28 long, fixed digit of chelicera multidentate with no *pilus dentilis*, movable digit with 3 teeth.

Tectum minutely denticulated. Length of leg I – IV: 400, 320, 320 and 530 respectively. Leg IV with macrosetae on genu – 60 long, tibia – 77, basitarsus – 140 long.

Leg chaetotaxy:

$$\begin{array}{ll} \text{genu II } 2 \frac{3}{1} \frac{3}{1} 1 & \text{tibia II } 2 \frac{3}{1} \frac{2}{1} 1; \\ \text{genu III } 2 \frac{2}{2} \frac{2}{1} 1 & \text{tibia III } 2 \frac{2}{1} \frac{1}{1} 1. \end{array}$$

Male: Unknown

Habitat: *Psidium guajava* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Pazhur (Kozhikode district), 25.ix.2015, ex. *Psidium guajava* (L.), coll. Santhosh (No.P 552/1). Four paratype slides with 4 ♀♀ (No.P 552/2, 552/3, 552/4, 552/5) from the same habitat.

Remarks: This species resembles *Lasioseius scapulatus* Kennett, 1958 in general appearance but can be clearly differentiated by the following characters:

1. The number of dorsal setae varies in both species. (31 pairs in the new species and 36 pairs in *L. scapulatus*)
2. *Pilus dentilis* absent in the new species.
3. In the new species, 3 pairs of R-setae present on membrane surrounding ventrianal shield whereas in *L. scapulatus*, 5 pairs of setae present.
4. Variations in the number of spines on the tectum.

5. Variations in the shape of ventrianal shield.
6. In the new species, 3 pairs of prominent pores present on the dorsal shield whereas it is absent in *L. scapulatus*.

***Lasioseius plumatus* Karg, 1980**

PLATE 27 (A, B)

1. 1980. *Lasioseius (crinidens) plumatus* Karg, *Zool.Jb.Syst.* 107:344–367
2. 2006. *Lasioseius (crinidens) plumatus* Karg, *Zool.Jb.Syst.*, p.186

Female

Dorsum: Body 450 long, 240 wide. Dorsal shield densely ornamented with polygonal reticulations on entire shield. Dorsal shield with 31 pairs of setae, of which 16 pairs on anterior shield. All setae spine like except S₃, S₄, S₅, Z₄ and Z₅. These setae slightly plumose at distal end. j, z and s series with 5 pairs of setae. Setae j₁ – 24, j₂ – 33, j₃, j₄ and j₅ – 22 long, j₆ – absent. Setae z₁, z₂, z₃, z₄ and z₅ – 22 long. z₆ – absent. Setae s₁, s₂ and s₃ – 26 each, s₄ – 28, s₅ – 35 and r₃ – 46 long. Series R with single pair of setae. Posteriodorsal setae; series J, Z and S each with 5 pairs of setae. Setae J₁, J₂, J₃ and J₄ – 22 each, J₅ – 11 long. Setae Z₁, Z₂ – 28 long, Z₃ – 33, Z₄ – 46 and Z₅ – 50 long which is more plumose than all other sets of setae. Setae S₁ – 33, S₂ and S₃ – 35, S₄ – 37, S₅ – 44 long. Peritremal exopodal shield fused anteriorly to podonotal shield. Spermatheca as shown in the figure. Peritreme extends anteriorly upto the base of j₁.

Venter: Sternal shield smooth, 100 long and 83 wide, length and width ratio 1.2. Sternal setae $ST_1 - 26$, ST_2 , $ST_3 - 22$ and ST_4 on metasternal shield 17 long. Genital shield 88 long and 70 wide with setae $ST_5 - 13$ long. Ventrianal shield wider than longer, measuring 140 long and 150 wide, triangular, densely reticulated with broader anterior and narrow posterior part. Length and width ratio 0.9. Setae JV_1 , $JV_2 - 13$ long, $JV_4 - 15$, $JV_5 - 37$ long. Setae ZV_1 , ZV_2 and $ZV_3 - 13$ long. Two pairs of metapodal plates present, primary one crescent shaped, 22 long, 5 wide and accessory one 8 long. A discontinuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulations. Chelicera 41 long, fixed digit of chelicera multidentate with no *pilus dentilis*, movable digit with 4 teeth. Tectum minutely denticulate. Length of leg I – IV: 380, 360, 270 and 450 respectively. Leg IV with no macrosetae on genu and tibia, basitarsus 35 long.

Leg chaetotaxy:

genu II $1 \frac{3}{1} \frac{3}{1} 1$	tibia II $1 \frac{3}{1} \frac{2}{2} 1$;
genu III $2 \frac{2}{2} \frac{2}{0} 1$	tibia III $2 \frac{2}{1} \frac{2}{1} 1$.

Male: Sternogenital shield 154 long, smooth. $ST_1 - 26$ long. Setae ST_2 , ST_3 , ST_4 and $ST_5 - 24$ each. Ventrianal shield densely reticulated, wider than longer measuring 138 long and 220 wide. $JV_4 - 15$, $JV_5 - 26$ long. All other setae 12 long. Movable digit 33 long and spermatophoral process as shown in the figure.

Habitat: *Solanum anguivi* Lam.

Known habitat: Soil habitat.

Material examined: Female marked on the slide, INDIA: KERALA: Kavumvattam (Kozhikode district), 1.xii.2015, ex. *Solanum anguivi* Lam., coll. Santhosh (No.W 827/1). 2 ♀♀ and 2 ♂♂ (No. W 827/2, 827/4, 827/5, 827/6) from the same habitat.

Distribution: America, South America, Venezuela

Remarks: This species resembles *Lasioseius plumatus* Karg, 1980 in general appearance and other characters and hence fixed so. It is the first report from India. In the present survey it was recovered from a new host plant *Solanum anguivi* Lam.

***Lasioseius kurachundensis* sp.nov**

PLATE 28

Female

Dorsum: Body 415 long, 240 wide. Dorsal shield sclerotised but not reticulated. Dorsal shield with 30 pairs of setae, of which 16 pairs on anterior shield. All setae plumose. j, z and s series with 5 pairs of setae. Setae $j_1 - j_5$ 25 each, j_6 – absent. Setae $z_1 - 7$, $z_2 - 6$, $z_3 - 4$, $z_4 - 35$ and $z_5 - 25$ long, z_6 – absent. Setae s_1 , $s_2 - 25$ each, $s_3 - 23$, $s_4 - 7$ and $s_5 - 32$, $r_3 - 46$ long. Series R with two pairs of setae. Posterior dorsal setae; series J with 4 setae, series Z and S each with 5 pairs of setae. Setae $J_1 - 27$, J_2 , $J_3 - 37$ each, J_4 – absent and $J_5 - 6$ long. Setae $Z_1 - 30$, $Z_2 - 27$, $Z_3 - 37$, $Z_4 - 40$ and $Z_5 - 45$ long, more plumose than other sets of setae. Setae $S_1 - S_4$, 25 long and $S_5 - 30$ long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 . Tectum with two long lateral points, central points are minutely denticulate. Spermatheca not visible.

Venter: Sternal shield smooth, 82 long and 81 wide, length and width ratio 1. Sternal setae $ST_1 - ST_3 - 20$ each and ST_4 on metasternal shield 12 long. Genital shield 68 long and 75 wide with setae $ST_5 - 12$ long. Ventrianal shield longer than wider, measuring 126 long and 111 wide; length and width ratio 1.1. Ventrianal shield nearly triangular densely reticulated with broader anterior and narrow posterior part. Setae JV_1 , $JV_2 - 13$ long, $JV_4 - 7$ long and $JV_5 - 27$ long. Setae ZV_1 , ZV_2 and $ZV_3 - 7$ long. Primary metapodal plate 30 long, accessory one not visible. A continuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulations. Chelicera 28 long, fixed digit of chelicera with 3 teeth anterior to *pilus dentilis* and 7 teeth posterior to it, movable digit with 4 teeth. Length of leg I – IV: 450, 400, 360 and 550 respectively. Leg IV with macrosetae on genu – 50, tibia – 78 and basitarsus 126 long.

Leg chaetotaxy: genu II $2 \frac{3}{1} \frac{2}{1} 3$ tibia II $2 \frac{3}{1} \frac{2}{1} 1$;
genu III $2 \frac{2}{2} \frac{1}{1} 1$ tibia III $2 \frac{2}{2} \frac{1}{1} 1$.

Male: Unknown.

Habitat: *Theobroma cacao* L., *Solanum melongena* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kurachundu (Kozhikode district), 11.xi.2015, ex. *Theobroma cacao* L., coll. Santhosh (No.K 632/1). Two paratype slides with 3 ♀♀, Thekkumthara, Wayanad district, 1.xii.2015, ex. *Solanum melongena* L., coll. Santhosh (No. K 829/2, 829/3).

Remarks: This species resembles *Lasioseius berlesei* (Oudemans), 1938 in general appearance but can be clearly differentiated by the following characters:

1. In new species, dorsal shield 415 long with 30 pairs of setae whereas in *L. berlesei*, it is 550 long with 29 pairs of setae.
2. In the new species, a continuous septum seen in between genital and ventrianal shield which is absent in *L. berlesei*.
3. In new species, ventrianal shield is with 4 pairs of preanal setae instead of 6 pairs.
4. In new species, 3 pairs of setae present on membrane surrounding ventrianal shield where as in *L.berlesei*, only a single pair of setae present.
5. In the new species, movable digit is with 4 teeth instead of 3.
6. In the new species, macrosetae on leg IV – genu (50), tibia (78), and basitarsus (126) long whereas in *L.berlesei*, macro setae absent.

***Lasioseius saudhaminiae* sp.nov.**

PLATE 29

Female

Dorsum: Body 430 long, 230 wide. Dorsal shield densely reticulated with polygonal cell like sclerites over entire surface, 33 pairs of setae present on dorsal shield of which 19 pairs on anterio – dorsal shield. All setae plumose, except j_1 and J_5 . Series j, z and s each with 6 pairs of setae. Series J with 4 pairs of setae, Z and S series with 5 pairs of setae. Setae j_1, j_3, j_4, j_5 – 22 each, j_2 and j_6 – 24 long. Setae z_1 – 15, z_2, z_3, z_4, z_5 and z_6 – 22 each. Setae $s_1, s_3, s_4,$

$s_5 - 22$, $s_6 - 26$, $s_2 - 20$, $r_3 - 33$ long. Setae $J_1 - 24$, J_2 , $J_3 - 22$ each, J_4 – absent, $J_5 - 8$ long. Setae $Z_1, Z_2 - 24$ each, $Z_3 - 26$, $Z_4 - 35$ and $Z_5 - 46$ long. Setae Z_4 and Z_5 thickly plumose at tip. Setae $S_1 - 22$, $S_2, S_3, S_4 - 26$ each and $S_5 - 33$ long. Peritremal exopodal shield fused anteriorly to podonotal shield. Peritreme extends anteriorly upto the base of j_1 . Spermatheca with long vesicular cervix 33 long with bifid atrium and pea nut shaped vesicle present.

Venter: Sternal shield 77 long, 77 wide, length and width ratio 1, slightly reticulated in lateral side. Sternal setae $ST_1, ST_2, ST_3 - 22$ long, ST_4 on metasternal shield, 17 long. Genital shield 66 long and 55 wide with reticulation on lateral side, genital setae $ST_5 - 22$ long. Ventrianal shield triangular with broader anterior and narrow posterior part measuring 120 long, 130 wide; length and width ratio 1. Setae $JV_1, JV_2, JV_4 - 11$ each, $JV_5 - 22$ long. Setae $ZV_1, ZV_2, ZV_3 - 11$ long. Two pairs of metapodal plates present. Primary one 22 and accessory one 12 long. A discontinuous septum present between the genital shield and ventrianal shield. Anal region well marked with plate like reticulation. Chelicera 39 long, fixed digit of chelicera multidentate, movable digit with 4 teeth. Tectum minutely denticulated. Length of leg I – IV: 350, 330, 280 and 450 respectively. Leg IV with macrosetae on basitarsus, 30 long.

Leg chaetotaxy :

genu II	$2 \frac{3}{2} \frac{2}{1} 1$	tibia II	$2 \frac{3}{2} \frac{2}{1} 1$;
genu III	$2 \frac{2}{1} \frac{2}{0} 1$	tibia III	$2 \frac{1}{1} \frac{1}{1} 1$.

Male: Unknown

Habitat: *Helicterus isora* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Botanical Garden, Calicut University (Malappuram district), 18.xii.2015, ex. *Helicterus isora* (L.), coll. Santhosh (No.K 903/2). Three paratype slides with 4 ♀♀ (No. K 903/1, 903/3, 903/4), collection details same as above.

Remarks: This species resembles *Lasioseius tetraspinosus* Karg, 1980 but can be clearly differentiated by the following characters:

1. In the new species, dorsal shield is 430 long whereas in *L. tetraspinosus*, it is 380 long.
2. The length and width ratio of ventrianal shield is 1:1 in the new species whereas in *L. tetraspinosus*, it is 3:4.
3. In new species, $Z_4 - 35$ and $Z_5 - 46$ long whereas in *L. tetraspinosus*, it is 55 long.
4. Sternal shield is smooth in the new species whereas in *L. tetraspinosus*, it is with many fine dots.
5. Length of legs varies in both species.

***Lasioseius wayanadensis* sp.nov**

PLATE 30

Female

Dorsum: Body 390 long, 160 wide. Dorsal shield nearly smooth with 31 pairs of setae of which 19 pairs on anterior shield. Many pores present on the posterior dorsal shield. Each setae arising from a swollen tubercles. Setae j_1 cordiform with spiny edges, setae r_3 obovate with finely serrated. Setae Z_5 -long, thick and serrated. All other setae spine like with swollen bases. j series with 5 pairs of setae and series z and s with 6 pairs of setae.

Setae j_1 – 28, j_2 , j_3 , j_4 and j_5 – 4 long and setae j_6 absent. Setae z_1 , z_2 – 22, z_3 – 17, z_4 and z_6 – 5 long. Setae s_1 – 24, s_2 – 22, s_3 – 17, s_4 – 24, s_5 – 17 and s_6 – 33 long. Setae r_3 – 13 long. On posteriodorsal side, series J with 4 pairs of setae, series Z and S with 5 pairs of setae. Setae J_1 , J_2 , J_3 and J_4 – 5 long and J_5 – 11 long. Setae Z_1 – 11, Z_2 , Z_3 , Z_4 – 10 each and Z_5 – 72 long. Setae S_1 – 28, S_2 , S_3 – 33, S_4 – 50, S_5 – 44 long. Peritreme terminates below the base of j_1 . Spermatheca with ‘S’ shaped cervix 25 long and undifferentiated atrium.

Venter: Sternal shield smooth, 88 long and 81 wide, length and width ratio 1. Sternal setae ST_1 – 15, ST_2 – 9, ST_3 – 22 and ST_4 on metasternal shield 5 long. Genital shield 88 long and 77 wide with setae ST_5 – 5 long. Posterior end of sternal shield and anterior apex of genital shield join together form common membrane and metasternal shield also found attached laterally with it. Ventrianal shield measuring 110 long and 125 wide. Length and width ratio 0.9. Ventrianal shield smooth and rectangular with 4 pairs of preanal setae. Striations present around the ventrianal shield. Three pairs of pores present between setae ZV_1 and ZV_4 . JV_1 , JV_2 and JV_4 – 4 each, JV_5 – absent. Setae ZV_1 , ZV_2 and ZV_3 – 4 each. Two pairs of metapodal plate present. Primary metapodal plate 15 long and accessory plate 4 long. Anal region well marked with single plate like reticulations. Chelicera 22 long, fixed digit of chelicera with 4 teeth, movable digit with 3 teeth. Tectum not visible. Length of leg I – IV: 350, 400, 350 and 500 respectively. Setae on all legs are short and spiny. Anterioventral setae of all legs are stout with sharp tips. Macrosetae present only on leg I tarsus. Macrosetae absent on Leg IV.

Leg chaetotaxy: genu II $2\frac{3}{0}\frac{2}{0}2$ tibia II $2\frac{2}{1}\frac{2}{1}2$;
genu III $2\frac{2}{0}\frac{1}{0}1$ tibia III $2\frac{2}{0}\frac{1}{0}1$.

Male: Sternogenital shield smooth, 113 long, 63 wide. ST₁ – 12, ST₂ and ST₄ – 5 each, ST₃ – 14 and ST₅ minute. Ventrianal shield smooth, 126 long and 127 wide, semi-circular with 5 pairs of setae. Movable digit of chelicera having spermatophoral process 18 long.

Habitat: *Salacia reticulata* Wight.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Thekkumthara (Wayanad district), 1.xii.2015, ex. *Salacia reticulata*, coll. Santhosh (No.W 787/1). Five paratype slides with 3 ♀ ♀ and 2 ♂ ♂ (No.W 786/3, 787/4, 787/5, 787/6) from the same habitat.

Remarks: This species resembles *Lasioseius fleschneri* Chant, 1963 in general appearance and dorsal chaetotaxy but can be clearly differentiated by the following characters:

1. In the new species, dorsal shield 390 long, 160 wide whereas in *L. fleschneri* it is 408 and 220 respectively.
2. Setae j₁ cordiform with spiny edges but in *L. fleschneri*, it is thick and serrated.
3. Humeral setae (r₃) thick and serrated in *L. fleschneri* whereas in the new species, setae r₃ obovate and finely serrated.
4. In the new species, all marginal setae thick, spiny form and arising from strong tubercles whereas in *L. fleschneri* it is short, peg like.

5. In the new species, posterior end of sternal shield and anterior apex of genital shield join together to form common membrane and metasternal shield found attached with it laterally but in *L. fleschneri*, all the shields are articulated separately.
6. In the new species, ventrianal shield is 110 long, smooth with 4 pairs of setae but in *L. fleschneri*, it is 150 long, reticulated with 6 pairs of setae.
7. In the new species, 5 pairs of setae present on the membrane surrounding ventrianal shield which is striated where as in *L. fleschneri*, it is smooth with 3 pairs of simple setae.
8. In the new species, peritreme terminates below the setae j_1 whereas in *L. fleschneri*, it extends up to vertical setae.
9. In the new species, fixed digit of chelicera with 4 teeth and movable digit with 3 teeth whereas in *L. fleschneri*, it is 6 and 3 respectively.
10. Macro setae absent on leg IV.

6.1.3 Family PHYTOSEIIDAE Berlese, 1916

1916. Phytoseiini: Berlese, Centuria prima di Acari nuovi, *Redia.*, p.3
1941. Phytoseiinae: Berlese, Vitzthum, *Das Tierreich*, **5**(4):767
1952. Phytoseiidae: Baker and Wharton, *An Introduction to Acarology.*, p.87.
1955. Phytoseiidae: Muma, *Ann.Entomol.Soc.Am.*, **48** (4):262– 272
1957. Phytoseiidae : Athias– Henriot, *Bull.Soc.Hist.nat. Afr.N.*, **48**: 319– 352
1958. Phytoseiidae: Chant, *J.Linnean. Soc.London Zool.*, **43**(294): 599– 643

1959. Phytoseiidae: Chant, *Can. Entomol.*, **91**: (Suppl. 12): 5– 164.
1961. Phytoseiidae: Muma, *Bull. Fla. St. Mus.*, **5** (7): 267– 302.
1962. Phytoseiidae: Pritchard and Baker, *Hilgardia*, **33** (7):205– 309
1963. Phytoseiidae: Schuster and Pritchard, *Hilgardia*, **34** (7): 191– 285.
1964. Phytoseiidae: Muma, *Fla. Agr. Exp. Sta. Tech. Bull.*, **685**:1– 42
1965. Phytoseiidae: Chant and Baker, *Mem. Entomol. Soc. Can.*, **41**:3– 56.
1966. Phytoseiidae: Denmark, *Fla. Dpt. Agr. Bull.*, **6**:5– 105.
1967. Phytoseiidae: Muma, *Fla. Entomol.*, **450** (4): 267– 280
1968. Phytoseiidae: Van der Merwe, *Entomol. Mem. S. Africa Dept. Agric. Tech. Services*, **18**: 1– 198
1969. Phytoseiidae: Gai and Menon, *Oriental Ins.*, **3** (4): 347– 352.
1971. Phytoseiidae: Chant and Hansell, *Can. J. Zool.*, **49** (5):705– 758.
1972. Phytoseiidae : Ehara, *Mushi* ., **46** (12):137– 173.
1973. Phytoseiidae: Tuttle and Muma, *Tech. Bull. Agr. Exp. Sta. Univ. Arizona. Tueson*, **208**:1– 5 5.
1974. Phytoseiidae: Gupta, *Ent. Rec.*, **86**:141– 144.
1975. Phytoseiidae: Tseng, *J. Agric. Assoc. China, New series, Taiwan.*, **91**: 45– 68.
1977. Phytoseiidae: Gupta, *Orient . Insect.*, **11** (4): 623– 638.
1978. Phytoseiidae: Rowel *et al.*, *Can. Entomol.*, **110**: 859– 876.
1982. Phytoseiidae: Karg, *Zool. Jahr. Syst.* **109**: 188– 210.
1984. Phytoseiidae: McMutry and de Moraes, *Internat. J. Acarol.*, **10**:27– 37
1986. Phytoseiidae: Chant and Yoshida– Shaul, *Can. J. Zool.*, **64**(9): 2024– 2034.
1986. Phytoseiidae: Gupta, *Fauna of India (Acari: Mesostigmata) Family Phytoseiidae, Zool. Surv. India, Calcutta*, p. 350.

1987. Phytoseiidae: Gupta, *Rec. zool. Surv. India. Occ. Pap.*, 95: 1– 167.
1988. Phytoseiidae: Denmark, *Internat. J. Acarol.*, **14** (1):23– 40
1989. Phytoseiidae: Denmark and Muma, *Occ.Pap. Fla. St. Coll. of Arthropods*, **4**:1– 149
1990. Phytoseiidae: Dhooria, *Acar.Newsl*, 18: 17– 18.
1991. Phytoseiidae: Papadoulis and Emmanouel, *Ent.Hell.Gre.*, **9**:35– 62.
1992. Phytoseiidae: Chant and Yoshida– Shaul, *Internat. J. Acarol.*, **18**(1):5– 23.
1992. Phytoseiidae: Gupta, In: *Fauna of West Bengal, State Fauna Ser.*, **3**, part 3. p. 61–211.
1993. Phytoseiidae: Takahashi and Chant, *Internat. J. Acarol.*, **19** (1):15– 22.
1995. Phytoseiidae: Yoshida– Shaul and Chant, *Acarologia*, **36** (1): 3 – 19.
1996. Phytoseiidae: Denmark and Rather, *Internat.J.Acarol.* **22** (1):43 – 77.
1997. Phytoseiidae: Gupta and Chatterjee, In: *Fauna of Delhi, State Fauna Ser.* **6**, p. 485 –532.
1999. Phytoseiidae: Walter, *Aust. J. Entomol.*, **38**:85– 95
2001. Phytoseiidae: Moraes *et al.*, *Zootaxa*, **8**:1– 10
2002. Phytoseiidae: Wu and Ou, *Syst. Appl. Acarol.*, **4**: 101–108.
2003. Phytoseiidae: Gupta, *A monograph on plant inhabiting predatory mites in India. Part II: Order: Mesostigmata. Mem. Zool.Surv.India*, **20**(1): 1–185.
2004. Phytoseiidae: Chant and McMurtry., *Internat. J. Acarol.*, **30** (4): 291– 312.
2004. Phytoseiidae: Moraes *et al.*, *Zootaxa*, **434**:1–494.

2005. Phytoseiidae: Chant and McMurtry, *Internat. J.Acarol.* **31**(4): 315–340.
2006. Phytoseiidae: Chant and McMurtry, *Internat. J. Acarol.*, **32**(2): 1– 27.
2006. Phytoseiidae: Moraes *et al.*, *Zootaxa*, **1114**:1– 52.
2007. Phytoseiidae: Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, Indira Publishing House, West Bloomfield, Michigan, USA, p.1– 219.
2011. Phytoseiidae: Gupta and Karmakar, *Zoosymposia*, **6**:57– 62
2012. Phytoseiidae: Prasad, *Checklist of Phytoseiidae of the World (Acari:Mesostigmata)*. Indira Publishing House, West Bloomfield, Michigan, USA, p.1063.
2014. Phytoseiidae: Demite *et al.*, *Phytoseiidae Database, Zootaxa*, **3795**: 571– 577.
2015. Phytoseiidae: Gupta and Karmakar, *Rec.Zool.Surv.India*, **115** (Part– 1): 51– 72.

Diagnosis: Phytoseiids bears an entire or transversely divided dorsal shield with less than 25 pairs of setae including stable and variable. Stigmata open between legs III and IV, peritreme extends anteriorly from mesolateral stigmata. Palp tarsus with 2 tined apotele, chelicerae chelate, undifferentiated hypostomal setae, a smooth or indistinctly serrate tectum, anus ventral, legs with pretarsus and ambulacra. Genital shield truncate posteriorly with a pair of seta, a pair of spermatheca open between coxae III and IV; metasternal shields are small, ventrianal shield elongate, square type or pentagonal with 1 to 7 pairs of preanal setae in addition to para and postanals. Male with

spermatophoral process on the movable digit of chelicerae; genital aperture of male placed anteriorly on the sternitigenital shield. Ventrianal shield with 2 to 7 pairs of preanal setae and a pair of caudal setae.

Type **Genus:** *Phytoseius* Ribaga, 1904.

6.1.3.1 Morphology and Terminology (Plate: 32)

The different terminologies used in the present study for the taxonomic description of Phytoseiidae are defined briefly for the better understanding of the morphology. Like any other Acari, phytoseiid mite body is differentiated into an anterior gnathosoma followed by idiosoma.

6.1.3.1.1 Gnathosoma

Gnathosoma consists of a pair of pedipalp, a pair of chelicerae, epistome, hypostome and corniculi. Dorsal side of gnathosoma is covered with a thin flap of epistome or tectum which is minutely denticulate but never with any process. The floor of the mouth is formed by hypostome which has 3 pairs of hypostomal setae. Hypostomal groove usually present on the median of gnathosoma. Mouth lies between and below the chelicerae, ventral to epistome and dorsal to hypostome.

a) Chelicerae: Chelicerae (Plate: 32) are the first pair of appendages. It consists of a basal segment, terminal fixed and movable digits. They are dentate type grasping organs with which they hold the prey. The inner surfaces of the fixed digits are provided with varying number of teeth and often a spine like *pilus dentilis*. They are mechano receptors. The movable digit bears teeth. In male, the movable digit of chelicera has a copulatory organ known as spermatodactyl or spermatophoral process

which is used to transfer spermatophores from the male genital opening to the female sperm induction pore (Plate 32).

- b) *Pedipalpi*:** They are the second pair appendages with coxa, trochanter, femur, genu, tibia and tarsus with two tined apotele. Palpi are sensory in function and assist in detection of food. In the male they are used for copulation.

6.1.3.1.2 Idiosoma

Idiosoma is the part of the body below the gnathosoma which includes podosoma and opisthosoma. Idiosoma is covered with a dorsal shield which may be entire or divided transversely. Its shape is often round or oval and also shows different reticulation patterns. It is furnished with variable number of seta, and their arrangement, number, nature and relative position are of extreme importance in generic and specific identification. The setae present on the dorsal surface of the podosoma are designated by lower case alphabets and those on the dorsal opisthosoma are designated by upper case alphabets. The following are the sets of setae present on the dorsal shield.

- a) *Dorsocentral setae* (j – J):** A row of paired setae present on the central region of the dorsal shield. Generally 3 pairs are present, usually 4th pair is also present, 5th pair is rarely present.
- i) *Vertical setae* (j₁):** A pair of setae present on the anterior position of the dorsal shield.
- ii) *Clunal setae* (J₅):** A pair of setae, posterior position on the dorsal shield.
- b) *Mediolateral setae* (z – Z):** Setae present between dorsocentral and dorsolateral setae. The first pair of median setae always lies mid way between j₅ and j₆. The second pair of median setae usually present or may

be absent, if present lies on the proscutum of the shield. A pair of median setae is always present on posterior region.

- c) ***Dorsolateral setae*** (s – S): Setae present between mediolateral and sublateral setae. Phytoseiids contain variable number of lateral setae. Maximum number is known to be 12 on one side.
- d) ***Sublateral setae*** (r₃ and R₁): Setae present on the sublateral integument or lateral integument of the dorsal shield. Sublateral setae are generally 2 pairs. In males, the r– R series setae are inserted on the dorsal shield.

6.1.3.1.3 Venter

The ventral side of phytoseiid mites possess the following structures. The setae present on both the podoventral and caudoventral regions of the ventral surface are designated by upper case alphabets.

- a) ***Sternal shield*** (SS): Sternal shield is formed by the fusion of coxal plates which lies posterior to tritosternum. It may be smooth, reticulate and variously sclerotized in different genera. Normally 3 pairs of sternal setae (ST₁ – ST₃) are present on the shield, but in some cases there are only 2 pairs on the sternal shield and 3rd pair lies on the interscutal membrane. The sternal and genital shield in males is fused to form sternitigenital shield bearing 5 pairs of setae (Plate 32).
- b) ***Metasternal plate*** (Msp): A pair of metasternal is present which may be small or massive and usually bear a pair of sternal setae (ST₄).
- c) ***Genital shield*** (GS): Genital shield lies posterior to the sternal shield below the metasternal plate. This shield guards the female genital pore

and is normally truncated in the posterior region and has a pair of setae (ST₅).

- d) ***Ventrianal shield*** (VAS): Ventrianal shield lies posterior to genital shield and shows extreme variation in size and shape. The varied shapes of ventrianal shield are triangular, rectangular, oval, sole shaped etc. One to 4 pairs of preanal setae, a pair of anal and post– anal setae are present on it. The ventrianal shield bears a pair of conspicuous preanal pores, but sometimes they may be absent. In males the ventrianal shield shows little variation among species and is of little taxonomic importance. Ventrianal shield of all males are of same shape and is equipped with 4 to 5 pairs of setae. The ventrianal shield is entire, fragmented or sometimes fused with sternitigenital shield.
- e) ***Metapodal plate*** (Mp): One or 2 pairs of round, oval or triangular shaped metapodal plates are present just behind coxae IV. Sometimes small platelets are often present between the genital and ventrianal shield.
- f) ***Setae on membrane***: Variable number of setae and pores are present on the membrane surrounding the ventrianal shield. A single pair of caudal setae JV₅ is always present which may be smooth, serrated or barbed. In addition to setae JV₅, 1– 5 pairs of setae and a variable number of pores are also present.
- g) ***Spermatheca*** (Sp): Spermathecae of female phytoseiids are very important in species identification. A pair is always present in family Phytoseiidae for the reception of spermatophores. The spermatheca consists of membranous vesicle with a sclerotized portion called cervix

which leads into a chamber called atrium. A minor and major duct arises from the atrium. Spermathecal vesicle opens out through the atrium and cervix between the coxae III and IV (Plate: 71).

h) *Peritreme* (P): The peritreme and stigmata lies on the peritremal shield which may anteriorly fused with the dorsal shield and are posteriorly curved around coxae IV. Peritreme and stigmata serves the respiratory function. In the tribe Macroseiini, the peritremal shield is fused anteriorly with the dorsal shield and in rest of the tribes it is not fused with the dorsal shield anteriorly.

6.1.3.1.4 Legs

Phytoseiids have 4 pairs of legs and the chaetotaxy of legs are very important for generic and species identification. Based on Evans (1963) classification of all phytoseiids possess standard chaetotaxy of legs II and III. Setal number of leg II and III varies in different species. Genus *Chantia* bears 7 setae on each of genu II and III, tibia II and III. Genus *Typhlodromus* bears 7 or 8 setae on genu II and 7 on genu III. Genus *Macroseius* has 8 setae on genu II and 7 on genu III. *Platyseiella* and *Phytoseius* bears 7– 6– 7 setae on genu II, III and IV respectively, but some species of genus *Phytoseius* has 7 setae on genu III. Genus *Amblyseius* and *Ipheseius* have 7– 7– 7 setae on genu II, III and IV respectively. In *Paraamblyseius*, Genu II has 7 and genu III has 6. *Phytoseiulus* has 7, 8 or 9 setae on genu II and 7 on genu III. The leg chaetotactic formula of genu II and III and tibia II and III can be represented as:

$$\text{genu, } 2 \frac{2}{0} \frac{2}{0} 1 \quad \text{or} \quad 2 \text{ al } \frac{2\text{ad}}{0\text{av}} \frac{2\text{pd}}{0\text{av}} 1 \text{ pl}$$

where, al– anteriolateral, ad – anteriodorsal, av – anterioventral, pd– posteriodorsal, pv – posterioventral, pl – posteriolateral.

Generally genu, tibia and basitarsus of Leg IV and in some cases the genu and tibia of leg II and leg III bears macrosetae. Macrosetae may be knobbed, spatulated, simple or with some other shape. The length and shape of the macrosetae are of much taxonomic importance as they help in separation of species.

Key to the subfamilies of family Phytoseiidae

1. *Setae* z_3 and s_6 absent Amblyseiinae Muma
 - Either or both setae small, z_3 and s_6 present..... 2
2. *Setae* Z_1 , S_2 , S_4 and S_5 absent..... Phytoseiinae* Berlese
 - * *Seta* z_3 present..... **Genus:** *Phytoseius* Ribaga
 - At least one of Z_1 , S_2 , S_4 , or S_5 present Typhlodrominae* Wainstein
 - * Most species with S_4 and JV_4 present
 -Tribe: Typhlodromini* * Wainstein
 - ** *Seta* Z_1 absent **Genus:** *Typhlodromus* Scheuten

Subfamily AMBLYSEIINAE Muma, 1961

1961. Amblyseiinae Muma, *Bull. Fla. St. Mus.*, **5** (7): 273.
1963. Amblyseiinae Schuster and Pritchard, *Hilgardia*, **34** (7): 225.
1965. Phytoseiinae, Chant, *Can. Entomol.*, **97**(4): 359 (in part).
1984. Amblyseiinae, Gupta, *Handbook. Plant mites of India*. p.333.
1986. Amblyseiinae, Gupta, *Fauna of India (Acari: Mesostigmata) Family Phytoseiidae*, p.32.
1987. Amblyseiinae, Gupta, *Rec. zool. Surv. India, Occ. Pap.*, **95**: 4.
1989. Amblyseiinae, Cobanoglu, *Turk. Entomol. derg.*, **13** (3): 169.

1989. Amblyseiinae, Gupta, In: *Prog. Acarol.*, **1**: 404.
1990. Amblyseiinae, El-Banhawy and Abou-Awad, *Insect Sci. Appl.*, **11**: 899 – 901.
1992. Amblyseiinae, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal Part 3*, p.150.
- 1993.. Amblyseiinae, Schicha and O'Dowd, *J. Aust. Ent. Soc. Indiroopilly*, **32**: 297 – 305.
1995. Amblyseiinae, Amitai, *Entomol. Hell.*, **10**:19–20.
2003. Amblyseiinae, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 1–185.
2007. Amblyseiinae, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, Indira Publishing House, West Bloomfield, Michigan, USA, p.13.

Diagnosis: Dorsal shield undivided with 4 to 6 pairs of setae on dorsocentral series; 1 to 2 pairs of median setae, 6 to 9 pairs of lateral setae (4 of those on prolateral series), 1 to 2 pairs of preanal setae on ventrianal shield, 1 to 3 macrosetae on leg IV; males with fragmented or entire ventrianal shield with 3 to 4 pairs of preanal setae, 2 pairs of sublateral setae both placed on dorsal shield.

Type **Genus:** *Amblyseius* Berlese, 1915.

Key to the Tribes/ Sub tribe in the Subfamily Amblyseiinae included in the present study

1. Sternal shield with median posterior projection; deutosternal groove wider ($>5\ \mu$ in width), with forward migration of preanal setae (JV_2 and

- ZV₂); preanal setae in male usually arranged in tangential row rather than in triangular pattern Tribe: Euseinii* Chant and McMurtry
- * Chelicera reduced in size, stubby, with a group of small teeth clustered at the distal end of the fixed digit; peritreme usually not extending beyond seta j₃, often much shorter; deutosternal groove wider, 7–9 μm wide Subtribe: Euseiina Chant and McMurtry
- Sternal shield without posterior projection; deutosternal groove narrower (< 5μ in width); setae JV₂ and ZV₂ not forwardly migrated; preanal setae of male usually arranged in triangular pattern rather than in a tangential row 2
2. Seta S₄ present 3
- Seta S₄ absent Tribe: Kampimodromini* Kolodochka
- * Some dorsal setae thickened serrated arising from tubercles with distinctive notch or incision in lateral margin of dorsal shield at level of s₄ Subtribe: Paraphytoseiina* Chant and McMurtry
3. Ratio of setae s₄:Z₁ < 3:1, Setae s₄, Z₄ and Z₅ not usually longer than other dorsal setae; usually lightly sclerotized, never with wide sternal shield; seta J₂ always present 4
- Ratio of setae s₄: Z₁ > 3:1, setae s₄, Z₄, Z₅ markedly longer than other dorsal setae, J₂ may be present or absent
 Tribe: Amblyseiini Muma
4. Macroseta on genu II absent, on genu III is rarely present, fixed digit of chelicera usually with fewer than six teeth, rarely multidentate, never with these two characters present together
 Tribe: Neoseiulini* Chant and McMurtry

- Macroseta on genu II and III rarely present, fixed digit of chelicerae with more than 6 teeth, most species with both these characters present .
..... Tribe: Typhlodromipsini Chant and McMurtry

Key to Subtribes of tribe Amblyseiini

1. Sternal shield narrower, length: width =1:1, female ventrianal shield usually longer than wide; sternal shield usually smooth; lightly reticulate; genital shield smooth; ventrianal shield may be lightly striate; peritremal shield narrow, ectal strip rarely present; legs II and III usually and leg I often with macrosetae; leg IV with 3 macrosetae, Setae z_2 , z_4 minute; Setae j_5 , S_2 , S_4 present; Setae J_2 , S_5 , Z_1 present or absent....
..... Amblyseiina Muma
- Sternal shield broader, length: width ratio less than one, female ventrianal shield broader, genital shield and ventrianal shield almost equal. Sternal and genital shields smooth or reticulate, ventrianal shield smooth or striate or reticulate, legs III– IV with or without macroseta setae z_2 and z_4 often may be long, setae j_5 , J_2 , S_2 , S_4 and Z_1 present or absent Proprioiseiopsina Chant and McMurtry

Key to the genera of the subfamily Amblyseiinae

1. Ventrianal shield absent or indistinctly demarcated, only pre anal setae distinctly present..... *Gynaeseius*
- Ventrianal shield distinctly present 2
2. Ventrianal shield massive covering major portion of posteroventral portion *Proprioiseiopsis*
- Ventrianal shield not like above 3

- 3. Fixed digit of chelicerae with 8-12 prominent teeth 4
- Fixed digit of chelicerae usually with many teeth *Amblyseius*
- 4. Ventrianal shield approximately shield shaped or pentagonal 5
- Ventrianal shield oval or vase shaped 7
- 5. Sternal shield longer than wide *Neoseiulus*
- Sternal shield as wide as or wider than long 6
- 6. Seta J₁ present; seta s₄ at least twice the length of other lateral setae *Typhlodromips*
- Seta J₁ present; seta s₄ less than twice the length of other lateral setae.....
..... *Scapulaseius*
- 7. Seta S₅ present *Euseius*
- Seta S₅ absent *Paraphytoseius*

Tribe: Neoseiulini Hughes, 1948.

- 2003. Neoseiulini, Chant and McMurtry, *Internat. J. Acarol.*, **20**(4): 2007.
- 2007. Neoseiulini, In: Chant and McMurtry. *Illust. Keys and Diag. for the Genera and Subgenera of the Phytoseiidae of the World (Acari: Mesostigmata)*. Indira Publishing House, West Bloomfield, Michigan, USA, p.13.

Type **Genus: *Neoseiulus*** Hughes, 1948.

Genus *Neoseiulus* Hughes, 1948

- 1948. *Neoseiulus* Hughes, *Min. Agr. Fish. Lonon*, p.141.
- 1949. *Typhlodromus* (*Typhlodromopsis*) De Leon. *Entomol. News.*, **70**: 133 (in part).
- 1959. *Neoseiulus Typhlodromus* (*Typhlodromopsis*), De Leon, *Entomol. News*, **70**:33.

1965. *Neoseiulus*, De Leon, *Proc. Entomol. Soc. Wash.*, **67**(1):23
1970. *Neoseiulus*, Muma and Denmark, *Arthropods of Florida*, **6**:100.
1982. *Neoseiulus*, Moraes *et al.*, *Intrnat.J. Acarol.*, **4** (1):12.
1986. *Neoseiulus*, Gupta, *Fauna of India. Phytoseiidae*. p.100.
1987. *Neoseiulus*, Gupta, *Rec. Zool. Surv. India Occ. Pap.*, **95**: 33– 34.
1987. *Neoseiulus*, Daneshvar. *Ent. Phyt. Appl.*, **54**(1– 2): 13.
1992. *Neoseiulus*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal, part 3*, p.161.
2003. *Amblyseius (Neoseiulus)*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 1–185.
2007. *Neoseiulus*, Chant and Mc Murtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, Indira Publishing House, West Bloomfield, Michigan, USA, p.22.
2011. *Neoseiulus*, Gupta and Karmakar, *Zoosymposia.*, **6**:57– 62
2012. *Neoseiulus*, Prasad, *Checklist of Phytoseiidae of the World (Acari: Mesostigmata)*. Indira Publishing House, West Bloomfield, Michigan, USA, p.1063.
2014. *Neoseiulus*, Demite *et al.*, *Phytoseiidae Database, Zootaxa.*, **3795**: 571– 577.
2015. *Neoseiulus*, Gupta and Karmakar, *Rec.Zool.Surv.India*: **115** (Part– 1): 51– 72.

Diagnosis: Dorsal shield well sclerotized, smooth or reticulate with 17 pairs of setae (6 pairs of dorsocentral, 2 pairs median and 9 pairs lateral). Chelicera with

4 to 8 teeth on fixed digit. Sternal shield as long as or longer than wide, with 3 pairs of sternal setae. Ventrianal shield elongate, pentagonal, shield shaped or nearly quadrate with 3 pairs of preanal setae. No distinguishable macrosetae on leg I, II, III but always present on basitarsus IV, on some species.

Type species: *Neoseiulus barkeri* Hughes, 1948.

Key to the species of *Neoseiulus* included in the present study

1. Setae on dorsal shield all of the same length, not greatly longer than others *Neoseiulus radhamaniae* sp.nov.
- All setae on dorsal shield very long, touching basis of the following setae except S₅ which is minute *Neoseiulus longispinosus* (Evans)

Neoseiulus longispinosus (Evans), 1952

PLATE 33

1952. *Typhlodromus longispinosus* Evans, *Ann. Mag. Nat. Hist.*, **5** (12): 413 – 416.
1959. *Amblyseius (Typhlodromus) longispinosus* Ehara, *Acarologia*, **1**: 285–295.
1961. *Amblyseius (Typhlodromus) longispinosus* Muma, *Flor.Sta. Mus.Bull.*, **5** (7): 267– 302.
1970. *Amblyseius longispinosus* Gupta, *Science and Culture*, **36**: 98– 99.
1975. *Amblyseius longispinosus* Gupta, *Internat. J. Acarol.*, **1**(2): 26– 45.
1977. *Typhlodromus longispinosus* Gupta, *Oreint. Insects*, **11** (4): 267– 302.
1978. *Typhlodromus longispinosus* Gupta, *Indian J. Acarol.*, **2**: 60– 77.
1981. *Typhlodromus longispinosus* Xin et al., *Internat. J. Acarol.*, **7**: 75– 80.

1983. *Typhlodromus longispinosus* Gupta and Gupta. *Abst. II. All India Symp. Acarology*, Pune, p. 23.
1984. *Amblyseius longispinosus*, Lo, *et al.*, *J. Agri. Res. China*, **33**(4): 417.
1984. *Amblyseius longispinosus* Lo, *Acarol.*, **VI**, **2**: 703. 1986.
1986. *Amblyseius longispinosus* Lo, *Pl. Prot. Bull., Taiwan*, **28**: 37 – 39.
1986. *Amblyseius (Neoseiulus) longispinosus*, Gupta, *Fauna of India. Phytoseiidae*, p.116– 117.
1987. *Amblyseius (Neoseiulus) longispinosus*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 37– 40.
1992. *Amblyseius (Neoseiulus) longispinosus*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal, part 3*, p.162.
1992. *Amblyseius (Neoseiulus) longispinosus*, Gupta, In: *Contributions to Acarological Researches in India*, p.443.
1994. *Amblyseius (Neoseiulus) longispinosus*, Singh, *Shashpa*, **1**(2): 69.
1995. *Amblyseius longispinosus*, Chandrasekharappa *et al.*, *Abst V Nat. Symp. Acarol.*, Bangalore, p. 32– 33.
1996. *Amblyseius (Neoseiulus) longispinosus* Chatterjee and Gupta, *J. Beng. Nat. Soc. (NS)*, **15**: 26.
1999. *Amblyseius (Neoseiulus) longispinosus*, Gupta and Chatterjee, *Sci. and Cult.*, **65** (5 – 6): 162.
2003. *Amblyseius (Neoseiulus) longispinosus*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20** (1): 54.
2007. *Neoseiulus longispinosus*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the*

world (Acari: Mesostigmata), Indira Publishing House, West Bloomfield, Michigan, USA p.29.

2009. *Neoseiulus longispinosus*, Wu, Ou and Huang, *Science Press, Beijing, China*, p.511.
2011. *Neoseiulus longispinosus*, Sadanandan, *J. Ecobiology.*, **28** (2):147– 151.
2012. *Neoseiulus longispinosus*, Oliveira *et al.*, In: *Zootaxa*, **3453**: 1–24.
2013. *Neoseiulus longispinosus*, Kreiter *et al.*, *Acarologia*, **53** (3): 285– 303.
2014. *Neoseiulus longispinosus*, Abo– Shnaf and Moraes, *Zootaxa*, **3865**:1–71
2016. *Neoseiulus longispinosus*, Abo– Shnaf *et al.*, *Syst. Appl. Acarol.*, **21** (5): 607– 646

Female: Dorsal shield 338 long, 189 wide, smooth with 17 pairs of setae, mostly long except j_1 , J_5 and S_5 . Measurement of setae: j_1 – 14, j_3 – 53, j_4 – 61, j_5 – 75, j_6 – 72, J_2 – 70, J_5 – 8, z_2 – 77, z_4 – 81, z_5 – 43, Z_1 – 72, Z_4 – 77, Z_5 – 86, s_4 – 81, S_2 – 78, S_4 – 58, S_5 – 17, r_3 – 61, R_1 – 68. Sternal shield 50 long and 60 wide, with setae ST_1 – 30, ST_2 – 36, ST_3 – 32, ST_4 – 32 long present on metasternal shield. Genital shield 68 wide with setae ST_5 34 long. Ventrianal shield 100 long and 84 wide, reticulated with 3 pairs of preanal setae and a pair of semilunar preanal pore. Four pairs of setae present around the ventrianal shield, JV_1 – 32, JV_2 – 30, ZV_2 – 36, ZV_1 – 30, ZV_3 – 28, JV_4 – 19 and JV_5 – 77 long. Two pairs of metapodal plates present, primary one 19 long and 5 wide, accessory one 11 long. Spermatheca as figured. Fixed digit of chelicera 23 long with 2 teeth anterior to *pilus dentilis*, movable digit 25 long with 2 teeth. Peritreme extends anteriorly upto j_1 . Macrosetae on leg IV present only on bastitarsus – 81 long.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{2}{1} \frac{1}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Bauhinia racemosa* Lam., *Sida rhombifolia* L., *Justicia adhatoda* (L.), *Gymnema sylvestre* R.Br.

Known habitat: *Bauhinia purpuria*, Castor, *Datura metal*. *Tabernaemontana coronaria*, *Zinia* sp., lady's finger, Guava, Paddy, Rose

Material examined: Female marked on the slide along with other 3 ♀♀, INDIA, KERALA: Pantherankavu (Kozhikode district), 29.x.2015, ex. *Bauhinia racemosa* Lam., coll. santhosh (No.C 368/1, 368/3), 3 ♀♀, from Pattambi (Palakkad district), ex. *Sida rhombifolia* L., (No. C 368/4, 368/5). 2 ♀♀, from Uppala (Kasaragod district) ex. *Justicia adhatoda* (L.), (No. C 368/6) and 2 ♂♂ from Parapangadi (Malappuram district), ex. *Gymnema sylvestre* R.Br. coll. santhosh (No.C 368/7).

Distribution: INDIA: Kerala, Orissa, Bihar, West Bengal, Tamil Nadu, Pondicherry, Andaman Nicobar Islands, Uttar Pradesh. OUTSIDE INDIA: Taiwan, Indonesia, Phillipines, Hongkong, Tasmania, South Africa, Malaya, Jamaica, Hawaii.

Remarks: This species examined resembles *N. longispinosus* (Evans), 1952 in almost all characters and hence fixed so. This mite was found feeding on all stages of tetranychid species. In the present survey *N. longispinosus* was recovered from new host plants *Justicia adhatoda* (L.) and *Gymnema sylvestre* R.Br.

Neoseiulus radhamaniae* sp.nov.*PLATE 34**

Female: Dorsal shield 417 long, 227 wide with 3 pairs of pores. Measurements of setae: $j_1 - 15$, $j_3 - 22$, $j_4 - 10$, $j_5 - 15$, $j_6 - 12$, $J_2 - 10$, $J_5 - 8$, $z_2 - 10$, $z_4 - 8$, $z_5 - 8$, $s_4 - 12$, $S_2 - 15$, $S_4 - 16$, $S_5 - 16$, $Z_5 - 65$, $Z_1 - 14$, $Z_4 - 15$, $r_3 - 12$, $R_1 - 18$. Sternal shield smooth, 96 long, 88 wide with 3 pairs of sternal setae, $ST_1 - 25$, $ST_2 - 25$, $ST_3 - 22$ long. Metasternal shield rounded with $ST_4 - 22$ long and distances between ST_1 , ST_2 , ST_3 , ST_4 are 60, 75, 78 and 78 respectively. Genital shield 90 long and 88 wide with ST_5 22 long. Ventrianal shield 136 long and 101 wide anterior transverse striations and posterior plate like striations around the anal pore with three pairs of setae. Four pairs of setae present around the ventrianal shield. Length of $ZV_1 - 17$, $ZV_2 - 15$, $ZV_3 - 14$, $JV_1 - 24$, $JV_4 - 15$, $JV_5 - 56$. Two pairs of metapodal plates present, primary one 25 long and 3 wide, accessory one 12 long. Calyx of spermatheca conical with forked atrium, calyx length 18 and diameter of vesicle 13. Fixed digit of chelicera 35 long with 3 teeth and movable digit 34 long with 2 teeth placed apically. Peritreme extends anteriorly upto the level of j_1 . Macroseta present only on basitarsus of leg IV, 63 long.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$

Male : Unknown

Habitat : *Solnum melognena* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 13.x.2015, ex. *Solaum melognena* L., coll.

Santhosh (No.M 503/1). Two ♀♀ paratype slides, collection details same as holotype (No. M 503/2, 503/2)

Remarks: This new species closely resembles *Neoseiulus indicus* (Narayanan and Kaur), 1960 in dorsal chaetotaxy, leg chaetotaxy and leg IV setae, but differs in the following characters.

1. Longer nature of Z₅ and JV₅ (65 and 56) in new species whereas it is 56 and 40 in *N. indicus*.
2. In the new species, fixed digit of chelicera with a small *pilus dentilis*, movable digit bidentate whereas in *N. indicus* fixed digit tridentate with a strong *pilus dentilis*, movable digit unidentate.
3. In the new species, cervix of spermatheca is conical with forked atrium whereas in *N. indicus*, it is vesicular with nodular atrium.
4. The relative lengths of dorsal idiosomal setae differ in both species.

Tribe: Kampimodromini Kolodochka, 1998

1998. Kampimodromini Kolodochka, *Vestn. Zool. Ukraine*, **38**: 59.

2007. Kampimodromini, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.36.

Type **Genus:** *Kampimodromus* Nesbitt, 1951.

Subtribe: Paraphytoseiina Chant and Mc Murtry, 2003

2003. Paraphytoseiina Chant and McMurtry, *Internat. J. Acarol.*, **29** (3): 211.

2007. Paraphytoseiina, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the*

world (Acari: Mesostigmata), Indira Publishing House, West Bloomfield, Michigan, USA, p.347.

Type **Genus:** *Paraphytoseius* Swirski and Schechter, 1961.

Genus: *Paraphytoseius* Swirski and Schechter, 1961

1961. *Paraphytoseius* Swirski and Schechter. *Isreal J. Agric Res.*, **11**: 113.
1992. *Paraphytoseius*, Gupta. *Fauna of India:Phytoseiidae*, , p. 122 –123..
1986. *Paraphytoseius* Gupta. *Rec. Zool. Surv. India. Occ. Pap.* **95**: 46.
1989. *Paraphytoseius* Denmark and Muma. *Fla. St.Coll. of Arthropods Occ. Pap.* **4**: 44– 45.
1992. *Paraphytoseius*, Gupta. In: *State Fauna Ser. 3. Fauna of West Bengal, Part 3*, p. 163.
1997. *Paraphytoseius* Wei– nan, *Economic Fauna of China, Phytoseiidae*. p. 132.
2003. *Amblyseius (Paraphytoseius)*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20** (1): 58.
2007. *Paraphytoseius*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.49.
2012. *Paraphytoseius*, Prasad, *Checklist of Phytoseiidae of the World (Acari: Mesostigmata)*. Indira Publishing House, West Bloomfield, Michigan, USA, p.1063.
2014. *Paraphytoseius*, Demite *et al.*, *Phytoseiidae Database, Zootaxa.*, **3795**: 571– 577.
2015. *Paraphytoseius*, Gupta and Karmakar, *Rec.Zool.Surv.India*: **115** (Part– 1): 51

Diagnosis: Dorsal shield moderately sclerotized with 5 pairs of setae on dorsocentral series, 2 pairs of median and 5 – 6 pairs of laterals, 2 pairs of sublateral setae on lateral integument. Setae $j_1, j_3, s_4, Z_5, Z_4, r_3$, and R_1 , being long, thick and serrate. Sternal shield with 3 pairs of setae. Leg IV macrosetae on genu, tibia and basitarsus, mostly spatulate and knobbed.

Type species: *Paraphytoseius multidentatus* Swriski and Schechter, 1961.

Key to the species of *Paraphytoseius* included in the present study

1. Macrosetae on leg IV, broadly spatulate
..... *Paraphytoseius bhadrakaliensis* (Gupta)
- Macrosetae on leg IV narrowly spatulate or club shaped.....
..... *Paraphytoseius orientalis* Narayanan *et al.*

Paraphytoseius bhadrakaliensis (Gupta), 1969

PLATE 35

1969. *Amblyseius bhadrakaliensis* Gupta, *Bull. Entomolgy*, **10**(2): 126–129.
1977. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Gupta, *Orient. Insect*, **11**(4):623– 638.
1978. *Paraphytoseius* (*Paraphytoseius*) Gupta, *Indian J. Acarol.*, **2**: 60– 77
1979. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Gupta, *Bull. Zool. Surv. Ind*, **2**(1): 79–82.
1981. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Gupta and Ray, *Bull. Zoo. Surv. India*, **4**: 41–48.
1990. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Dhooria, *Acarol. Newsl*, **17/18**:17– 18

1999. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Denmark, *Indira Publishing House, WestBloomfield, USA*, p.125.
2003. *Amblyseius* (*Paraphytoseius*) *bhadrakaliensis* Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20**(1): 59.
2003. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Chant and McMurtry, *Internat. J. Acarol.*, **2**: 60– 73.
2004. *Paraphytoseius* (*Paraphytoseius*) *bhadrakaliensis* Moraes *et al.*, In: *Zootaxa*, p.160.
2007. *Paraphytoseius bhadrakaliensis* Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.53.

Female: Dorsal shield 275 long and 150 wide, lightly reticulated anteriorly. Setae j_1 , j_3 , s_4 , Z_4 , Z_5 , long, thick, serrated, measuring j_1 –32, j_3 –75, s_4 –112, Z_4 –62, Z_5 –88 long. j_4 , j_5 –3, j_6 –4, z_2 , z_4 –8, z_5 –4, Z_1 – 4, J_2 –3. Sublateral setae r_3 –35, R_1 –12 lies on lateral integument. Sternal shield 75 long and 78 wide with ST_1 , ST_2 , ST_3 –13 each, 4th pair of sternal setae ST_4 – 12 long lies on metasternal shield. Genital shield 90 wide with setae ST_5 24 long. Ventrianal shield 100 long, 65 wide. Setae ZV_1 –10, ZV_3 –12, JV_1 –14, JV_2 –14, ZV_2 –17 and JV_5 – 63 long, thick and serrate. Metapodal plate not discernable. Fixed digit of chelicera 25 long with 3 teeth anterior to *pilus dentilis* and 5 posterior to it; movable digit with 3 teeth. Spermatheca with bowl shaped cervix. Peritreme extends upto level of j_1 . Macroseta on leg IV: genu – 27, tibia – 38, basitarsus – 50, all spatulated.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$

Male: Unknown

Habitat: *Plumbago indica* (L.), *Psuedarthria viscid* (L.), *Helicteres isora* (L.)

Known Habitat: *Datura metel*, paddy, brinjal, banana, peat, rose, bean, tea, eucalyptus, sunflower, cashewnut, fern, cotton, *shorea robusta*, *Albizzia lucida*, *Ipomea*

Material examined: Female marked on the slide, INDIA: KERALA: Valapattanam (Kannur district), 8.xii.2015, ex. *Plumbago indica* (L.), coll: Santhosh, (No.P.748/1). Two ♀♀ from same host plant, collection details same (No.P.917/1, 917/2). Three ♀♀ from Pantherankavu (Kozhikode district), 12.xii.2015, ex. *Psuedarthria viscid* (L.), (No.P.783/1, 783/2), Two ♀♀ from Cherpulassery (Palakkad district), ex. *Helicteres isora* (L.) (No. P 783/3), coll. Santhosh.

Distribution: INDIA: Kerala, Andaman Islands, Arunachal Pradesh, Assam, Jammu and Kashmir, Karnataka, West Bengal, Meghalaya, Orissa, Pujab, Bihar, Tamil Nadu, Tripura.

Remarks: The specimen examined agrees with *P. bhadrakaliensis* (Gupta), 1969 in almost all characters like general appearance, dorsal chaetotaxy etc. and hence fixed so. In the present survey *Paraphytoseius bhadrakaliensis* was recovered from new host plants *Plumbago indica* (L.), *Psuedarthria viscid* (L.) and *Helicteres isora* (L.)

Paraphytoseius orientalis Narayanan *et al.*, 1960.

PLATE 36

1960. *Typhlodromus (Amblyseius) orientalis* Narayanan *et al.*, *Proc. Nat. Inst. Sci.* **26 B**: 394.
1961. *Paraphytoseius multidentatus* Swirski and Shechter, *Isreal, J. Agric. Res.* **11**(2) : 114– 116.
1984. *Amblyseius (Paraphytoseius) multidentatus*, Wei– nan, *Acarology* VI, **1**: 222.
1985. *Paraphytoseius multidentatus*, Schicha and Corpuz Raros, *Internat. J. Acarol.* **11**(2): 67– 69.
1986. *Amblyseius (Paraphytoseius) multidentatus*, Gupta, *Fauna of India: Phytoseiidae*, p. 123– 124.
1987. *Amblyseius (Paraphytoseius) multidentatus*, Gupta, *Rec. Zool. Surv. India. Occ. Pap.*, **95**: 46– 47.
1990. *Amblyseius narayanani*, Dhooria, *Acar. Newsl.*, **17– 18** : 18.
1990. *Amblyseius bhadrakaliensis*, Dhooria, *Acar. Newsl.*, **17– 18**: 18.
1992. *Amblyseius (Paraphytoseius) multidentatus*, Gupta, In: *Contributions to Acarological Researches in India*, p. 442.
1992. *Amblyseius (Paraphytoseius) multidentatus*, Chant and Yoshida– Shaul, *Internat. J. Acarol.*, **18** (3): 183.
1993. *Amblyseius (Paraphytoseius) multidentatus*, Mukherjee and Singh, *J. Insect Sci.*, **6** (1): 136.

1994. *Amblyseius (Paraphytoseius) multidentatus*, Singh, *Shashpa*, **1**(2): 69.
1995. *Amblyseius (Paraphytoseius) multidentatus*, Singh, *Adv. Agric. Res. India*, **3**: 190.
1995. *Amblyseius (Paraphytoseius) multidentatus*, Gutpa, In: *State Fauna Ser. 4. Fauna of Meghalaya, Part 2*. p. 34 – 35.
1996. *Amblyseius (Paraphytoseius) multidentatus*, Chatterjee and Gutpa, *J. Beng. Nat. Hist. Soc., (NS)*, **15**: 26.
1997. *Paraphytoseius multidentatus*, Wei-Nan, *Economic Insect Fauna of China: Phytoseiidae*, p.134.
1999. *Paraphytoseius multidentatus*, Denmark *et al.*, *Indira Publishing House, WestBloomfield, USA*, p.125.
2000. *Amblyseius (Paraphytoseius) multidentatus*, Gupta, In: *State Fauna Ser. 7. Fauna of Tripura, Part 2*, p.25.
2003. *Amblyseius (Paraphytoseius) multidentatus*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20** (1): 59.
2005. *Paraphytoseius orientalis*, Rosa *et al.*, *Neotrop. Entomol.*, **34** (4): 689–692.
2006. *Paraphytoseius orientalis*, Furtado *et al.*, *Exp. Appl. Acarol.*, **40**: 157–174
2007. *Paraphytoseius orientalis*, In: Chant and McMurtry. *Illust. Keys and Diag. for the Genera and Subgenera of the Phytoseiidae of the World (Acari: Mesostigmata)*. p. 51.

2008. *Paraphytoseius orientalis*, Guanilo *et al.*, In: *Zootaxa*, **1884**: 1–35.
2009. *Paraphytoseius orientalis*, Lofego *et al.*, In: *Zootaxa*, **2240**: 41–59.
2012. *Paraphytoseius orientalis*, Mineiro *et al.*, *Internat. J. Acarol.*, **38** (7): 595 – 604.
2016. *Paraphytoseius orientalis*, Nguyen, *J. Acarol. Soc. Jap.*, 25(51): 133–136

Female: Dorsal shield elongate, 285 long and 165 wide, rugose. Setae j_1 , j_3 , s_4 , Z_4 , Z_5 long thick and serrate measuring $j_1 - 25$, $j_3 - 75$, $s_4 - 100$, $Z_4 - 62$ and $Z_5 - 80$. Measurements of other setae: $j_4 - 5$, j_5 , $j_6 - 7$, $z_2 - 9$, $z_4 - 13$, $z_5 - 5$, $Z_1 - 7$, $r_3 - 37$, $R_1 - 25$ present on lateral integument. Sternal shield 75 long, 62 wide with 3 pairs of sternal setae, ST_1 , ST_2 , $ST_3 - 20$ each, 4th pair 18 long and placed on metasternal shield. Genital shield 68 wide with a pair of setae 13 long. Ventrianal shield 100 long, 52 wide. Measurement of preanal setae, JV_1 , ZV_2 and $JV_2 - 14$ each. Three pairs of setae present on the membrane around the shield, $ZV_1 - 22$, $ZV_3 - 9$ long. A pair of metapodal plate present, primary one 12 long and accessory 7 long. Setae $JV_5 - 62$ long, thick and serrate. Fixed digit of chelicera 32 long multidentate with strong *pilus dentilis*, movable digit with two teeth. Spermatheca with popcular cervix, 3.2 long with nodular atrium. Peritreme extends upto the level of j_3 . Macrosetae present on leg IV: genu – 26, tibia – 30 basitarsus – 42, all thick with knobbed tips.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Solanum melongena* L., *Bauhinia acuminata* L., *Solanum virginianum* L.

Known habitat: *Datura metel*, paddy, *Rubus* sp, *Cajanus cajan*, banana, brinjal, pear, rose, tea, beans, eucalyptus, cashew nut, sunflower, *Shorea robusta*, *Ipomea*, *Alibizzia lucida*, cotton, *Polygonum* sp., *Eupatorium odoratum*, *Raphanus sativus*, *Hibiscus mutabilis*, *Vigna unguiculata*, mango, jackfruit, arecanut, *Dolichos lablab*, *Abelmoschus esculentus*, *Lantana*, orchid.

Material examined: Female marked on the slide, INIDA: KERALA: Ashokapuram (Kozhikode district), 7.xi.2015, ex. *Solanum melongena*, coll. Santhosh (No.R.579/1). Five ♀♀ from the same habitat with same collection details (No.R.579 /2, 579/3, 579/4). Four ♀♀ and 2 ♂♂ from Kadalundi (Kozhikode district), 3.xi.2015, ex. *Bauhinia acuminata* (L.) and 2 ♀♀ from Calicut University campus (Malappuram district), 7.x.2015, ex. *Solanum violaceum* (Ortega), (No.R.525/1, 525/2).

Distribution: INDIA: Kerala, Tripura, Maharashtra, West Bengal, Andaman and Nicobar Islands, Bihar, Meghalaya, Assam, Tamil Nadu, Karnataka, Andra Pradesh, Uttar Pradesh. OUTSIDE INDIA: Hong Kong, Malagassy, Thailand, Nigeria and Madagascar. Pakistan, Philippines, Taiwan, Venezuela, Japan, Colombia

Remarks: The specimen examined agrees with *P. orientalis* in almost all characters hence fixed so. *P. orientalis* was recovered from three new host plants viz., *Solanum melongena* L., *Bauhinia acuminata* L. and *Solanum virginianum* L.

Tribe: Typhlodromipsini Chant and Mc Murtry, 2005

2005 Typhlodromipsini Chant and McMurtry, *Internat. J. Acarol.* **31**(3): 318.

2007 Typhlodromipsini Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.55– 57.

Type **Genus:** *Typhlodromips* De Leon, 1965.

Key to the genera in the tribe Typhlodromipsini

1. Dorsal shield with waist at level of seta R₁; dorsal shield usually reticulate; usually with scale– like markings on the anteriolateral margin of dorsal shield, seta R₁ never inserted on the dorsal shield of female, posterior margin of the sternal shield striate or concave, never with posterior projection, seta Z₄ variable in length but never minute
..... *Typhlodromips* De Leon
- Dorsal shield without prominent waist at level of R₁; usually with distinct longitudinal striations along anteriolateral margin of dorsal side, lateral setae j₃, z₂, z₄, Z₁, S₂, S₄ and S₅ short or minute, subequal; seta R₁ inserted on the edge of the dorsal shield of the females of some species, posterior margin of the sternal shield sometimes with a median projection or sometimes lightly sclerotized, seta Z₄ variable in length, sometimes minute. Seta J₁ absent; seta s₄ less than twice the length of any other lateral setae *Scapulasieus* Karg and Oomen– Kalsbeek

Genus *Typhlodromips* De Leon, 1959

1959. *Typhlodromips* De Leon, *Entomol. News.*, **70**:133

1986. *Typhlodromips*, Gupta, *Fauna of India: Phytoseiidae*, p.159.

1987. *Typhlodromips*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 57.

1987. *Typhlodromips*, Daneshvar. *Ent. Phyt. Applique*, **54**:20.

2003. *Amblyseius (Typhlodromips)* Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20** (1): 82.

2007. *Typhlodromips*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.63.

Diagnosis: Dorsal shield with 6 pairs of dorsocentral, 2 pairs of median, 9 pairs of laterals, Z₅ and Z₄ serrate or plumose. Fixed digit of chelicera mostly multidentate. Sternal shield as wide as or wider than long. Ventrianal shield pentagonal or shield shaped. Macrosetae may be present on genu and occasionally on tibia of legs I, II and III. Leg IV macroseta present on genu, tibia and basitarsus.

Type species: *Typhlodromus (Typhlodromopsis) simplicissimus* De Leon, 1965.

Key to the species of *Typhlodromips* included in the present study

1. Z₅ and Z₄ , other setae being are equal, the ratio of length and width of ventrianal shield is 1.04*Typhlodromips syzygii* Gupta
- Besides Z₄ and Z₅ they are other long setae, the ratio of length and width of ventrianal shield is 1.6*Typhlodromips mathaii* sp.nov.

Typhlodromips mathaii* sp.nov.*PLATE 37**

Female: Dorsal shield 367 long and 253 wide, reticulated along antero-lateral margin. Measurement of setae: $j_1 - 20$, $j_3 - 41$, $j_4 - 8$, $j_5 - 8$, $j_6 - 8$, $J_2 - 8$, $J_5 - 6$, $z_2 - 9$, $z_4 - 8$, $s_4 - 70$, $Z_1 - 10$, $S_2 - 6$, $S_4 - 8$, $S_5 - 8$, $Z_5 - 88$, $z_5 - 8$ and $Z_4 - 68$. Sternal Shield 70 long, 65 wide with sternal setae ST_1 , ST_2 and $ST_3 - 19$ each, ST_4 on metasternal shield 18 long. Genital shield 75 wide with ST_5 17 long. Ventrianal shield 113 long, 81 wide with crescent shaped pores. Preanal setae JV_1 , JV_2 and $ZV_2 - 13$ long. Four pairs of setae around the ventrianal shield, $ZV_1 - 13$, $ZV_3 - 12$, $JV_4 - 12$, $JV_5 - 50$ long. Two pairs of metapodal plates present, primary one 15 long, 5 wide accessory one 12 long. Spermatheca with vesicular cervix having nodular atrium. Peritreme extends up to j_1 . Fixed digit of chelicera bears 3 teeth anterior to *pilus dentilis* and 5 teeth posterior to it, movable digit with 3 teeth. Macroseta on Leg IV: genu - 70, tibia - 45, basitarsus - 86.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$

Male: Unknown

Habitat: *Zingiber zerumbet* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Thekkumthara (Wayanad district), 11.xii.2015, ex. *Zingiber zerumbet* (L.), coll. Santhosh (No.W 884/1), two ♀ ♀ paratype slides from the same habitat (No. W 884/2, 884/3).

Remarks: This new species closely resembles *Typhlodromips guajavae* Gupta, 1978 in general appearance but differs in the following features,

1. In the new species dorsal shield is 367 long and 253 wide with reticulation present on the anterior lateral margin whereas in the *T. guajavae* it is smooth, 325 long and 224 wide.
2. The relative length of macrosetae on leg IV differs in both species. In the new species, genu – 70, tibia – 45 and tarsus 85 long whereas in *T. guajavae*, it is 62,40 and 78 respectively.
3. In the new species fixed digit with 3 teeth anterior to *pilus dentilis* and 5 teeth posterior to it whereas in *T. guajavae*, it is 4 and 3 respectively.
4. Spermatheca with pocular flared cervix in *T. guajavae*, whereas in the new species spermatheca is non pocular with slightly flared cervix.
5. In the new species sternal shield 70 long, 65 wide whereas in *T. guajavae* it is 82 and 80 respectively.
6. Longer nature of JV₅ (50) in the new species instead of 13.

***Typhlodromips syzygii* Gupta, 1975**

PLATE 38

1975. *Amblyseius syzygii* Gupta, *Internat. J. Acarol.*, **1**(2): 44– 45.
1977. *Amblyseius (Amblyseius) syzygii* Ehara and Bhandhufalck, *J. faculty Edu., Tottori University , Natural Science*, **27** (2) 43– 82.
1985. *Amblyseius (Typhlodromips) syzygii*, McMurtry and Moraes, *Internat. J. Acarol.*, **11**:75– 88.

1986. *Amblyseius (Typhlodromips) syzygii*, Gupta, *Fauna of India: Phytoseiidae*, p.188– 190.
1987. *Amblyseius (Typhlodromips) syzygii*, Gupta, *Rec, Zool. Surv. India, Occ. Pap.* **95**: 68.
1989. *Amblyseius (Typhlodromips) syzygii*, Singh *et.al.*, In: *Prog. Acarol.*, **2**: 361:367.
1992. *Amblyseius (Typhlodromips) syzygii*, Gupta, In: *State Fauna ser.3, Fauna of West Bengal, Part 3*, p. 169.
1995. *Amblyseius (Typhlodromips) syzygii*, Gupta, In: *State Fauna ser.4, Fauna of Meghalaya, Part 2*, p. 37.
1996. *Amblyseius (Typhlodromips) syzygii*, Chatterjee and Gupta, *J. Beng. Nat. Hist. Soc. (NS)*, **15**: 26.
2000. *Amblyseius (Typhlodromips) syzygii* Gupta, In: *State Fauna ser.3, Fauna Ser. 7, Fauna of Tripura, Part 2*, p.26.
2003. *Amblyseius (Typhlodromips) syzygii*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20**(1): 82.
2005. *Amblyseius (Typhlodromips) syzygii*, Chant and McMurtry, *Internat. J. Acarol.*, **31**(4): 315– 340.
2007. *Typhlodromips syzygii*, Chant and Mc Murtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.63.
2009. *Amblyseius (Neoseiulus) syzygii* Wu *et al.*, *Science Press, Beijing, China*, p.51.

2012. *Typhlodromips syzygii*, Prasad, Indira Publishing House, Westbloomfield, USA, p.1063.

2013. *Typhlodromips syzygii*, Sajna Haneef and Mary Anitha, *Biological Forum*: 5 (2): 119– 122.

Female: Dorsal shield reticulated, 360 long and 215 wide. Measurement of setae: $j_1 - 18$, $j_4 - 5$, $j_5 - 6$, $j_6 - 8$, $J_2 - 10$, $J_5 - 8$, $z_2 - 10$, $z_4 - 10$, $s_4 - 14$, $Z_1 - 10$, $S_2 - 10$, $S_4 - 10$, $S_5 - 8$, $Z_5 - 75$ (serrated), $z_5 - 8$ and $Z_4 - 25$. Sternal Shield 75 long, 62 wide with sternal setae, $ST_1 - 10$, ST_2 , $ST_3 - 11$ long, $ST_4 - 12$ long on metasternal shield. Genital shield 80 wide with ST_5 12 long. Ventrianal shield 106 long, 75 wide with crescent shaped pores. Preanal setae $JV_1 - 14$, JV_2 , $ZV_2 - 12$ each. Four pairs of setae, ZV_1 , ZV_3 , JV_4 and JV_5 around the ventrianal shield. ZV_1 , $ZV_3 - 14$ each, $JV_4 - 12$ and $JV_5 - 26$ long. Two pairs of metapodal plates present, primary one 22 long 7 wide, accessory one 15 long. Spermatheca having pocular cervix with an elongated atrium. Peritreme extends beyond j_1 . Fixed digit of chelicera bears 2 teeth anterior to *pilus dentilis* and 3 posterior to it, movable digit with 4 teeth. Macroseta on Leg IV: genu – 38, tibia – 30 and basitarsus – 52.

Leg chaetotaxy:

genu II $2\frac{2}{0}\frac{2}{0}1$	tibia II $1\frac{1}{1}\frac{2}{1}1$;
genu III $1\frac{2}{1}\frac{2}{0}1$	tibia III $1\frac{1}{1}\frac{2}{1}1$

Male: Unknown

Habitat: *Solanum virginianum* L., *Averrhoa bilimbi* L., *Ocimum sanctum* L.

Known habitat: *Syzygium cumini*, guava, jute, maize, beans, sugarcane.

Material examined: Female marked on the slide, INDIA: KERALA, Pattambi (Palakkad district), 5.xi.2015, ex. *Solanum violaceum* (Ortega),

coll. Santhosh (No.T 561/1). Two ♀♀, collection details as above (No. T 561/2, 561/3). Two ♀♀ marked on the slide, Malabar Christian College Herbal Garden (Kozhikode district), 7.xi.2015, ex. *Averrhoa bilimbi* (L.), coll. Santhosh (No.T 586/1, 586/2) and 2 ♀♀ from Thalassery (Kannur district)ex. *Ocimum sanctum* (L.) (No.T. 743/1).

Distribution: INDIA: Kerala, West Bengal, Orissa, Tripura, Bihar, Uttar Pradesh. OUTSIDE INDIA: Thailand, Indonesia, Papua New Guinea, China

Remarks: This species resembles *T. syzygii*, Gupta, 1975 in general appearance, setal measurements, structure of spermatheca etc. and hence fixed so. *T. syzygii* was recovered from two new host plants viz., *Averrhoa bilimbi* (L.) and *Ocimum sanctum* (L.)

Genus: *Scapulaseius* Karg and Oomen – Kalsbeek, 1987

1987. *Amblyseius (Scapulaseius)* Karg and Oomen – Kalsbeek, *Zool. Jahr. Syst.* **118**(1): 132.

1987. *markwelli* species group Schicha, *Phytoseiidae of Australia and neighbouring areas*. Indira Publ. House, Michigan. p. 25.

1998. *japonicus* species group, Ehara and Amano, *Species Diversity* **3**(1): 26

1999. *oguroi* species group, Wu and Ou, *Syst. Appl. Acarol.*, **4**:103

2003. *Amblyseius (Typhlodromalus)* Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20**(1): 66–67.

2004. *Scapulaseius* Moraes *et al.*, *Zootaxa*, **434**: 1–494.

2005. *Scapulaseius*, Chant and McMurtry, *Internat. J. Acarol.*, **31**(4): 331

2007. *Scapulaseius*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.219.

2014. *Scapulaseius*, Demite *et al.*, *Database. Zootaxa*, **3795** (5): 571–577

Diagnosis: Dorsal shield with 6 pairs of dorsocentral, 2 pairs of median, 8 – 9 pairs of laterals, of those Z_5 being longest. Sternal shield longer than wide, lobate posteriorly. Ventrianal shield elongate, mostly vase shaped, with 3 pairs of preanal setae anterior pair mostly adjacent to anterior margin of shield. Macroseta present on genu, tibia and basitarsus of leg IV, the one on basitarsus being longest. Fixed digit of chelicera multidentate, half of which proximal to *pilus dentilis*.

Type species: *Amblyseius (Scapulaseius) stilus* Karg and Oomen– Kalsbeek, 1987.

Key to the species of *Scapulaseius* included in the present study

1. Ventrianal shield measuring 103 long and 96 wide; pentagonal with pointed posterior end.....*Scapulaseius suknaensis* Gupta
- ventrianal shield 93 long and 75 wide; pentagonal with rounded posterior end owing slightly concave lateral margin.....
.....*Scapulaseius mohanasundarami* sp.nov.

Scapulaseius mohanasundarami sp.nov.

PLATE 39

Female: Dorsal shield 303 long, 190 wide, sclerotized on antero– laterally with a pair of pore present near Z_4 . Measurements of setae: j_1 – 20, j_3 – 12, j_4 , j_5 , j_6 – 7 each, J_2 – 9, J_5 – 7, z_2 – 10, z_4 – 10, z_5 – 8, Z_1 – 10, Z_4 – 55, Z_5 – 75, s_4 – 18, S_2 – 8, S_4 – 8, S_5 – 8, r_3 – 12, R_1 – 14. r_3 and R_1 on interscutal

membrane which is quite wide. Sternal shield 70 long 63 wide, with ST_1 , ST_2 – 12 each and ST_3 – 14 long. ST_4 – 11 long on metasternal shield. Posterior margin of sternal shield concave and lateral margin making an angle. Genital shield 80 wide with setae 12 long. Ventrianal shield 93 long, 75 wide with indented lateral side to the area around anal pore, with 3 pairs of preanal setae and a pair of pores. JV_1 – 12, JV_2 – 14, ZV_2 – 12, ZV_3 – 7, JV_4 – 8, JV_5 – 26 long. Two pairs of metapodal plates present, primary one 12 long and 2 wide, accessory one 4 long. Fixed digit of chelicera 27 long with 7 teeth and movable digit with 2 teeth. Cervix of spermatheca 38 long, diameter of vesicle 12. Peritreme extends anteriorly upto j_1 , Macarosea on leg IV: genu – 31, basitarsus – 65 and no macarosea on tibia.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{1}{1} \frac{2}{1} 1$ tibia III $1 \frac{2}{1} \frac{1}{1} 1$

Male: Unknown

Habitat: *Solanum melongena* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Thekumthara (Wayanad district), 1.xii.2015, ex. *Solanum melongena* (L.) coll. Santhosh (No.W.831/1). Paratype slides with 2 ♀♀, collection details same as above (No.W. 831/2, 831/3).

Remarks: This species resembles *Scapulaseius suknaensis* Gupta, 1970 in dorsal chaetotaxy, general appearance but differs in the following respects.

1. In the new species, ventrianal shield 93 long, 75 wide, whereas in *S. suknaensis* ventrianal shield measuring 103 long and 96 wide. Shape of ventrianal shield differs in both species.

2. *Pilus dentilis* is absent in the new species, movable digit of chelicera with 2 teeth instead of 3.
3. Structure of spermatheca slightly differs in both species; In the new species atrium is nodular whereas in *S. suknaensis*, it is tubular.
4. The leg chaetotaxy of genu III and tibia III of this new species is $1\frac{1}{2}\frac{2}{0}1$ and $1\frac{2}{1}\frac{1}{1}1$, whereas in *S. suknaensis*, it is $1\frac{1}{1}\frac{2}{0}1$ and $1\frac{1}{1}\frac{2}{1}1$ respectively.
5. In *S. suknaensis*, leg IV tibia measuring 26 long whereas in this new species it is 14 long.

***Scapulaseius suknaensis* Gupta, 1970**

PLATE 40

1970. *Amblyseius suknaensis* Gupta, *Ori. Ins.*, **4**: 185– 186.
1986. *Amblyseius (Typhlodromips) suknaensis* Gupta, *Fauna of India: Phytoseiidae*. p. 185– 188.
1986. *Amblyseius (Typhlodromips) suknaensis* Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 67.
1992. *Amblyseius (Typhlodromips) suknaensis*, Gupta, *In: State Fauna Ser. 3, Fauna of West Bengal, Part.3*, p. 168.
1992. *Amblyseius (Typhlodromips) suknaensis*, Gupta, *In: Contributions to Acarological Researches in India*, p.443.
1994. *Amblyseius (Typhlodromips) suknaensis*, Singh, *Shashpa*, **1**(2):70.
1995. *Amblyseius (Typhlodromips) suknaensis*, Gupta, *In: State Fauna Ser. 4, Fauna of Meghalaya, Part.2*, p.36– 37.
1996. *Amblyseius (Typhlodromips) suknaensis* Chatterjee and Gupta, *J. Beng. Nat. Hist. Soc., (NS)*, **15**: 26.

2003. *Amblyseius (Typhlodromips) suknaensis*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 72.
2004. *Scapulaseius suknaensis*, Moraes et al., *Zootaxa*, **434**:1– 494
2005. *Scapulaseius suknaensis*, Chant and McMurtry, *Internat. J. Acarol.* **31**(4): 315–340.
2007. *Scapulaseius suknaensis*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.68.
2012. *Scapulaseius suknaensis*, Prasad, *Indira Publishing House, Westbloomfield , USA*, p.1063.

Female: Dorsal shield 301 long, 202 wide, sclerotised with 4 pairs of pores present. Measurement of setae: j_1 –14, j_3 – 12, j_4 , j_5 – 6, j_6 – 8, J_2 – 8, J_5 – 5, z_2 – 12, z_4 – 12, z_5 – 12, s_4 – 14, Z_1 – 12, S_2 – 14, S_4 – 12, S_5 – 11, Z_4 – 46 serrated anteriorly, Z_5 – 75 serrated anteriorly, r_3 – 12, R_1 – 11. Sternal shield 75 long and 88 wide with ST_1 – 15, ST_2 – 20, ST_3 – 18 and ST_4 – 15 long on metasternal plate. Genital shield 75 long 80 wide with setae 12 long. Ventrianal shield 106 long, 83 wide, with 3 pairs of preanal setae and a pair of crescent shaped pores. JV_1 – 10, JV_2 and ZV_2 – 9 each, 3 pairs of setae around ventrianal shield ZV_1 , ZV_3 , JV_4 – 9 each. JV_5 smooth – 22 long. Two pairs of metapodal plates present, primary 18 long and 5 wide, accessory 13 long. Fixed digit of chelicera 18 long with 3– 4 teeth, anterior to *pilus dentilis* and 2 – 3 teeth posterior to it, movable digit with 2 teeth. Spermatheca with tubular cervix widen posteriorly; atrium bifid. Peritreme extends anteriorly upto j_1 . Macroseta on leg IV: genu – 32, tibia – 27, basitarsus – 62.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$, tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{1}{1} \frac{2}{0} 1$, tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Helicteres isora* (L.)

Known habitat: *Colocasia esculenta*, *glycosmis*, brinjal, mango, palm, Neem, cashewnut, bamboo, wood apple, *Tectona grandis*, rose, fern, *Shorea robusta*, bitter guard, mulberry, papaya, citrus, *Dolichos lablab*, *Lantana*, guava, *Euphorbia*, *Eupatorium odoratum*.

Material examined: Three ♀♀ marked on the slide, INDIA: KERALA: Kakkadampoyil (Kozhikode district), 18.xii.2015, ex. *Helicteres isora* L. coll. Santhosh (No.K.899/1, 899/2, 899/3).

Distribution: INDIA: Kerala, Arunachal Pradesh, Assam, Sikkim, Mizoram, Tripura, West Bengal, Orissa, Meghalaya, Uttar Pradesh, Andaman and Nicobar Islands.

Remarks: This species resembles all most all characters to *S. suknaensis* Gupta, 1970 and hence fixed so. *Scapulaseius suknaensis* was recovered from a new habitat viz., *Helicteres isora* (L.).

Genus *Amblyseius* Berlese, 1914

1914. *Amblyseius* Berlese, *Redia*, **10**:143.

1961. *Amblyseius* (*Amblyseius*), Muma, *Bull. Fla. St. Mus.*, **5** (7): 287.

1984. *Amblyseius* (*Amblyseius*) Wei – nan, Zhao– quan, *Zootaxonomica Sinica*, **9**: 156–158.

1984. *Amblyseius (Amblyseius)* Wei – nan, *Acarology* VI, **1**: 222–227.
1986. *Amblyseius (Amblyseius)* Gupta, *Fauna of India (Acari: Mesostigmata)* Family Phytoseiidae, p. 350.
1987. *Amblyseius (Amblyseius)* Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 6.
1988. *Amblyseius (Amblyseius)* Gupta, In: *Prog.Acarol.*, **1**: 403 –410.
1990. *Amblyseius (Amblyseius)*, El– Banhawy and Abou– Awad, *Insect Sci. Appl.*, **11**: 899 – 901.
1991. *Amblyseius (Amblyseius)*, Papadoulis and Emmanouel, *Entomol. Hell*, **9**: 35.
1992. *Amblyseius (Amblyseius)*, Chant and Yoshida–Shaul, *Internat. J. Acarol.*, **18** (3):179.
1992. *Amblyseius (Amblyseius)*, Ryu and Lee, *Korean J. Entomol.*, **22** (1): 23– 42.
1992. *Amblyseius (Amblyseius)*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal Part 3*, p.151.
2003. *Amblyseius (Amblyseius)*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20** (1): 1–185.
2007. *Amblyseius*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.73.

Diagnosis: Dorsal shield smooth, well sclerotized, with 17 pairs of setae, 6 pairs on dorsocentral, 2 pairs on median, 9 pairs on laterals. Setae Z₅, s₄, Z₄ long, whip like, may be serrate minutely. J₁, J₃ also long. Sternal shield

smooth, as wide or wider than long, with 3 pairs of sternal setae. Peritreme extends anteriorly upto j_1 . Fixed digit of chelicera multidentate with long *pilus dentilis*, movable digit with 1 – 4 teeth. Leg IV with macrosetae on genu, tibia, basitarsus, that on genu being longest.

Type species : ***Zercon obtusus*** Koch, 1839.

Key to the species of genus *Amblyseius* included in the present study

1. Ventrianal shield vase shaped with lateral margin concave 2
 - Ventrianal shield pentagonal or squarish 9
2. Ventrianal shield with a septum at level of JV_2
 - *Amblyseius velayudhani* Santhosh and Mary Anitha 2016
 - Septum absent 3
3. Ratio of setae $Z_5:Z_4$ more than 3 *Amblyseius kadalundiensis* sp.nov.
 - Ratio of setae $Z_5:Z_4$ less than 3 4
4. Ratio of setae $Z_5:Z_4$ is 2.2 *Amblyseius melongenae* sp.nov.
 - Ratio of setae $Z_5:Z_4$ between 2.5 – 3 5
5. Ratio of length and width of ventrianal shield is
 - *Amblyseius devakiae* sp.nov.
 - Ratio of length and width of ventrianal shield less than 2 6
6. Spermathecal cervix narrow, nodular atrium
 - *Amblyseius ramaniae* sp.nov.
 - Spermathecal cervix wider, nodular atrium 7
7. Movable digit of chelicera with 2 teeth
 - *Amblyseius largoensis* (Muma)
 - Movable digit of chelicera with 4 teeth 8

8. Setae z_2 longer than z_4*Amblyseius aerialis* (Muma)
 - Setae z_2 and z_4 minute, movable digit of chelicera with 1 tooth.....
.....*Amblyseius cucurbitae* Rather
9. Ventrianal shield pentagonal, cervix curved tube and of parallel diameter.....*Amblyseius kavumvattamsis* sp.nov.
 - Spermatheca not like above..... 10
10. S_4 longer than Z_4 11
 - S_4 shorter than Z_4 *Amblyseius channabasavannai* Gupta and Daniel
11. Ratio of Z_5 and Z_4 is equal to 1.5*Amblyseius neorykei* Gupta
 - Ratio of Z_5 and Z_4 is more than 1.5 12
12. Ratio of Z_5 and Z_4 is 1.8 and spermatheca cervix straight tube and of parallel diameter *Amblyseius zoansi* sp.nov.
 - Ratio of Z_5 and Z_4 is 1.9..... *Amblyseius thejassi* sp.nov.

***Amblyseius aerialis* (Muma),1955**

PLATE 41

1955. *Amblyseiopsis aerialis* Muma, *Ann. Ent. Soc. Amer.*, **48**: 264– 266.
1957. *Amblyseiopsis aerialis* , Athias– Henriot, *Bull.Soc.Hist. Nat.Afr.Nord*, **48**: 319– 352.
1964. *Amblyseius aerialis*, Rao and Rao, *Common Wealth Insti.Biol. Contr. Tech. Bull.*, **4**: 38– 39.
1986. *Amblyseius (Amblyseius) aerialis* Gupta, *Fauna of India: Phytoseiidae*, p.39.
1987. *Amblyseius (Amblyseius) aerialis*, Gupta, *Rec.Zool.Surv. India*, Occ. Pap., **95**: 7.

1989. *Amblyseius aerialis*, Denmark and Muma, *Fla.St.Coll. Arthropods Occ. Pap.*, **4**:15– 16.
1992. *Amblyseius (Amblyseius) aerialis* Gupta, In: *Contrib. to Acarol. Res. India*, p.442.
2000. *Amblyseius aerialis*, Moraes, *Acarologia*, **40**(3), 237– 264.
2003. *Amblyseius aerialis*, Gupta, *Memoirs.*, **20** (1) : 1– 185
2004. *Amblyseius aerialis*, Chant and McMurtry, *Internat. J. Acarol.*, **30** (3): 171– 228.
2006. *Amblyseius aerialis*, Kreiter, *Zootaxa*, **1294**: 1– 27.
2009. *Amblyseius aerialis*, Mineiro *et al.*, *Biota Neotropica*, **9** (1): 37– 46
2011. *Amblyseius aerialis*, Karmakar and Gupta, *Zoosymposia*, **6**: 62– 67.
2015. *Amblyseius aerialis*, Nuvoloni *et al.*, *Zootaxa*, **3964** (2): 260– 274.
2013. *Amblyseius aerialis*, Sajna Haneef and Mary Anitha, *Biological Forum*: **2**: 119– 122.
2016. *Amblyseius aerialis*, Silva *et al.*, *Sys. App. Acarol.*, **21**(8):1133– 1144.

Female: Dorsal shield smooth, 367 long, 240 wide with 17 pairs of setae, j_1 , j_3 , s_4 , Z_4 and Z_5 being the longest. Measurement of setae: j_1 – 32, j_3 – 50, s_4 – 106, Z_4 – 164, Z_5 – 278 all other setae minute. Sternal shield 75 long 73 wide with setae ST_1 , ST_2 , ST_3 measuring 12 long. ST_4 lies on the metasternal shield 11 long. Genital shield 93 wide with setae ST_5 – 12 long. Ventrianal shield 126 long and 75 wide with 3 pairs of preanal setae. ZV_1 , ZV_2 , ZV_3 – 15 long, JV_1 – 18, JV_2 – 14, JV_4 – 12. JV_5 smooth, 78 long. Two pairs of metapodal plate present, primary one 17 long, accessory one 5 long. Spermatheca with tubular cervix 22 long. Chelicera fixed digit 36 long, with

4 strong teeth posterior to *pilus dentilis* and 2 teeth anterior to it. Movable digit 35 long with 4 teeth. Peritreme extends beyond j_1 . Macrosetae on leg IV: genu – 88, tibia – 63 and basitarsus – 50.

Leg chaetotaxy:

genu II	$2 \frac{2}{0} \frac{2}{0} 1$	tibia II	$1 \frac{1}{1} \frac{2}{1} 1;$
genu III	$1 \frac{2}{1} \frac{2}{0} 1$	tibia III	$1 \frac{2}{1} \frac{1}{1} 1$

Male: Unknown

Habitat: *Justicia adhatoda* (L.), *Benincasa hispida* (Thunb.)

Known habitat: Citrus, *Bauhinia* sp.

Material examined: Female marked on the slide. INDIA: KERALA: Kumbala (Kasaragod district), 10.ix.2014, ex. *Justicia adhatoda* (L.), coll. Santhosh (No.K 1/15). 2 ♀♀ collected from the same habitat (No. K 2/15, 3/15), other 2 ♀♀ from Ottapalam (Palakkad district), ex. *Benincasa hispida* (Thunb.), (4/15, 5/15).

Distribution: INDIA: Kerala, Assam, Bihar, Karnataka and West Bengal. OUTSIDE INDIA: Algeria, Argentina, Brazil, Alagoas, Rondonia, Pernambuco, Colombia, Guyana, Cuba, Dominican Republic, Guyana, Jamaica, Mexico, Peru, USA, Saint Martin, Venezuela.

Remarks: This species resembles *A. aerialis* (Muma), 1955 and hence fixed so. These mites found associated with tetranychid pest mite. In the present survey, *A. aerialis* was recovered from new habitats viz., *Justicia adhatoda* (L.) and *Benincasa hispida* (Thunb.)

***Amblyseius cucurbitae* Rather, 1985**

PLATE 42

1985. *Amblyseius cucurbitae* Rather, *Revisita Parasitol.*, **46** (1– 2): 291–293.
1989. *Amblyseius cucurbitae*, Denmark and Muma, *Fla.St.Coll. Arthropods, Occ.Pap.*, **4**: 77.
2003. *Amblyseius cucurbitae*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20** (1): 17.
2004. *Amblyseius cucurbitae*, Chant and McMurtry, *Internat.J. Acarol.*, **30** (3): 171– 228
2004. *Amblyseius cucurbitae*, Moraes *et al.*, *Zootaxa*, **434**:1– 494
2007. *Amblyseius cucurbitae*, Chant and McMurtry, *Indira Publishing House, Westbloomfield , USA*, p.219.
2011. *Amblyseius cucurbitae*, Denmark and Evans, *Indira Publishing House, Westbloomfield , USA*, p.451.
2012. *Amblyseius cucurbitae*, Prasad, *Indira Publishing House, Westbloomfield , USA*, p.1063.

Female: Dorsal shield 379 long and 278 wide, smooth with 17 pairs of setae. Measurement of setae: $j_1 - 40$, $j_3 - 50$, $s_4 - 113$, $Z_4 - 118$, $Z_5 - 227$, other setae like j_4 , j_5 , j_6 , J_2 , J_5 , z_2 , z_4 , z_5 , S_2 , S_4 , S_5 , r_3 and R_1 are minute. Sternal shield 75 long, 83 wide with 3 pairs of setae. Lateral margin of sternal shield slightly concave. ST_1 , ST_2 and $ST_3 - 22$, $ST_4 - 15$, $ST_5 - 14$. Genital shield is

93 wide. Ventrianal shield 113 long and 75 wide with 3 pairs of preanal setae measuring JV_1 –10, ZV_2 –9, and JV_2 –5. Four pairs of setae present on the area around the ventrianal shield. Setae JV_4 –4, JV_5 –75, ZV_1 –8, ZV_3 –6. Two pairs of metapodal plate present. Primary one 18 long and accessory one 5 long. Peritreme extends anteriorly up to j_1 . Spermatheca with corniform cervix 12 long and bifid atrium. Fixed digit of chelicera with 4 teeth anterior to *pilus dentilis*, 5 teeth posterior to it; movable digit with 1 tooth. Macrosetae present on leg IV– genu–139, tibia–83 and basitarsus 75.

Leg chaetotaxy: genu II 1 $\frac{2}{1}$ $\frac{2}{0}$ 1 tibia II 1 $\frac{1}{1}$ $\frac{2}{1}$ 1;
 genu III 1 $\frac{2}{0}$ $\frac{2}{1}$ 1 tibia III 1 $\frac{1}{1}$ $\frac{2}{1}$ 1

Male: Unknown

Habitat: *Abelmoschus moschatus* (L.) *Cucurbita maxima* Duch.

Known habitat: *Cucurbita* sp.

Material examined: Female marked on the slide, INDIA: KERALA: Botanical Garden, Calicut University (Malappuram District), 16.x.2015, ex. *Abelmoschus moschatus* (L.), coll. Santhosh (No. A. 467/1), with 4 ♀♀, 2 from the same habitat. (No. A 467/2,) 2 from Panathur (Kasaragod), ex. *Cucurbita maxima* Duch. (467/3, 467/4).

Distribution: INDIA: Kerala, Srinagar, Jammu and Kashmir

Remarks: The specimen studied resembles almost all characters of *A.cucurbitae* Rather, 1985 and hence fixed so. It is the first report from Kerala from a new habitat *Abelmoschus moschatus* (L.).

***Amblyseius channabasavannai* Gupta and Daniel, 1978**

PLATE 43

1978. *Amblyseius channabasavannai* Gupta and Daniel, *Ori. Ins.*, **12**: 328 – 330.
1986. *Amblyseius (Amblyseius) channabasavannai*, Gupta, *Fauna of India: Phytoseiidae*, p. 41– 43.
1987. *Amblyseius (Amblyseius) channabasavannai*, Gupta, *Rec. Zool. Surv. India. Occ.Pap.* **95**: 8.
1989. *Amblyseius channabasavanni*, Denmark and Muma, *Fla. St. Coll. of Arthropods. Occ.Pap.* **4**: 14– 15.
1992. *Amblyseius (Amblyseius) channabasavannai* Gupta, In: *Contrib. Acarol.Res. India*, p. 441.
1992. *Amblyseius (Amblyseius) channabasavannai*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal, part 3*, p.152.
1995. *Amblyseius (Amblyseius) channabasavannai*, Gupta, In: *State Fauna Ser. 4, Fauna of Maghalaya*, p.20.
2003. *Amblyseius (Amblyseius) channabasavannai*, Gupta, In: *State Fauna Ser. 9, Fauna of Sikkim*.p.14.
2003. *Amblyseius (Amblyseius) channabasavannai*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20** (1): 1–185.
2007. *Amblyseius channabasavannai*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae*

of the world (Acari: Mesostigmata), p.78 (mentioned as *channabasavanni*).

2011. *Amblyseius channabasavannai*, Karmakar and Gupta, *Zoosymposia*, **6**: 62– 67

2011. *Amblyseius channabasavannai*, Denmark and Evans, *Indira Publishing House, Westbloomfield , USA*, p.451.

2012. *Amblyseius channabasavannai*, Prasad, *Indira Publishing House, Westbloomfield , USA*, p.1063.

2012. *Amblyseius channabasavannai*, Carrillo *et al.*, *Exp. Appl. Acarol.*, **57**: 347– 360.

Female: Dorsal shield smooth, 329 long, 240 wide with 17 pairs of setae, j_1 , j_3 , s_4 , Z_4 and Z_5 are long. Z_5 being the longest. Measurement of setae: j_1 – 25, j_3 – 45, s_4 – 83, Z_4 – 101, Z_5 – 210 all other setae minute. Sternal shield 76 long 80 wide with setae ST_1 , ST_2 , ST_3 measuring 20, 18 and 22 respectively. 4th pair, ST_4 lies on the metasternal shield 22 long. Genital shield 108 wide with setae ST_5 – 22 long. Ventrianal shield 118 long and 101 wide with 3 pairs of preanal setae and a pair of crescent shaped pores. ZV_1 – 20, ZV_2 – 18, ZV_3 – 9, JV_1 – 12, JV_2 – 11, JV_4 – 11. JV_5 smooth, 75 long. Two pairs of metapodal plate present, primary one 25 long and accessory one 11 long. Spermatheca with long cervix, 40 long and swollen atrium. Chelicera of fixed digit 37 long, multidentate with strong *pilus dentilis*, movable digit 34 long with 3 teeth. Peritreme extends beyond j_1 and curved down. Macrosetae on leg IV: genu – 92, tibia – 66, basitarsus – 58.

Leg chaetotaxy:

genu II $2 \frac{2}{0} \frac{2}{0} 1$	tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$	tibia III $1 \frac{1}{1} \frac{2}{1} 1$

Male: Dorsal chaetotaxy similar to that of female. Spermatophoral process 12.7 long, sternal shield 135 long, 70 wide and ventrianal shield 88 long and 139 wide.

Habitat: *Datura metel* L., *Ipomoea sepriaria* Roxb., *Piper betle* L., *Saraca indica* L., *Solanum melongena* L., *Ocimum basilicium* L.

Known habitat: Neem, Chrysanthemum, *Dahlia*, palm, Mango, Citrus, *Shorea robusta*, *Lantana*, jute, Champa.

Material examined: Female marked on the slide. INDIA: KERALA: Calicut University (Malappuram District), 10.ix.2015, ex. *Datura metel* (L.), coll. Santhosh (No.C. 9/15). 8 ♀♀ collected from the same place, ex. *Ipomoea obscura* (L.), coll Santhosh (No. C 10/15, 11/15). This species also reported from Pulpally (Wayanad district), ex. *Piper betle* L., Balussery (Kozhikode district), ex. *Saraca indica* L., Koppam (Palakkad district), ex. *Solanum melongena* L., Payyanur (Kannur), ex. *Ocimum basilicium* L.

Distribution: INDIA: Kerala, Tamil Nadu, Arunachal Pradesh, West Bengal. OUTSIDE INDIA: USA

Remarks: The specimen studied resembles almost all characters of *A. channabasavannai* Gupta and Daniel (1978) and hence fixed so. In the present survey *A. channabasavannai* was recovered from new habitats, *Datura metel* and *Ipomoea obscura*, was seen associated with tetranychid mite population.

Amblyseius devakiae* sp.nov.*PLATE 44**

Female: Dorsal shield smooth, 263 long and 172 wide with 17 pairs of setae. j_1, j_3, s_4, Z_4 and Z_5 are longer setae and all other setae minute. All long setae being smooth. Measurements of setae: j_1 – 30, j_3 – 37, s_4 – 65, Z_4 – 75, Z_5 – 189, j_4, j_6, j_5, J_2, J_5 – 4 each, z_1, z_2 – 6 and z_4, z_5 – 5, r_3 – 13, S_2, S_4, S_5 – 4 each, R_1 – 6 long. Sternal shield longer than wide, 77 long, 76 wide with 3 pairs of sternal setae, 4th pair lie on the metasternal shield. Posterior margin of sternal shield more or less straight, anterior margin slightly concave. Sternal setae ST_1, ST_2, ST_3, ST_4 – 21 each and ST_5 – 22. Genital shield 92 long and 76 wide with a pair of setae. Ventrianal shield 93 long and 45 wide. ZV_1, ZV_2 – 12 each, ZV_3 – 7, JV_1 – 22, JV_2 – 21. Setae JV_5 smooth, 74 long. Fixed digit of chelicerae 28 long, multidentate with 7 teeth, movable digit 26 long with 2 teeth. Peritreme extends up to the base of j_1 . Cervix of spermatheca 11 long, tubular with parallel wall. Macroseta present on leg IV: genu – 118, tibia – 72, basitarsus – 68.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{2}{1} \frac{1}{1} 1$;
genu III $1 \frac{2}{1} \frac{1}{1} 1$ tibia III $1 \frac{2}{0} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Ixora coccinea* L., *Abelmoschus moschatus* (L.), *Baliospermum montanum* (willd)

Material examined: Holotype ♀ marked on the slide INDIA: KERALA: Kadalundi (Kozhikode district), 7.xi.2015, ex. *Ixora coccinea* L., coll. Santhosh (No.C.12/1). Two paratype slides with 4 ♀♀ marked on the slide

from Kottakkal (Malappuram district) 25.xi.2015, ex. *Baliospermum montanum* (Willd.) and 2 ♀♀ from ex. *Abelmoschus moschatus* (L.), coll. Santhosh. (No.C. 12/2, 12/3, 12/4, 12/5).

Remarks: This new species resembles *A. largoensis* Muma, 1995 in general appearance, structure of chelicerae but differs in the following characters:

1. Z_5 (189) shorter in this new species as compared to that of *A. largoensis* (235).
2. Ventrianal shield is vase shaped with 110 long, 75 wide in *A. largoensis*, but in the new species it is vase shaped with slightly convex lateral margin measuring 93 long and 45 wide.
3. Cervix of spermatheca shorter than *A. largoensis*.
4. Z_4 shorter (75) when compared to *A. largoensis* (105).
5. Tibia II and tibia III of this new species is $1\frac{2}{1}1$ and $1\frac{2}{0}1$ whereas in *A. largoensis* it is $1\frac{1}{1}2$ and $1\frac{1}{1}2$ respectively.
6. Macrosetae on Leg IV genu– 118, tibia– 70 and basitarsus 68 in new species whereas it is 105, 76 and 54 respectively in *A. largoensis*.

This new species also resembles *A. velayudhani* Santhosh and Mary Anitha, 2016 in appearance and structure of spermatheca but differs in the following characters.

1. Lack of division on ventrianal scutum below the elliptical pore.
2. Number of teeth on fixed digit is 7 in new species, instead of 11
3. Z_5 shorter than *A. velayudhani*.

Amblyseius kadalundiensis* sp.nov.*PLATE 45**

Female: Dorsal shield 316 long, 220 wide, smooth except setae j_1, j_3, s_4, Z_4, Z_5 all other setae are very small or minute. Measurement of setae: $j_1 - 30, j_3 - 40$, setae $j_4, j_5, j_6, J_2, J_5, z_2, z_4, z_5$ are below 5. $s_4 - 90, S_2, S_4, S_5$ minute, $Z_4 - 80, Z_5 - 225$. Sternal shield 68 long, 76 wide, posterior margin concave and angular with 3 pairs of sternal setae $ST_1, ST_2, ST_3 - 23$ each, $ST_4 - 19$ long on metasternal shield. Genital shield 60 wide with seta ST_5 63 long. Ventrianal shield 113 long and 55 wide; with concave lateral margin. Preanal setae $JV_1 - 15, JV_2 - 13$ and $ZV_2 - 11$ long. Setae $ZV_1 - 13, ZV_3 - 6, JV_4 - 4, JV_5 - 59$ long, smooth. A pair of metapodal plate present, primary one 13 long, 5 wide, accessory one 8 long. Spermatheca calyx 37 long with rounded vesicle and atrium, major duct small and narrow. Fixed digit of chelicera 33 long with 3 teeth anterior to *pilus dentilis* and 5 posterior to it. Movable digit 30 long with 2 teeth. Peritreme extending anteriorly upto level j_1 . Macroseta on leg IV: genu - 108, tibia - 80, basitarsus - 65 long.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Persea macrantha* (Nees.), *Abelmoschus moschatus* (L.), *Piper betle* L.

Material examined: Holotype ♀ marked on the slide. INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex. *Persea macrantha* (Nees.), coll. Santhosh (No.D. 10/1), Four paratype slides with 6 ♀♀,

collection details same as that of holotype. (No.D 10/2, 10/3, 10/4) and 2 ♀♀ from Kadalundi (Kozhikode district), 2.xi.2015, ex. *Abelmoschus moschatus* (L.), *Piper betle* L., coll.santhosh (No.D.10/5, 10/6)

Remarks: This species resembles *A. herbicolus* (Chant), 1959 in dorsal chaetotaxy, leg chaetotaxy, structure of sternal and ventrianal shield, but it can be clearly differentiated by the possession of the following characters.

1. Dorsal shield 316 long and 220 wide in new species, whereas in *A. herbicolus* it is 357 and 255 respectively.
2. In the new speices cervix of spermatheca very slender fundibular 37 long with nodular atrium which is much longer and narrower than that of *A. herbicolus* (18).
3. Seta Z_5 in this new species is much longer (225) as compared to *A. herbicolus* (205).
4. Fixed digit of chelicera 33 long with 3 teeth anterior to *pilus dentilis* and 5 posterior to it in the new species instead 2 teeth anterior to *pilus dentilis* and 3 posterior to it in *A. herbicolus*.
5. Macrosetae on Leg IV Genu– 108, Tibia– 80 and basitarsus– 65 in new species whereas it is 129, 90, 70 respectively in *A. herbicolus*.
6. Ventrianal shield wider (80) in *A. herbicolus* than new species (55).

***Amblyseius kavumvattamsis* sp.nov.**

PLATE 46

Female: Dorsal shield 340 long, 240 wide, smooth with 17 pairs of setae, except setae j_1 , j_3 , s_4 , Z_4 , Z_5 all other setae are very small or minute. Measurement of setae: j_1 –25, j_3 – 50, setae j_4 , j_5 , j_6 , J_2 , J_5 , z_2 , z_4 , z_5 are below

5, S₄ – 100, S₂, S₄, S₅ minute, Z₄ – 118, Z₅ – 220. Sternal shield 70 long, 65 wide, anterior margin concave and angular, with 3 pairs of sternal setae ST₁, ST₂, ST₃ and ST₄ – 30 each. Genital shield 88 wide with seta 90 long. Ventrianal shield 120 long and 95 wide; with posterior end pointed. Preanal setae JV₁, JV₂, JV₄ – 5 each. Setae ZV₁, ZV₂, ZV₃ – 6 each and JV₅ – 75 long, smooth. A pair of metapodal plate present, primary one 13 long, 5 wide, accessory one 8 long. Spermatheca calyx 13 long with rounded vesicle. Fixed digit of chelicera 35 long with 4 teeth anterior to *pilus dentilis* and 6 posterior to it. Movable digit 33 long with 1 tooth. Peritreme extending anteriorly upto the level of j₁. Macroseta on leg IV: genu – 107, tibia – 75 and basitarsus – 60 long.

Leg chaetotaxy : genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
 genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Murraya koenigii* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kavumattam (Kozhikode district), 24.x.2015, ex. *Murraya koenigii* (L.), coll. Santhosh (No. E. 9/1), 2 paratype slides with 2 ♀♀, collection details same as above (No.D 9/2, 9/3).

Remarks: This species resembles *A. orientalis* Ehara, 1959 in dorsal chaetotaxy, but differs in the following characters.

1. In the new species, cervix of spermatheca 13 long, tubular-flared with characteristic bending, anterior end is notched like snake head with nodular atrium whereas in *A. orientalis*, it is 16 long saccular-flared cervix with nodular atrium.

2. Seta Z₅, 250 – 280 long in *A. orientalis* whereas in new species it is 220 long.
3. In the new species, chelicera 35 long with 1 tooth in movable digit whereas in *A. orientalis*, it posses 3– 4 teeth.
4. Macrosetae on Leg IV: Genu– 108, Tibia– 75 and basitarsus – 60 in new species whereas in *A. orientalis*, it is 112, 64, 72 respectively.
5. In the new species ventrianal shield is wider (95) and posterior end is widely pointed whereas in *A. orientalis*, it is 80 wide with narrowly pointed posterior end.

***Amblyseius largoensis* (Muma), 1955**

PLATE 47

1955. *Amblyseiopsis largoensis* Muma, *Ann. Ent. Soc. Amer.*, **48**: 2006
1984. *Amblyseious largoensis*, Wei– nan, *Acarology VI*, **1**: 222.
1984. *Amblyseious largoensis*, Gutierrez and Schicha, *Internat. J. Entomol.*, **26** (4): 386.
1986. *Amblyseius (Amblyseius) largoensis*, Gupta, *Fauna of India: Phytoseiidae*, p.51– 55.
1987. *Amblyseius (Amblyseius) largoensis*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 10– 11.
1989. *Amblyseius (Amblyseius) largoensis*, Singh *et al.*, In: *Progress in Acarology*, **2**: 361– 367.
1992. *Amblyseius (Amblyseius) largoensis*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal Part 3*, p.153– 154.
1994. *Amblyseius (Amblyseius) largoensis*, Singh, *Shashpa*, **1**(2): 67.

- 1995 *Amblyseius (Amblyseius) largoensis*, Gupta, In: *State Fauna Ser.4, Fauna of Maghalaya, Part 2*, p. 30.
1996. *Amblyseius (Amblyseius) largoensis*, Chatterjee and Gupta, *J. Beng. Nat. Hist. Soc. (NS)*, **15**(2): 25.
1999. *Amblyseius (Amblyseius) largoensis*, Gupta and Chatterjee, *J. Sci and Cult.*, **65**: 161– 162.
2000. *Amblyseius (Amblyseius) largoensis*, Gupta, In: *State Fauna Ser. 7, Fauna of Tripura, Part 2*, p. 22.
2003. *Amblyseius (Amblyseius) largoensis*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20**(1): 1–185.
2007. *Amblyseius (Amblyseius) largoensis*, Gupta and Chatterjee, In: *State Fauna Ser. 11, Fauna of Mizoram*.p.15.
2007. *Amblyseius largoensis* Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.219.
2009. *Amblyseius largoensis*, Palevsky, et al., *J. of Natural History*, **43** (27–28): 1715 –1747.
2011. *Amblyseius largoensis*, Sadanandan, *J. Ecobiology.*, **28**(2): 147– 151.
2012. *Amblyseius largoensis*, Adar et al., *Exp. and App. Acarol.*, **58**: 341–357
2013. *Amblyseius largoensis*, Moraes et al., In: *Zootaxa*, **3700**(3): 301–347.
2013. *Amblyseius largoensis*, Haneef and Sadanandan, *Bio. Four.*, **5**(2), 119– 122.
2014. *Amblyseius largoensis*, Doker et al., In: *Zootaxa*, **3827**(3): 331–342.

2016. *Amblyseius largoensis*, Abo-shnaf *et al.*, *Sys. App. Acarol.*, **21**(5): 607– 646.

2016. *Amblyseius largoensis*, Silva *et al.*, *Sys. App. Acarol.*, **21**(8):1133– 1144.

Female: Dorsal shield 375 long and 250 wide, smooth. Measurement of setae $j_1 < j_3$, j_1 –25, j_3 –35, Z_4 –100, Z_5 –245, s_4 –90, r_3 –8, all other setae minute below 5. Sternal shield wider than longer with concave lateral margin, 68 long and 89 wide. Setae ST_1 , ST_2 , ST_3 , ST_4 , ST_5 – 20 each. Genital shield 70 long and 81 wide. Ventrianal shield 108 long and 63 wide. ZV_1 , ZV_2 , ZV_3 –10 each, JV_1 , JV_2 , JV_4 – 12 long, JV_5 –50 and other ventral setae minute. A pair of metapodal plate present primary one 25 long and 4 wide, accessory 10 long. Fixed digit of chelicerae 38 long with 3 teeth anterior to *pilus dentilis* and 6 teeth posterior to it, movable digit 36 long with 2 teeth. Spermatheca with tubular cervix, 24 long with nodular atrium. Peritreme extending anteriorly beyond j_1 . Macroseta on leg IV: genu – 105, tibia– 90, basitarsus– 65

Leg chaetotaxy : genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Aegle marmelos* (L.)

Known habitat: Gamer, peach, apple, mango, tea, sapota, jack fruit, money plant, cotton, *Colophyllum inophyllum*, *Musandra corymbosa*, *Tabernaemontana coronaria*, castor, beans, citrus, pomegranate, fig, guava, pepper, chilli, cucurbits, *Bauhinia acuminata*, *Anona squamosa*.

Material examined: Female marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 19.ix.2015, ex. *Aegle marmelos* (L.), coll. Santhosh (No.D.10/1), with 6 ♀♀, collection details same as above (No. A 10/2, 10/3, 10/4).

Distribution: INDIA: Kerala, Andaman Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Manipur, Meghalaya, Myabunder Islands, Nagaland, Nicobar Islands, Orissa, Pondicherry, Punjab, Rangat Islands, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal. OUTSIDE INDIA: Angola, Australia, Benin, Brazil, Colombia, Cook Islands, Cuba, Guatemala, Hawaii, Indonesia, Iran, Israel, Ivory Coast, Jamaica, Japan, Kenya, La Desirade, Les Saintes, Madeira Island, Malaysia, Marie Galante, Martinique, Mexico, Mozambique, New Caledonia, New Zealand, Oman, Papua New Guinea, Peru, Philippines, Puerto Rico, Reunion Island, Saint Barthelem, Saint Kitts, Saint Martin, Sierra Leone, Singapore, Sri Lanka, Tahiti, Taiwan, Tanzania, Thailand, Trinidad, Turkey, Us Samoa, California, Florida, Venezuela.

Remarks: The specimen examined agrees with almost all characters of *A. largoensis* and hence fixed so. In the present survey *A. largoensis* was recovered from a new habitat, *Aegle marmelos* (L.) and was seen associated with tetranychid mite population.

Amblyseius melongenae sp.nov.

PLATE 48

Female: Dorsal shield smooth, 350 long and 240 wide with 17 pairs of setae, j_1 shorter than j_3 . All long setae being smooth. Measurements of setae: j_1 – 35, j_3 – 43. Setae j_4 , j_5 , j_6 – all 5 long, J_2 –6, J_5 – 5 long. s_4 – 76, S_2 , S_4 , S_5 all 5 long, z_2 , z_4 , z_5 – 6, Z_4 – 100, Z_5 – 217. Sternal shield 70 long, 61 wide with

ST₁ – 22, ST₂ – 22, ST₃ – 22, ST₄ – 21 on metasternal shield. Lateral margin of sternal shield more concave on posterior than anterior. Genital shield 66 wide with setae ST₅ 16 long. Ventrianal shield 99 long, 59 wide, ZV₁ – 15, ZV₂ – 11, ZV₃ – 13, JV₄ – 7, JV₁ – 19, JV₂ – 15, JV₅ – 50. A pair of metapodal plates present, primary one 22 long and 5 wide, accessory one 8 long. Peritreme extends upto base of j₁. Tubular spermatheca with cervix wide at base measuring 24 long and ends in a globular atrium. Fixed digit of chelicera 33 long with 2 teeth anterior to *pilus dentilis* and 3 teeth posterior to it; movable digit 30 long with 2 teeth. Macroseta present on leg IV: genu – 114, tibia – 88, basitarsus – 57.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Solanum melongena* L., *Elaeocarpus tuberculatus* Roxb.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 13.x.2015, ex. *Solanum melongena* L., coll. Santhosh (No.B.19/1). Two paratype slides with 3 ♀♀ (No.B. 19/2, 19/3), collection details same as above and one ♀ from Botanical Garden, Calicut University Campus (Malappuram district), 5.v.2015, ex. *Elaeocarpus tuberculatus* Roxb., coll. Santhosh (No.19/4).

Remarks: This new species resembles *A. largoensis* (Muma) in certain characters and general appearance but differs in the following characters.

1. Fixed digit of chelicera with only 2 teeth present anterior to *pilus dentilis* whereas in *A. largoensis* it is 3 – 4.

2. Macrosetae on leg IV genu— 114, tibia – 88 and tarsus – 57 long in new species, whereas in *A. largoensis* it is 105, 76 and 54 respectively.
3. In new species, cervix of spermatheca is tubular measuring 24 long and having broad base whereas in *A. largoensis* it is with tubular cervix having parallel wall.
4. The Z_5 of this new species is shorter (217) while compared to the Z_5 of *A. largoensis* (235).
5. In *A. largoensis* the sternal shield is 86 long and 74 wide but in this new species it is 70 long and 61 wide.

Amblyseius neorykei gupta, 1977

PLATE 49

1977. *Amblyseius neorykei* Gupta, *Entomologist mon.Mag.*, **112** : 56– 57.
1986. *Amblyseius neorykei* Gupta, *Indian J.Acarol.*, **6**: 27.
2003. *Amblyseius neorykei* Gupta *Memoirs.*, **20**(1): 1 – 185.
2011. *Amblyseius neorykei* Karmakar and Gupta, *Zoosymposia*, **6**: 62– 67.
2012. *Amblyseius neorykei* Prasad, *Indira Publishing House, Westbloomfield, USA, p.1063.*

Female: Dorsal shield smooth, 362 long, 227 wide with 17 pairs of setae, j_1 , j_3 , s_4 , Z_4 and Z_5 are long. Z_5 being the longest. Measurement of setae: j_1 – 26, j_3 – 43, s_4 – 98, Z_4 – 78, Z_5 – 177 all other setae minute. Sternal shield 81 long 91 wide with setae ST_1 , ST_2 , ST_3 measuring 21 each. ST_4 lies on the metasternal shield 20 long. Genital shield 88 wide with setae ST_5 – 21 long. Ventrianal shield 126 long and 86 wide with 3 pairs of preanal setae and a pair of crescent shaped pores. ZV_1 – 18, ZV_2 – 16, ZV_3 – 14, JV_1 – 15, JV_2 –

12, JV₄ – 11. JV₅ smooth, 50 long. Two pairs of metapodal plate present, primary one 15 long and 3 wide, accessory one 5 long. Spermatheca with vesicular cervix 11 long. Chelicera fixed digit 36 long with 2 strong teeth posterior to *pilus dentilis* and 3 teeth anterior to it. Movable digit 35 long with one tooth. Peritreme extends up to the j₁. Macrosetae on leg IV: genu – 113, tibia – 50, basitarsus – 78.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{1}{1} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Murraya koenigii* (L), *Solanum virginianum* L.

Known habitat: *Chrysanthemum*.

Material examined: Female marked on the slide. INDIA: KERALA: Panathur (Kasaragod district), 10.ix.2014, ex. *Murraya koenigii* (L), coll. Santhosh (No.K. 1/18), 4 ♀♀ collected from the same habitat (No. K 2/18, 3/18, 5/18), 2 ♀♀ from Ambalavayal (Wayanad district), ex. *Solanum virginianum* L. (No.C 6/18).

Distribution: INDIA: Kerala, Arunachal Pradesh, West Bengal, Uttar Pradesh.

Remarks: The specimen studied resembles almost all characters of *Amblyseius neorykei* Gupta, 1977 and hence fixed so. In the present survey *A. neorykei* was recovered from two new habitat, *Murraya koenigii* (L) and *Solanum virginianum* L., seen associated with tetranychid mite population. It is the first report from Kerala

Amblyseius ramaniae* sp.nov.*PLATE 50**

Female: Dorsal shield 270 long and 202 wide, smooth with 17 pair of setae. Measurement of setae: j_1 – 25, j_3 – 32, Z_4 – 113, Z_5 – 177, s_4 – 78, all other setae small. Sternal shield 75 long, 65 wide with 3 pairs of setae. Lateral margin of sternal shield slightly concave. ST_1 , ST_2 –18 each, ST_3 – 20, ST_4 and ST_5 – 12. Genital shield is 63 long and 75 wide. Ventrianal shield flat posteriorly with indented lateral sides, 81 long and 53 wide with 3 pairs of preanal setae measuring JV_1, ZV_2 – 10 each and JV_2 –7 long. Four pairs of setae present on the area around the ventrianal shield. Setae JV_4 – 10, JV_5 – 50, ZV_1 and ZV_3 –10. Two pairs of metapodal plates present. Primary one 12 long and accessory one 7 long. Peritreme extends anteriorly upto j_1 . Slightly bowed tubular cervix (18) with nodular atrium. Major duct entering laterally. Fixed digit of chelicera 18 long with 3 teeth anterior to *pilus dentilis* and 5 posterior to it. Movable digits 17 long with 3 teeth. Macrosetae present on leg IV: genu–76, tibia–52 and tarsus– 38.

Leg chaetotaxy:

genu	II	2	$\frac{2}{0}$	$\frac{2}{0}$	1	tibia	II	1	$\frac{2}{0}$	$\frac{2}{1}$	1;
						genu	III	1	$\frac{2}{1}$	$\frac{2}{1}$	1
						tibia	III	1	$\frac{2}{1}$	$\frac{1}{0}$	1.

Male: Unknown

Habitat: *Magnolia chempaka* (L.), *Piper betle* L.,

Material examined: Holotype ♀ marked on the slide INDIA: KERALA: Calicut University Campus (Malappuram district), 18.iv.2014, ex. *Piper betle* L., coll.Santhosh (No.M 30/1). Three Paratype slides with 3 ♀♀, Pazhur (Kozhikode district), 25.vi.2015, ex. *Magnolia chempaka* (L.), coll.Santhosh (No.K 30/2, 30/3, 30/4).

Remarks

This new species closely resembles *A. herbicolus* (Chant), 1959 in general appearance, dorsal chaetotaxy, structure of chelicerae, but differs from it in the spermathecal structure and possession of the following features:

1. Dorsal shield of *A. herbicolus* measures 369 long and 236 wide, whereas in new species it is 270 long and 202 wide.
2. Ventrianal shield in new species is 81 long, 53 wide with indented lateral sides, whereas in *A. herbicolus* it is smooth measuring 116 long and 70 wide.
3. In the new species Z_4 (113) and Z_5 (177) is shorter than that of *A. herbicolus* (Z_4 –125, Z_5 –205).
4. Macrosetae on leg IV genu –76, tibia –52 and basitarsus – 32 long in new species, whereas it is 129, 90, 70 respectively in *A. herbicolus*.
5. In the new species spermatheca is characterized with slightly bowed, flared tubular cervix (18) and nodular atrium but in *A. herbicolus* spermatheca with fundibular cervix and swollen atrium.
6. Difference exists in the leg chaetotaxy with respect to tibia II and tibia III.

***Amblyseius thejassi* sp.nov.**

PLATE 51

Female: Dorsal shield smooth, 330 long, 250 wide with 17 pairs of setae, j_1 , j_3 , s_4 , Z_4 and Z_5 being the longest. Measurement of setae: j_1 – 25, j_3 – 45, s_4 – 93, Z_4 – 113, Z_5 – 220 all other setae minute. Sternal shield 70 long 80 wide with setae ST_1 , ST_2 , ST_3 and ST_4 measuring 30 long. Genital shield 70 long

and 80 wide with setae ST_5 – 30 long. Ventrianal shield 120 long, 80 wide with 3 pairs of preanal setae and a pair of crescent shaped pores. ZV_1 , ZV_2 , ZV_3 – 20 long, JV_1 – 20, JV_2 – 18, JV_4 – 16. JV_5 smooth, 88 long. Two pairs of metapodal plates present, primary one 17 long and 7 wide, accessory one 12 long. Spermatheca with long cervix 35 long. Chelicera of fixed digit 37 long, with 5 strong teeth posterior to *pilus dentilis* and 2 teeth anterior to it. Movable digit 35 long with 1 tooth. Peritreme extends beyond j_1 . Macrosetae on leg IV: genu – 107, tibia – 70, basitarsus – 67.

Leg chaetotaxy : genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Datura metel* L., *Ipomoea obscura* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Calicut University campus, (Malappuram District), 10.ix.2015, ex. *Datura metel* (L.), coll. Santhosh (No.A 9/15), 4 ♀♀ collected from the same place, ex. *Ipomoea obscura* (L.), coll. Santhosh (No. A 10/15, 11/15, 11/15).

Remarks: This new species resembles *A. paraaerialis* Muma, 1967 in dorsal chaetotaxy, structure of spermatheca, structure of sternal and ventrianal shield, but differs in the following characters.

1. Seta Z_5 in this new species is much longer (220) than *A. paraaerialis* (161).
2. In this new species, chelicera 22 long with 2 teeth anterior to *pilus dentilis* and 5 posterior to it, whereas in *A. paraaerialis*, it is 4 – 5 teeth anterior to *pilus dentilis* and 1–2 posterior to it.

3. Much longer macrosetae on Leg IV, Genu –107, Tibia –70 and basitarsus – 67 in new species whereas in *A. paraaerialis*, it is 73, 46, 56 respectively.
4. Longer JV₅ (88) in the new species, whereas it is 67 in *A. paraaerialis*.

Amblyseius velayudhani Santhosh and Mary Anitha, 2016

PLATE 52

2016. *Amblyseius velayudhani* Santhosh and Mary Anitha, *Entomon*, **41** (1): 67– 70.

Female: Dorsal shield 370 long and 280 wide, smooth with 17 pairs of setae and 2 small pores. Measurement of setae: j₁ – 30 , j₃ – 40, Z₄– 90 , Z₅– 250, s₄ – 100 , other setae like j₄, j₅, j₆, J₂, J₅, z₂, z₄, z₅, S₂, S₄, S₅, r₃ and R₁ are minute. Distance between j₁–10, j₃– 40. Sternal shield 90 long, 100 wide with 3 pairs of setae. Lateral margin of sternal shield slightly concave. ST₁, ST₂ and ST₃ – 20, ST₄ – 15, ST₅ – 14. Distance between ST₁ – 50, ST₂ and ST₃ – 60, ST₅ – 80. Genital shield is 90 wide. A clear septum is present between the ventrianal shield and genital shield. Ventrianal shield has a division below the elliptical pore but the shield is not separated each other. Ventrianal shield 100 long and 50 wide with 3 pairs of preanal setae measuring JV₁ – 10, ZV₂ – 9, JV₂ – 5. Four pairs of setae present on the area around the ventrianal shield. Setae JV₄ – 4, JV₅ – 50, ZV₁– 8, ZV₃ – 6. Two pairs of metapodal plate present. Primary one 10 long and accessory one 7 long. Peritreme extends anteriorly up to j₁. Spermatheca with tubular cervix (10) and short atrium. Fixed digit of chelicera with 6 teeth anterior to a short *pilus dentilis*, 5 teeth posterior to it, movable digit with 3 teeth. Macrosetae present on leg IV– genu – 110, tibia– 70, basitarsus 50.

Leg chaetotaxy: genu II $1 \frac{2}{2} \frac{1}{0} 1$ tibia II $1 \frac{2}{1} \frac{2}{0} 1$;
genu III $1 \frac{2}{2} \frac{1}{0} 1$ tibia III $1 \frac{2}{0} \frac{2}{0} 1$.

Male: Dorsal chaetotaxy similar to that of female, ventrianal shield 126 long and 88 wide. Spermatophoral process as figured.

Habitat: *Ocimum sanctum* L., *Cucurbita maxima* Duch.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Botanical Garden, Calicut University, (Malappuram District), 18.iv.2014, ex. *Ocimum sanctum* L., coll.Santhosh (No.M 30/1). Four Paratype slides with 3 ♀♀ from Vengeri (Kozhikode district), 25.vi.2015, ex. *Cucurbita maxima* Duch., coll.Santhosh (No.K 30/2, 30/3, 30/4) and 2 ♂♂, collection details same as holotype (No.M 30/5).

Remarks: This new species closely resembles *A. cucurbitae* (Rather, 1985) in dorsal chaetotaxy but differs from it by the possession of the following features:

1. Dorsal shield longer and wider (400, 290) than that of *A. cucurbitae* (365, 197).
2. The ventrianal scutum shows division below the elliptical pore which is absent in *A.cucurbitae*.
3. In the new species Z_4 (90) is shorter and Z_5 (250) is longer, without serration whereas in *A. cucurbitae* it is serrated (Z_4 – 109, Z_5 – 235).
4. Fixed digit of chelicera with 11 teeth with short *pilus dentilis* whereas in *A.cucurbitae* it has 9 teeth without a *pilus dentilis*.
5. Movable digit of chelicera with 3 teeth, instead of 1 in *A. cucurbitae*.

6. Short nature of macrosetae on leg IV genu, tibia and tarsus; genu – 110 (137), tibia – 70 (74), and tarsus – 50 (74).
7. Spermatheca with tubular cervix and short atrium instead of corniform cervix and bifid atrium in *A. cucurbitae*.

This new species also resembles *A. perditus* Chant and Baker, 1965 in dorsal chaetotaxy, structure of ventrianal shield and chelicerae but differs from it by the following features:

1. Dorsal shield longer and wider (400, 290) whereas it is 351 and 212 in *A. perditus*.
2. Spermatheca with tubular cervix and short atrium instead of tubular – pocular cervix with nodular atrium in *A. perditus*.
3. Longer nature of macrosetae on Leg IV; genu – 110, tibia – 70, tarsus – 50 whereas it is of 78, 58, 64 in *A. perditus*.

***Amblyseius zoansi* sp.nov.**

PLATE 53

Female: Dorsal shield 243 long and 182 wide, smooth. Measurement of setae $j_1 < j_3$, j_1 – 25, j_3 – 30, Z_4 – 70, Z_5 – 164, s_4 – 63, r_3 – 6, all other setae minute. Sternal shield wider than longer with deep concave lateral margin. Sternal shield 55 long and 60 wide with setae ST_1 , ST_2 , ST_3 , ST_4 , ST_5 – 15 each. Genital shield 58 long and 53 wide. Ventrianal shield 86 long and 68 wide. JV_5 – 50, ZV_1 , JV_1 – 6 long and other ventral setae minute. A pair of metapodal plate present primary one 17 long and 5 wide, accessory 10 long. Fixed digit of chelicerae 25 long with 5 teeth anterior to *pilus dentilis* and 5 teeth posterior to it, movable digit 23 long with 2 teeth. Spermatheca with

tubular atrium 12 long. Peritreme extends anteriorly beyond j_1 . Macroseta on leg IV: genu – 73, tibia– 49, basitarsus– 30

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Ventrianal shield 63 long and 116 wide, spermatophoral process as figured.

Habitat: *Saraca indica* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 19.ix.2015, ex. *Saraca indica* L., coll. Santhosh (No.D.10/1). Three paratype slides with 7 ♀♀, collection details same as above (No. A 10/2, 10/3, 10/4, 10/5).

Remarks: This new species resembles *A. kulini* Gupta, 1978 in dorsal chaetotaxy but differs in the following respects;

1. Dorsal shield 243 long and 182 wide in new species, whereas in *A. kulini* it is 300 and 220 respectively.
2. Shorter Z_4 and Z_5 (70, 164) than *A. kulini* (84, 200).
3. Ventrianal shield is 88 long and 68 wide in this new species, whereas it is 104 long and 72 wide in *A. kulini*.
4. Fixed digit of chelicera 25 long with 5 teeth anterior to *pilus dentilis* and 5 teeth posterior to it whereas in *A. kulini* fixed digit bears 10 – 11 teeth without *pilus dentilis*.
5. Structure of spermatheca distinctly differs in both species, as this new species has tubular cervix.

6. The new species has setae s_4 – 63 long which are shorter than *A. kulini* (s_4 – 80).
7. Macrosetae on Leg IV Genu – 73, Tibia – 49 and basitarsus – 30 in new species whereas in *A. kulini*, it is 80, 64, 62 respectively.

Subtribe: Proprioseiopsina Chant and McMurtry, 2004

2004. Proprioseiopsina Chant and McMurtry, *Internat. J. Acarol.*, **13**(3): 219.
2007. Proprioseiopsina Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.85– 87.

Type **Genus: Proprioseiopsis** Muma, 1961.

Genus: Proprioseiopsis Muma, 1961

1961. *Proprioseiopsis* Muma, *Bull. Fla. St. Mus.* **5**(7): 277.
1968. *Amblyseius (Proprioseiopsis)* van der Merwe, *Entomol. Mem. S. Africa Dept. Agric. Tech. Services* **18**:161
1982. *Proprioseiopsis*, Karg, *Zool. Jb. Syst. Bd.* **109**: 196.
1986. *Proprioseiopsis*, Gupta, *Fauna of India: Phytoseiidae*, p.131.
1987. *Proprioseiopsis*, Gupta, *Rec. Zool. Surv. India Occ. Pap.* **95**: 49– 50.
1987. *Proprioseiopsis*, Daneshvar, *Ent. Phyt. Appliq.* **54**(1– 2): 22.
2003. *Amblyseius (Proprioseiopsis)*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 1–185.
2007. *Proprioseiopsis*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.219.

Diagnosis: Dorsal shield with 5 pairs of dorsocentral, 2 pairs of median, 9 pairs of lateral setae. Dorsal shield well sclerotized, smooth. Sternal shield as wide as or wider than long, reticulate. Ventrianal shield, shield shaped or pentagonal, reticulate, with 3 pairs of setae. Fixed digit of chelicerae with 6 – 14 teeth, movable digit with 0 – 4 teeth. Macrosetae present on genu, tibia and basitarsus of leg IV.

Type species: *Typhlodromus (Amblyseius) terrestris* Chant, 1959.

***Proprioseiopsis peltatus* Van der Merwe, 1968**

PLATE 54

1968. *Amblyseius (Amblyseius) peltatus* Van der Merwe, *Ent. Mem. Dept. Agr. Tech. Serv. Rep. S. Afr.*, **18**:119.
1970. *Amblyseius rosellus* Gupta, *Sci. and Cult.*, **36**: 98. (misidentification)
1974. *Amblyseius rosellus* Prasad, *A catalogue of mites of India*, p.169
1980. *Iphiseius punicae* Gupta, *Entomologists mon.Mug.*, **115**: 213 (new synonymy)
1986. *Proprioseiopsis peltatus* Gupta, *Zool.Surv.India, Calcutta*, p.350.
1983. *Proprioseiopsis peltatus* Schicha, *Internat. J. Entomol.*, **25** (2– 3): 103– 126.
1994. *Proprioseiopsis peltatus* Corpuz– Raros and Garcia, *Philippine Entomologist*, **9** (4): 359– 376
1995. *Proprioseiopsis peltatus* Wu and Lan, *Acta Acarol. Sini.*, **42** (2): 99– 102
2002. *Proprioseiopsis peltatus* E l. Banhawy, *Internat.J. Acarol.*, **28** (2): 187– 191.

2005. *Proprioseiopsis peltatus* Chant and McMurtry , *Internat. J. Acarol.*, **31** (1): 3– 22.
2004. *Proprioseiopsis peltatus* Moraes *et al.*, *Zootaxa*, **434**: 1– 494.
2012. *Proprioseiopsis peltatus* Prasad Indira Publishing House, Westbloomfield , USA, p.1063.

Female: Dorsal shield 350 long and 300 wide. Measurement of setae: $j_1 - 25$, $j_3 - 70$, j_4 , $j_5 - 5$ each $j_6 - 8$, $J_5 - 6$, $z_2 - 6$, $z_4 - 10$, $z_5 - 5$, $Z_1 - 6$, $Z_4 - 102$, $Z_5 - 100$. $s_4 - 96$, S_2 , S_4 , $S_5 - 6$, $r_3 - 12$, $R_1 - 12$. Sternal shield longer than wider, reticulate with sternal setae $ST_1 -$, $ST_2 - 13$, $ST_3 - 14$ long and $ST_4 - 13$ long on metasternal shield. Genital shield 88 long, 110 wide, laterally reticulate with $ST_5 - 13$ long. Ventrianal shield 101 long and 110 wide, reticulate with 3 pairs of preanal setae. A pair of pores present below the level of 3rd pair of preanal setae, 3 pairs of setae present around ventrianal shield. Setae ZV_1 , ZV_2 , ZV_3 , JV_1 , JV_2 , JV_4 measuring 22, 18, 18, 15, 22 and 8 long respectively. $JV_5 - 75$ long, smooth. Primary metapodal plates with 20 long and 6 wide, accessory one 8 long. Peritreme extends upto the level of j_1 . Spermatheca with bell shaped cervix 13 long, nodular atrium. Fixed digit of chelicera multidentate, 26 long; movable digit 25 long with one minute tooth. Macroseta of leg IV: genu - 49, tibia - 36, basitarsus - 75.

Leg chaetotaxy: genu II $2\frac{2}{0} \frac{2}{0} 1$ tibia II $1\frac{1}{1} \frac{2}{1} 1$;
 genu III $1\frac{2}{1} \frac{1}{1} 1$ tibia III $1\frac{2}{1} \frac{1}{1} 1$

Male: Unknown.

Habitat: *Justicia adhatoda*. (L.)

Known Habitat: *Punica granatum*, fern, bean, *Dioscorea*, *Achyranthes aspera*, *Bridellasp.*, citrus, corn. *Carica papaya*, Strawberry.

Material examined: Female marked on the slide. INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex. *Justicia adhatoda* (L.), coll. Santhosh (No. K 339/1). Two ♀♀ collection details same as above (No. K 339/2, 339/3).

Distribution: INDIA: West Bengal; OUTSIDE INDIA: Australia, China, Hainan, Fiji Lesotho, Madagascar Island, Papua New Guinea, Philippines, South Africa, Thailand, Zimbabwe.

Remarks: This species resembles closely to *Proprioseiopsis peltatus* Van der Merwe, 1968 in general appearance, dorsal chaetotaxy, spermathecal shape etc. and hence fixed so. In the present survey, *Proprioseiopsis peltatus* was recovered from a new habitat, *Justicia adhatoda* (L.) as a new record from Kerala.

Tribe: **Indoseiulini** Ehara and Amano 1998

1998. Indoseiulini Ehara and Amano, *Species diversity*, **3** (1):25-73.

2007. Indoseiulini, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.105.

Diagnosis: Dorsal shield smooth which does not cover the whole dorsum, 16 pairs of setae present (8 pairs of laterals, 2 pairs of median and 6 pairs of dorsocentrals) all are small, smooth and simple. Two pairs of sublateral setae on lateral integument, ventrianal shield poorly defined 3 pairs of preanal setae present, sternal shield with 3 pairs of setae, a pair of metapodal plate present, peritreme extends anteriorly upto j₃ and posteriorly curves around coxae IV. Leg chaetotaxy as in *Amblyseius*.

Type **Genus:** *Gynaeseius* Wainstein 1962 (= *Indoseiulus* Ehara, 1982)

Key to the genus of the tribe Indoseiulini

1. Peritremal shield not fused anteriorly with adult dorsal shield
.....Tribe: Indoseiulini* Ehara and Amano.
- * Dorsal setae including seta Z_5 short, minute, setiform, subequal
.....**Genus:** *Gynaeseius* Wainstein

Genus: *Gynaeseius* Wainstein, 1962.

1962. *Amblyseius (Kampimodromus) Gynaeseius* Wainstein, 14

1969. *Indoseius* Ghai and Menon, *Oriental Ins.*, **3**:384.

1974. *Indoseius* Gupta and Dhooria, *Proc.Indian Sci.Congr.*, p.69.

1977. *Indoseius* Gupta, *Indian J. Acarol.*, **1**:18.

1981. *Indoseius* Gupta and Nahar, *In. Contrib. to Acar. India*, p.10.

1982. *Indoseius* Gupta, *Rec.Zool.Surv. India*, **79** (3–4):369.

1982. *Indoseiulus* Ehara, *Appl.Ent. Zool.*, **17** (1):42

2007. *Gynaeseius*, Chant and Mc Murtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.219.

***Gynaeseius mumai* sp.nov.**

PLATE 55

Female: Dorsal shield 420 long, 300 wide, smooth with 16 pairs of setae, S_4 absent. A pair of pores present anteriorly near j_5 . All setae short, measurement of setae : $j_1 - 13$, $j_3 - 10$, $j_4 - 8$, $j_5 - 6$, $j_6 - 6$, J_2 , $J_5 - 8$ each, $z_2 - 6$, $z_4 - 6$, $z_5 - 7$, $Z_1 - 13$, $Z_4 - 8$, $Z_5 - 21$, $s_4 - 13$, $S_2 - 12$, $S_5 - 8$, r_3 , $R_1 - 10$ each.

Sternal shield 90 long and 78 wide, with setae $ST_1 - 22$, $ST_2 - 22$, $ST_3 - 25$ long, $ST_4 - 26$ long present on metasternal shield. Genital shield 100 wide, as figured with setae $ST_5 - 25$ long. Ventrianal shield 130 long, 90 wide, with 3 pairs of preanal setae, all with pointed tips and a septum present below the semilunar preanal pores. Four pairs of setae present around the ventrianal shield, $JV_1 - 26$, $JV_2 - 20$, $ZV_2 - 22$, $ZV_1 - 25$, $ZV_3 - 22$, $JV_4 - 20$ and $JV_5 - 18$ long. Metapodal plate not visible, Spermatheca with conical vesicular cervix 15 long. Fixed digit of chelicera 34 long with 4 teeth anterior to *pilus dentilis*, 4 teeth posterior to it, movable digit 32 long with 3 teeth. Peritreme extends anteriorly upto j_3 . Macroseta on leg IV: genu – 37, tibia – 60, basitarsus – 50, all pointed.

Leg chaetotaxy:

genu II	$2 \frac{2}{0} \frac{2}{0} 1$	tibia II	$1 \frac{2}{1} \frac{1}{1} 1;$
genu III	$1 \frac{2}{0} \frac{2}{1} 1$	tibia III	$1 \frac{2}{1} \frac{1}{1} 1$

Male: Unknown

Habitat: *Carica papaya* L.

Materials examined: Holotype ♀ marked on the slide, INDIA: KERALA: Herbal garden Govt. Ayurveda college, Pariyaram (Kannur district), 18.xii.2015, ex. *Carica papaya* L. coll. Santhosh (No.P 791/1). Two paratype slides with 3 ♀ ♀, collection details as that of holotype (No.P 791/2, 791/3).

Remarks: This new species closely resembles *Indoseiulus racini* Ghai and Menon, 1969 in dorsal chaetotaxy, structure of chelicerae etc. but differs in the following characters.

1. In the new species dorsal shield not sclerotised whereas in *I. racini* it is well sclerotised.
2. In the new species, spermatheca with vesicular cervix and undifferentiated atrium whereas in *I. racini* cervix of spermatheca is vesicular with nodular atrium.
3. Larger nature of macrosetae on leg IV. In the new species genu– 38, tibia– 60 and basitarsus 50 whereas in *I. racini* it is 32, 40 and 36 respectively.
4. In new species j_1 – 13 long whereas in *I. racini*, it is 21 long.
5. A Pair of pores present between setae z_4 and j_5 in new species but this pore absent in *I. racini*.

This species also resembles with *Indoseiulus eharai* (Gupta, 1986) in dorsal chaetotaxy but differs in following characters.

1. Dorsal shield is poorly sclerotised and reticulated in *I. eharai* whereas in new species dorsal shield neither reticulated nor sclerotised.
2. In the new species fixed digit of chelicera multidentate with a strong *pilus dentilis* whereas in *I. eharai*, it is with 2– 4 teeth and no *pilus dentilis*.
3. Spermatheca with short tubular cervix in *I. eharai*, whereas in new species spermatheca with conical, vesicular cervix.
4. Macrosetae on leg IV ,genu– 32, tibia– 40 and basitarsus 36 in *I. racini* where as in the new species it is 38,60 and 50 respectively.
5. In new species j_1 – 13 long whereas in *I. racini*, it is 26 long.

Tribe: Euseiini Chant and McMurtry, 2005

2005. Euseiini Chant and McMurtry, *Internat. J. Acarol.*, **31**(3): 191.
2007. Euseiini Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.107– 108.

Type **Genus:** *Amblyseius (Amblyseius) Euseius* Wainstein, 1962.

Subtribe: Euseiina Chant and McMurtry, 2005

2005. Euseiina Chant and McMurtry, *Internat. J. Acarol.*, **31**(3): 209.
2007. Euseiina Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.118.

Type **Genus:** *Amblyseius (Amblyseius) Euseius* Wainstein, 1962.

Genus *Euseius* Wainstein, 1962

1962. *Amblyseius (Amblyseius) sacchari* Sec. Wainstein, *Acarologia*, **4**: 15.
1979. *Euseius* Chaudhri *et al.*, *Univ. Agr. Faisalabad*, p. 56.
1982. *Euseius*, Karg, *Zool. Jb. Syst. Bd.*, **109**: 196.
1987. *Euseius*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 29– 30.
1989. *Euseius*, Cobanoglu, *Turk. Entomol. Derg.*, **13** (3) : 164.
1992. *Euseius*, Gupta, In: *State Fauna Ser. 3. Fauna of West Bengal, part 3*, p.154.
1995. *Euseius*, Amitai, *Entomol. Hell.*, **10** : 19 – 20.
2003. *Euseius*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 31.

2007. *Euseius*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.118.

Diagnosis: Dorsal shield with 6 pairs of dorsocentral setae, 9 pairs of laterals and 2 pairs of median setae, Z_5 being longest. Chelicera small, fixed digit with 0 to 2 teeth distal to medially located *pilus dentilis*, Sternal shield wider than long, indistinctly lobate posteriorly. Peritreme not extends to the level of j_1 . Ventrianal shield elongate frequently vase shaped, preanal setae more or less arranged in two transverse curved rows; genu, tibia and basitarsus of leg IV always with macroseta, the latter being the longest.

Type species: *Seiulus finlandicus* Oudemans, 1915.

Key to species of genus *Euseius* included in the present study

1. All setae on dorsal shield minute except j_1 and Z_5 2
 - Beside j_1 and Z_5 there are other long setae *Euseius moosai* sp.nov.
2. Ratio of macrosetae tibia: basitarsus equal or more than 1.5
 - *Euseius faisali* sp.nov.
 - Ratio of macrosetae tibia: basitarsus less than 1.5 3
3. Ratio of macrosetae tibia: basitarsus 1.18.....
 - *Euseius macrospatulatus* Gupta.
 - Ratio of macrosetae tibia: basitarsus less than 1.18 4
4. S_2 noticeably longer than Z_1 *Euseius alstoniae* Gupta.
 - S_2 and Z_1 almost equal 5
5. S_2 and S_5 equal *Euseius curcasae* sp.nov.
 - S_2 and S_5 unequal 6

- 6. Macrosetae on leg IV simple..... *Euseius finlandicus* Oudemans.
- Macrosetae on leg IV knobbed..... 7
- 7. S_4 and S_5 equal and longer than S_2 *Euseius pariyarensis* sp.nov.
- S_4 longer than S_2 and S_5 , both S_2 and S_5 almost equal 8
- 8. Movable digit of chelicera with one tooth *Euseius ovalis* Evans.
- Movable digit of chelicera tooth less.....*Euseius rhododendronis* Gupta.

***Euseius alstoniae* Gupta, 1975**

PLATE 56

- 1975. *Amblyseius alstoniae*, Gupta, *Internat. J. Acarol.*, **1**(2): 31– 32.
- 1977. *Amblyseius alstoniae*, Gupta, *Indian J. Acar.*, **1**: 29
- 1978. *Euseius alstoniae*, Gupta, *Oriental Ins.*, **12** (3):327.
- 1980. *Amblyseius alstoniae*, Dhooria, *Acar. Newsl.*, **10**: 5.
- 1982. *Amblyseius (Euseius) alstoniae*, Gupta, *Rec.Zool.Surv.India*, **79** (3– 4):369– 370
- 1986. *Amblyseius (Euseius) alstoniae*, Gupta, *Fauna of India: Pytoseiidae*, p.74– 75.
- 1987. *Amblyseius (Euseius) alstoniae*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 21.
- 1989. *Amblyseius alstoniae*, Jose *et al.*, In: *Prog. Acarol.*, **2** : 357– 360.
- 1990. *Amblyseius alstoniae*, Dhooria, *Acar: Newsl.*, **17– 18**: 17.
- 1992. *Amblyseius (Euseius) alstoniae*, Gupta, In: *Contributions to Acarological Researchers in India*. p. 442.
- 1992. *Amblyseius (Euseius) alstoniae*, Gupta, In: *State Fauna Ser.3, Fauna of West Bengal, Part 3*, p. 165.

1993. *Amblyseius (Euseius) alstoniae*, Mukherjee and Singh, *Insect Sci.*, **6** (1): 136.
1995. *Amblyseius (Euseius) alstoniae*, Gupta In: *State Fauna Ser. 4, Fauna of Meghalaya*, Part 2, p.31.
1995. *Amblyseius (Euseius) alstoniae*, Singh, *Adv. Agri. Res., India*, **3**: 189.
1995. *Amblyseius alstoniae*, Kumari and Sadana, *Ind. J. Acarol.*, **13**: 55.
1996. *Amblyseius (Euseius) alstoniae*, Chatterjee and Gupta, *J. Beng. Nat. Hist. Soc. (NA)*: **15** (2): 25.
1997. *Amblyseius (Euseius) alstoniae*, Gupta, In: *State Fauna Ser.6, Fauna of Delhi*, p.524.
2000. *Amblyseius (Euseius) alstoniae*, Gupta, In: *State Fauna Ser.7, Fauna of Tripura*, Part 2, 422.
2003. *Amblyseius (Euseius) alstoniae*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 32.
2004. *Euseius alstoniae*, Moraes et al., In: *J. Acarol. Soc. Japan*, **13**(2):141–160.
2007. *Euseius alstoniae*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.120.
2011. *Euseius alstoniae*, Sadanandan, *J. Ecobiology*, **28**(2): 147– 151.
2012. *Euseius alstoniae*, Prasad, *Indira Publishing House, Westbloomfield, USA*, p.1063.
2013. *Euseius alstoniae*, Sajna Haneef and Mary Anitha, *Biological Forum*, **5**(2): 119– 122.

Female: Dorsal shield 320 long, 230 wide, reticulated on anterior lateral margin. Measurements of setae : $j_1 - 15$, $j_3 - 13$, $j_4 - 9$, j_5 , $j_6 - 8$ each, $J_2 - 8$, z_2 , $z_4 - 8$ each, $z_5 - 6$, $Z_4 - 19$, $Z_5 - 45$, $s_4 - 9$, $S_2 - 7$, $S_4 - 8$, $S_5 - 7$, $r_3 - 7$, $R_1 - 6$. Sternal shield 70 long and 60 wide with ST_1 , ST_2 , $ST_3 - 21$ each. ST_4 on metasternal shield, 20 long. Genital shield – 65 wide with $ST_5 - 20$ long. Ventrianal shield – 100 long and 63 wide $ZV_1 - 18$, $ZV_2 - 18$, $ZV_3 - 18$, $JV_1 - 19$, $JV_2 - 18$, $JV_4 - 18$ long. $JV_5 - 30$ long. Fixed digit of chelicera 21 long with 2 teeth and movable digit with 17 long with one tooth. Primary metapodal plate 22 long and 4 wide, accessory one 10 long. Spermatheca with tubular cervix 26 long and nodular atrium. Macroseta on leg IV: Genu – 24, tibia – 32, basitarsus – 42, with pointed tips.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown.

Habitat: *Jatropha curcas* (L.), *Bauhinia racemosa* L.

Known Habitat : *Alstonia scholaris*, pomogrenate, *Tabernae montana coronaria*, chilli, cotton, *Zinia* sp., sapota, date palm, Acacia, *Nerium indicum*, cucurbits, palm pear, maize, sugarcane, *Dalbergia sissoo*, *Butea monosperma*, rose, grass, guava, ficus, *Nyctanthes arbortristis*, citrus, vines, ornamental plants, beans, mulberry, sunflower.

Material examined: Female marked on the slide, INDIA: KERALA: Calicut University Campus (Malappuram District), 13.v.2015, ex. *Jatropha curcas* L., coll.Santhosh (No.B 14/1), with 4 ♀♀, two from the same place and

habitat (No.B 15/2, 15/3) and two from Pantheerankavu (Kozhikode district), 20.vi.2015, ex. *Bauhinia racemosa* L, (No.B 15/4, 15/5).

Distribution: INDIA: Arunachal Pradesh, Tamil Nadu, Gujarat, Jammu and Kashmir, Punjab, West Bengal, Bihar, Delhi, Kerala, Madhya Pradesh, Orissa, Rajasthan, Utter Pradesh. OUTSIDE INDIA: Sri Lanka.

Remarks: This specimen described is fixed to be *E. alstoniae* (Gupta), 1975 as it resembles almost all the characters of this species. In the present survey, *E. alstoniae* was recovered from new habitat viz., *Jatropha curcas* (L.) and *Bauhinia racemosa* L.

***Euseius curcasae* sp.nov.**

PLATE 57

Female: Dorsal shield slightly reticulated along the lateral margin, 368 long, 270 wide with 17 pairs of simple setae. Measurement of setae: $j_1 - 30$, $j_4 - 9$, $j_5, j_6 - 8$ each, $J_2 - 11$, $J_5 - 8$, $j_3 - 13$, $z_2 - 11$, $z_4 - 11$, $s_4 - 12$, $Z_1 - 15$, $S_2 - 11$, $S_4 - 15$, $S_5 - 11$, $Z_5 - 44$, smooth, $z_5 - 8$, $Z_4 - 15$, $r_3 - 11$ and $R_1 - 8$. Sternal shield 75 long and 73 wide with 3 pairs of sternal setae, ST_1 and $ST_2 - 22$ each, ST_3 measuring 18 long, ST_4 lies on the metasternal plate measures 20 long. Genital shield 75 long, 93 wide with $ST_5 - 20$ long. Ventrianal shield vase shaped slightly concave laterally, 124 long and 65 wide with 3 pairs of preanal setae and 4 pairs of setae present around ventrianal shield. $ZV_1, ZV_2 - 15$ long, $ZV_3 - 12$, $JV_1, JV_2 - 15$ each, $JV_4 - 12$, $JV_5 - 25$ long. Two pairs of metapodal plates present, primary 17 long, 5 wide and accessory one 10 long. Spermatheca with long tubular cervix (33) bended anteriorly. Peritreme terminates anteriorly between j_1 and j_3 . Fixed digit of chelicera 22 long with 2

apical teeth and movable digit with no tooth. Macrosetae on leg IV: genu – 37, tibia – 35 and basitarsus – 49.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Jatropha curcas* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Calicut University Campus (Malappuram District), 15.v.2014, ex. *Jatropha curcas* L., coll.Santhosh (No.C 15/1). Four ♀♀ paratype slides, 2 from the same host plant (No.C 15/2, 15/3) and 2 from Chellembra (Malappuram district), 20.vi.2015, ex. *Bauhinia acuminata* (L.), coll.Santhosh (No.C 15/4, 15/5).

Remarks: The specimen studied resembles *E. alstoniae* Gupta, 1975 in dorsal chaetotaxy and length of macro setae but differs in the following characters.

1. Dorsal shield longer and wider (368, 270) than that of *E. alstoniae* (325, 204).
2. In the new species, dorsal shield slightly reticulated on the anterior half of the body along the lateral margins whereas it is smooth anteriorly and rugose posteriorly in *E. alstoniae*.
3. In the new species S_2 shorter than Z_1 whereas in *E. alstoniae*, S_2 noticeably longer than Z_1

4. In the new species, j_3 – 13 long whereas in *E. alstoniae*, j_3 double the length (34).
5. In the new species atrium is funnel shaped whereas in *E. alstoniae*, atrium is undifferentiated.
6. In the new species JV_5 – 25 long whereas in *E. alstoniae*, the length of JV_5 – 44
7. The number of teeth on fixed digit 3 in the new species whereas it is 2 in *E. alstoniae*.
8. Peritreme terminates anteriorly between j_1 and j_3 in new species where as in *E. alstoniae* it terminate between j_3 and z_2

This new species also resembles *E. bambusae* Ghai and Menon, 1967 in dorsal chaetotaxy but differs in the following characters.

1. Dorsal shield slightly reticulated along the lateral margin of the new species whereas in *E. bambusae* dorsal shield gently reticulate all over the body.
2. In the new species JV_5 – 22 long whereas in *E. bambusae* it is 38 long.
3. Macrosetae on leg IV genu – 37, tibia – 35 and basitarsus – 49 long, whereas in *E. sacchari* genu – 56, tibia – 45, and basitarsus – 72 long.
4. In the new species peritreme terminates between j_1 and j_3 whereas in *E. bambusae*, peritreme terminates anteriorly between j_3 and z_2 .
5. Fixed digit of chelicerae with 3 apical teeth, movable digit with no tooth in the new species whereas in *E. bambusae*, 3 – 4 apical teeth and a single tooth in movable digit.

Euseius faisali* sp.nov.*PLATE 58**

Female: Dorsal shield smooth, 450 long, 280 wide. Measurement of seta : $j_1 - 14$, $j_3 - 12$, $j_4 - 8$, $j_5 - 10$, $j_6 - 8$, $J_2 - 8$, $J_5 - 5$, $z_2 - 8$, $z_4 - 10$, $s_4 - 8$, $Z_1 - 10$, $S_2 - 9$, $S_4 - 10$, $S_5 - 10$. $Z_5 - 20$, $z_5 - 8$, $Z_4 - 11$, $r_3 - 14$, $R - 8$. Three pairs of pores present in between $j_1 - z_1$, $j_5 - s_4$ and near S_2 . Sternal shield 80 long and 75 wide, with sternal setae ST_1 , ST_2 , ST_3 measuring 40 each. $ST_4 - 38$ on metasternal shield. Genital shield 90 wide with setae 20 long. Ventrianal shield 130 long and 100 wide with a pair of anal pore. $ZV_1 - 26$, $ZV_3 - 8$, $JV_4 - 10$ long. $JV_1 - 24$, $ZV_2 - 19$, $JV_2 - 22$, $JV_5 - 36$ long smooth. Peritreme extends between j_3 and z_2 . Primary metapodal plate 30 long 4 wide, accessory one 14 long. Fixed digit of chelicera with 10 teeth and movable digit with 3 – 4 teeth. Spermatheca with elongated cervix, 22 long. Macroseta on leg IV: genu – 32, tibia – 49, basitarsus – 42.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{2}{1} \frac{2}{0} 1$;
genu III $1 \frac{1}{1} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown.

Habitat: *Carica papaya* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Pariyaram (Kannur district), 8.xii.2015. ex. *Carica papaya* L., coll. Santhosh (No. E 7/60). Five ♀♀, collection details same as above (No. E 8/61, 9/62, 10/63).

Remarks: This new species closely resembles *E. rhododendronis* Gupta, 1970 in dorsal chaetotaxy but differs in the following features.

1. The length and width of dorsal shield smaller (325, 230) in *E. rhododendronis* than the new species (450, 280).
2. Dorsal shield faintly reticulated laterally in *E. rhododendronis*, whereas in the new species there is no reticulation.
3. In the new species, fixed digit of chelicerae with 10 teeth and movable digit with 3 teeth whereas in *E. rhododendronis*, it is 2 and tooth less respectively.
4. Macrosetae on leg IV genu – 32 and tibia – 49 long with pointed tips whereas in *E. rhododendronis*, genu – 40 and tibia – 30 long with rounded tip.
5. Spermatheca with elongated cervix in *E. rhododendronis*, whereas in new species spermatheca with tubular cervix narrowly constricted on posterior end.
6. In the new species j_1 – 14, Z_5 – 20 and JV_5 – 22 long, whereas in *E. rhododendronis*, it is 27, 60 and 40 respectively.

***Euseius finlandicus* (Oudemans), 1915**

PLATE 59

1915. *Seiulus finlandicus* Oudemans, *Ent. Ber.*, **4**: 183.

1958. *Amblyseius finlandicus*, Athias–Henriot, *Bull. Soc. Hist. Nat. Afr. Nord.*, **49**: 24–36.

1983. *Amblyseius finlandicus*, Rishi and Rather, *J. Ent. Res.*, **7** (1): 39–42.

1985. *Amblyseius finlandicus*, Sharma and Sadana, *J. Acar.*, **9**: 57.

1986. *Amblyseius (Euseius) finlandicus*, Gupta, *Fauna of India: Phytoseiidae*, p. 86– 88.
1987. *Amblyseius finlandicus*, Sharma and Sadana, *Entomon*, **12** (3): 191– 195.
1987. *Amblyseius (Euseius) finlandicus*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 24– 25.
1990. *Amblyseius finlandicus*, Dhooria, *Acar. Newsl.*, **17– 18** : 17.
1990. *Amblyseius finlandicus*, Sharma and Sadana, *Acar. Newsl.*, **17– 18**: 15.
1992. *Amblyseius (Euseius) finlandicus*, Gupta, In: *State Fauna Ser 3, Fauna of West Bengal, Part 3*, p.157– 158.
1995. *Amblyseius (Euseius) finlandicus*, Gupta, In : *State Fauna Ser. 4, Fauna of Meghalaya, Part 2*, p. 32– 33.
1995. *Amblyseius finlandicus*, Jagadish, *et al.*, *Abst. V Nat. Symp. Acarol.*, p.17.
1997. *Amblyseius (Euseius) finlandicus*, Gupta and Chatterjee, In: *State Fauna Ser. 6, Fauna of Delhi*, p.252.
1999. *Amblyseius (Euseius) finlandicus*, Gupta and Chatterjee, *Sci. and Cult.*, **65** (5– 6): 162.
2000. *Amblyseius (Euseius) finlandicus*, Gupta, In: *State Fauna Sr. 7, Fauna of Tripura, Part 2*, p. 23.
2003. *Amblyseius (Euseius) finlandicus*, Gupta, In: *State Fauna Ser. 9, Fauna of Sikkim*.p.16.
2003. *Amblyseius (Euseius) finlandicus*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20** (1):39.

2007. *Euseius finlandicus*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.121.
2009. *Euseius finlandicus*, Wu, Ou and Huang, In: *Science Press, Beijing, China*, **47**: 511.
2010. *Euseius finlandicus*, Tixier, *Zool. Scripta*, **42** (3): 327–334.
2010. *Euseius finlandicus*, Rahmani *et al.*, In: *Internat. J. Zoo.*, **34**: 497–508.
2014. *Euseius finlandicus*, Puchalska *et al.*, *Internat. J. Acarol.*, **40**(7): 473–483
2016. *Euseius finlandicus*, Doker *et al.*, *Sys. Appl. Acarol.*, **21** (4) 505– 527

Female: Dorsal shield 329 long, 232 wide and reticulated. Measurements of setae: j_1 –26, j_3 – 20, j_4 –15, j_5 –59, j_6 –8, J_2 –8, J_5 –6, z_2 –21, z_4 –19, z_5 –16, s_4 –25, Z_1 –14, S_2 –22, S_4 –25, S_5 –27, Z_4 – 14, Z_5 –68, r_3 –10, R_1 –12. Sternal shield 68 long and 70 wide with 3 pairs of sternal setae *viz.*, ST_1 , ST_2 , and ST_3 measuring 20, 18 and 21 respectively. Fourth pair of sternal setae ST_4 , 20 long lies on the metasternal shield. Genital shield 88 wide with a pair of genital setae ST_5 , 20 long. Ventrianal shield 101 long and 65 wide with 3 pairs of preanal setae and a pair of crescent shaped pores, below the level of 3rd pair of preanal setae; 4 pairs of setae present around the ventrianal shield. ZV_1 –16, ZV_2 – 16, ZV_3 –14, JV_1 –17, JV_2 –21, JV_4 – 12 long. Setae JV_5 smooth and 25 long. Fixed digit of chelicera 27 long with 2 teeth and movable digit 25 long with one tooth. Spermatheca as illustrated. Peritreme extends up to the level of z_1 . Macroseta on leg IV: genu – 37, tibia 25, basitarsus 45, all with broad tips.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{1}{1} \frac{2}{1} 1$ tibia III $1 \frac{2}{1} \frac{1}{1} 1$.

Male: Unknown

Habitat: *Bauhinia acuminata* (L.), *Gmelina arborea* Roxb.

Known habitat: Guava, maize, grape vine, tea, peach, pine, cucurbitaceous plant. citrus, apple, wood apple, castor, bamboo, cotton, *Pyrus communis*, *Nerium indicum*.

Material Examined: Female marked on the slide, INDIA: KERALA: Kakkodi (Kozhikode district), 13.v.2012, ex, *Bauhinia acuminata* (L.), coll. Santhosh (No. K 148/1). 4 ♀♀ marked on the slide, collection details same as above. (No. K 148/2, 148/3), 2 ♀♀ from Parapanangadi (Malappuram), ex. *Gmelina arborea* Roxb (No.K 148/4).

Distribution: INDIA: Andhra Pradesh, Karnataka, Tamil Nadu, Punjab, Meghalaya, West Bengal, Tripura, Bihar, Pondicherry, Kerala, Andaman and Nicobar Islands. OUTSIDE INDIA: Albania, Algeria, angola, Argentina, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia , Herzegovina, Bulgaria,Canada,Caucasus Region, China , Croatia, Cyprus, Czech Republic, Czechoslovakia, Denmark, England, Finland,France, Germany, Greece, Japan, Kazakhstan,Latvia, Macedonia Mexico, Moldova, Montenegro, Netherlands, Nicaragua, Norway, Poland,Portugal, Russia, Scandinavia, Serbia, Slovakia, Slovenia,South Korea,Spain, Sweden,Switzerland,Turkey Ukraine,USA .

Remarks: This specimen described is fixed to be *E. finlandicus* (Oudemans), 1915 as it resembles almost all the characters. *Bauhinia acuminata* L. and

Gmelina arborea Roxb. was the new habitat from where the particular species recovered in the present survey.

***Euseius macrospatulatus* Gupta, 1986**

PLATE 60

1986. *Amblyseius macrospatulatus* Gupta, *Indian J. Acar.*, In press.

1986. *Amblyseius (Euseius) macrospatulatus* Gupta, *Zool. Surv. India*, Calcutta, p.350

1988. *Euseius macrospatulatus* Gupta, *Prog. Acarol.*, **1**:403– 410.

2003. *Euseius macrospatulatus*, Gupta, *Memoirs, Zool. Surv. India*, **20** (1): 1– 185

2004. *Euseius macrospatulatus*, Moraes *et al.*, *Zootaxa*, **434**: 1– 494.

2012. *Euseius macrospatulatus*, Prasad, *Indira Publishing House, West bloomfield , USA*, p.1063.

Female: Dorsal shield 430 long, 320 wide, lateral margin of anterior side reticulated. Measurements of setae: j_1 –50, j_3 – 25, j_4 –4, j_5 –4, j_6 –5, J_2 –14, J_5 – 5, z_2 , z_4 , z_5 –5 each, s_4 – 4, Z_1 –10, S_2 – 4, S_4 – 8, S_5 –10, Z_4 – 10, Z_5 – 65, r_3 –10 and R_1 –12. Sternal shield 90 long and 80 wide with 3 pairs of sternal setae viz., ST_1 , ST_2 , and ST_3 measuring 20 each; ST_4 – 15 long. Genital shield 95 wide with a pair of genital setae ST_5 , 20 long. Ventrianal shield 130 long and 90 wide with 3 pairs of preanal setae, below the level of 3rd pair of preanal setae; 4 pairs of setae present around the ventrianal shield. ZV_1 , ZV_2 , ZV_3 , JV_1 and JV_4 –15 each, JV_2 –20 long. Setae JV_5 smooth and 40 long. Fixed digit of chelicera 19 long with 2 teeth and movable digit 18 long with one tooth. Spermatheca with oval cervix with bottle neck atrium, 10 long.

Peritreme terminate between j_3 and z_2 . Macroseta on leg IV: genu – 38, tibia 45, basitarsus 68, all with curved tips.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{1} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Habitat: *Bauhinia acuminata* L., *Canavalia ensiformis* (L.)

Known Habitat: Undet. plant.

Material Examined: Female marked on the slide, INDIA: KERALA: Nileshwaram, (Kasargod district), 12.v.2010, ex. *Bauhinia acuminata* (L.), coll. Santhosh (No. K 91/2). 4 ♀♀ marked on the slides, collection details same as above (No. K 92/3, 92/5, 92/8), 2 ♀♀ from Mananthavady (Wayanad district), ex. *Canavalia ensiformis* (L.), (No.K 92/9).

Distribution: INDIA: Arunachal Pradesh

Remarks: The specimen studied agrees in almost all characters of *E. macrospatulatus* (Gupta, 1986) hence fixed so. It is a new record from Kerala. *Bauhinia acuminata* L., *Canavalia ensiformis* (L.) was the new habitats from where the particular species recovered in the present survey.

***Euseius moosai* sp.nov.**

PLATE 61

Female: Dorsal shield 300 long, 202 wide. Measurement of setae: $j_1 - 13$, $j_3 - 18$, $j_4 - 14$, $j_5 - 16$, $j_6 - 12$, $J_2 - 13$, $J_5 - 4$, $z_2 - 12$, $z_4 - 12$, $s_4 - 33$, $Z_1 - 12$, $S_2 - 15$, $S_4 - 20$, $S_5 - 25$, $Z_5 - 62$, $z_5 - 12$, $Z_4 - 14$, $r_3 - 12$, $R_1 - 12$, on lateral integument. Sternal shield smooth, 68 long, 65 wide with 3 pairs of sternal

setae, ST₁, ST₂, ST₃ and ST₄ 16 long. Genital shield slightly rugose 66 long, 50 wide with setae ST₅ 16 long. Ventral side striated only on posterior region with 100 long and 75 wide. Ventrianal shield with 3 pairs of preanal setae. Length of ZV₁ – 12, ZV₂ – 10, ZV₃ – 13, JV₄ – 13, JV₁ – 13, , JV₂ – 10 and JV₅ – 25. A single pair of metapodal plate present, primary one 12 long and accessory one 7 long. Spermatheca with cervix 10 long. Fixed digit of chelicera 25 long with 2 teeth, movable digit with no tooth. Peritreme extends to the level of z₂. Macroseta on leg IV: genu – 25, tibia – 28 and bastarsus – 52 long.

Leg chaetotaxy : genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{1} 1$ tibia III $1 \frac{2}{1} \frac{1}{1} 1$.

Male: Unknown

Habitat: *Helicterus isora* L.

Material Examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kakkadampoyil (Kozhikode district), 12.ix.2102, ex. *Helicteres isora* L., coll. Santhosh (No. E 15/1). Four ♀♀ marked on the slide, collection details same as above. (No.E 15/2, 15/3, 25/4)

Remarks: This species resembles *E. sacchari* Ghai and Menon, 1967 in dorsal and leg chaetotaxy but differs in the following features.

1. The length and width of dorsal shield smaller (300, 202) in new species than the *E. sacchari* (360,250).
2. The number of teeth on fixed digit 3 in the new species whereas it is 2 in *E. sacchari*.

3. Sternal shield measuring 68 long and 63 wide with reticulation in new species whereas in *E. sacchari*, it is 92 long, 82 wide with no reticulation.
4. Longer nature of Z_5 and S_4 .
5. In new species, setae like j_3 , j_4 , j_5 , S_4 and S_5 longer whereas in *E. sacchari*, setae like j_4 , j_5 , S_4 and S_5 smaller except j_3 (33).
6. Genital shield width smaller (50) when compared with *E. sacchari* (95).
7. In in the new species spermatheca is with vesicular, bladder like cervix whereas in *E. sacchari*, spermatheca is with tubular cervix.
8. Striation seen around the ventrianal shield whereas in *E. sacchari*, it is non striated.

***Euseius ovalis* (Evans), 1953**

PLATE 62

1953. *Typhlodromus ovalis* Evans, *Ann. Mag. Nat. Hist.*, **6**: 458– 461
1960. *Typhlodromus (Amblyseius) ovalis*, Narayanan *et al.*, *Proc. Nat. Inst. Sci.*, **26**(6):388– 389.
1986. *Amblyseius (Euseius) ovalis*, Gupta, *Fauna of India: Phytoseiidae*, p.92– 94.
1987. *Amblyseius ovalis*, Lo, *pl. Proc. Bull. Taiwan*, **28**: 31– 39.
1987. *Amblyseius (Euseius) ovalis*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**: 27– 28.

1989. *Amblyseius ovalis*, Hariyappa and Kulkarni, *J. Biol. Contr.*, **3**(1): 31– 32.
1990. *Amblyseius ovalis*, Nangia *et al.*, *Acar. Newsl.*, **17– 18** :22.
1992. *Amblyseius (Euseius) ovalis*, Gupta, In: *Contr.Acarol. Res. India*, p.442.
1994. *Amblyseius (Euseius) ovalis*, Singh, *Shashpa*, **1**(2): 68.
1995. *Amblyseius (Euseius) ovalis*, Gupta, In: *State Fauna Ser. 4 Fauna of Meghalaya*, p.33.
1996. *Amblyseius (Euseius) ovalis*, Chatterjee and Gupta, *J. Beng. Nat. Hist. Soc. (NS)*, **15**(2): 26.
1999. *Amblyseius (Euseius) ovalis*, Gupta and Chatterjee, *Sci. and Cult.*, **65**(5– 6) : 162.
2000. *Amblyseius (Euseius) ovalis*, Gupta, In: *State Fauna Ser.7, Fauna of Tripura, Part 2*, p. 23.
2003. *Amblyseius (Euseius) ovalis*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs, Zool. Surv. India*, **20**(1), 1–185.
2007. *Euseius ovalis*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.219.
2009. *Euseius ovalis*, Wu, Ou and Huang, *Science Press, Beijing, China*, **57**, p.511.
2010. *Euseius ovalis*, Tixier, *Zool. Scripta*, **42** (3): 327–334.
2012. *Euseius ovalis*, Tixier, *Zool. Cladistics*, **28**: 489–502.
2011. *Euseius ovalis*, Karmakar and Gupta, *Zoosymposia*, **6**: 62– 67.
2017. *Euseius ovalis*, Lio *et al.*, *Zootaxa*, **4226** (2): 205– 228.

Female : Dorsal shield 300 long, 190 wide, Measurements of setae : $j_1 - 25$, $j_3 - 13$, j_4 , j_5 , $J_5 - 4$, j_6 , $J_2 - 6$, z_2 , $z_4 - 6$, each, $z_5 - 4$, $Z_1 - 7$, $Z_4 - 9$, $Z_5 - 43$, $s_4 - 12$, $S_2 - 7$, $S_4 - 10$, $S_5 - 7$, $r_3 - 7$, $R_1 - 6$. Sternal shield 55 long and 60 wide with $ST_1 - 18$, $ST_2 - 18$, $ST_3 - 20$ long. ST_4 on metasternal shield, 20 long. Genital shield 68 wide with $ST_5 - 21$ long. Ventrianal shield - 95 long and 70 wide, $ZV_1 - 15$, $ZV_2 - 22$, $ZV_3 - 5$, $JV_1 - 12$, $JV_2 - 23$, $JV_4 - 7$ long. $JV_5 - 25$ long. Fixed digit of chelicera 26 long with 2 teeth and movable digit 24 long with one tooth. Primary metapodal plate 8 long, accessory one 4 long. Spermatheca with tubular cervix 12 long. Macroseta on leg IV: Genu - 35, tibia - 37, basitarsus - 55, with broadened tip.

Leg chaetotaxy: genu II $2\frac{2}{0} \frac{2}{0} 1$ tibia II $1\frac{1}{1} \frac{2}{1} 1$;
genu III $1\frac{2}{1} \frac{1}{1} 1$ tibia III $1\frac{1}{1} \frac{2}{1} 1$.

Male: Unknown.

Habitat: *Averrhoa bilimbi* L., *Achyranthus aspera* L.

Known habitat : Castor, Ficus, *Nerium* sp., Napier grass, *Vitex pubescens*, Lucern, Cashew nut, Pigeon pea, Glycosomus, Pentaphylla, *Dolichos lablab*, *Bougainvillea spectabilis*, grass, jackfruit, *Cassia fistula*, *Macrocos paniculatus*, Banana, *Bauhinia purpuria*, coconut, *Tabernaemontana*, Beans, mango, sugarcane, cotton, paddy, chilli, ornamental plants.

Material Examined: Female marked on the slide, INDIA: KERALA: Ponnani (Malappuram district), 13.v.2012, ex. *Averrhoa bilimbi* L., coll. Santhosh (No. K 144/1). 4 ♀♀ marked on the slide, collection details same as above. (No. K 144/2, 144/3), 2 ♀♀ from Alathur (Palakkad district), ex. *Achyranthus aspera* L. (No.P 144/4).

Distribution : INDIA: Assam, Arunachal Pradesh, Sikkim, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat, Punjab, Mizoram, Meghalaya, West Bengal, Tripura, Bihar, Manipur, Pondicherry, Kerala, Maharashtra, Andaman and Nicobar Islands, Lakshadweep Islands. OUTSIDE INDIA: Australia, China, Cook Islands, Fiji, Hawaii, Hong Kong, Indonesia, Japan Malaysia, Mauritius, Mexico, New Zealand, Papua New Guinea, Philippines, Sri Lanka, Taiwan

Remarks: This specimen described is fixed to be *E. ovalis* (Evans, 1953) as it resembles almost all the characters of this species. *Averrhoa bilimbi* (L.) and *Achyranthus aspera* L. are the two new habitats were recovered in the present survey.

***Euseius pariyarensis* sp.nov.**

PLATE 63

Female : Dorsal shield 320 long, 202 wide with 17 pairs of setae. Measurements of Setae: $J_1 - 37$, $j_3 - 20$, j_4 , j_5 , $j_6 - 8$ each, $J_2 - 9$, z_2 , $z_4 - 6$ each. $Z_5 - 4$, $Z_1 - 12$, $Z_4 - 15$, $Z_5 - 50$, $s_4 - 8$, $S_2 - 8$, $S_4 - 9$, $S_5 - 9$, $r_3 - 8$, $R_1 - 15$. Peritreme terminates anteriorly between leg I and II (Z_2 and Z_4). Sternal shield 73 long and 68 wide with $ST_1 - 22$, ST_2 and $ST_3 - 20$ long. ST_4 on metasternal shield, 12 long. Genital shield 65 wide with $ST_5 - 20$ long. Ventrianal shield pentagonal in shape – 88 long and 53 wide. $ZV_1 - 12$, ZV_2 and $ZV_3 - 14$ each, $JV_1 - 15$, $JV_2 - 8$, $JV_4 - 12$ and $JV_5 - 30$ long. A thick fold present between genital and ventrianal shield. Chelicera 24 long, 3 teeth on fixed digit and none on movable digit. Metapodal plate primary 13 long, 4 wide, accessory 5 long. Spermatheca with tubular cervix (20) long with

funnel shaped atrium. Macroseta on leg IV Genu – 37 with pointed tip, tibia – 30 with broadened tip, basitarsus – 48, with broadened tip.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{1} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Saraca indica* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Herbal Garden, Ayurveda college, Pariyaram, (Kannur district), 18.xii.2015, ex. *Saraca indica* L. coll.Santhosh (No.D 75/1). Three Paratype slides with 7 ♀♀, collection details same as above (No.D 75/2, 75/3, 75/4).

Remarks: This new species closely resembles *E. ovalis* (Evans), 1953 in dorsal chaetotaxy and general appearance but differs distinctly from it by the possession of the following features.

1. Fixed digit of chelicera with 3 teeth and none on movable digit, whereas in *E. ovalis* fixed digit has 2 teeth and a small tooth on movable digit.
2. Spermatheca with long tubular cervix (20) with funnel shaped atrium whereas in *E. ovalis* cervix is funnel shaped.
3. A thick fold present between genital and ventrianal shield which is absent in *E. ovalis*
4. j_1 of the new species is longer (37) when compared to the j_1 of *E. ovalis*.

5. In the new species, ventrianal shield slightly pentagonal in shape measuring 88 long and 53 wide, where as in *E. ovalis*, it is oval in shape, 84 – 90 long and 72– 78 wide.

This new species also resembles *E. sacchari* (Ghai and Menon), 1967 in the structure of chelicerae and spermatheca but differs by the possession of the following features:

1. In the new species peritreme terminate between z_2 and z_4 where as in *E. sacchari*, peritreme terminates anteriorly between j_3 and z_2 .
2. The length and width of dorsal shield smaller (320, 202) in new species than the *E. sacchari* (350, 230).
3. Fixed digit of chelicera with 3 teeth in the new species instead 2.
4. The ventrianal shield small (88 long and 53 wide) in the new species whereas it is larger (90 long, 70 wide) in *E. sacchari*.
5. Macrosetae on leg IV basitarsus with broadened tip whereas in *E. sacchari* tip is pointed.

***Euseius rhododendronis* Gupta, 1970**

PLATE 64

1970. *Amblyseius rhododendronis* Gupta, *Oriental Ins.*, **4**: 187– 188.
1974. *Amblyseius rhododendronis* Prasad, *A Catalogue of mites of India*, Indira Publishing House, Westbloomfield , USA, p. 169.
1975. *Amblyseius rhododendronis*, Gupta, *Internat. J.Acarol.* **1**(2):43
1978. *Euseius Kodaikanalensis* Gupta, *Oriental Ins.*, **12**: 331– 333 (new synonymy)

1985. *Euseius (Amblyseius) rhododendronis* Gupta, *Zoological Survey of India, Hand Book Series*, Calcutta, **5**: p.520
1991. *Amblyseius rhododendronis*, Ray and Gupta, *Bull.Zool.Surv.India*, **4**(3): 280.
1992. *Euseius (Amblyseius) rhododendronis*, Gupta, *Zoological Survey of India*, Calcutta, p.61– 211.
2003. *Euseius rhododendronis*, Gupta, *Memoirs, Zool.Surv.India*, **20**(1): 1– 185.
2004. *Euseius rhododendronis*, Moraes *et al.*, *Zootaxa*, **434**: p.494.
2005. *Euseius rhododendronis*, Chant and McMurtry, *Internat.J. Acarol.* **31**(3) 187– 224.
2007. *Euseius rhododendronis*, Chant and McMurtry, *Indira Publishing House, West Bloomfield*, p.219.
2011. *Euseius rhododendronis*, Sadanandan, *Ecobiology*, **28**(2): 147– 151
2012. *Euseius rhododendronis*, Prasad, *Indira Publishing House, Westbloomfield, USA*, p.1063.

Female: Dorsal shield 340 long, 240 wide. Measurement of setae: $j_1 - 25$, $j_4 - 5$, $j_5 - 10$, $j_6 - 11$, $J_2 - 11$, $J_5 - 5$, $j_3 - 15$, $z_2 - 8$, $z_4 - 8$, $s_4 - 17$, $Z_1 - 12$, $S_2 - 14$, $S_4 - 24$, $S_5 - 17$, $Z_5 - 60$, $z_5 - 8$, $Z_4 - 12$, $r_3 - 8$, $R_1 - 6$, on lateral integument. Sternal shield smooth, 81 long, 70 wide with 3 pairs of sternal setae, $ST_1 - 18$, $ST_2 - 19$, $ST_3 - 21$ long. Metasternal shield with $ST_4 - 18$ long. Genital shield 75 wide with setae 16 long. Ventrianal shield 106 long and 81 wide. Ventrianal shield with 3 pairs of preanal setae and a pair of crescent shaped pores. Length of $ZV_1 - 16$, $ZV_3 - 11$, $JV_4 - 10$, $JV_1 - 17$, $ZV_2 - 16$, $JV_2 - 14$, $JV_5 - 38$. One pair of metapodal plate present, primary

one 8 long. Spermatheca with tubular cervix 25 long. Fixed digit of chelicera 32 long with 3 teeth, movable digit 29 long with no tooth. Peritreme extends to the level of z_2 . Macroseta on leg IV: genu – 34, tibia –25, bastarsus – 50 long, all with rounded tips.

Leg chaetotaxy: genu II $2\frac{2}{0}\frac{2}{0}1$ tibia II $1\frac{2}{1}\frac{2}{0}1$;
genu III $1\frac{1}{1}\frac{2}{1}1$ tibia III $1\frac{1}{1}\frac{2}{1}1$

Male: Unknown

Habitat: *Jatropha curcas* L.

Known Habitat: *Rhododendron* sp., *Shorea robusta*, *litchi*

Material Examined: Female marked on the slide, INDIA: KERALA: Calicut University campus (Malappuram district), 13.v.2012, ex, *Jatropha curcas* L., coll. Santhosh (No. E 23/1). Four ♀♀ marked on the slide, collection details same as above. (No. E 23/2, 23/3, 23/4, 23/5).

Distribution: INDIA: Kerala, Karnataka, Tamil Nadu, West of Bengal, Tripura.

Remarks: This species is same as *E. rhododendronis* Gupta 1970, but certain variation occurs with regard to relative lengths of dorsal idiosomal setae and in length and width of ventrianal shield. Despite this difference it is fixed as *E. rhododendronis*. In the present survey *E. rhododendronis* was recovered from a new hoat plant viz., *Jatropha curcas* (L.).

Subfamily PHYTOSEIINAE Berlese, 1916

1916. *Phytoseiinae* Berlese, *Redia*, **12**:11

1985. *Phytoseiinae*, Wei–nan, Zhao–quan, *Acta Zootaxonomica*, **10**: 393–398.

1986. *Phytoseiinae*, Gupta, *Fauna of India: Phytoseiidae*, p.216.
1987. *Phytoseiinae*, Gupta, *Rec. Zool. Surv, India, Occ. Pap.*, **95**:78.
1989. *Phytoseiinae*, Cobanoglu, *Turk. Entomol. Derg.*, **13**: 163– 178.
1992. *Phytoseiinae*, Wei – nan and Zhao– quan, *Acta Entomologica Sinica*, **27**: 457– 461.
1992. *Phytoseiinae*, Denmark, *Fla. St. Coll. of Arthropods, Occ. Pap.*, **7**:3
1992. *Phytoseiinae*, Ryu Myon and Won Koo Lee, *Korean J. Entomol.*, **22**:23.
1993. *Phytoseiinae*, Schicha and Dowd, *J. Aust. Ent. Soc.*, **32**: 297 – 305.
1995. *Phytoseiinae*, Yoshida– Shaul and Chant, *Acarol.*, **36**: 3.
2003. *Phytoseiinae*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 95.
2007. *Phytoseiinae*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.125.

Diagnosis: Dorsal shield undivided with 5 to 6 pairs of dorsocentral setae, 2 to 3 pairs of median setae, 7 to 11 pairs of lateral setae, of those 5 pairs of prolateral, 1 to 2 pairs of sublateral, both may be on interscutal membrane. Ventrianal shield with 1 to 4 pairs of preanal setae, leg IV macrosetae 0 to 3. Males with shield shaped ventrianal shield.

Type **Genus:** *Phytoseius* Ribaga, 1904

Genus *Phytoseius* Ribaga, 1904

1904. *Phytoseius* Ribaga, *Riv. Pat.Veg.*, **10**: 177.

1984. *Phytoseius*, Schicha, *Internat. J. Acarol.*, **10**(2):177.
1986. *Phytoseius*, Gupta, *Fauna of India: Phytoseiidae*, p.219.
1987. *Phytoseius* Gupta, *Rec. Zool. Surv, India, Occ. Pap.*, **95**:79.
1989. *Phytoseus*, Cobanoglu, *Turk. Entomol. Derg.*, **13**: 163– 178.
1989. *Phytoseius*, Gupta, In: *Progress in Acarology*, **1**: 403– 410.
1992. *Phytoseius*, Denmark, *Fla. St. Coll. of Arthropods, Occ. Pap.*, **7**:1– 43.
2003. *Phytoseius*, (*Pennaseius*), Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Ordr: Mesostigmata. Memoirs*, **20**(1): 96.
2007. *Phytoseius*, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.125.
2012. *Phytoseius*, Prasad, *Checklist of Phytoseiidae of the World (Acari:Mesostigmata)*. Indira Publishing House, West Bloomfield, Michigan, USA, p.1063.
2014. *Phytoseius*, Demite *et al.*, *Phytoseiidae Database, Zootaxa*, **3795**: 571– 577.
2015. *Phytoseius*, Gupta and Karmakar, *Rec.Zool.Surv.India*: **115** (Part– 1): 51– 72.

Diagnosis: Dorsal shield often heavily sclerotized with 15 to 16 pairs of setae, of those 5 to 6 pairs on prolateral series, all long setae on dorsal shield heavily serrate. r_3 on dorsal shield, R_1 either on lateral integument or absent. All species with 7 pairs of lateral setae, 2 pairs of median setae and 5 to 6 pairs of dorsocentral setae. Ventrally, female with sternal, genital and ventrianal shield. Ventrianal shield longer than wide with distinct waist, 1–3

pairs of preanal setae. Macrosetae on leg IV often spatulate. Genu II with 7 setae, genu III – 7 setae, tibia III – 6 setae.

Type species: *Phytoseius ribagai* Chant and Athias–Henriot (1960).

(= *Gamasus plumifer* C. and F., Ribaga, 1904)

Key to the species of genus *Phytoseius* included in the present study

1. Macrosetae absent on genu, tibia, basitarsus of leg IV
..... *Phytoseius intermedius* Evans and Macfarlane
- Macrosetae present on leg IV 2
2. Setae s_4 shorter than the distance between its base and that of setae s_6
..... *Phytoseius prakasani* sp.nov.
- Setae s_4 longer than the distance between its base that on setae s_6 3
3. Setae s_4 barely touches the base of setae s_6
..... *Phytoseius rachele* Swirski and Shechter
- Setae s_4 exceeds the base of setae s_6 4
4. Setae s_4 one and half times its base and the distance of setae s_6 , sternal shield as long as broad *Phytoseius macropilis* (Bank)
- Setae s_4 slightly exceeds to the base of setae s_6 , sternal shield longer than broad *Phytoseius asperae* sp.nov.

Phytoseius asperae sp.nov.

PLATE 65

Female: Dorsal shield 315 long 160 wide rugose, anteriodorsal shields with one pair of pores. Setae j_3 , j_1 , s_4 , z_3 , s_6 , Z_4 , Z_5 , r_3 are long, thick and serrate. Measurement of setae: j_1 –25, j_3 –40, setae j_4 , j_5 , j_6 , J_5 , z_2 , z_4 and z_5 –4 each,

$z_3 - 27$, $s_4 - 110$, $s_6 - 75$, $Z_4 - 80$, $Z_5 - 88$. Sternal shield 86 long, 75 wide with ST_1 , ST_2 , ST_3 , $ST_4 - 28$ each. Genital shield 71 wide with setae $ST_5 - 29$ long. A skin fold present between genital shield and ventrianal shield. Ventrianal shield 133 long and 53 wide with 3 pairs of preanal setae. Setae $JV_1 - 14$, $JV_2 - 10$, $ZV_2 - 17$, $ZV_1 - 21$, $ZV_3 - 12$, $JV_5 - 40$ long, smooth. Primary metapodal plates 32 long. Spermathecal cervix 20 long funnel shaped with rounded atrium. Fixed digit of chelicera 28 long with two teeth and movable digit with a single tooth. Peritreme extending upto j_1 . Macroseta on leg IV: genu-18, tibia - 43, basitarsus - 34, all spatulated.

Leg chaetotaxy : genu II $2\frac{2}{0}\frac{2}{0}$ I tibia II $1\frac{2}{1}\frac{1}{1}$ 1;
genu III $1\frac{2}{0}\frac{2}{0}$ 1 tibia III $1\frac{1}{1}\frac{2}{1}$ 1.

Male: Unknown.

Habitat: *Achyranthes aspera* (L.)

Materials examined: Holotype ♀ marked on the slide, INDIA: KERALA: Pariyaram (Kannur district), 8.xii.2015. ex. *Achyranthes aspera* (L.), coll.Santhosh (No.P 793/1), one paratype slide with 2 ♀♀, collection details same as above (No. P 793/2).

Remarks: This new species closely resembles *Phytoseius macropilis* (Banks), 1909 in most of the setal measurements, general appearance etc., but differs from it in the following aspects.

1. In this new species the cervix of the spermatheca is funnel shaped with a narrow tubular anterior apex and a nodular atrium whereas in *P. macropilis*, the funnel shaped cervix has no tubular anterior extension.

2. Ventrianal shield vase shaped measuring 90 long and 80 wide in *P. macropilis*, whereas in the new species it is 113 long, 53 wide with slight concavity in lateral margins.
3. Fixed digit of chelicerae with 3 teeth in new species whereas in *P. macropilis*, only 2 teeth present.
4. Primary metapodal plate 35 long with tubular shape whereas in *P. macropilis*, it is 25 long with triangular shape.

***Phytoseius intermedius* Evans and Macfarlane, 1962**

PLATE 66

1962. *Phytoseius (Dubininellus) intermedius* Evans and Macfarlane, *Ann. Mag.Nat.His.*, **4**(13) : 587– 588.
1966. *Phytoseius (Dubininellus) intermedius*, Denmark, *Fla.Dep.Agri.Bull.*, **6**:70.
1970. *Phytoseius (Dubininellus) intermedius*, Gupta, *Sci. and Cult.*, **36** :98.
1972. *Phytoseius (Phytoseius) intermedius* Ehara, *Mushi*, **46**(12) 137– 173.
1974. *Phytoseius intermedius*, Prasad, *A catalogue of mites of India*, p.171.
1977. *Phytoseius (Dubininellus) intermedius*, Gupta, *Oriental Ins.*, **11**: 636– 637.
1982. *Phytoseius (Dubininellus) intermedius*, Gupta, *Indian J.Acarol.*, **6**:31.
1985. *Phytoseius intermedius*, Rather, *Acarologia*, **26** (1): 13– 16.
1986. *Phytoseius intermedius*, Gupta, *Zool. Surv. India*, Calcutta, India, p.350.
1989. *Phytoseius intermedius*, Moraes *et al.*, *Internat. J. Acarol.*, **15**(2):79– 93
1990. *Phytoseius intermedius*, Sadana *et al.*, *Acarol. Newsl.*, **17**/18:16.

1992. *Phytoseius intermedius*, Ueckerman, *Phytophylactia*, **24**: 145– 155.
1992. *Phytoseius intermedius*, Gupta, *Zool. Surv. India, Culcutta, India*, p. 61– 211
2001. *Phytoseius intermedius*, Chinniah and Mohanasundaram, *Zooprint J.*, **16** (7): 523– 531.
2002. *Phytoseius intermedius*, Kreiter *et al.*, *Acarologia*, **42**(4) :335– 350.
2004. *Phytoseius intermedius*, Moraes *et al.*, *Zootaxa*, **434**: 1– 494.
2005. *Phytoseius intermedius*, Zannou *et al.*, *Internat. J. Acarol.*, **31** (2):149– 164.
2007. *Phytoseius intermedius*, Chant and McMurtry, *Indira Publishing House, Westbloomfield , USA*, p.219.
2008. *Phytoseius intermedius*, Demite *et al.*, *Zootaxa*, **1909**: 16– 26.
2010. *Phytoseius intermedius*, Daud *et al.*, *Revisita de Biologia Neotropical*, **7**(2):49– 60.
2011. *Phytoseius intermedius*, Rezende and Lofego, *Acarologia*, **51** (4)449– 463.
2013. *Phytoseius intermedius*, Demite *et al.*, *Systematic and Biodiversity*, **11**(2): 141– 148.
2013. *Phytoseius intermedius* , Silva *et al.*, *Zootaxa*, **3681** (5): 595– 599.

Female: Dorsal shield entirely sclerotized, 275 long and 175 wide with 15 pairs of setae. Setae j_1 , j_3 , r_3 , z_2 , z_4 serrate. s_4 , s_6 , Z_4 , Z_5 , long and serrate. All other setae minute. Measurement of setae: j_1 – 16, j_3 – 18, j_4 – 4, j_5 – 5, j_6 – 5, J_5 – 5, s_4 – 50, z_2 – 12, z_3 – 12, z_4 – 25, Z_4 – 56, Z_5 – 54, r_3 – 25. Sternal shield 68 long, 60 wide with 3 pairs of sternal setae, ST_1 , ST_2 , ST_3 and ST_4 – 5 each.

Genital shield 55 wide, ST₅ measuring 5 long. Ventrianal shield 75 long, 42 wide with 3 pairs of preanal setae, preanal pores absent. JV₁, ZV₁, ZV₂ and JV₂ all measuring 5 in length, JV₅ – 18 long, smooth. Spermatheca with cork shaped cervix. Peritreme extending upto the level of j₁. Fixed digit of chelicera 17 long, with 5 teeth. Movable digit 16 long with 3 teeth. Leg IV without macrosetae.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{1}{1} \frac{2}{1} 1$;
genu III $1 \frac{2}{0} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown

Habitat: *Solanum virginianum* L., *Averrhoa bilimbi* L.

Known Habitat: Brinjal, *Hibiscus esculentus*, *Solanum melongena*, *S.tuberosum*. *Aloe* sp.,

Material Examined: Female marked on the slide, INDIA: KERALA: Herbal garden, Malabar Christian College Campus, (Kozhikode district), 18.v.2015, ex. *Solanum virginianum* L., coll. Santhosh (No.F 18/1). Four ♀♀ marked on the side, collection details same as above (No.F 18/2, 18/3), one ♀ from Ashokapuram (Kozhikode district), 7.xi.2015, ex. *Averrhoa bilimbi* (L.), coll.Santhosh (No.F 18/4, 18/5).

Distribution: INDIA: Kerala, West Bengal, Andaman Island, Delhi, Punjab, Himachal Pradesh, Uttar Pradesh. OUTSIDE INDIA: Benin, Brazil, Japan, Kenya, Madagascar Island, Malawi, Pakistan, Philippines, Reunion Island, Rwanda, Zimbabwe.

Remarks: The species studied closely resembles *P. intermedius* in setal measurements, general appearance etc. and hence fixed so. *Solanum violaceum* (Ortega) and *Averrhoa bilimbi* (L) were noted as the new host plants.

***Phytoseius macropilis* (Banks), 1909**

PLATE 67

1909. *Seius macropilis* Banks, *Proc.ent.Soc.Wash.* **11**:35.
1951. *Phytoseius spoofi* Nesbitt, *Zoologische Verhandelingen*, **12**: 64
1953. *Phytoseius macropilis*, Cunliffe and Baker, *Pinellas Biol., Lab. Pub.*, **1**:22.
1954. *Phytoseius spoofi*, Nesbitt, *Natuurhistorisch Maandblad*, **43**: 19– 24.
1957. *Phytoseius spoofi*, Chant, *Can. Entomol.*, **89**(8) 357– 363.
1959. *Phytoseius spoofi*, Chant, *Can. Entomol.*, **61** (12): 1– 166
1960. *Phytoseius*, Narayanan *et al.*, *Proc. Nat. Inst.Sci.*, **26 B** (6): 386– 387.
1960. *Phytoseius spoofi*, Chant and Athias – Henriot, *Entomophaga*, **5**: 213– 228
1964. *Phytoseius macropilis*, Ghai, In. *Entomology in India*, P. 390.
1966. *Phytoseius macropilis*, Ehara, *Mushi*, **39**: 9– 30.
1970. *Phytoseius (Dubininellus) woodburyi* Gupta, *Sci. and Cult.*, **36**: 98 (misidentification).
1974. *Phytoseius (Dubininellus) macropilis*, Prasad, A catalogue of mites of India, p.171.
1977. *Phytoseius (Dubininellus) macropilis*, Gupta, *Indian J. Acarol.*, **1**:9
1978. *Phytoseius (Dubininellus) macropilis*, Chant, *Can. J. Zoology*, **56**: 1330– 1347.

1986. *Phytoseius macropilis*, Gupta, *Zool. Surv. India*, Calcutta, India. p.350
1988. *Phytoseius macropilis*, Gupta, *Prog. Acarol.*, **1**: 403– 410.
1995. *Phytoseius macropilis*, Yoshida– shaul and Chant, *Acarologia*, **36** (1): 3– 19.
2001. *Phytoseius macropilis*, Bolland, *Internat. J.Acarol.* **27** (3): 225– 227.
2003. *Phytoseius macropilis*, Gupta, *Memoirs, Zool. Surv. India*, **20** (1): 1– 185.
2004. *Phytoseius macropilis*, Moraes *et al.*, *Zootaxa*, **434**: 1– 494.
2007. *Phytoseius macropilis*, Faraji *et al.*, *Internat. J. Acarol.*, **33**(3): 231– 239.
2011. *Phytoseius macropilis*, Denmark and Evans, *Indira Publishing House, Westbloomfield, USA*, p.451.
2012. *Phytoseius macropilis*, Prasad, *Indira Publishing House, Westbloomfield, USA*, p.1063.
2013. *Phytoseius macropilis*, Taxier, *Zootaxa*, **3721** (2): 101– 142
2015. *Phytoseius macropilis*, Hajizadeb and Mortazavi, *Internat. J. Acarol.*, **41** (1): 53– 66.

Female: Dorsal shield 303 long, 202 wide with 15 pairs of setae. Setae j_1 , j_3 , r_3 , s_4 , s_6 , Z_4 , Z_5 , long and serrate. Measurement of setae: j_1 – 30, j_3 – 45, j_4 , j_5 and j_6 –6 each, J_2 –5, J_5 – 5, z_2 – 12, z_4 – 30, s_4 – 108, Z_5 – 88, z_5 – 5, Z_4 – 75, r_3 – 40. Sternal shield 63 long and 55 wide with 3 pairs of sternal setae, ST_1 – 13, ST_2 , ST_3 – 10 each. ST_4 – 12 long. Genital shield 60 wide and with ST_5 measuring 15 long. A fold present between genital and ventrianal plate. Ventrianal shield 88 long, 50 wide with 3 pairs of preanal setae, preanal pores present. JV_1 , ZV_2 and JV_2 – 6 each, ZV_1 – 5 long. JV_5 – 30 long,

smooth. Spermatheca with funnel shaped cervix, 22 long. Peritreme extends anteriorly upto j_1 . Fixed digit of chelicera 28 long with 2 teeth; movable digit 27 long with 1 tooth. Macroseta on leg IV: Genu – 25, tibia – 56, basitarsus – 40.

Leg chaetotaxy: genu II $2 \frac{2}{0} \frac{2}{0} 1$ tibia II $1 \frac{2}{1} \frac{1}{1} 1$;
 genu III $1 \frac{2}{0} \frac{2}{0} 1$ tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Dorsal chaetotaxy similar to that of female. Sternogenital shield 139 long and 75 wide. Ventrianal shield 83 long and 100 wide and spermatophoral processes as figured, measuring 55 long.

Habitat: *Vitis vinifera* L.

Known Habitat: *Shorea robusta*, *Lantana camara*, *Polygonum molle*, wood-apple

Material examined: Female marked on the slide, INDIA: KERALA, Pariyaram (Kannur district), and 18.xii.2015. ex. *Vitis vinifera* L., coll. Santhosh (No.V 795/1). Three ♀♀ marked on the slide, with collection details same as above, (No. V 795/2, 795/1, 795/2).

Distribution: INDIA: Kerala, West Bengal, Orissa, Utter Pradesh, New Delhi, Arunachal Pradesh, OUTSIDE INDIA: USA, Hawaii, Mexico, Australia, Canary Island, Canadian Provinces, France, Belgium, Finland, Germany, Greece, Hungary, Italy, Netherland, Poland, Norway, Russia, Spain, Portugal.

Remarks: This species closely resembles *P. macropilis* (Banks), 1909 in setal measurements, structure of spermatheca and general appearance and hence fixed so. *Vitis vinifera* (L.) is a new host plant from which the species recovered.

Phytoseius prakasani* sp.nov.*PLATE 68**

Female: Dorsal shield 228 long, 175 wide, striated anteriolaterally. $j_1 - 18$, $j_3 - 30$, $j_4 - 4$, $j_5 - 5$, $j_6 - 5$, $J_5 - 6$, $z_2 - 8$, $z_3 - 12$, $z_4 - 14$, $z_5 - 12$, $Z_4 - 65$, $Z_5 - 61$, $s_4 - 62$, $s_6 - 66$, $r_3 - 13$. Setae j_1 , j_3 , z_3 and r_3 barbed. Setae s_4 , s_6 , Z_4 very thick, Z_5 thick and barbed. Sternal shield measuring 68 long and 50 wide with 3 pairs of sternal setae, ST_1 , ST_2 , ST_3 and ST_4 all measuring 8 long. Genital shield smooth 75 wide, $ST_5 - 6$ long, Ventrianal shield pitcher shaped 80 long, 65 broad, with three pairs of prenal setae JV_1 , ZV_2 and JV_2 measuring 6, 5 and 4 respectively, ZV_1 and $ZV_3 - 5$ long, $JV_5 - 18$ long. Ventrianal setae smooth. Metapodal plates not visible. Peritreme extend up to the level of j_3 . Cervix of spermatheca bell shaped, 15 long. Fixed digit of chelicera 19 long with 3 sharp teeth, movable digit 17 long with one sharp tooth. Macroseta on leg IV: genu - 20, tibia - 30 and basitarsus - 31.

Leg chaetotaxy: genu II $2\frac{2}{0} \frac{2}{0} 1$ tibia II $1\frac{1}{1} \frac{2}{1} 1$;
genu III $1\frac{2}{0} \frac{2}{0} 1$ tibia III $1\frac{1}{1} \frac{2}{0} 1$.

Male: Unknown.

Habitat: *Averrhoa bilimbi* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Herbal Garden, Malabar Christian College, Calicut (Kozhikode District), ex. *Averrhoa bilimbi* L., coll. Santhosh (No.P.144/3), 3 paratype slides with 3 ♀♀, collection details same as holotype (No.P 144/1, 144/2, 144/5).

Remarks: This species resembles *Phytoseius wainsteini* Gupta, 1981 but can be clearly differentiated by the following characters:

1. In the new species, dorsal shield 228 long, 175 wide, smooth, striated only on lateral margin whereas in *P. wainsteini*, it is rugose, 270 long and 147 wide.
2. In the new species, spermathecal cervix is short vesicular with an undifferentiated atrium instead of long vesicular cervix with a well defined atrium.
3. Macrosetae on Leg IV: genu 15 (rarely distinguishable from other setae), tibia 67, basitarsus – 32 long in *P. wainsteini* whereas in new species, genu – 20 (distinguishable from other setae), tibia – 30 and basitarsus – 31.
4. Length of s_4 – 124 and JV_5 – 56 in *P. wainsteini* whereas in new species it is 62 and 18 respectively.
5. In the new species peritreme extend upto j_3 , whereas in *P. wainsteini*, it extend up to j_1 .

***Phytoseius rachelae* Swirski and Shechter, 1961**

PLATE 69

1961. *Phytoseius (Dubininellus) rachelae* Swirski and Shechter, *Israel J. agric.Res.*, **11**:108– 109.
1966. *Phytoseius (Phytoseius) rachelae*, Ehara, *Mushi*, **39**: 9– 30.
1966. *Phytoseius (Dubininellus) rachelae*, Denmark, *Dept. Agric. Bull.*, **6**:1– 105.
1966. *Phytoseius (Phytoseius) rachelae*, Amita and Swirski, *Israel J. Agric.Res.* **16**:19– 24.

1971. *Phytoseius (Phytoseius) rachelae*, Ehara and Lee, *Journal of the Faculty Education*, Tottori University, Natural Science, **22** (2):61– 78
1980. *Phytoseius (Dubininellus) rachelae*, Gupta, *Bull.Zool.Surv. India*, **3** (1– 2):52.
1985. *Phytoseius (Phytoseius) rachelae*, Gupta, *Zool. Surv. India, Hand. Ser.*, **5**:1– 250
1992. *Phytoseius (Phytoseius) rachelae*, Gupta, *Zool.Surv.India*, Calcutta, India: p. 61– 211.
2002. *Phytoseius rachelae*, Ehara, *Acta Arachnologica*, **51** (2): 125– 133.
2003. *Phytoseius rachelae*, Gupta, *Memoirs, Zool.Surv.India*, **20** (1): 155.
2004. *Phytoseius rachelae*, Moraes *et al.*, *Zootaxa*, **434**: 1– 494.
2005. *Phytoseius rachelae*, Ehara, *Acta Arachnologica*, **54** (1): 31– 39.
2007. *Phytoseius rachelae*, Chant and McMurtry, *Indira Publishing House, Westbloomfield , USA*, p.219.
2009. *Phytoseius rachelae*, Wu *et al.*, *Science Press*, Beijing, China, p.511.
2010. *Phytoseius rachelae*, Wu *et al.*, *Progress in Chinese Acarology, Zoosymposia*, **4**: 288– 315.
2012. *Phytoseius rachelae*, Prasad, *Indira Publishing House, Westbloomfield, USA*, p.1063.

Female: Dorsal shield anteriorly sclerotized, 205 long, 103 wide with 15 pairs of setae. Setae j_1 , j_3 , r_3 , s_4 , s_6 , Z_4 , Z_5 , long and serrate. Measurement of setae: $j_1 - 20$, $j_3 - 37$, $j_4 - 6$, $j_5 - 6$, $j_6 - 6$, $J_2 - 6$, $J_5 - 5$, $S_4 - 63$, $z_2 - 10$, $z_4 - 20$, $s_4 - 63$, $Z_5 - 50$, $z_5 - 5$, $Z_4 - 50$, $r_3 - 25$, and $R_1 - 17$ present on lateral integument. Sternal shield 55 long, 45 wide with 3 pairs of sternal setae, ST_1

– 25, ST₂ – 18, ST₃ – 18, ST₄ – 19 long. Genital shield 55 long and 45 wide, ST₅ measuring 15 long. A fold present between genital and ventrianal shield. Ventrianal shield 63 long, 38 wide with 3 pairs of preanal setae, preanal pores absent. JV₁, ZV₂ and JV₂ – 5 long, ZV₁ – 4 and JV₅ – 33 long, smooth. Spermatheca with funnel shaped cervix 15 long. Peritreme extends anteriorly upto j₁. Fixed digit of chelicera 28 long with 2 teeth, movable digit 26 long with a single tooth. Macrosetae on leg IV: genu – 11, tibia – 30, basitarsus – 26.

Leg chaetotaxy: genu II $2\frac{2}{0}\frac{2}{0}1$ tibia II $1\frac{1}{1}\frac{2}{1}1$;
genu III $1\frac{2}{0}\frac{2}{0}1$ tibia III $1\frac{1}{1}\frac{2}{0}1$.

Male: Ventrianal shield 75 long and 130 wide, sternogenital shield 125 long and 70 wide, spermatophoral process as figured.

Habitat: *Solanum virginianum* L.

Known Habitat: *Hibiscus* sp., *Rhus chinensis*.

Material examined: Female marked on the slide, INDIA: KERALA: Ashokapuram (Kozhikode district), 19.v.2015. ex. *Solanum virginianum* L., coll.Santhosh (No.K 32/1). 4 ♀♀, collection details same as above (No. K 32/2, 33/1, 33/2, 34/1).

Distribution: INDIA: Kerala, West Bengal. OUTSIDE INDIA: Hong Kong, Indonesia.

Remarks: This species closely resembles *P.rachelae* Swirski and Shechter, 1961 in size, structure of spermatheca, setal measurements and general

appearance etc. and hence fixed so. *Solanum virginianum* L. is a new habitat from which the species were recovered.

Subfamily TYPHLODROMINAE Wainstein, 1962.

1958. *Typhlodromus* Scheuten, Evans, *J. Linnean Soc. Zool.*, **43**: 223.
1957. *Typhlodromus* (*Typhlodromus*) Scheuten Chant, *Canadian. Entomol.*, **89** (11): 531.
1962. Typhlodromini Wainstein, *Acarol.* **4**:26.
1973. Gigagnathinae Wainstein, *Zool. Zh.* **52**: 276.
1983. Gigagnathini, Karg, *Mitt. Zool.Mus. Berlin*, **59**(2):299.
1986. Cydnodromellinae Chant and Yoshida – Shaul, *Can. J. Zool.*, **64**(12): 2812.
1994. Typhlodrominae Wainstein, Chant and McMurtry. *Internat. J. Acarol.*, **20**(4):285.
2007. Typhlodrominae Wainstein, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.131.

Diagnosis: The subfamily Typhlodrominae is diagnosed with the presence of either or both of setae z_3 and s_6 on the podonotum and with at least one of setae Z_1 , S_2 , S_4 and S_5 on the opisthonotum.

Type **Genus:** *Typhlodromus* Scheuten, 1857

Tribe: Typhlodromini Wainstein, 1962

1953. *Typhlodromus* Scheuten, Evans, *Ann. Mag. Nat. Hist.*, **6**: 449.
1957. *Typhlodromus* (*Typhlodromus*), Chant, *Canadian Entomol.*, **89**(11): 528.
1962. Typhlodromini Wainstein, *Acarologia.*, **4**:26.

2007. Typhlodromini Wainsten, Chant and McMurtry, In: *Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*, p.144.

Type **Genus:** *Typhlodromus* Scheuten, 1857.

***Typhlodromus (Anthoseius) bambusicolus* Gupta, 1977**

PIATE 70

1977. *Typhlodromus bambusicolus* Gupta, *Indian J. Acarol.*, **2**: 2 – 4.
1983. *Typhlodromus (Typhlodromus) bambusicolus*, Tseng, *Chin. J. Entomol.*, **3**: 33– 47.
1985. *Typhlodromus (Amblydromella) bambusicolus*, Gupta, *Zool.Surv. India, Handbook Series, Calcutta*, **5**: 1– 520
1986. *Typhlodromus (Amblydromella) bambusicolus*, Gupta, *Fauna of India: Phytoseiidae*, p.267 –268.
1986. *Typhlodromus bambusicolus*, Moraes *et al.*, *EMBRAPA– DDT, Brasilia, Brazil*, p.353
1987. *Typhlodromus (Amblydromella) bambusicolus*, Gupta, *Rec. Zool. Surv. India, Occ. Pap.*, **95**:103.
- 1997 *Typhlodromus (Amblydromella) bambusicolus*, Gupta, In: *State Fauna Ser. 7, Fauna of Tripura Part 2*, p.28.
2002. *Typhlodromus bambusicolus*, Denmark and Welboun, *Internat. J. Acarol.*, **28**(4):291– 316
2003. *Typhlodromus (Amblydromella) bambusicolus*, Gupta, In: *A monograph on plant inhabiting predatory mites of India. Part II: Order: Mesostigmata. Memoirs*, **20** (1): 118.
2004. *Typhlodromus bambusicolus*, Moraes *et al.*, *Zootaxa*, **434**: 1– 494.

2007. *Typhlodromus (Anthoseius) bambusicolus*, Chant and McMurtry. *Illust. Keys and Diag. for the Genera and Subgenera of the Phytoseiidae of the World (Acari: Mesostigmata)*. p. 152.
2011. *Typhlodromus bambusicolus*, Sadanandan, *J. Ecobiology.*, **28**(2): 147–151.
2012. *Typhlodromus bambusicolus*, Prasad, *Indira Publishing House, Westbloomfield, USA, p.1063*.
2012. *Typhlodromus bambusicolus*, Hernandez *et al.*, *Zootaxa*, **3451**: 46– 59

Female: Dorsal shield reticulated with 207 long, 144 wide. Measurement of setae: j_1-12 , j_4-10 , j_5-9 , j_6-10 , j_2-10 , j_5-12 , j_3-16 , z_2-14 , z_3-12 , z_4-18 , S_2-18 , S_4-22 , S_5-12 , Z_5-37 serrated, z_5-12 , Z_4-25 , r_3 , R_1-12 long. Sternal shield 55 long, 50 wide with sternal setae ST_1 , ST_2 , ST_3 and ST_4-14 each. Genital shield 50 wide with ST_5-13 long. Ventrianal shield 65 long, 50 wide with a pair of pores. Four pairs of preanal setae JV_1-8 , JV_2-6 , ZV_2-8 , and JV_3-8 . Setae around ventrianal shield ZV_1 , ZV_3 , JV_4-8 each, JV_5-27 long and smooth. A pair of metapodal plate, primary one 12 long and 5 wide accessory one very small. Spermatheca with bell shaped cervix, 12 long. Peritreme extending beyond j_1 and curved inwards. Fixed digit of chelicera 23 long bears 3 teeth anterior to *pilus dentilis* and none posterior to it, movable digit with 3 teeth. Macroseta on leg IV: genu–7, tibia –11, baritarsus – 21, all spatulated.

Leg chaetotaxy:

genu II	$2 \frac{2}{0} \frac{2}{0} 1$	tibia II	$1 \frac{2}{1} \frac{1}{1} 1$
genu III	$1 \frac{2}{0} \frac{2}{1} 1$	tibia III	$1 \frac{2}{1} \frac{1}{1} 1$

Male: Unknown.

Habitat: *Solanum virginianum* L.

Known habitat: Bamboo, citrus

Material Examined: Female marked on the slide. INDIA: KERALA: Herbal garden, Malabar Christian College (Kozhikode district), 18.v.2015, ex. *Solanum virginianum* L. coll. Santhosh (No.T 27/1). Four ♀♀ marked on the side, collection details same as above (No.F 27/2, 27/3, 27/4, 27/6).

Distribution: INDIA: Kerala, Assam, Tripura.

Remarks: This species resembles closely to *T. (A.) bambusicolus*, Gupta1977 in general appearance, dorsal chaetotaxy, spermathecal shape etc. and hence fixed so. *Solanum virginianum* L. is a new habitat from which the species were recovered.

6.2 SUBORDER: PROSTIGMATA

Superfamily: BDELLOIDEA Duges, 1834

Diagnosis: The superfamily Bdelloidea characterized by soft bodied to hard bodied mites, sometimes with sclerotized plates, chelicerae separated and hinged at base, moving laterally or scissors like over snout or cone like gnathosoma, movable cheliceral digit is small. Rostrum and hypostome elongate, palpi simple or modified for grasping prey, propodosoma with 2 pairs of sensillae, eyes present or absent. True claws with empodia present. Several erect sensory setae on tarsus and tibia. Trichoboth on tibia IV, genital area with 2, 3 or 0 pairs of discs present.

6.2.1 Family BDELLIDAE Duges, 1834

1834. Bdellei Duges, *Ann. Sci. Naturelles*. **1** (2) (Zool.): 21.
1907. Bdellidae Banks, *Proc. Nat. Mus.*, **32**: 595 – 625.
1959. Bdellidae: Meyer and Ryke, *Ann. Mag. nat. Hist.*, **2** (13): 372.
1960. Bdellidae: Atyeo, *Univ. Kansas Sci. Bull.*, **40** (8): 370.
1963. Bdellidae: Atyeo, *Bull. Univ. Nebraska St. Mus.*, **4** (8): 120.
1976. Bdellidae: Wallace and Mahon, *Acarologia*, **18** (1): 65.
1977. Bdellidae: Atyeo, *Ann. Mus. Roy. Afr. Centr.*, **8**: 300–305.
1978. Bdellidae: Tseng, *J. Agric. Asso., China*, **104**: 25 – 51.
1979. Bdellidae: Chaudhri *et al.*, *Univ. Agr. Faisalabad*, p.127.
1980. Bdellidae: Gupta and Ghosh, *Rec. Zoo. Surv. India*, **77**: 201.
1985. Bdellidae: Gupta, *Handbook. Plant Mites of India*, p.311.
1987. Bdellidae: Swift and Goff, *Internat. J. Acarol.*, **13** (1): 29.
1991. Bdellidae: Gupta, *Rec. Zool. Surv. India*, **88** (2): 219.
2010. Bdellidae: Lin and Zhang, *Zoosymposia*, **4**: 42 – 50.
2013. Bdellidae: Hernandez, *Internat. J. Acarol.*, **39** (1): 58 – 66.
2016. Bdellidae: Hernandez *et al.*, *Zootaxa*, **4152** (1): 1 – 83

Diagnosis: Medium to large sized mites (approximately 0.5 to 3.5 mm.) with finely striated integument (*Trachymolgus* armored); subcutaneous shields may be present on the propodosoma; cone like gnathosoma formed by elongated, chelate chelicerae bearing one or more setae, and a ventral hypostome bearing 2, 6 or 7 pairs of conspicuous ventrolateral setae and 2 pairs of minute setae inserted on the lateral lips; geniculate palpi 5

segmented, trochanter and genu short, femur divided distally into a short telofemur and a long basifemur; tibiotarsus of various lengths and bears apically 2 long setae (one in *Monotrichobdella*) ; trachea opens near the cheliceral bases; idiosoma divided dorsally into propodosoma and hysterosoma; 4 dorsal sensilla inserted in pseudostigmatic organs; 2, 4 or 5 eyes present; legs 8 segmented (including short pretarsus) with 2 claws and a padlike, rayed puvillus; maximally 5 pairs of trichobothria; well developed genital tracheae may be present; 3 pairs of genital suckers; anal cleft terminal; sexes similar.

Type: *Bdella* Linnaenus, 1758

6.2.1.1 Morphology and terminology (Plate: 72 A, B)

The body is divided into 2 distinct regions, the gnathosoma and idiosoma. Idiosoma distinguished into propodosoma and hysterosoma. The anterior gnathosoma consists of 2 elongate, chelate chelicerae, a ventral hypostome and 2 geniculate palpi. The chelicerae and hypostome forms a cone like structure projecting from the palpal bases. The propodosoma bears the 2 anterior pairs of legs, eyes and pseudostigmatic organs, this region delimited dorsoposteriorly by a conspicuous constriction. The hysterosoma bears the posterior legs, anus and genitalia. Leg consists of 8 segments; Coxae, trochanter, basifemora, telofemora, genu, tibia, pretarsus and tarsus. All leg segments with variable number of tactile and sensory setae. In addition to these, long sensory setae in deep socket (trichobothria) or hollow chemosensory setae (solinidia) present. Genu I – IV with decreasing number of attenuate sensory setae.

The setal nomenclature used this study follows Kethley (1990) except for propodosomal setae, which follows the notation given by Fischer *et al.* 2011.

<i>at</i>	–	Anterior trichobothria
<i>pt</i>	–	Posterior trichobothria
<i>lps</i>	–	Lateral propodosomal setae
<i>mps</i>	–	Median propodosomal setae
<i>c1</i>	–	Internal humeral
<i>c2</i>	–	External humeral
<i>d1</i>	–	Internal dorsal
<i>e1</i>	–	External lumbral
<i>f1</i>	–	Internal sacral
<i>f2</i>	–	External sacral
<i>h1</i>	–	Internal clunal
<i>h2</i>	–	External clunal
<i>ps</i>	–	Postanal
<i>Vh</i>	–	Ventral hypostomal setae
<i>VES</i>	–	Ventral end setae
<i>DES</i>	–	Dorsal end setae
<i>t</i>	–	Tactile setae

Subfamily 1. BDELLINAE Grandjean, 1938

1938. BdeUllinae Grandjean, *Ann. Soc. Ent. France*, **107**: 1 – 24.

1959. BdeUllinae, Meyer and Ryke, *Ann.Mag. Nat.His.*, **13** (2) : 373.

1960. BdeUllinae, Atyeo, *Univ. Kan. Sci. Bull.*, **40**: 371.

1963. BdeUllinae, Atyeo, *Bull. Univ. Nebraska St. Mus.*, **4** (8): 120.

1972. Bdellinae, Wallace and Mahon, *Acarologia*, **14** (4):544 – 580.

1987. Bdellinae, Michocka, *Monografie Fauny Polski*, **14**: 21

1904. Bdellinae, Tragardh, *Fauna Arctica*, **41**: 45.

1991. Bdellinae, Gupta, *Rec. Zool. Surv. India*, **88** (2): 220.

Diagnosis: Six pairs of ventral hysterosomal setae, 4 pairs of trichoboth, undeveloped genital tracheae and expanded palpal tibiotarsus.

Type: *Acarus longicornis* Linnaeus, 1758

Key to the subfamilies and genera of the family Bdellidae

1. Venter of hypostome with 6 or 7 pairs of strong setae and 2 pairs of small adoral setae ,without well developed genital trachea..... 2
 - Venter of hypostome with 2 pairs of strong and 2 pairs of small adoral setae with well developed genital trachea.....Subfamily: Cytinae*
- * Median eye present between anterior sensilla.....**Genus:** *Cyta*
2. Trichoboth absent on tibia II, palpal tibiotarsus expanded distally
 -subfamily: Bdellinae*
- * Palp tibiotarsus truncate, shorter than palpal basifemur.... **Genus:** *Bdella*
 - Trichoboth present on tibia II, palp tibiotarsus cylindrical or elongated
 -subfamily: Odontoscirinae

Genus: *Bdella* Latreille, 1795

1795. *Bdella* Latreille, *J. des Lettres et des Arts*, Paris, **4**: 18.

1804. *Scirus (Ciron)* Hemmiann, *Memoire apterologique*. Strasbourg, p. 60.

1893. *Bdella*, Berlese, *Acari, Myriapoda et Scorpiones hucusque in Italia reperta. Ordo Prostigmata (Trombidiidae)*. Padova, p.42.

1929. *Bdellidium* Oudemans, *Ent. Ber. Nederl. Ver.*, **7**: 449
1937. *Caenobdella* Oudemans, *Kritisch Historisch Overzicht der Acarologie*, Leiden, **3**: p. 1227.
1959. *Bdella*, Meyer and Ryke, *Ann. Mag. Nat. His.*, **13**(2) : 373.
1960. *Bdella*, Atyeo, *Univ. Kan. Sci. Bull.*, **40**: 372.
1963. *Bdella*, Atyeo, *Bull. Univ. Nebraska St. Mus.*, **4** (8):120.
1975. *Bdella*, Soliman and Zaher, *Bull. Soc. Roy. Entomol.*, **59**: 73 – 82
1979. *Bdella*, Chaudhri *et al.*, *Studies on the Predatory Leaf inhabiting mites of Pakistan, Uni. Agr. Faisalabad*. p. 130.
1987. *Bdella*, Swift and Goff, *Internat. J. Acarol.*, **13** (1):29.
1991. *Bdella*, Gupta, *Rec. Zool. Surv. India*, **88**: 220.
1992. *Bdella*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p.119
2002. *Bdella*, Gupta, *Memoirs, Zool Surv. India*, **19** (2), 25 – 38.
2005. *Bdella*, van Der Schyff *et al.*, *African Entomol.*, **13** (2): 221 – 238.

Diagnosis: Palpal tibiotarsus is truncate and considerably shorter than the palpal basifemur, the subequal end setae are as long as or longer than the palpal femur. Normal or inflated chelicerae bear 2 setae found on the proximal three fourth of their lengths, and the small chelae have sickle shaped movable digits, may have one small tooth. The dorsal propodosoma with 4 pairs of eyes lateral to the unmodified posterior pseudostigmatic organs.

Type: *Acarus longicornis* Linnaeus, 1758

Key to the species of the genus *Bdella* included in the present study.

1. Hysterosoma with 7 pairs of setae *Bdella vincenti* sp.nov.
 - Hysterosoma with more than 7 pairs of setae 2
2. Ratio of VES/DES is 1.14 *Bdella aniyammae* sp.nov.
 - Ratio of VES/DES is 1.36 *Bdella khasyana* Gupta

***Bdella aniyammae* sp.nov.**

PLATE 73

Female: Body 648 long, 404 wide; hypostome 126 long, 76 wide; *VES* – 129 and *DES* – 113 long. Leg I – 354, leg II – 354, leg III – 379 and leg IV – 455. Palp segments: trochanter – 25, basifemur – 88, telofemur – 25, genu – 22 and tibiotarsus – 43 long.

Palpal Chaetotaxy: Palpi 5 segmented and transversely striated, small, simple setae, trochanter none, basifemur 7t – 4 small simple dorsal setae, 3 small ventral setae, telofemur 1t – 1 small simple seta, genu 4t – 2 simple ventral setae and 2 dorsal simple setae, dorsal and ventral setae equal in size, tibiotarsus with *VES*, *DES* and 4t – 2 long lateral setae and 2 dorsomedian setae.

Gnathosoma: Two pairs of large ventral hypostomal setae (*vh1* and *vh2*), proximal pair 22 long and distal pair 20 long; 2 pairs of short adoral setae near the tip of gnathosoma, and 3 pairs in between *Vh1* and *Vh2*.

Chelicerae: 151 long, smooth with broad base having a single proximal setae and a distal setae. Teeth are absent.

Dorsum: Prodorsum longitudinally striated on the base of gnathosoma, obliquely striated on lateral region, transversely striated on central region and continuous striae present all over the dorsum. Two pairs of eyes on lateral region of prodorsum, separated by a distance 11 and each eyes encircled with concentric rings of striae. Diameter of both anterior and posterior eye is 18. Hysterosomal setae serrated and forked on the tip. Prodorsal setae *lps* – 37, *mps* – 40, *at* – 77, *pt* – 92. Hysterosomal setae; *c1* – 48, *c2* – 55, *d1* – 48, *e1* – 44, *f1* – 37, *f2* – 37, *h1* – 48, *h2* – 48.

Venter: Fine striations present on ventral side. Anterior side marked with central transversely dotted striations and posterior side with longitudinal and transverse striations. The striae on sternal region look rhombus appearance. Genital valves with 7 pairs of setae and other 9 pairs of setae present around it. The distal end of anal plate with 2 pairs of long and apically serrated setae.

Leg: Finely striated with no striation on basal segments. Setae on leg segments as follows: Coxae I – IV: 5 – 4 – 4 – 3, all setae tactile; trochanters I – IV: 1 – 1 – 1 – 1, all setae tactile. Basifemora I : 5 tactile setae; basifemora II : 6 tactile setae; basifemora III : 5 tactile setae plus 1 solinidion; basifemora IV : 4 tactile setae. Telofemora I – 5 tactile setae plus 1 solinidion; telofemora II – 5 tactile setae plus 1 solinidion; telofemora III : 4 tactile setae plus 2 solinidia; telofemora IV: 4 tactile setae plus 1 solinidion. Genu I – 5 tactile setae; genu II – 4 tactile setae plus 1 solinidion; genu III: 5 tactile setae plus 1 solinidion; genu IV: 3 tactile setae, 3 solinidia. Tibia I: 10 tactile setae plus 1 trichobothrium; tibia II: 8 tactile setae plus 1 trichobothrium; tibia III: 8 tactile setae plus 1 trichobothrium; tibia IV: 7 tactile plus 1 trichobothrium. Tarsus I: 18 tactile setae plus 2 solinidia; tarsus II: 10 tactile setae, 3 solinidia plus 2

sensory setae; tarsus III: 14 tactile setae, 1 solinidion; tarsus IV: 12 tactile setae, 2 solinidia plus 1 trichobothrium.

Male: Unknown

Habitat: *Helicteres isora* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kakkadampoyil (Kozhikode district), 18.xii.2015, ex. *Helicteres isora* L., coll. Santhosh, (No.W.903/1). Three paratype slides with 3 ♀♀ marked on the slide from the same habitat (No.K. 903/2, 903/3, 903/3).

Remarks: This new species closely resembles *Bdella maldahensis* Gupta, 1992 in general appearance but differs in the following features.

1. In the new species body 648 long and 404 wide whereas in *B.maldahensis*, it is 622 long and 306 wide.
2. In the new species palpal tibia with 5 setae, *DES* – 113, *VES* – 129 long whereas in *B. maldahensis*, tibia with 4 setae and *DES* – 45 long, *VES* – 100 long.
3. Dorsal propodosoma with 5 pairs of setae including setae ‘at’ and ‘pt’ in *B. maldahensis*, whereas in new species only 4 pairs of setae present.
4. In *B .maldahensis*, hysterosoma with 7 pairs of setae including humerals whereas in new species it is having 8 pairs setae.

***Bdella khasyana* Gupta, 1991.**

PLATE 74

1991. *Bdella* Gupta, *Rec. Zool. Surv. India*, **88** (2), 207 – 239

2002. *Bdella*, Gupta, *Memoirs, Zool. Surv. India*, **19** (2), 25 – 38.

Female: Body 770 long, 466 wide ; hypostome 151 long , 81 wide ; *VES* – 226, *DES* – 166 long. Leg I – 555, leg II – 574, leg III – 629 and leg IV – 685. Palp segments: trochanter – 12, basifemur – 113, telofemur – 26, genu – 25 and tibiotarsus – 50.

Palpal Chaetotaxy: Palpi 5 segmented with no striation, small, simple setae present; trochanter none, basifemur 7t – 3 small simple dorsal setae, 4 small ventral setae, telofemur 1t – 1 small simple seta, genu 4t – 2 simple ventral setae and 2 dorsal simple setae, dorsal and ventral setae equal in size, tibiotarsus with *VES*, *DES* and 3t – 2 long lateral setae and 1 dorsomedian seta.

Gnathosoma: 2 pairs of large ventral hypostomal setae (*Vh1* and *Vh2*), proximal pair 37 long and distal pair 37 long; 2 pairs of short adoral setae near the tip of gnathosoma, and 3 pair in between *Vh1* and *Vh2*.

Chelicerae: 177 long, smooth with broad base having a single proximal and a distal setae. Teeth are absent.

Dorsum: Prodorsum transversely striated on the base of gnathosoma, longitudinally striated on central region upto the base of propodosoma obliquely striated on lateral region and continuous striae present all over the dorsum. Two pairs of eyes on lateral region of prodorsum, separated by a distance 7 and each eyes encircled with concentric rings of striae. Diameter of anterior eye is 8 and posterior eye is 11. Hysterosomal setae serrated with brush like tip. Prodorsal setae; *lps* and *mps* – 55 each, *at* – 85, *pt* – 111. Hysterosomal setae; *c1* – 44, *h2* – 48, all other setae including *c2*, *dl*, *e1*, *fl*, *f2* and *h1* – 37 each.

Venter: Fine striations present on ventral side except leg segments. Anterior side marked with central transversely dotted striations and posterior side with longitudinal and transverse striations. Longitudinal striations on sternal region is kite like in appearance. Genital valves with 7 pairs of setae and other 9 pairs of setae present around it, the distal end of anal plate with 2 pair of long and apically serrated setae.

Leg: No striations present on legs. Setae on leg segments as follows: Coxae I – IV: 5 – 4 – 5 – 2, all setae tactile; trochanters I – IV: 1 – 1 – 1 – 1, all setae tactile. Basifemora I : 2 tactile setae; basifemora II: 7 tactile setae ; basifemora III : 6 tactile setae; basifemora IV : 1 tactile seta. Telfemora I: 5 tactile setae plus 1 solinidion; telfemora II : 4 tactile setae plus 1 solinidion; telfemora III: 3 tactile setae plus 2 solinidia; telfemora IV: 3 tactile setae plus 2 solinidia. Genu I : 5 tactile setae, 1 solinidion plus 1 sensory seta; genu II: 5 tactile setae plus 3 solinidia; genu III: 4 tactile setae plus 2 solinidia; genu IV: 3 tactile setae plus 3 solinidia. Tibia I: 12 tactile, 1 sensory plus 1 trichobothrium; tibia II : 8 tactile setae, 2 sensory plus 2 solinidia; tibia III : 5 tactile setae plus 3 solinidia; tibia IV : 6 tactile plus 1 trichobothrium. Tarsus I: 18 tactile setae plus 2 solinidia plus 1 sensory seta; tarsus II: 10 tactile setae plus 2 solinidia; tarsus III: 12 tactile setae plus 6 sensory setae; tarsus IV: 11 tactile setae, 2 sensory setae.

Male: Unknown

Habitat: *Argeria nervosa* (Burm.f.)

Known Habitat: *Litsea khasyana*

Material examined: Female marked on the slide INDIA: KERALA: Botanical garden, Calicut University (Malappuram district), 16.x.2015, ex.

Argeria nervosa (Burm.f.), coll. Santhosh, (No.T.742/1). 2 ♀♀ marked on the slide from the same habitat (No.T. 742/2, 742/3).

Distribution: *Arunachal Pradesh*

Remarks: The specimen examined agrees with *Bdella khasyana* Gupta, 1991 in almost all characters and hence fixed so. It is the new record from Kerala from a new habitat viz., *Argeria nervosa* (Burm.f.).

***Bdella vincenti* sp.nov.**

PLATE 75

Female: Body 888 long and 437 wide; hypostome 177 long, 86 wide; *VES* – 151, *DES* – 113 long. Leg I – 379, leg II – 392, leg III – 437 and leg IV – 518. Palp segments: trochanter – 8, basifemur – 76, telofemur – 25, genu – 20 and tibiotarsus – 50 long.

Palpal Chaetotaxy: Palpi 5 segmented and transversely striated except genu. Simple setae present, trochanter none; basifemur 7t – 4 small simple dorsal setae, 3 small ventral setae; telofemur 1t – 1 small simple seta; genu 4t – 2 simple ventral setae and 2 dorsal simple setae, dorasal and ventral setae equal in size; tibiotarsus 4t – 2 long lateral setae and 2 dorsomedian setae excluding *VES* and *DES*.

Gnathosoma: Two pairs of large ventral hypostomal setae (*Vh1* and *Vh2*), proximal pair 50 long and distal pair 30 long; 2 pairs of short adoral setae near the tip of gnathosoma, and 3 pairs above *Vh2*.

Chelicerae: 296 long, smooth with broad base having a single proximal and a distal setae. Fixed digit of chelicera smaller than movable one. Teeth are absent.

Dorsum: Prodorsum longitudinally striated on the base of gnathosoma, obliquely striated on lateral and central region, fine and continuous striae present all over the dorsum. Two pairs of eyes on lateral region of prodorsum, separated by a distance 17 and each eyes encircled with concentric rings of striae. Diameter of both anterior and posterior eye is 18. Hysterosomal setae serrated forked on the tip. Prodorsal setae *lps*, *mps* – 44 each, *at* – 88, *pt* – 92. Hysterosomal setae; *c1* and *c2* – 88, *d1* – 40, *e1* – 37, *f1* and *f2* – 37, *h1* – 44, *h2* – 55.

Venter: Fine striations present on ventral side. Anterior side marked with dotted striations and posterior side with longitudinal and transverse striations. Genital valve with 7 pairs of setae and other 9 pairs of setae present around it. The distal end of anal plate with 2 pairs of long and apically serrated setae.

Leg: Finely striated, setae on leg segments as follows: Coxae I – IV 5 – 4 – 5 – 2, all setae tactile; trochanters I – IV – 1 – 1 – 2 – 1, all setae tactile. Basifemora I – 7 tactile setae plus 1 solinidion; basifemora II – 7 tactile setae ; basifemora III – 5 tactile setae; basifemora IV – 5 tactile setae plus 1 solinidion; telofemora I – 5 tactile setae plus 1 solinidion; telofemora II – 5 tactile setae plus 1 solinidion; telofemora III – 5 tactile setae plus 1 solinidion; telofemora IV – 2 tactile setae plus 2 solinidia. Genu I – 4 tactile setae plus 2 solinidia; Genu II – 3 tactile setae plus 2 solinidia; genu III – 3 tactile setae plus 2 solinidia; genu IV – 1 tactile seta plus 3 solinidia. Tibia I – 10 tactile , 2 sensory setae, plus 1 solinidion; Tibia II – 9 tactile setae , 2 solinidia plus 2 sensory setae; tibia III – 6 tactile setae, 1 sensory seta plus 1 solinidion; tibia IV – 6 tactile plus 1 trichobothrium. Tarsus I – 16 tactile setae, 1 sensory seta plus 3 solinidia; tarsus II – 16 tactile setae, 3 solinidia

plus 2 sensory setae; tarsus III – 10 tactile setae, 1 solinidion; tarsus IV – 8 tactile plus 1 solinidion.

Male: Unknown

Habitat: *Benincasa hispida* (Thunb)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kadalundi (Kozhikode district), 03.xi.2015, ex. *Benincasa hispida*, coll. Santhosh, (No.D.606/1). Two paratype slides with 2 ♀♀ marked from the same habitat (No.K. 606/2, 606/3).

Remarks: This new species closely resembles *Bdella maldahensis* Gupta, 1992 in general appearance but differs in the following feature.

1. In the new species, body measuring 888 long and 437 wide, whereas in *B. maldahensis*, it is 622 long 306 wide.
2. Hysterosoma with 8 pairs of setae in the new species instead of 7.
3. In the new species, gnathosoma 202 long whereas in *B. maldahensis*, it is 183 long.
4. In the new species, tibiotarsus 50 long with *DES* – 113, *VES* – 151 whereas in *B. maldahensis*, it is 44 long with *DES* – 45, *VES* – 100.
5. Basifemur with 4 setae in the new species instead of 5 in *B. maldahensis*.
6. In new species, chelicerae 296 long whereas in *B. maldahensis*, it is 145 long.
7. Dorsal propodosoma with 5 pairs of setae in *B. maldahensis*, whereas in the new species only 4 pairs present.

8. In the new species, coxae I – IV: 5 – 4 – 5 – 2, tarsus I with 16 tactile setae , 1 sensory setae plus 1 solinidion whereas in *B .maldahensis*, coxae I – IV: 4 – 4 – 5 – 2, tarsus I with 18 tactile setae and 2 sensory setae.

Subfamily: Odontoscirinae Grandjean, 1938

1938. Odontoscirinae Grandjean, *Ann. Soc. Ent. France*, **107**: 1 – 24.
1959. Odontoscirinae, Meyer and Ryke, *Ann.Mag. Nat.His.*, **13**(2) : 378.
1960. Odontoscirinae, Atyeo, *Univ. Kan. Sci. Bull.*, **40**: 385.
1963. Odontoscirinae, Atyeo, *Bull. Univ. Nebraska St. Mus.*, **4** (8):122.
1976. Odontoscirinae, Wallace and Mahon, *Acarologia*, **18** (1): 65 – 123.
1987. Odontoscirinae, Michocka, *Monografie Fauny Polski*, **14**: 43.

Diagnosis: Odontoscirinae is characterized by 6 or 7 pairs of ventral hypostomal setae, 5 pairs of trichobothria, and the absence of genital tracheae. The palpal tibiotarsus is cylindrical and usually as long as or longer than the palpal basifemur. The end setae are equal or subequal and usually shorter than the palpal tibiotarsus. Normal to inflated chelicerae bear one to many setae inserted on the proximal three fourth. The chelae have the movable digits sickle shaped (straight in *Odontoscirus*). Lateral propodosomal setae may be present or absent; secondary apodemes are usually not developed, although large amounts of cuticular deposition may form large subcutaneous plates. The striations patterns on the dorsum of the propodosoma are similar in all genera; 4 eyes are lateral or posteriolateral to the modified or unmodified posterior pseudostigmata.

Type: *Bdella virgulata* C.and F, 1876

Key to the genera and species of subfamily Odontoscirinae included in the present study.

1. Lateral propodosomal setae absent; leg II usually shorter than leg I.....
..... **Genus: *Bdellodes****
- * Posterior pseudostigmata and sensilla unmodified
..... *Bdellodes thankamaluae* sp.nov.
- Lateral propodosomal setae may present or absent; leg II are as long as or longer than leg I..... **Genus: *Thoribdella****
- * Posterior pseudostigmata and sensilla modified
..... *Thoribdella citrifoliae* sp.nov.

Genus: *Bdellodes* Oudemans 1937 (= *Odontoscirus* Thor, 1913)

1913. *Odontoscirus* Thor, *Zoologischer Anzeiger*, **42**: 29

1937. *Bdellodes* Oudemans, *Kritisch Historisch Overzicht der Acarologie*, Leiden, 3: 1217.

1959. *Bdellodes*, Meyer and Ryke, *Ann.Mag. Nat.His.*, **13**(2) : 378.

1960. *Bdellodes*, Atyeo, *Univ. Kan. Sci. Bull.*, **40**:412.

1963. *Bdellodes*, Atyeo, *Bull. Univ. Nebraska St. Mus.*, **4** (8):124.

1976. *Bdellodes*, Wallace and Mahon, *Acarologia*, **18** (1): 67.

1980. *Bdellodes*, Gupta and Ghosh, *Rec. Zool. Surv.India*, **77**:201.

1987. *Bdellodes*, Michocka, *Monografie Fauny Polski*, **14**: 56.

1991. *Bdellodes*, Gupta, *Rec. Zool. Surv. India*, **88**: 224.

1992. *Bdellodes*, Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p.121

Diagnosis: *Bdellodes* are closely related to *Octobdellodes* but lacks the lateral propodosomal setae. Normal chelicerae with 1 or 2 setae. The sickle shaped movable digits are longer than the fixed digits, and may be smooth, flattened distally on the inner surfaces, or have a single tooth. The posterior pseudostigmatic organs are unmodified and the posterior sensilla are longer than the median propodosomal setae. Leg II usually shorter than leg I. The differentiating character for this group is an extreme modification of cuticular deposition, which is considered to be a continuous character.

Type species: *Scirus longirostris* Hermann, 1804

***Bdellodes thankamaluae* sp.nov.**

PLATE 76 (A,B)

Female: Body 1125 long, 855 wide; hypognathum – 256 long, 100 wide; *VES* – 155, *DES* – 111, Leg I – 666, leg II – 740, leg III – 759, leg IV – 833. Palp segments: trochanter – 25, basifemur – 151, telofemur – 37, genu – 25 and tibiotarsus – 151 long.

Palpal Chaetotaxy: Palpi 5 segmented and transversely striated with long setae and spine like setae, trochanter none, basifemur 10t – 2 dorsal setae, 3 ventral setae and 5 lateral setae, telofemur 1t – 1 spine like dorsal setae, genu 2t – 1 ventral seta and 1 dorsal seta, tibiotarsus with *VES*, *DES* and 12t – 3 lateral setae, 7 ventral setae, 2 dorsal setae.

Gnathosoma: Gnathosoma not striated but loosely granulated on adoral region. Two pairs of large ventral hypostomal setae (*Vh1* and *Vh2*), proximal pairs 81 long and distal pairs 66 long; 2 pairs of short adoral setae near the tip of gnathosoma, this region also covered with a tuft of setae, 4 pairs of setae present on hypostomal region.

Chelicerae: 313 long, vase shaped, longitudinally striated upto the base of proximal setae, single long proximal setae and distal setae present.

Dorsum: Prodorsum longitudinally striated on the base of gnathosoma, obliquely striated on lateral region and transversely striated on central region and continuous striae present all over the dorsum. Two pairs of eyes on lateral region of prodorsum, separated by a distance 44 and each eyes encircled with concentric rings of striae. Diameter of anterior eye is 38 and posterior eye is 30. Hysterosomal setae spine like and equal in length. Prodorsal setae *lps* –absent, *mps* – 90, *at* – 100, *pt* – 80. Hysterosomal setae; *c1* and *c2* – 75 each, *d1* – 78, *e1* – 75, *f1* – 50, *f2* – 27, *h1* – 62, *h2* – 45.

Venter: Fine striations present on ventral side. Anterior side marked with transversely dotted striations and posterior side obliquely striated. Transverse striations present on the sternal region. A prominent band of transverse striations present in between genital and anal plate. Genital valves with 10 pairs of setae and other 2 pairs of setae present around it. The anal plate with 2 pairs of setae, a long setae present on the distal end of the body.

Leg: Finely striated on all segments of legs. Setae on leg segments as follows: Coxae I – IV: 4 – 3 – 3 – 2, all setae tactile; trochanters I – IV: 1 – 1 – 1 – 1, all setae tactile. Basifemora I: 12 tactile setae; basifemora II: 10 tactile setae; basifemora III: 11 tactile setae; basifemora IV: 5 tactile setae plus 1 long spine like solinidion. Telofemora I : 6 tactile setae plus 1 solinidion; telofemora II : 6 tactile setae plus 1 solinidion; telofemora III : 5 tactile setae plus 1 solinidion; telofemora IV : 4 tactile setae plus 1 solinidion. Genu I : 4 tactile setae plus 10 sensory setae; genu II : 4 tactile setae plus 8 sensory setae; genu III : 5 tactile setae plus 3 sensory setae; genu IV : 5 tactile setae plus 3

sensory setae. Tibia I: 10 tactile setae, 2 sensory plus 1 trichobothrium; tibia II: 9 tactile setae; 1 sensory plus 1 trichobothrium; tibia III: 9 tactile setae; tibia IV: 9 tactile setae 1 trichobothrium. Tarsus I: 24 tactile, 3 sensory setae; tarsus II: 24 tactile setae plus 1 sensory setae tarsus III: 17 tactile setae plus 1 trichobothrium; tarsus IV: 16 tactile plus 1 trichobothrium.

Male: Unknown

Habitat: *Syzygium samarangense* (Blume)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Pazhoor (Kozhikode district), 25.ix.2015, ex. *Syzygium samarangense*, coll. Santhosh, (No.P.544/1). Two paratype slides with 3 ♀♀ marked on the slide from the same habitat (No.P. 544/2, 544/3, 544/4).

Remarks: This new species closely resembles. *Bdellodes longirostris* (Hermann), 1804 in general appearance but differs in the following features.

1. In the new species, body measuring 1125 long whereas in *B. longirostris*, it is 2190 long.
2. In the new species chelicerae 313 long, striated upto the base of proximal setae, no tooth present whereas in *B. longirostris*, it is 569 long, nonstriated, movable digit with pre apical teeth present.
3. Palpal basifemur 438 long with 13 – 14 setae in *B. longirostris* whereas in new species it is 188 long with 10 setae.
4. A remarkable difference exists in the leg chaetotaxy of both species. In the new species basifemur I – 140 long with 12 tactile setae, telofemur I – 82 long with 6 tactile setae plus 1 solinidion whereas in *B. longirostris*, basifemur I – 288 long with 14 – 15 tactile setae, telofemur I – 138 long with 7 setae.

5. In the new species, distance between two anterior sensillae is 27 whereas in *B. longirostris* it is 88.
6. Genital plate with 10 pairs of setae in new species whereas in *B. longirostris*, it is 6 or 7 pairs only.

Genus: *Thoribdella* Grandjean, 1938

1937. *Haploscirus* Thor , *Zoologischer Anzeiger*, **119**: 43–44.

1938. *Thoribdella* Grandjean, *Ann. Soc. Ent.*, France, **107**: 4.

1960. *Octobdellodes* Atyeo, *Univ. Kan. Sci. Bull.*, **40**: 407

Diagnosis: *Thoribdella* closely related to *Bdellodes*, which is distinguished by the deep goblet shaped posterior pseudostigmatic organs and usually by the extreme reduction of the posterior sensilla. The chelicerae are normal and each has one or 2 setae. The inner surface of the movable digits are usually flattened distally, and are usually longer than the fixed digits. The lateral propodosomal setae may be present or absent. Legs II are as long as or longer than legs I.

Type: *Haploscirus* Thor , 1937.

***Thoribdella citrifoliae* sp.nov.**

PLATE 77 (A, B)

Female: Body 950 long , 520 wide ; hypognathum 300 long, 113 wide ; *VES* – 172, *DES* – 144. Leg I – 700, leg I – I 722, leg III – 740 and leg IV – 888. Palp segments: trochanter – 25, basifemur – 151, telofemur – 37, genu – 25 and tibiotarsus – 151 long.

Palpal Chaetotaxy: Palpi 5 segmented and transversely striated with spine like setae, trochanter none, basifemur 7t – 1 dorsal seta, 2 ventral setae and 4

lateral setae; telofemur 1t – single dorsal seta, genu 4t – 2 small ventral setae and 2 long dorsal setae; tibiotarsus with *VES*, *DES* and 6t – 1 long lateral seta, 1 ventral seta, 3 dorsal setae and small bud like apical setae.

Gnathosoma: Transversely striated all over the region except on adoral part. Two pairs of large ventral hypostomal setae (*Vh1* and *Vh2*), proximal pair 50 long and distal pair 37 long; 2 pairs of short adoral setae present near the tip of gnathosoma, this region also covered with a tuft of setae. Five pairs of setae present below *Vh2*. A prominent ‘U’ shaped striations present between *Vh1* and *Vh2*.

Chelicerae: 313 long, vase shaped, stumpy and chelate with movable digit bears 2 teeth and fixed digit with 4 teeth, with a single long proximal and a distal setae separated by a distance 37.

Dorsum: Prodorsum longitudinally striated on the base of gnathosoma forming a ‘U’ shaped pattern upto the setae *pt*, obliquely striated on lateral and transversely striated on central region and continuous striae present all over the dorsum, 2 pairs of eyes on lateral region of prodorsum, separated by a distance 25 and each eyes encircled with concentric rings of striae. Diameter of anterior eye is 30 and posterior eye is 25. Hysterosomal setae spine like and equal in length. Prodorsal setae *lps* – 125, *mps* – 100, *at* – 100, *pt* – absent. Hysterosomal setae; *c1* – 50, *c2* – 50, *d1* – 60, *e1* – 50, *f1* – 50, *f2* – 40, *h1* – 42, *h2* – absent

Venter: Fine striations present on ventral side. Anterior side marked with central transversely dotted striations and posterior side with longitudinal and transverse striations. Genital valve with 9 pairs of setae and other 4 pairs of setae present around it. The anal plate with 2 pairs of setae, a long setae present on the distal end of the body.

Leg: Finely striated on all segments except the coxae. Setae on leg segments as follows: Coxae I – IV: 5 – 3 – 4 – 2, all setae tactile; trochanters I – IV: 1 – 1 – 1 – 0, all setae tactile. Basifemora I : 11 tactile setae; basifemora II : 12 tactile setae; basifemora III : 8 tactile setae; basifemora IV : 4 tactile setae. Telofemora I : 7 tactile setae plus 1 solinidion; telofemora II : 8 tactile setae plus 1 solinidion; telofemora III : 3 tactile setae plus 2 solinidia; telofemora IV : 4 tactile setae plus 2 solinidia. Genu I : 6 tactile setae; genu II : 6 tactile setae; genu III : 3 tactile setae plus 2 solinidia; genu IV : 4 tactile setae, 2 solinidia. Tibia I : 11 tactile setae plus 1 trichobothrium; tibia II : 9 tactile setae plus 1 trichobothrium; tibia III : 8 tactile setae plus 1 solinidion; tibia IV : 6 tactile setae 3 solinidia. Tarsus I : 15 tactile, 10 serrated sensory setae plus 1 solinidion; tarsus II : 7 tactile setae, 7 serrated sensory setae plus 1 solinidion; tarsus III : 13 tactile setae, 7 serrated sensory setae plus 1 trichobothrium; tarsus IV : 6 tactile plus 10 sensory setae.

Male: Unknown

Habitat: *Morinda citrifolia* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kurachundu (Kozhikode district), 02.xii.2015, ex. *Morinda citrifolia* L., coll. Santhosh, (No.M.619/1). Two paratype slides with 2 ♀♀ marked on the slide from the same habitat (No.K. 619/2, 619/3).

Remarks: This new species closely resembles *Thoribdella californica* (Banks), 1904 in general appearance but differs in the following features.

1. In the new species body measuring 1250 long whereas in *T. californica*, it is 1880 long.

2. In new species chelicerae 313 long with 4 teeth on fixed on digit and 2 teeth on movable digit whereas in *T. californica* it is 483 long with no tooth.
3. Propodosomal striations pattern differs in both species. In *T. californica* longitudinal striations present on propodosoma whereas in new species, transverse patterns are present.
4. In the new species distance between two anterior sensillae is 28, whereas in *T. californica* it is 100.
5. Leg chaetotaxy also differs in both species. in the new species, coxae I – IV: 4 – 3 – 3 – 2, basifemur – I – IV: 12 – 10 – 11 – 6, telofemur – I – IV: 7 – 7 – 6 – 5 whereas in *T. californica* ,Coxae I – IV: 4 – 3 – 4 – 3, basifemur – I – IV 13 – 13 – 8 – 4, telofemur – I – IV: 8 – 8 – 6 – 6

Subfamily: Cytinae Grandjean, 1938

1938. Cytinae Grandjean, *Ann. Soc. Ent. France*, **107**: 1 – 24.

1959. Cytinae: Meyer and Ryke, *Ann. Mag. Nat. His.*, **13**(2) : 375

1960. Cytinae: Atyeo, *Univ. Kan. Sci. Bull.*, **40**: 416.

1963. Cytinae: Atyeo, *Bull. Univ. Nebr. St. Mus.*, **4** (8): 121

1987. Cytinae: Michocka, *Monografie Fauny Polski*, **14**: 72

Diagnosis: This subfamily has 2 pairs of conspicuous ventral hypostomal setae, maximally 3 pairs of trichobothria and well developed genital tracheae. The palpal tibiotarsus is truncate and usually slightly longer than the combined length of the genu and telofemur. The subequal end setae are longer than the palpal femur. The chelicerae are thickened (*Cyta*) or normal (*Trachymolgus*) and each bears 2 setae, one of which is inserted at the base

of the fixed digit. The dorsal propodosoma has lateral propodosomal setae, secondary apodemes well developed, 4 eyes lateral to the unmodified posterior pseudostigmatic organs, and in *Cyta*, a fifth, unpaired eye between the anterior sensilla. The podocephalic canal is an internal tube in *Trachymolgus* and an external groove in *Cyta* (Grandjean, 1938). An unpaired seta occurs immediately anterior to the genital flaps.

Type: *Scirus latirostiris* Hermann, 1804

Genus: *Cyta* von Heyden, 1826

1826. *Cyta* Heyden, *vergl. Anat. und Phys.*, **19**: 6

1837. *Troglohdella* Oudemans, *Kritisch Historisch Overzicht der Acarologie*, **3**: 1228.

1930. *Cyta*, Thor, *Skrifter Svalbard Og Ishavet.*, **27**:1 – 156

1931. *Cyta*, Thor, *Das Tierreich.*, **56**:87

1959. *Cyta*, Meyer and Ryke, *Ann.Mag. Nat.His.*, **13**(2) :377.

1960. *Cyta*, Atyeo, *Univ. Kan. Sci. Bull.*, **40**: 416.

1963. *Cyta*, Atyeo, *Bull.Univ. Nebr. St. Mus.*, **4** (8): 121.

1975. *Cyta*, Soliman and Zaher, *Bull. Soc. Roy. Entomol.*, **59**: 73 – 82

1981. *Cyta*, Den Heyer, *Phytophylactia*, **13**: 31 – 41.

1987. *Cyta*, Michocka, *Monografie Fauny Polski.*, **14**: 72.

1987. *Cyta*, Swift and Goff, *Internat. J. Acarol.*, **13** (1): 36.

Diagnosis: The genus *Cyta* is related to *Trachymolgus*, but is distinguished by thickened chelicerae with massive chelae, and an unpaired median eye between the anterior sensilla. The distal pair of ventral hypostomal setae are inserted immediately anterior or posterior to the suture separating the buccal

cone and the strongly developed lateral lips. The posterior sensilla are widely separated and near the lateral margins of the dorsal propodosoma. Well developed lateral apodemes and weakly developed transverse apodemes are present. There may be 3, 1, or no pairs of trichobothria. The podocephalic canal is an external groove.

Cyta troglodyte Hernandez, 2011

PLATE 78 (A, B)

2011. Hernandez *et al.*, *Journal of Natural History*, **45**: (13 –14): 799–812.

***Female*:** Body 637 long, 470 wide; hypostome 129 long, 88 wide; *VES* – 75, *DES*– 63 long. Leg I – 417, leg II – 443, leg III – 430 and leg IV – 481 long. Palp segments: trochanter – 32, basifemur – 37, telofemur – 63, genu – 25 and tibiotarsus – 82 long.

***Palpal Chaetotaxy*:** Palpi 5 segmented, trochanter none, basifemur 2t – 2 small simple ventral setae, telofemur 4t – 2 ventral setae, one dorsolateral seta, one dorsomedian seta. genu 1t – median long spine like seta, tibia 3t – 2 spine like setae , one very small lateral seta, tarsus 8t – 3 median setae, one lateral long spine like seta and one small simple seta, 2 anteriolateral setae , one median spine like seta, 2 additional long end setae – *VES* and *DES* are also present on tarsus.

***Gnathosoma*:** Two pairs of large ventral hypostomal setae (*Vh1* and *Vh2*), proximal pair 37 long and distal pair 36 long; 2 pairs of short adoral setae near the tip of gnathosoma and 2 dorsolateral pairs below and above *Vh1*.

***Chelicerae*:** 113 long, smooth with broad base having a single proximal setae. Fixed digit of chelicera smaller than movable one. Teeth are absent.

Dorsum: Central and lateral region of prodorsum is obliquely striated, fine and continuous striae present all over the dorsum. A concentric ring of striae present on the mid-lateral region below the eye. Two pairs of eyes on lateral region of prodorsum, separated by a distance 44 and each eyes encircled with concentric rings of striae. Prodorsal and hysterosomal regions separated by slightly visible sejugal furrow. Hysterosomal setae pointed and serrated. Each setae encircled by one or 3 rows of concentric striae on its base. Prodorsal setae *at* – 70, *pt* – 111, *lps* – 37, *mps* – 48, Diameter of anterior eye 11, posterior eye 14. Hysterosomal setae; *c1* – 55, *c2* – 59, *d1* – 55, *e1* – 55, *f1* – 37, *f2* – 18, *h1* – 37, *h2* – 18

Venter: Fine and continuous striations present on ventral side. Genital valves each with 3 setae, anal plate with 3 pairs of setae.

Leg: Setae on leg segments as follows: Coxae I – IV: 3 – 2 – 3 – 2, all setae tactile, trochanters I – IV: 1 – 1 – 1 – 1, all setae tactile. Basifemora I – IV: 9 – 9 – 5 – 1, all setae tactile; telofemora I: 4 tactile setae plus 1 trichobothrium; telofemora II: 4 tactile setae plus 1 trichobothrium; telofemora III: 3 tactile setae plus 1 trichobothrium; telofemora IV : 3 tactile setae plus 1 trichobothrium. Genu I : 4 tactile setae plus 5 sensory setae; genu II: 3 tactile plus 5 sensory setae and 2 trichobothria; genu III : 3 tactile plus 2 trichobothria; genu IV : 2 tactile plus 2 sensory setae and 2 trichobothria. Tibia I : 4 tactile plus 5 sensory setae; tibia II : 4 tactile plus 2 sensory setae and 1 trichobothrium; tibia III : 3 tactile setae; tibia IV : 4 tactile plus 1 trichobothrium. Tarsus I: 8 tactile plus 5 sensory setae and 2 solinidia; Tarsus I : 19 tactile setae and 2 solinidia; tarsus II : 17 tactile plus 1 trichobothrium and 1 solinidion; tarsus III : 16 tactile plus 1 trichobothrium and 1 solinidion; tarsus IV : 16 tactile plus 1 trichobothrium and 1 solinidion.

Male: Unknown

Habitat: *Curcuma longa* (L.)

Known Habitat: faeces of *Kerodon rupestris*

Material examined: Female marked on the slide, INDIA: KERALA: Kurachundu (Kozhikode district), 11.xi.2015, ex. *Curcuma longa* (L.), coll. Santhosh, (No.K.619/1), 3 ♀♀ from the same habitat (No.K. 619/2, 619/3, 619/4).

Distribution: Brazil.

Remarks: The specimen examined agrees with *Cyta troglodyte* Hernandez, 2011 in almost all characters and hence fixed so. It is the first report from India from a new habitat viz., *Curcuma longa* (L.)

6.2.2 Family: CUNAXIDAE Thor, 1902

1902. Cunaxidae: Thor, *Verh. Zool.Bot.Ges.Wien*, 159– 165.

1904. Cunaxidae: Berlese, *Acari Nuovi. Redia*, **2**: 231–238.

1910. Cunaxidae: Berlese, *Acari Nuovi. Redia*, **6**: 199–201.

1931. Cunaxidae: Thor, *Gesammelt Zool.Anz.*, **97**:62.

1948. Cunaxidae: Baker and Hoffmann, *An .Esc. Nac. Cienc. Biol. Mex.*, **5**(3– 4): 229– 273.

1958. Cunaxidae: Atyeo, *J. Kans. Entomol. Soc.*, **19**(1): 55–61.

1960. Cunaxidae: Muma, *Ann.Ent.Soc. Amer.*, **53**: 321– 326.

1975. Cunaxidae: Smiley, *Ann.Ent.Soc.Amer.* **68**(2): 227– 244.

1976. Cunaxidae: Den Heyer, *Natuurwetenskapen Nr.*, **93**:1– 10.

1977. Cunaxidae: Den Heyer, *Acarologia*, **19** (4): 601– 618

1979. Cunaxidae: Den Heyer *et al.*, *Acarologia*, **20** (4): 522– 541.

1980. Cunaxidae: Den Heyer, *Publ. Univ. of the North Ser.A.* **23**: 1– 12.

1981. Cunaxidae: Den Heyer, *Phytophylactia*, **13**:59.
1984. Cunaxidae: Liang, *Acta Zootaxonomica Sin.*, 9:49– 51.
1985. Cunaxidae: Gupta, *Handbk. Plant Mites of India*, p. 313.
1991. Cunaxidae: Gupta, *Rec .Zool.Surv. India*, **88**(1–4): 207–239.
1992. Cunaxidae: Smiley, *Cuaxidae (Acari) of the World*, Indira Publishing House, p. 1– 356.
2003. Cunaxidae: Sionti and Papadoulis, *Internat.J. Acarol.*, **29** (4): 315– 325.
2007. Cunaxidae: Corpuz– Raros, *Asia Life Sciences*, **16**(2):153– 173.
2008. Cunaxidae: Corpuz– Raros, *Asia Life Sciences*, **17** (1): 71– 89
2009. Cunaxidae: Den Heyer, In: *Van Harten A. (Ed) Arthropod fauna of the UAE*, **2**: 17–25.
2011. Cunaxidae: Den Heyer *et al.*, *Internat. J. Acarol.* **37** (2): 143–160.
2011. Cunaxidae: Den Heyer, *Zoosymposia*, **6**: 1– 304.
2013. Cunaxidae: Den Heyer *et al.*, *J. Nat. His.*, **47** (31–32):2049–2070
2014. Cunaxidae: Skvarla *et al.*, *Zookeys*, **418**: 1–103.

Diagnosis: Chelicerae separated and hinged at base, moving laterally or scissors like, over cone like gnathosoma. Ventral hypostome with 4– 6 pairs of setae. Female genitalia without internal setae and spines except *Parabonzia*. Genital aperture with 2– 3 pairs of acetabula. Palpus 3 – 5 segments with strong spine, spurs or apophysis. Palpal segment terminating with claw except *Parabonzia*. Palpal solinidion when present non– setiform with strong spines and apophyses. Tarsal empodium claw like. Eyes present or absent. Tibia IV with or without trichobothrium.

Type: *Cunaxa* von Heyden, 1826

6.2.2.1 The morphology and terminology (Plate: 80 A, B)

The body of cunaxid mite is divided into 3 distinct regions *viz.*, gnathosoma, propodosoma and hysterosoma. Gnathosoma consists of the palpi, hypostome, chelicerae and tracheal system. The morphology and terminology used herein are that of Smiley (1975), setal notation for anal setae follows Kethley (1990) and ventral hypostomal abbreviations are adopted from Den Heyer (1978).

6.2.2.1.1 Setal terminology:

P ₁ – P ₂	:	Propodosomal setae
D ₁ – D ₅	:	Dorsal setae
L ₁	:	Lateral setae
h ₁ – h ₂	:	Anal setae
ad	:	Adoral setae
hg	:	Hypostomal setae

Key to the subfamilies of family Cunaxidae included in the present study

1. Pedipalp 5 segmented and extend beyond the subcapitulum by atleast the distal half of the tibiae. Apophyses may be present on the telofemora and between the genua and tibiotarsi..... Cunaxiinae
- Pedipalp composed of 3 segments, a bladder or bulb-like apophysis may be present on tibiotarsiCunaxoidinae

Subfamily CUNAXIINAE Oudemans, 1902

1902. Cunaxiinae Oudemans, *Tijdschrift voor Entomologie*, **45**: 58– 60

1992. Cunaxiinae, Smiley, *Cunaxidae (Acari) of the World*, Indira Publishing House, USA. p. 356.

Diagnosis: Palpus with 5 segments. Terminal segment (tibiotalrus) inner, median surface with a simple seta, or a rod like seta. Palpal telofemur with or without elongate apophysis; distal apex of tibiotalrus terminating in a small claw and simple seta. Chelicera extremely broad posteriorly and attenuate anteriorly. Dorsum of propodosoma with or without shield. Hysterosoma with or without shields, when present never more than three. Tarsi I– IV either short and stubby or long and slender and tapering distally, with or without conspicuous lateral flange like apices. Tibia IV with a smooth trichobothrium.

Type: *Cunaxa* von Heyden, 1826

Key to the genera of family Cunaxidae included in the present study.

1. Setae L₄ absent, palpus 3 segmented with 2 or 3 knob like apophysis or a single spur; and sometimes a flange like seta....**Genus:** *Neocunaxoides*
- Setae L₄ absent, palpi are 5 segmented and may bear stout spine like setae and elongated apophysis..... 2
2. Palpal genu apically without elongate apophysis, Tarsus I – IV long, slender, attenuated, without conspicuous bilobed lateral flanges terminally **Genus:** *Cunaxa*
- Palpal genu apically with or without elongate apophysis, tarsus I– IV stout, short or long and terminal in a conspicuous lateral bilobed flanges **Genus:** *Dactyloscirus*

Genus: *Cunaxa* Von Heyden, 1826.

1826. *Cunaxa* Von Heyden, In: *Isis of Oke.*, **18** (6): 608– 613.

1941. *Cunaxa*, Thor and Willmann, *Das. Tierreich.*, **71**: 1– 186

1948. *Cunaxa*, Baker and Hoffmann, *An. Esc. Nac. Cienc. Biol. Mex.*, **5** (3– 4): 229– 273.
1952. *Cunaxa*, Baker and Wharton, *Macmillan Co, N.Y.*, 465
1958. *Cunaxa*, Atyeo, *J. Kans. Entomol. Soc.*, **31**(2): 173– 174
1960. *Cunaxa*, Muma, *Ann. Entomol. Soc. Am.* **53**(3): 321– 326.
1976. *Cunaxa*, Hughes, 2nd ed. *Fish. Invest. Minist. Agric. Fish. Food. Tech. Bull. 9, Her.*, P 400
1978. *Cunaxa*, Krantz, *Oregon State Univ. Book Stores, Inc, Corvallis, Oregon*, p.509
1980. *Cunaxa*, Den Heyer, *Publ. of the Univ. of the North Ser. A.* **23**: 1– 12
1980. *Cunaxa*, Gupta and Ghosh, *Rec. Zool. Surv. India.* **77**: 189– 213
1984. *Cunaxa*, Sepasgosarian, *Zeit. Ang. Zool.* **71**: 135– 150.
1992. *Cunaxa*, Smiley, *Cuaxidae (Acari) of the World*, Indira Publishing House, USA, p.356
2001. *Cunaxa*, Lin and Zhang, *Sys. Appl. Acarol.*, **6**: 145– 153.
2003. *Cunaxa*, Sergeyenko, *Acarina.*, **11**(2): 225– 229.
2003. *Cunaxa*, Sionti and Papadoulis, *Internat. J. Acarol.*, **29**(4): 315– 325.
2005. *Cunaxa*, Bashir *et al.*, *Pak. Entomol.*, **27** (2): 57– 60
2006. *Cunaxa*, Bashir *et al.*, *Sys. Appl. Acarol.*, **11**: 63–68.
2007. *Cunaxa*, Corpuz– Raros and Gruezo, *Asia Life Sciences*, **16**(2): 175– 181.
2009. *Cunaxa*, Sergeyenko, *Zootaxa*, **2161**: 1– 19.
2009. *Cunaxa*, Kaluz, *Zootaxa*, **2198**: 27– 40.
2009. *Cunaxa*, Sergeyenko, *Zootaxa*, **2161**: 1– 9.
2011. *Cunaxa*, Bashir *et al.*, *Pak. J. Zool.*, **43** (1): 37– 40.

Diagnosis: The body colour ranges from red, orange, green, purple to brown, strongly sclerotized and may be covered with two dorsal shields. Palps 3 to 5 segmented with strong spines, spurs, solenidion, tubercles or apophyses. Palpal genu apically without large subrectangular apophysis. Hypognathum bearing 4 or 6 pairs of ventral (hg) setae, either simple tactile or geniculate (only hg₁) setae; cheliceral setae absent or present. Dorsum with nil to 19 smooth, striate or reticulate shields, bearing 2 pairs of long, pilose sensillae *vi* and *sce* as well as 8, 9, 10 or 12 pairs of tactile setae. Tibiotarsi terminate in either a strong claw in an association with a terminal solenidion or 2 distal end setae and solenidion. Propodosomal shields may be smooth, reticulated or striated. Striae may be with or without lobes; propodosoma and hysterosoma may be with or without a shield. Shield when present may be smooth or reticulated. Tarsi I– IV long, slender, attenuate and are without large conspicuous lateral bilobed flanges. Genital valves with usually 4 pairs (but may vary from 3 to 11 pairs) of genital setae and anal valves with one seta to 3 pairs of setae. Coxal plates I and II may be separate, partly fused or fused to form a sternal plate. Tarsi I with proximal or distal famulus, leg tarsi III and IV may be provided with knobbed (very minute) dt setae. Tibia IV with either smooth or pilose trichobothrium or without.

Type: *Scirus setirostris* Hermann, 1804

Key to the species of *Cunaxa* included in the present study

1. Both propodosomal and hysterosomal shield reticulated 2
- Either of the propodosomal or hysterosomal shield reticulated or non reticulated 4

2. Both propodosomal and hysterosomal shield reticulated
.....*Cunaxa justiciae* sp.nov
- Only propodosomal shield reticulated, hysterosomal shield striated 3
- Only hysterosomal shield reticulated, propodosomal shield striated
.....*Cunaxa myristicae* sp.nov.
3. The ratio of anterior sensillum to posterior sensillum equal to 0.77.....
.....*Cunaxa vinodi* sp.nov
- The ratio of anterior sensillum to posterior sensillum ratio is equal to 0.6
.....*Cunaxa jayasreeae* sp. nov.
4. Palpal telofemur inner surface without flanges or apophysis, P₁ setae
much lesser $\frac{1}{4}$ of P₂.....*Cunaxa rahuli* sp.nov.
- Palpal telofemur inner surface with distinct apophysis 5
5. Palpal telofemur with blunt apophysis.....*Cunaxa medicae* sp.nov.
- Palpal apophysis tapering distally 6
6. . Setae D₁ shorter than D₂.....*Cunaxa vilayurensis* sp.nov.
- Setae D₁ longer than D₂*Cunaxa womerselyi* Baker and Hoffmann.

***Cunaxa jayasreeae* sp.nov.**

PLATE 81 (A, B)

Female: Idiosoma 540 long, 340 wide including gnathosoma.

Dorsum: Dorsal shield 428 long and 285 wide. Chelicera as figured. Gnathosoma 112 long and 55 wide. Hypostome subrectanglar, cone shaped distally. Dorsal shield has a small subrectangular, reticulated propodosomal shield originating behind the base of the gnathosoma extending to the

anterior region of hysterosoma. Propodosomal shield reticulated on entire plate, anterior apex shows transverse striations upto the base of anterior sensillae. Shield with anterior and posterior sensillae and propodosomal seta P_1 and P_2 present. P_1 about one fourth as long as P_2 . Hysterosomal shield without a subrectangular reticulated median shield, it separated from propodosoma by striae bearing extremely small dot like lobe. Hysterosoma entirely striated but not reticulated. Lateral margin of hysterosoma bearing a thick granulated area below the posteriolateral margin. Posterior end of hysterosoma separated from distal body by double lined dot like striae. Anterior sensillae 148 long and posterior sensillae 259 long. Ratio between anterior sensillae to posterior sensillae is 0.6. Seta $P_1 - 4$, $P_2 - 12$, $D_1 - 12$, $D_2 - 8$, $D_3 - 8$, $D_4 - 25$, $D_5 - 25$ and $L_1 - 12$.

Palpal Chaetotaxy: Length of palp 215, palpi 5 segmented, trochanter none, basifemur with one dorsomedian simple seta, telofemur inner surface with short finger like apophysis plus one dorsomedian seta and lateral thorn like process. Genu inner surface with stout spine like seta, medially with slender simple seta, outer surface with simple seta; tibiotarsus inner surface with small simple seta, medially with one stout spine like seta, a medial simple seta and outer surface with one dorsolateral seta; terminating one simple seta and small claw.

Venter: Idiosoma shows transverse striations on anterior apex which forms longitudinal striations on sternal region between Ist and IInd pair of coxae. Coxae I and II contiguous connected by small lateral apodemes. Coxae III and IV coalesced, striated on base, broader than coxae I and II. Venter with 6 pairs of simple setae between coxae II and distal part of the body in addition

to the setae of genital and anal region. Anal plate oval shaped with 4 pairs of setae. Length of Leg I– 379, Leg II – 354, Leg III – 384 and Leg IV– 400.

Leg Chaetotaxy: Coxae: 3– 1– 3– 2; trochanter: 1– 1– 2– 1; basifemur: 2– 3– 3– 1; telofemur: 2– 3– 2– 2 ; genu I: 2 attenuate solenidia plus 2; genu II: 2 attenuate solenidia plus 2; genu III: 2 attenuate solenidia plus 2; genu IV: 2 attenuate solenidia plus 4; tibia I: 2 attenuate solenidia plus 3; tibia II: 1 attenuate solenidion plus 2, tibia III: 2 attenuate solenidia plus 3, tibia IV: 1 long trichobothrium plus 4 ; tarsus I: 1 long attenuate solenidion plus 5; tarsus II: 1 attenuate solinidion plus 5; tarsus III: 1 attenuate solenidion plus 8; tarsus IV: 1 attenuate solinidion plus 6.

Male: Unknown.

Habitat: *Psidium guajava* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Ballusseri (Kozhikode district), 17.xi.2015, ex. *Psidium guajava* L., coll. Santhosh (No.B.713/1). Three paratype slides with 3 ♀♀ marked on the slide from the same habitat (No.P 713/2, 713/3, 713/4).

Remarks: This new species closely resembles *Cunaxa floridanus* Chaudhari, 1980 in general appearance but differs in the following features;

1. In the new species, hysterosoma moderately striated. A disc shaped granular mass present on the lateral margin of dorsal body surface near posterior sensillae whereas in *C. floridanus*, fine striations present on hysterosomal shield.
2. Tibiofemur medially with one short spine like seta without any spur like process whereas in *C. floridanus*, tibiofemur medially with one stout spine like seta and spur like process.

3. Hysterosoma venter with 4 pairs of setae present between coxae II and distal part of body in addition to genital and anal setae but in *C. floridanus*, 6 pairs of simple setae present.
4. Leg chaetotaxy of new species is coxae I– IV: 3– 1– 3– 1, basifemur I– IV: 3– 3– 3– 0 whereas in *C. floridanus*, Coxae I– IV: 3– 1– 3– 2 and basifemur I– IV: 3– 3– 3– 1.

***Cunaxa justiciae* sp.nov.**

PLATE 82 (A, B)

Female: Idiosoma 261 long, 181 wide including gnathosoma.

Dorsum: Dorsal shield 151 long and 118 wide. Chelicera as figured. Gnathosoma 110 long and 63 wide. Hypostome subrectangular, cone shaped distally. Dorsal shield has a small subrectangular propodosomal shield originating behind the base of the gnathosoma extending to the anterior region of hysterosoma. Propodosomal shield 63 long and 101 wide reticulated on entire plate. Shield with anterior and posterior sensillae and propodosomal seta P_1 and P_2 present. P_1 and P_2 equal in size. Hysterosomal shield 88 long and 116 wide, subrectangular with cells like reticulations. Anterior sensillae 139 long and posterior sensillae 177 long. Ratio between anterior sensillae to posterior sensillae is 0.8. Seta P_1 – 5, P_2 – 5, D_1 – 6, D_2 – 8, D_3 – 10, D_4 – 13, D_5 – 12 and L_1 – 8 long.

Palpal Chaetotaxy: Length of palp 130, palpi 5 segmented, trochanter none, basifemur with one dorsomedian simple seta and ventro– lateral simple seta, telofemur inner surface with short finger like apophysis plus one dorsomedian seta and lateral thorn like process. Genu inner surface with stout spine like seta, medially with slender simple seta, outer surface

anteriorly with stout simple seta and long anterior apophysis; tibiotarsus inner surface with small simple seta, medially with one stout spine like seta without spur like process, a medial simple seta and outer surface with one dorsolateral seta; one terminal simple seta and a small claw.

Venter: Idiosoma – coxae I and II contiguous connected by small lateral apodemes. Coxae III and IV coalesced, striated on base, broader than coxae I and II with 3 pairs of setae on each side. Distal part of the body transversely striated. Length of Leg I– 283, Leg II – 248, Leg III– 258 and Leg IV – 303.

Leg chaetotaxy: All legs are sclerotised and basifemur of Leg III and IV highly sclerotised and granulated. Coxae: 3– 2– 2– 2; trochanter: 1– 1– 2– 1; basifemur: 3– 1– 3– 1; telofemur I: 5 setae; telofemur II: 3 setae; telofemur III: 1 attenuate solenidion plus 3; telofemur IV: 1 attenuate solenidion plus 2; genu I: 2 attenuate solenidia plus 4; genu II: 1 attenuate solenidion plus 3; genu III: 1 attenuate solenidion plus 3; genu IV: 1 attenuate solenidion plus 3; tibia I: 2 attenuate solenidia plus 2; tibia II: 2 attenuate solenidia plus 2; tibia III: 1 attenuate solenidion plus 2; tibia IV: 1 long trichobothrium plus 3 ; tarsus I: 1 long attenuate solenidion plus 13; tarsus II: 2 solinidia plus 8; tarsus III: 1 attenuate solenidion plus 5; tarsus IV: 1 attenuate solinidion plus 12.

Male: Unknown.

Habitat: *Justicia adhatoda* (L.)

Material examined: Holotype ♀ marked on the slide INDIA: KERALA: Botanical Garden, Calicut University (Malappuram district), 19.x.2015, ex. *Justicia adhatoda* (L.), coll. Santhosh (No.C.446/1). Four paratype slides with 4 ♀♀ marked on the slide from the same habitat (No.P 446/2, 446/3, P 446/4, 446/5).

Remarks: This new species closely resembles *Cunaxa thailandicus* Den Heyer, 1979 in general appearance but differs in the following features;

1. In the new species, idiosoma 261 long and 181 wide whereas in *C. thailandicus* it is 559 long, 293 wide.
2. Propodosomal shield is heavily reticulated and hysterosoma having small dot like striations in the new species whereas in *C. thailandicus*, propodosomal shield is smooth and hysterosoma with broken striae forming cell like reticulations.
3. In the new species, P_1 and P_2 equal whereas in *C. thailandicus*, P_1 about one fourth as long as P_2 .
4. No striations present on the junction between propodosoma and hysterosoma.
5. In the new species, length of D_1 , D_2 , D_3 and L_1 almost equal length to that of D_4 and D_5 whereas in *C. thailandicus*, setae D_4 and D_5 is twice longer than setae D_1 , D_2 , D_3 and L_1 .
6. Palpi 130 long with a short simple setae but in *C. thailandicus*, palpi 186 long with long setae.
7. Leg chaetotaxy of new species is coxa I–IV: 3– 2– 2– 2 and basifemur I– IV: 3– 1–3– 1 whereas in *C. thailandicus*, coxae I– IV: 3– 1– 3– 1 and basifemur I– IV: 4– 4– 3– 1.

***Cunaxa medicae* sp.nov.**

PLATE 83 (A, B)

Female: Idiosoma 413 long, 305 wide including gnathosoma.

Dorsum: Dorsal shield 300 long and 230 wide has a small subrectangular propodosomal shield which originating behind base of gnathosoma

extending to anterior region of hysterosoma. Gnathosoma 113 long and 75 wide. Chelicerae as figured. Hypostome subrectangular, cone shaped distally. Propodosomal shield reticulated on area between posterior sensillae. Shield with anterior and posterior sensillae and propodosomal setae P_1 and P_2 present. P_2 about $\frac{3}{4}$ as long as P_1 . Hysterosoma separated from propodosoma by a smooth striae bearing dot like lobe. Lateral margin of dorsal shield is striated around the hysterosomal shield. A pair of pore is present on lateral side of D_4 . Setae D_4 surrounded with semicircular plate like structure with smooth striations. Anterior sensillae 259 long and posterior sensillae 285 long. Ratio between anterior and posterior sensillae is 0.9. Setae $P_1 - 5$, $P_2 - 25$, $D_1 - 12$, $D_2 - 12$, $D_3 - 12$, D_4 and $D_5 - 30$ each with sharp and pointed tip, $L_1 - 12$.

Palpal chaetotaxy: Length of palp 227, palpi 5 segmented and granulated. Trochanter none, basifemur with one dorsomedian simple seta, telofemur inner surface with one stout spine like seta and one simple dorsomedian seta. Genu inner surface with stout spine like seta, apically with slender dorsomedian simple seta, outer surface with short, dorsolateral spine like seta. Tibiotarsus inner surface with long simple seta, medially with one minute thorn like seta, adjacently with stout spine like seta and a simple seta above, outer surface with one dorsolateral seta; terminating one simple seta and small claw.

Venter: Idiosoma – transverse and longitudinal striations present on entire ventral shield. Coxae I and II contiguous connected by small lateral apodemes. Each side of the plate with one seta. Coxae III and IV coalesced, broader than coxae I and II with 5 pairs of setae on each side. Anal shield

with 4 pairs of setae. Length of Leg I– 346, Leg II– 321, Leg III– 435 and Leg IV– 468.

Leg chaetotaxy: Coxae: 3– 1– 3– 1, trochanter :1– 1– 2– 1, basifemur : 3– 3– 3– 1 with 1 solenidion, telofemur : 4– 4– 4– 3 with 1 solenidion , genu I: 1 attenuate solenidion plus 4, genu II: 2 attenuate solenidia plus 3, genu III: 2 attenuate solenidia plus 3, genu IV: 2 attenuate solenidia plus 3; tibia I : 1 attenuate solenidion plus 4, tibia II: 2 attenuate solenidia plus 3, tibia III: 2 attenuate solenidia plus 3, tibia IV:1 long trichobothrium plus 3 ; tarsus I: 1 attenuate solenidion plus 8, tarsus II: 2 attenuate solenidia plus 5, tarsus III: 1 attenuate solenidion plus 7, tarsus IV:1 attenuate solenidion plus 9.

Male: Unknown.

Habitat: *Citrus medica* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex.*Citrus medica* L., coll. Santhosh, (No.K.337/1). Three paratypes with 3 ♀♀ marked on the slide from the same habitat (No.K. 337/2, 337/3, 337/4).

Remarks: This new species closely resembles *Cunaxa reevesi* Den Heyer, 1968 in general appearance and palpal chaetotaxy but differs in the following features;

1. In the new species, idiosoma 413 long and 305 wide whereas in *C. reevesi*, it is 653 long, 306 wide.
2. Reticulations restricted to the base of propodosoma between posterior sensillae in the new species, whereas in *C. reevesi*, it is entirely reticulated.

3. In the new species, hysterosoma loosely striated but in *C. reevesi*, hysterosoma thickly striated.
4. In this species, L_1 is equal to D_1 and D_3 whereas in *C. reevesi*, L_1 about half length of D_1 and D_3 .
5. In the new species, P_1 minute and P_2 25 long whereas in *C. reevesi*, P_1 one half as long as P_2
6. In the new species, leg chaetotactic formula coxae I– IV: 3– 1– 3– 1; telofemur I– IV: 4– 4– 4– 3 whereas in *C. reevesi*, coxae I– IV: 3– 1– 3– 2; telofemur I– IV: 4– 4– 4– 4.

***Cunaxa myristicae* sp.nov.**

PLATE 84 (A, B)

Female: Idiosoma 348 long, 240 wide including gnathosoma.

Dorsum: Dorsal shield 240 long and 177 wide. Dorsal shield has a small subrectangular propodosomal shield extending to anterior region of hysterosoma which is striated on anterior region. Shield with anterior and posterior sensillae and setae P_1 and P_2 . Chelicera as shown in the figure. Gnathosoma 108 long and 63 wide. Hypostome subrectangular, cone shaped distally. Hysterosomal shield is subrectangular and reticulated. Anterior sensillae 126 long and posterior sensillae 149 long. Ratio between anterior sensillae to posterior sensillae is 0.84. Setae P_1 – 5, P_2 – 12, D_1 – minute, D_2 – 12, D_3 – 10, D_4 and D_5 – 15 each with sharp and pointed tip, L_1 – 5.

Palpal chaetotaxy: Length of palp 130. Palpi 5 segmented basifemur and telofemur not clearly distinguishable, but long and stout. Trochanter none,

basifemur with one dorsomedian simple seta, telofemur inner surface with finger like apophysis plus one dorsomedian seta. Genu inner surface with spine like seta, apically with a spine like seta and one dorsal simple seta. Tibiotarsus with 5 setae; inner surface with long simple seta, medially with one stout spine like seta without spur like process, a medial simple seta and outer surface with one dorsolateral seta; a terminal simple seta and small claw.

Venter: Idiosoma – coxae I and II contiguous connected by small lateral apodemes. Sternal region of the plate is longitudinally striated and with one seta. Coxae III and IV coalesced, broader than coxae I and II with 5 pairs of setae on each side. Distal part of the body transversely striated. Length of Leg I – 265, Leg II – 227, LegIII– 278 and LegIV– 303.

Leg chaetotaxy: Coxae: 3– 1– 3– 1; trochanter: 1– 1– 2– 1; basifemur:3– 3– 3–0; telofemur:4– 4– 4– 4; genu I: 3 attenuate solenidia plus 2, genu II: 1 attenuate solenidion plus 3, genu III: 1 attenuate solenidion plus 4; genu IV:1 attenuate solenidion plus 4; tibia I: 1 attenuate solenidion plus 4; tibia II: 1 attenuate solenidion plus 3; tibia III: 1 attenuate solenidion plus 3; tibia IV: 1 long trichobothrium plus 3 ; tarsus I: 1 attenuate solenidion plus 5; tarsus II: 1 solinidion plus 5; tarsus III: 1 attenuate solenidion plus 6; tarsus IV: 1 attenuate solinidion plus 10.

Male: Unknown.

Habitat: *Myristica fragrans* Houtt.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kadalundi (Kozhikode district), 2.xi.2015, ex. *Myristica fragrans* Houtt.,

coll. Santhosh, (No.K.382/1). Three paratype slides with 3 ♀♀, marked on the slide from the same plant (No.K 382/2, 382/3, 382/4).

Remarks: This new species closely resembles *Cunaxa thailandicus* Den Heyer, 1979 in general appearance and palpal chaetotaxy but differs in the following features;

1. In the new species, idiosoma 581 long and 410 wide whereas in *C. thailandicus*, it is 625 long, 315 wide.
2. Hysterosomal shield having polygonal reticulations whereas in *C. thailandicus* shield having broken striae forming cell like structure.
3. In the new species, setae $D_4 - D_5$ almost equal to setae D_3 and L_1 , D_1 is minute but in *C. thailandicus*, $D_4 - D_5$ about twice as long as setae $D_1 - D_3$ and L_1 .
4. P_1 about half long as P_2 whereas in *C. thailandicus*, length of palpi 186.
5. A small apophysis present on telofemur but in *C. thailandicus*, apophysis is long and prominent.
6. Leg chaetotaxy of basifemur I– IV: 3– 3– 3– 0 in the new species, whereas in *C. thailandicus*, basifemur I– IV: 3– 3– 3– 0. Leg chaetotactic formula of coxae, trochanter and telofemur similar , but genu, tibia and tarsus differs in both species

***Cunaxa rahuli* sp.nov.**

PLATE 85 (A, B)

Female: Idiosoma 556 long, 329 wide including gnathosoma.

Dorsum: Dorsal shield 375 long and 242 wide. Propodosoma with reticulated subrectangular shield originating behind base of gnathosoma,

extending to anterior region of hysterosoma which is clearly distinguished from hysterosoma by smooth striae. Propodosoma heavily reticulated on the area around posterior sensillae and a disc shaped granulation present on posteriolateral margin. The lateral side of hysterosomal region is striated. Chelicera as figured. Gnathosoma 181 long and 87 wide. Hypostome subrectangular, cone shaped distally. Shield with anterior and posterior sensillae and propodosomal setae P_1 and P_2 present. P_1 setae $\frac{1}{4}^{\text{th}}$ long as P_2 . Anterior sensillae 240 long and posterior sensillae 266 long. Ratio between anterior sensillae to posterior sensillae is 0.90. Setae $P_1 - 4$, $P_2 - 22$, $D_1 - 12$, $D_2 - 12$, $D_3 - 10$, $D_4 - 30$, $D_5 - 40$ each with sharp and pointed tip, $L_1 - 5$ long.

Palpal Chaetotaxy: Length of palp 198, palpi 5 segmented, genu thickly granulated. Trochanter none, basifemur with one dorsomedian simple seta, telofemur inner surface without finger like apophysis but one dorsomedian seta present. Genu inner surface with spine like seta, one dorsolateral simple seta and medioventral simple seta. Tibiotarsus with 5 setae; inner surface with one long simple seta, medially with one stout spine like seta, a simple lateral seta and outer surface with one dorsolateral seta; terminating one simple seta and a small claw. Two small thorn like projections present below the median stout spine like seta of tibiotarsus.

Venter: Idiosoma— the whole venter is striated. Coxae I and II contiguous connected by small lateral apodemes. Each side of the plate with one seta. Coxae III and IV coalesced, broader than coxae I and II. Venter with 5 pairs of setae between coxae II and distal part of body in addition to setae of genital and anal region. Anal shield oval shaped with 4 pairs of setae. Length of Leg I— 410, Leg II— 400, Leg III— 455 and Leg IV— 493.

Leg Chaetotaxy: Coxae: 2– 1– 2– 2; trochanter: 1– 1– 2– 1; basifemur: 3– 3– 3– 1; telofemur : 4– 4– 4– 4; genu I: 1 attenuate solenidion; 1 duplex seta plus 4, genu II: 2 attenuate solenidia plus 5, genu III: 2 attenuate solenidia plus 5, genu IV: 1 attenuate solenidion plus 4; tibia I: 1 attenuate solenidion plus 3, tibia II: 1 attenuate solenidion plus 3, tibia III: 1 attenuate solenidion plus 4, tibia IV: 1 long trichobothrium plus 4 ; tarsus I: 1 attenuate solenidion plus 6; tarsus II: 1 solinidion plus 5; tarsus III: 1 attenuate solenidion plus 14; tarsus IV: 1 attenuate solinidion plus 14.

Male: Unknown.

Habitat: *Bauhinia acuminata* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kadalundi (Kozhikode district), 3.xi.2015, ex. *Bauhinia acuminata* L., coll. Santhosh (No.K.594/1). Three paratype slides with 3 ♀♀ marked on the slide, (No.K 594/2, 594/3, 594/4), collection details same as above.

Remarks: This new species closely resembles *Cunaxa evansi* Chaudhari, 1980 in general appearance but differs in the following features;

1. In the new species, propodosoma with reticulatd subrectangular shield whereas in *C. evansi*, it is smooth.
2. In this species, seta L_1 minute, D_2 – 12 and D_5 – 40 long but in *C. evansi*, L_1 , D_2 and D_5 equal in length.
3. Genu densely granulated with 3 setae in the new species whereas in *C.evansi*, genu with 2 setae and no granulations.
4. Length of palpi 198 in the new species whereas in *C. evansi*, it is 173.
5. In the new species, two thorn like projections present below the median stout spine like seta of tibiotarsus whereas in *C. evansi*, it is absent.

6. Leg chaetotaxy in the new species is coxae I– IV: 2– 1– 2– 2, Basifemur I– IV: 3– 3– 3– 1 whereas in *C. evansi*, coxae I– IV: 3– 1– 2– 2 and basifemur I– IV: 5– 5– 4– 2.

***Cunaxa vilayurensis* sp.nov.**

PLATE 86 (A, B)

Female: Idiosoma 395 long, 248 wide including gnathosoma.

Dorsum: Dorsal shield 295 long, 179 wide has a small subrectangular propodosomal shield which clearly distinct from hysterosoma. Gnathosoma 100 long, 63 wide. Hypostome subrectangular, cone shaped distally. Chelicerae as figured. No striations or granules present on propodosomal shield. Shield with anterior and posterior sensillae and propodosomal setae P_1 and P_2 present. P_1 about $\frac{3}{4}$ as long as P_2 . Hysterosomal shield is sub rectangular and granulated. Lateral margin of dorsal shield is striated around the propodosomal and hysterosomal shield. A pair of pore is present on lateral side of D_4 . Anterior sensillae 164 long and posterior sensillae 177 long. Ratio between anterior sensillae to posterior sensillae is 0.9. Setae P_1 – 7, P_2 – 10, D_1 – 7, D_2 – 7, D_3 – 7, D_4 and D_5 – 25 each with sharp pointed tips, L_1 – 7.

Palpal chaetotaxy: Length of palp 124, palpi 5 segmented, trochanter none, basifemur with one dorsomedian simple seta, telofemur inner surface with finger like apophysis plus one dorsomedian seta. Genu with apical spine like seta, one dorsolateral simple seta. Tibiotarsus with 5 setae; inner surface with simple seta, medially with one stout spine like seta, a simple lateral seta and small tubercle, outer surface with one dorsolateral seta; terminating one simple seta and small claw.

Venter: Idiosoma– striations present on the base of Leg III, Leg IV and above the anterior apex of anal plate. Coxae I and II contiguous connected by small lateral apodemes. Each side of the plate with one seta. Coxae III and IV coalesced, broader than coxae I and II with 5 pairs of setae on each side. Anal shield oval shaped with 4 pairs of setae. Length of Leg I– 270, Leg II– 240, Leg III– 293 and Leg IV– 306.

Leg Chaetotaxy: Coxae: 3– 2– 3– 1; trochanter: 1– 1– 2– 1; basifemur: 4– 4– 4– 1; telofemur: 4– 4– 4– 4; genu I: 1 attenuate solenidion plus 4; genu II: 1 attenuate solenidion plus 3; genu III: 1 attenuate solenidion plus 4; genu– IV: 1 attenuate solenidion plus 4; tibia I: 1 attenuate solenidion plus 7; tibia II: 1 attenuate solenidion plus 3; tibia III: 1 attenuate solenidion plus ; tibia IV: 1 long trichobothrium plus 3 ; tarsus I: 1 attenuate solenidion plus 6, tarsus II: 1 solinidion plus 5; tarsus III: 1 attenuate solenidion plus 7; tarsus IV: 1 attenuate solinidion plus 8.

Male: Unknown.

Habitat: *Clitoria ternatea* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Vilayur, (Palakkad district), 5.xi.2015, ex. *Clitoria ternatea* L., coll. Santhosh, (No.V.357/1). Five paratypes with 5 ♀♀ marked on the slide from the same habitat (No.V 357/2, 357/3, 357/4, 357/5 and 357/6).

Remarks: This new species closely resembles *Cunaxa terrula* Den Heyer, 1979 in general appearance but differs in the following features;

1. In the new species, idiosoma 395 long and 242 wide whereas in *C. terrula*, it is 670 long, 330 wide.

2. Hysterosoma reticulated in the new species, but it is smooth in *C. terrula*.
3. In the new species, all dorsal setae small except D₄ and D₅, it is spine like whereas in *C. terrula*, setae long and D₄–D₅ setoses.
4. Palpus 124 long in new species but it is 266 long in *C. terrula*.
5. In the new species, inner surface of tibiotarsus with one small simple seta whereas in *C. terrula*, it is long.
6. Leg chaetotaxy: coxae I–IV: 3–2–3–1; basifemur I–IV: 4–4–4–1 in the new species, whereas in *C. terrula*, coxae I–IV: 3–1–3–2; basifemur: I–IV: 4–4–3–1; leg chaetotactic formula of genu, tibia and tarsus also differs in both species.

***Cunaxa vinodi* sp.nov.**

PLATE 87 (A, B)

Female: Idiosoma 581 long, 410 wide including gnathosoma.

Dorsum: Dorsal shield 418 long and 309 wide. Propodosoma with a smooth subrectangular shield originating behind the base of gnathosoma, extending to anterior region of hysterosoma which clearly distinguished from hysterosoma by smooth striae. Chelicera as figured. Gnathosoma 163 long and 101 wide. Hypostome subrectangular, cone shaped distally. Propodosoma reticulated on the area between posterior sensillae. Hysterosoma without a subrectangular reticulated median shield. The whole hysterosomal region is striated. A pair of small pores present on the lateral side of D₄. Shield with anterior and posterior sensillae and propodosomal setae P₁ and P₂ present. Anterior sensillae 218 long and posterior sensillae 314 long. Ratio between

anterior sensillae to posterior sensillae is 0.69. Setae P₁– 14, P₂– 37, D₁– 18, D₂– 18, D₃– 18, D₄– 48, D₅– 40 each with sharp and pointed tip, L₁– 18.

Venter: Idiosoma – the area between coxae III and IV is granulated and striated. Coxae I and II contiguous connected by small lateral apodemes, coxae III and IV coalesced, broader than coxae I and II. Venter with 6 pairs of setae between coxae II and distal part of body in addition to setae of genital and anal region. Anal shield oval shaped with 4 pairs of setae. Length of Leg I – 382, Leg II– 379, Leg III– 367 and Leg IV – 435.

Palpal Chaetotaxy: Length of palp 189, palpi 5 segmented, trochanter none, basifemur with one dorsomedian simple seta, telofemur inner surface with finger like apophysis plus one dorsomedian seta. Genu inner surface with spine like seta, one dorsolateral simple seta and median simple seta. Tibiotarsus with 5 setae; inner surface with simple seta, medially with one stout spine like seta, a simple lateral seta and outer surface with one dorsolateral seta; apically with one simple seta and small claw.

Leg Chaetotaxy: Coxae: 2– 1– 3– 1; trochanter: 1– 1– 2– 1; basifemur: 3– 3– 4– 1; telofemur: 4– 4– 4– 4; genu I: 1 attenuate solenidion plus 3; genu II: 1 attenuate solenidion plus 5; genu III: 1 attenuate solenidion plus 4; genu IV: 1 attenuate solenidion plus 4; tibia I: 2 attenuate solenidia plus 6; tibia II: 1 attenuate solenidion plus 5; tibia III: 1 attenuate solenidion plus 5; tibia IV: 1 long trichobothrium plus 4; tarsus I: 1 attenuate solenidion plus 6; tarsus II: 1 solinidia plus 6; tarsus III: 1 attenuate solenidion plus 4; tarsus IV: 1 attenuate solinidion plus 8.

Male: Unknown.

Habitat: *Abelmoschus moschatus* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Botanical Garden, Calicut University (Malappuram district), 16.x.2015, ex. *Abelmoschus moschatus* (L.), coll. Santhosh, (No.C.463/1). Two paratype slides with 2 ♀♀ from the same habitat (No.C 463/2, 463/3).

Remarks: This new species closely resembles *Cunaxa setirostris* (Hermann), 1804 in general appearance but differs in the following features;

1. In the new species, idiosoma 581 long and 410 wide whereas in *C. setirostris* it is 625 long, 315 wide.
2. Propodosomal shield reticulated on area between two posterior sensillae whereas in *C. setirostris* it is smooth.
3. In the new species, apophysis is short whereas in *C. setirostris*, an elongate apophysis present.
4. Palpi 185 long in the new species whereas in *C. setirostris*, it is 165 long.
5. Leg chaetotaxy in new species is coxae I– IV: 2– 1– 3– 3, basifemur I– IV: 2– 4– 4– 1 whereas in *C. setirostris*, coxae I– IV: 3– 1– 3– 2, basifemur I– IV: 4– 4– 3– 1

***Cunaxa womersleyi* Baker and Hoffmann, 1948**

PLATE 88 (A, B)

1948. *Cunaxa womersleyi* Baker and Hoffmann, *An.Esc.Nac.Cienc. Biol. Mex.*, **5**(3– 4): 234.

1984. *Cunaxa womersleyi*, Sepagosarian, *Zeit.Ang.Zool.* **71**: 144.

1992. *Cunaxa womersleyi*, Smiley, *Cuaxidae (Acari) of the World*, Indira Publishing House., p. 213

1992. *Cunaxa womersleyi*, Gupta and Gupta, *Proc. 10th Internat. Congr.*, p. 487

Female: Idiosoma 438 long, 278 wide including gnathosoma.

Dorsum: Dorsal shield 390 long, 252 wide originating from anterior propodosoma and extending posteriorly up to the region of metapodosoma. Gnathosoma 48 long and 26 wide. Hypostome subrectangular, cone shaped distally. Chelicera as shown in the figure. Dorsal shield has a small propodosomal shield which has no clear boundary on lateral and anterior margin. Hysterosomal shield is squarish, separated from propodosoma by smooth striae. Shield with no striations on propodosoma, hysterosomal plate finely striated. Propodosomal and hysterosomal region striated on lateral side. Anterior sensillae 151 long and posterior sensillae 187 long. Ratio between anterior sensillae to posterior sensillae is 0.8. Setae $P_1 - 12$, $P_2 - 22$, $D_1 - 25$, $D_2 - 22$, $D_3 - 22$, $D_4 - 45$, $D_5 - 45$ and $L_1 - 20$.

Palpal chaetotaxy: Length of palp 200, palpi 5 segmented, trochanter none, basifemur with one dorsomedian simple seta, telofemur inner surface with finger like apophysis plus one dorsomedian seta. Genu with apical spine like seta, one dorsolateral simple seta. Tibiotarsus with 6 setae; inner surface with one long simple seta, one stout median seta, a simple seta above the median stout seta, outer surface with one posterior seta and small spine like anterior seta, one small apical seta with small claw.

Venter: Idiosoma – coxae I and II contiguous connected by small lateral apodemes. Each side of the plate with 2 pairs of setae. Coxae III and IV

coalesced, broader than coxae I and II with 5 pairs of setae on each side. Sternal plates possess transverse striations on inner margin. Anal shield bean shaped with 4 pairs of setae. Anal plate encircled with wave like striations. Length of Leg I – 387, Leg II – 341, Leg III– 422 and Leg IV – 481.

Leg Chaetotaxy: Coxae: 3– 1– 3– 2; trochanter: 1– 1– 2– 1; basifemur: 4– 3– 3– 1; telofemur: 4– 4– 4– 4; genu I: 2 attenuate solenidia plus 4, genu II: 1 attenuate solenidion plus 4, genu III: 1 attenuate solenidion plus 5, genu– IV: 1 attenuate solenidion plus 4; tibia I: 1 attenuate solenidion plus 4, tibia II: 3 attenuate solenidia plus 2, tibia III: 4 attenuate solenidia plus 2, tibia IV: 1 long trichobothrium plus 4 ; tarsus I: 1 attenuate solenidion plus 10, tarsus II: 1 solenidion plus 8, tarsus III: 1 attenuate solenidion plus 10, tarsus IV: 1 attenuate solinidion plus 14.

Male: Unknown

Habitat: *Psidium guajava* L., *Bauhinia acuminata* L.

Known Habitat: Papaya

Material examined: Female marked on the slide INDIA: KERALA: Pazhur (Kozhikode district), 25.ix.2015, ex. *Psidium guajava* L., coll. Santhosh (No.P.537/1). Two ♀♀ marked on the slide from the same habitat (No.P 537/2, 537/3), 2 ♀♀ from Pantherankavu (Kozhikode), ex. *Bauhinia acuminata* L., (537/4, 537/5).

Distribution: INDIA: West Bengal. OUTSIDE INDIA: USA

Remarks: The specimen studied agrees with *Cunaxa womersleyi* Baker and Hoffmann, 1948 in almost all characters, hence it is fixed so. It is the first report from Kerala from two new habitats viz., *Psidium guajava* L., *Bauhinia acuminata* L.

Genus: *Dactyloscirus* Berlese, 1916

1916. *Scirus* (*Dactyloscirus*) Berlese, Centuria Seconda di Acari Nuovi, *Redia.*, **12(1)**: 127– 177.
1931. *Scirus* (*Dactyloscirus*), Vitzthum, In: Kukenthal and Krumbach, *Handbuch der Zoologie.*, **3** (2): 1– 161.
1941. *Scirus* (*Dactyloscirus*), Thor and Willmann, *Das Tierreich.*, **71**: 1– 186.
1952. *Scirus* (*Dactyloscirus*), Baker and Wharton, *Macmillan Co, N.Y.* p. 465.
1922. *Rosenhofia* Oudemans, Acarologische Anteekeningen LX VII. *Entomol. Ber. (Amst.)*, **7**(157) : 257– 268.
1979. *Rosenhofia* ,Den Heyer, *Phytophylactia*, **11**(157): 257– 268.
1975. *Dactyloscirus*, Smiley, *Ann. Entomol. Soc. Am.*, **68** (2): 227– 244.
1977. *Dactyloscirus*, Chaudhari, *Pak. J. Agric. Sci.*, **14**:41– 52.
1984. *Dactyloscirus*, Sepsgosarian, *Zeit. Ang. Zool.*, **71**: 135– 150.
1985. *Dactyloscirus*, Liang, *Entomotaxonima* , **7** (1): 79– 829.
1992. *Dactyloscirus*, Smiley, *Cuaxidae (Acari) of the World*, Indira Publishing House., p. 214– 245.
1996. *Dactyloscirus*, Swift, *Anales del Instituto Biologia, Universidad Nacional Autonoma de Mexico, Serie Zoologia.*, **67**(2):225– 237.
2006. *Dactyloscirus*, Bashir and Afzal, *Pakistan J. Zool.*, **38** (4), 273– 278.

Diagnosis: Propodosoma ornamented with reticulated patterns of minute granulated striae. Hysterosoma with or without shields. Tarsal segments usually terminating with two strong lateral bilobed flanges. Palpus 5 segmented extending beyond apex of hypostome; strong lateral elongated or

spine like apophysis on segments II and III, and sometimes on IV. Leg I – IV robust and not tapering distally.

Type species: *Scirus (Dactyloscirus) eupaloides* Berlese

***Dactyloscirus vanajae* sp.nov.**

PLATE 89 (A, B)

Female: Idiosoma 514 long, 293 wide including gnathosoma.

Dorsum: Dorsal shield 350 long and 215 wide. Chelicerae as figured. Gnathosoma 164 long and 78 wide. Hypostome subrectangular, semicone shaped distally. Propodosoma with a smooth subrectangular shield originating behind the base of gnathosoma, extending to anterior region of hysterosoma. Hysterosoma without a subrectangular reticulated median shield. Both propodosoma and hysterosoma non striated and non reticulated. Shield with anterior and posterior sensillae, propodosomal setae P_1 and P_2 are equal. Anterior sensillae 202 long and posterior sensillae 204 long. Ratio between anterior sensillae and posterior sensillae is 0.99. Setae P_1 , P_2 – 4, D_1 – 5, D_2 – 4, D_3 – 4, D_4 – 12, D_5 – 12 each with sharp and pointed tip, L_1 – 4.

Palpal Chaetotaxy: Length of palp 320, palpi 5 segmented, trochanter none, basifemur with one dorsomedian spine like seta, telofemur inner surface with long finger like apophysis, one dorsomedian spine like seta and dorsolateral spine like seta. Genu inner surface with one medially long simple seta, one spine like dorsomedian seta and one spine like lateral seta. Tibiotarsus inner surface with short simple seta, medially with one stout spine like seta, outer surface with one thorn like dorsolateral seta; one terminal simple seta and small claw.

Venter: Idiosoma – shows striations between leg II and leg III. Coxae I and II contiguous connected by small lateral apodemes. Coxae III and IV coalesced, broader than coxae I and II. Venter with 5 pairs of setae between coxae II and distal part of body in addition to genital and anal setae. Genital plate with 4 pairs of subequal simple setae. Anal plate bearing 2 pairs of long simple setae. Length of Leg I–291, Leg II–278, Leg III–303 and Leg IV– 405.

Leg Chaetotaxy: Coxae: 3– 2– 4– 3, trochanter: 1– 1– 2– 1; basifemur: 4– 4– 4– 2; telofemur I– II: 3 and 4; telofemur III: 1 attenuate solenidion plus 3; telofemur IV: one spine like seta plus 2 ; genu I: 1 attenuate solenidion plus 4; genu II: 1 attenuate solenidion plus 5; genu III: 1 attenuate solenidion plus 4; genu– IV: 1 attenuate solenidion plus 5; tibia I: 1 attenuate solenidion plus 3, tibia II: 1 attenuate solenidion plus 5, tibia III: 1attenuate solenidion plus 4, tibia IV: 1 long trichobothrium plus 4 ; tarsus I: 1 attenuate solenidion plus 8, tarsus II: 1 solinidion plus 9; tarsus III: 1 attenuate solenidion plus 6, tarsus IV: 1 attenuate solinidion plus 12.

Male: Unknown.

Habitat: *Syzygium samarangense* (Blume)

Material examined: Holotype ♀ marked on the slide INDIA: KERALA: Pazhur (Kozhikode district), 25.ix.2015, ex. *Syzygium samarangense* coll. Santhosh (No.P.539/1). Three paratype slides with 3 ♀♀ marked on the slide from same habitat (No.P 539/2, 539/3, 539/4).

Remarks: This new species closely resembles *Dactyloscirus machairodus* (Oudemans), 1992 in general appearance but differs in the following features;

1. In the new species, idiosoma 514 long and 293 wide whereas in *D. machairodus* it is 306 long, 217 wide.
2. In the new species, both propodosoma and hysterosoma smooth whereas in *D. machairodus*, propodosoma is reticulated and hysterosoma finely striated.
3. P_1 and P_2 equal in new species whereas in *D. machairodus*, P_1 about one half as long as P_2 .
4. No striations present in the junction between propodosoma and hysterosoma.
5. D_4 and D_5 about one half longer than setae D_1 , D_2 , D_3 and L_1 in the new species whereas in *D. machairodus*, D_4 and D_5 about one fourth longer than setae D_1 , D_2 , D_3 and L_1 .
6. In the new species, palpi 320 long but in *D. machairodus*, palpi 191 long.
7. In the new species palpal telofemur inner surface with a long apophysis whereas in *D. machairodus*, telofemur inner surface with a short peg like setae and dorsomedian spine like setae present.

Subfamily: Cunaxoidinae Den heyer, 1978

Diagnosis: Pedipalp 3 segmented, trochanter without setae, fused femurogenua complemented with 5 or 6 setae and tibiotarsus complemented with 5 or 6 setae. Tibiotarsi may be complemented with a bladder or bulb-like apophysis. Pedipalps not reach beyond the subcapitulum by more than the distal half of the tibiotarsi. Chelicera with or without seta near the cheliceral digit. Subcapitulum with 4 pairs of setae (hg_{1-4}) present; setae hg_4 is often the longest, 2 pairs of adoral setae are present or absent.

Type: *Eupalus* Koch, 1838

Genus: *Neocunaxoides* Smiley, 1975.

1975. *Neocunaxoides* Smiley, *Ann.Entomol.Soc.Am.*, **68** (2):227– 244.
1977. *Neocunaxoides*, Chaudhari, *Pak. J.Agric.Sci.*, **14**:41– 52.
1979. *Neocunaxoides*, Den Heyer, *Acarologia*, **20** (3):338– 350.
1980. *Neocunaxoides*, Den Heyer, *Acarologia*, **21** (2): 187– 193.
1979. *Neocunaxoides*, Kuznetsov and Livshitz, *Trudy Gosud.Nik. Bot.Sad.*, **79**:51– 105.
1980. *Neocunaxoides*, Gupta and Ghosh, *Rec.Zool.Surv.India*, **77**:189– 213
1980. *Neocunaxoides*, Tseng, *Q. J.Taiwan Mus.*, **33**(3, 4):253– 227.
1982. *Neocunaxoides*, Michocka, *Acarologia*, **23** : 327– 332.
1984. *Neocunaxoides*, Sepasgosarian, *Zeit. Ang. Zool.*, **71**:135– 150
1989. *Neocunaxoides*, Inayatullah and Shahid, *Pak. J. Zool.*, **21**(3): 221–228.
1992. *Neocunaxoides*, Smiley, *Cuaxidae (Acari) of the World*, Indira Publishing House.,p. 274– 298.
2001. *Neocunaxoides*, Lin *et al.*, *Sys. Appl. Acarol.*, **6**: 145–153.
2003. *Neocunaxoides*, Lin *et al.*, *Sys. Appl. Acarol.*, **8**: 101–106.
2009. *Neocunaxoides*, Castro and Den Heyer, *Zootaxa*, **2141**: 20–36.

Diagnosis: Dorsum with a single shield extending from apical propodosoma into hysterosomal region. Shield extending above or below coxae IV. Setae L₄ absent. Palpus 3 segmented with distal segment usually possessing 2 or 3 knoblike apophyses or single spur or flange like setae. The femurogenua is complemented with 6 setae. Idiosoma venter with 4 to 7 plates. The coxal plates are sclerotized and well– defined. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV

may be fused. Each coxal plate is complemented with 2– 4 setae. The genital plates each bear 4 setae (g_1 – g_4) that are usually in a straight row; 2 pairs of genital papillae are visible underneath the plates. The anal plates bear a single pair of setae; a single pair of setae is present ventrally on the integument near the anal plates. A trichobothrium is present on leg tibia IV. A cheliceral seta is present.

Type species: *Scutopalus latisetosus* Den Heyer, 1980.

Key to the species of *Neocunaxoides* included in the present study

1. The setae D₁–D₅ thin, narrow and pointed.....
..... *Neocunaxoides raghavani* sp.nov.
- D₁–D₅ thick and blunt 2
2. Ratio of anterior and posterior propodosomal sensilla equal to 0.4.....
..... *Neocunaxoides anithae* sp.nov.
- Anterior and posterior propodosomal sensilla equal to 1.3
..... *Neocunaxoides kottakkalensis* sp.nov.

Neocunaxoides anithae sp.nov.

PLATE 90 (A, B)

Female: Idiosoma 408 long, 227 wide including gnathosoma.

Dorsum: Dorsal shield 212 long, 190 wide originating from anterior propodosoma and extending posteriorly only upto the region of metapodosoma. Gnathosoma – 105 long and 76 wide. Hypostome subrectangular, attenuate distally. Chelicerae as figured. Propodosoma covers 1/3 of the dorsal shield and a slight demarcation present on the setae between

D₁ and D₂. Dorsal shield smooth on propodosomal region and dot like punctuations present on hysterosomal region. Thick longitudinal striations present laterally on the area around the dorsal shield. Anterior sensillae 71 long, posterior sensillae 101 long and serrate. Ratio between anterior and posterior sensillae is 0.7. Setae P₁ – 37, P₂ – 18, D₁ – 25, D₂ – 17, D₃ – 17, D₄ – 20, D₅ – 17, h₁ – 9, h₂ – 4 and L₁ – minute.

Palpal Chaetotaxy: Length of palp 75, palpi 3 segmented, trochanter none, femurogenua with 4 outer lateral simple seta; 1 long medial simple seta; tibiotarsus club shaped with 4 lateral minute setae and 2 long median setae. Apophysis absent.

Venter: Idiosoma – ventral anterior portion divided medially forming one single sternal plate with coxae I and II. Each side of the plate with 4 setae. Coxae III and IV coalesced forming two separate, strong, elongate lateral plates with 6 simple setae. Genital plate with 4 pairs of simple setae. Anal plate wide with 5 pairs of setae. Ventral side shows longitudinal striations on entire medial plate excluding lateral side. Length of Leg I– 200, Leg II– 215, Leg III– 210 and Leg IV – 240.

Leg Chaetotaxy: Coxae: 2– 1– 3– 3; trochanter: 1– 1– 2– 1; basifemur: 2– 4– 4– 1; telofemur: 3– 3– 4– 1; genu I: 4 attenuate solenidia plus 2; genu II: 2 attenuate solenidia plus 3; genu III: 3 attenuate solenidia plus 1; genu IV: 2 attenuate solenidia plus 5; tibia I: 1 attenuate solenidion plus 4; tibia II: 1 attenuate solenidion plus 5; tibia III: 2 attenuate solenidia plus 3; tibia IV: 1 long trichobothrium plus 5 ; tarsus I: 1 attenuate solenidion plus 8; tarsus II: 1 long solinidion plus 5; tarsus III: 1 long trichobothrium plus 4; tarsus IV: 1 long trichobothrium plus 5.

Male: Unknown.

Habitat: *Ophiorrhiza mungos* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Arya Vaidhyasala Herbal Garden, Kottakkal (Malappuram district), 25.xii.2015, ex. *Ophiorrhiza mungos* L., coll. Santhosh, (No.K.674/1). Four paratype slides with 4 ♀♀ from the same habitat (No. K 674/2, 674/3, 674/4).

Remarks: This new species closely resembles *Neocunaxoides latisetosus* (Den Heyer), 1980 in general appearance but differs in the following features;

1. In the new species, idiosoma 408 long, 227 wide whereas in *N. latisetosus*, it is 325 long and 215 wide.
2. Dorsal setae thick and serrated in the new species whereas in *N. latisetosus*, it is spatulated.
3. In the new species, setae L_1 minute whereas in *N. latisetosus*, setae L_1 one half length of setae $D_1 - D_5$.
4. Dot like punctuations present only on hysterosomal shield in the new species, whereas in *N. latisetosus*, dot like punctuations present entirely on dorsal shield.
5. In the new species, no tooth like apophysis present on tibiotarsus whereas in *N. latisetosus*, two teeth like apophysis present.
6. Leg chaetotactic formula differs in both species. In the new species, basifemur I–IV: 4–5–3–1, telofemur I–IV: 4–4–3–2 whereas in *N. latisetosus*, basifemur I–IV: 2–4–4–1, telofemur I–IV: 3–3–4–1.

***Neocunaxoides kottakkalensis* sp.nov.**

PLATE 91

Female: Idiosoma 404 long, 227 wide including gnathosoma.

Dorsum: Dorsal shield 280 long, 227 wide originating from anterior propodosoma and extending posteriorly upto the region of metapodosoma. Dorsal shield has a small propodosomal shield 63 long, 131 wide and large rounded hysterosomal shield with 149 long, 172 wide. Chelicerae as figured. Length of gnathosoma 124, width 75, hypostome subrectangular, attenuate distally. Shield with dot like punctuations on both propodosomal and hysterosomal plate. Thick longitudinal striations present laterally on the area around the dorsal shield. Anterior sensillae 106 long, posterior 81 long. Ratio between anterior sensillae to posterior sensillae is 1.3. Setae P_1 – 22, P_2 – 25, D_1 – 25, D_2 – 22, D_3 – 27, D_4 – 24, D_5 – minute, h_1 , h_2 – minute, L_1 – 13.

Palpal Chaetotaxy: Length of palp 82, palpi 3 segmented, trochanter none, femurogenua with 3 median long setae; one simple lateral seta. Tibiotarsus with 6 setae; one long seta on tibia and 5 short setae on tarsus. Apophysis absent.

Venter: Idiosoma – ventral side shows longitudinal striations on entire medial plate but not laterally. Anterior portion of venter divided medially forming one single sternal plate with coxae I and II. The sternal plate appears like the neck of a pot. Each side of the plate with 4 setae. Anterior portion of sternal shield look like mouth of a pot with transverse striations and rest with longitudinal striations. Coxae III and IV coalesced forming triangular inner side with 4 pairs of setae on each side. Four pairs of simple setae present

adjacent to lateral and genital plate. Anal shield conical shape with 4 pairs of setae. Length of Leg I– 253, Leg II– 227, Leg III– 225 and Leg IV– 253.

Leg Chaetotaxy: Coxae : 2– 2– 4– 3 ; trochanter: 1– 1– 2– 1 ; basifemur: 4– 3– 3– 1; telofemur: 4– 4– 3– 3; genu I: 2 attenuate solenidia plus 4; genu II: 1 attenuate solenidion plus 4; genu III: 1 attenuate solenidion plus 4; genu IV: 1 attenuate solenidion plus 4; tibia I: 2 attenuate solenidia plus 2; tibia II– 1 attenuate solenidion plus 2; tibia III: 2 attenuate solenidia plus 2; tibia IV: 1 long trichobothridium plus 3 ; tarsus I: 2 attenuate solenidia plus 4, tarsus II: 2 solinidia plus 3; tarsus III: 1 attenuate solenidion plus 5; tarsus IV: 1 attenuate solenidion plus 4.

Male: Unknown

Habitat: *Hibiscus rosa-sinensis* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Arya Vaidhya sala Herbal Garden, Arya Vaidyasala, Kottakkal (Malappuram district), 3.xi.2015, ex. *Hibiscus rosa-sinensis* L., coll. Santhosh (No.H.598/1). Four paratype slides with 4 ♀♀ marked from the same habitat (No.H. 598/2, 598/3, 598/4, 598/5).

Remarks: This new species closely resembles *Neocunaxoides clathratus* (Shiba), 1978, in general appearance but differs from the following features;

1. In the new species, idiosoma 404 long, 227 wide whereas in *N. clathratus*, it is 365 long and 160 wide.
2. Dorsal setae rod shaped in the new species whereas in *N. clathratus*, it is club shaped.

3. In *N. clathratus*, dot like punctuations present all over the dorsal body surface whereas in the new species, it is restricted on propodosomal and hysterosomal shields only.
4. Palpi 82 long in the new species whereas in *N. clathratus*, it is 63 long.
5. Femurogenua with 4 setae in the new species instead of 5.
6. In the new species, tibiotarsus with no apophysis whereas in *N. clathratus*, single apophysis present.
7. Sternal plate with 4 pairs of simple setae in the new species whereas in *N. clathratus*, 6 pairs of setae present.
8. Leg chaetotactic formula differs in both species. In the new species, Coxae I– IV: 2– 2– 4– 3, basifemur I– IV: 4– 3– 3– 1, telofemur I– IV: 4– 4– 3– 3 setae present whereas in *N. clathratus*, Coxae I– IV: 3– 2– 3– 2, basifemur I– IV: 2– 2– 2– 2, telofemur I– IV: 4– 4– 4– 4 setae present. Leg chaetotactic formula of genu, tibia and tarsus also differs in both species.

***Neocunaxoides raghavani* sp.nov.**

PLATE 92 (A, B)

Female: Idiosoma: Length 260, width 186 including gnathosoma.

Dorsum: Dorsal shield 179 long and 100 wide originating from anterior propodosoma and extending posteriorly only upto the region of metapodosoma. Gnathosoma– 81 long, 86 wide. Hypostome subrectangular, attenuate distally. Chelicerae as shown in the figure. Shield with dot like punctuations present only on the posterior end of propodosoma. Thick

longitudinal striations present laterally on the area around the dorsal shield. Anterior sensillae 88 long and posterior one 75 long, serrate. Ratio between anterior sensillae to posterior sensillae is 1.2. Setae P_1 – 25, P_2 – 12, D_1 – 12, D_2 – 12, D_3 – 13, D_4 – 15, D_5 – 13, h_1 , h_2 – minute, L_1 – 8.

Palpal chaetotaxy: Length of palp 56, palpi 3 segmented, trochanter none, femurogenua with setae 5; 3 outer lateral simple setae; two anterior and one posterior; tibiotarsus with 4 outer lateral setae and one anterior setae. Apophysis absent.

Venter: Idiosoma – ventral anterior portion is continuous medially forming one single non divided sternal plate with coxae I and II. Each side of the plate with 3 setae. Coxae III and IV coalesced forming two separate, strong, elongate lateral plates with 3 simple setae. Genital plate with 4 pairs of simple setae. Anal plate wide with 5 pairs of setae. Ventral side shows longitudinal striations on entire plate. Length of Leg I – 164, Leg II – 131, Leg III – 144 and Leg IV – 188.

Leg chaetotaxy: Coxae: 3– 1– 2– 1; trochanter : 1– 1– 2– 1; basifemur : 3– 3– 2– 1; telofemur : 4– 2– 2– 2; genu I: 2 attenuate solenidia plus 6; genu II: 3 attenuate solenidia plus 2; genu III: 1 attenuate solenidion plus 3, genu IV– 3 attenuate solenidia plus 4; tibia I– 2 attenuate solenidia plus 2; tibia II: 1 attenuate solenidion plus 2; tibia III: 2 attenuate solenidia plus 2; tibia IV: 1 long trichobothrium plus 2 ; tarsus I: 2 attenuate solenidia plus 8 ; tarsus II: 1 long solenidion plus 4; tarsus III: 2 attenuate solenidia plus 6; tarsus IV with 8 setae.

Male: Unknown.

Habitat: *Citrus medica* L.

Material examined: Holotype ♀ marked on the slide INDIA: KERALA: Kavumvattam (Kozhikode district), 24.x.2015, ex.*Citrus medica* L. coll. Santhosh (No.K.336/1). Two paratype slides with 2 ♀♀ marked on the slide from the same habitat (No.K. 336/1, 336/2).

Remarks: This new species closely resembles *Neocunaxoides biswasi* Gupta and Chattopadhyay, 1978 in general appearance but differs in the following features.

1. In the new species, idiosoma 260 long and 186 wide whereas in *N. biswasi*, it is 339 long and 173 wide.
2. In the new species, thick longitudinal striations present on the lateral margin of dorsal body surface, whereas *N.biswasi*, no striations present on the lateral margin of dorsal body surface.
3. In *N.biswasi*, setae D_4 and D_5 longer than D_1 and D_3 , but it is same length in the new species.
4. Ventral anterior portion divided forming two distinct plates with coxae I and II, on each side with 6 setae in *N.biswasi*, whereas in the new species no division present and each sternal plate is with 4 setae.
5. In the new species, femurogenua with 5 setae, whereas in *N.biswasi*, femurogenua with 7 setae.
6. Apophysis is absent in new the species whereas in *N.biswasi*, two apophysis present on tibiotarsus.
7. Leg chaetotactic formula of new species, coxae I– IV: 3– 1– 2– 1, basifemur I– IV: 3– 3– 2– 1 and telofemur I– IV: 4– 2– 2– 2 with 1

solenidion whereas in *N.biswasi*, coxae I– IV: 3– 2– 3– 2, basifemur I– IV: 2– 5– 2– 1 and telofemur I– IV: 5– 5– 4– 3. Leg chaetotactic formula of genu, tibia and tarsus also differs in both species.

Superfamily: Cheyletoidea

6.2.3 Family: CHEYLETIDAE Leach, 1815

1815. Cheyletidae: Leach, *Trans. Linn.Soc. Lond.*, **11** (2): 306– 400.
- 1886 Cheyletidae : Canestrini, *Acarofauna Italiana.*, 168– 178
1878. Cheyletidae: Megnin, *Jour.de I Anat. et Physiol. (Paris)*.**14**:416–441.
1892. Cheyletidae: Canestrini, *Prospetto dell Acarofauna, 5. Abbozo del sistema acarologico.* Padova. **99**: 111.
1938. Cheyletidae: Ewing, *Proc.Entomol.Soc. Washington.* **40** (7): 180– 197.
1949. Cheyletidae: Baker, *Proc.U.S Nat.Mus.*, **99** (3238): 267– 320.
1949. Cheyletidae: Volgin, *Dokl. AN SSSR*, **64** (4):583– 586
1954. Cheyletidae: Dubinin, *Izv. AN SSAR, Seriya Biol.*, **4**: 59– 75.
1955. Cheyletidae: Cunliffe, *Proc.Entomol. Soc. Washington.* **57** (5): 209– 218.
1957. Cheyletidae: Dubinin, *Parazitol.sb.*, **17**: 71– 136.
1906. Cheyletidae: Oudemans, *Mem.Soc.Zool.France.* **19**: 36– 218
1961. Cheyletidae: Southcott, *Tr. Inst. Aust. Jour.Zoology.* **9** (3): 367– 610.
1962. Cheyletidae: De Leon, *Florida Entomol.*, **45** (3): 129– 137
1965. Cheyletidae: Vainshtein, *Tr. Inst. Biologii Vnutr. Vod AN S.S.S.R.*,**8**, **11**: 66– 83.
1967. Cheyletidae: Camin *et al.*, *J. Med. Entomol.*, **4** (3): 261– 272.

1969. Cheyletidae: Volgin, Acarina of the family: Cheyletidae, World fauna, *Zool.Inst., Operedel.p.Faune S.S.S.R.*, **101**: 1– 432.
1970. Cheyletidae: Smiley, *Proc.Entomol.Soc., Washington.*, **72** (2): 229.
1970. Cheyletidae: Summers and Price, *Univ. Calif Publ. Entomol.*, **61**: 1– 153
1973. Cheyletidae: Meyer *et al.*, *Ent.Mem.Dep.Agr.Tech Serv.*, **29**: 13p.
1978. Cheyletidae: Volgin, *Entomol. Review.*, **57** : 149– 152
1979. Cheyletidae: Fain, *Internat. J. Acarol.*, **5**(4): 305– 310
1981. Cheyletidae: Smiley and Whitaker, *Internat. J. Acarol.*, **7**:1– 4
1999. Cheyletidae: Fain and Smiley, *Entomolologie*, **69**:35– 86
2000. Cheyletidae: Alex Fain and Fariba Ardeshir, *Internat. J. Acarol.*, **26**(4): 329– 334,
2002. Cheyletidae: Alex Fain and Andre V. Bochkov, *Internat. J. Acarol.* **28**(1): 37– 40.
2001. Cheyletidae: Bochkov and Fain, *Entomologie*, **71**:5– 36.
2004. Cheyletidae: Bochkov, *Parasitologia*, **38**:122– 137
2005. Cheyletidae: Bochkov *et al.*, *Belg. J. Entomol.* **7**: 99– 109.
2013. Cheyletidae: Chernichko and Kivganov, *Vestnik zoologii*, **47** (1):82–86
2014. Cheyletidae: Negma and Mebah, *Internat. J. Acarol.*, **40** (5): 390–396.

Diagnosis: This family includes small mites about 0.2 to 1.6 mm long. Body colour is whitish, pale yellow, orange and more rarely brownish. Body distinctly divided into large gnathosoma with complex oral appendages and non segmented idiosoma with 4 pairs of ambulatory legs. Gnathosoma with a pair of well developed palpi, terminating in hamate claw and tarsus, usually

with one or two pectinate setae. Rostrum usually conical, oral apparatus stylet like. Peritreme with varying number of links on gnathosoma. Idiosoma rhomboidal or oval in shape. Dorsal side of idiosoma divided into propodosoma and hysterosoma with one or two sclerotized shields on it. Propodosoma usually with one small lenticular eye on each side between second and third pairs of marginal setae. Standard set of marginal setae on dorsal side of the body typical; 4 pairs on propodosoma and 5 pairs on hysterosoma. Setae piliform, squamiform or both. In many species, dorsocentral setae of female differs markedly from marginals in shape and size. Genital pore of females situated on ventral side of idiosoma along its posterior margin or rarely terminal. In males, it is on either terminal or dorsal side of body. Legs ambulatory with elongated apical segments. Coxae, trochanters, femora and genua with not more than two setae, usually 4 on tibiae and 7 or 8 on tarsi. Sexual dimorphism usually well developed.

6.2.3.1 Morphology and Terminology

Body has divided into gnathosoma and non segmented idiosoma. Gnathosoma consist of complex oral appendages, a pair of well developed palpi, terminating in hamate claw and tarsus, usually with one or two pectinate setae. Peritreme present on the gnathosoma with varying number of links. Idiosoma rhomboidal or oval in shape. Dorsal side of idiosoma divided into propodosoma and hysterosoma with one or two sclerotized shields on it. Idiosoma with 4 pairs of ambulatory legs. Propodosoma usually with one small lenticular eye on each side between second and third pairs of marginal setae. Standard set of marginal setae on dorsal side of the body consists of 4 pairs on propodosoma and 5 pairs on hysterosoma.

The terminology used for the body setae follows Fain (1979c) and Gerson (1994). Morphological terms are adopted from Volgin (1969) and Summers and Price (1970). Numbers in bracket refers to solinidia.

6.2.3.1.1 Setal Terminology (Plate: 94)

V_i	–	Anterior sensillum
V_e	–	Anterior simple setae
Sci	–	Posterior simple setae
Sce	–	Posterior sensillum
$d_1 - d_5$	–	Dorsomedian setae
N	–	Neotrichial setae
h	–	Humeral setae
$l_1 - l_5$	–	Lumbar setae
ic	–	Intercoxal setae
$a_1 - a_3$	–	Anal setae
$g_1 - g_3$	–	Genital setae

Subfamily: **CHEYLETINAE** Leach 1815.

1815. Cheyletinae: Leach, *Trans. Linn. Soc. Lond.*, **11** (2): 306–400.

Diagnosis: Palpal tarsi with one or two pectinate setae exceptionally absent dorsal setae on idiosoma squamiform, palpal claws with basal processes. Tarsi I and II elongated. Propodosoma often with eyes. Dorsal setae on idiosoma usually not piliform but thickened, lanceolate or squamiform. Genital pore of males located terminally, more rarely dorsally, but at very edge of posterior margin of idiosoma. Palpal claws of females curve laterally.

Type Genus: *Cheyletus* Latreille, 1796

Key to the genera of the family Cheyletidae included in the present study

1. Palp genu with 2 piliform setae *Cheyletus* Latreille, 1796
- Palp genu with 1 squamiform setae 2
2. Idiosoma with one large propodosomal shield and two small juxtaposed hysterosomal shield *Cheletomimus* Oudemans, 1904.
- Idiosoma with one large, granulated propodosomal shield and hysterosomal shield *Hemicheyletia* Volgin, 1969

Key to the species of Cheyletidae included in the present study

1. Eyes not evident..... *Cheyletus kunduparambensis* sp.nov.
- A pair of eyes present 2
2. Dorsum of hysterosoma with two small hysterosomal plates.....
..... *Cheletomimus melongenae* sp. nov.
- Dorsum of hysterosoma with single median plate 3
3. Dorsomedian body setae conventional form..... 4
- Dorsomedian body setae aberrant..... 7
4. First pair of dorsolateral hysterosomal setae on principal plate.....
..... *Hemicheyletia congensis* (Cunliffe)
- First pair of dorsolateral hysterosomal setae on separate trivial platelete.
..... 5
5. 3 pairs of dorsomedian setae on hysterosomal plate
..... *Hemicheyletia wellsi* (Baker)
- One pair of dorsomedian seta on hysterosomal plate..... 6

6. 3 pairs of median setae on propodosomal plate
.....*Hemicheyletia parvathiae* sp. nov.
- 3 pairs of dorsomedian setae on propodosomal plate.....
.....*Hemicheyletia cordovensis* (De Leon)
7. Hysterosomal plate distinct *Hemicheyletia aswini* sp.nov.
- Hysterosomal plate obsolete..... 8
8. Hysterosomal plate bears 2 pairs of dorsolateral setae plus one pair of
dorsomedian setae.....
.....*Hemicheyletia serrula* Summers and Price 1978.
- Hysterosomal plate unidentifiable only as a small patch of peculiarly
whorled striae carries no setae*Hemicheyletia volgini* (Cunliffe)

Genus: *Cheyletus* Latreille, 1796

1796. *Cheyletus* Latreille, *Precis des caracteres generiques des Insektes, disposees dans un ordre naturel*. Paris, **1**: 201.
1903. *Cheyletus*, Oudemans, *Entomol. Bericht Nederl.*, **46**: 93– 134.
1949. *Cheyletus*, Volgin, *Dokl. AN S.S.S.R.*, **64** (4): 583– 586.
1960. *Cheyletus*, Domrow, *Acarologia*, **2**: 456 – 460.
2001. *Cheyletus*, Fain and Bochkov, *Bull. Inst. R. Sci. Nat. Belg.* **71**: 83– 114.
2003. *Cheyletus*, Bochkov and Oconnor, *Internat. J. Acarol.*, **29** (4):327– 330.

Diagnosis: Gnathosoma moderate in size or large. Palpal femora with 3 setae – one dorsal and 2 ventral; genua with 2 setae; setae on femora, genua and tibia piliform or slightly thickened. Palpal claws with one to 4 basal process. Rostrum small; rostral shield usually cuneiform at apex. Peritreme with 8 –

11 pairs of segments or links. Dorsal side of idiosoma usually with 2 well developed shields except in male of *C. baloghi* Volgin, in which one propodosomal and 2 hysterosomal shields present. Eyes absent. All propodosomal setae situated on shield. Outer lumbar setae usually located outside the hysterosomal shield. Marginal setae on dorsal shield and lateral setae on idiosoma is piliform, broaden slightly or lanceolate. Dorsal setae on femora, genua and tibiae piliform, broaden slightly or lanceolate other setae invariably piliform. Tibia I with short dorsal solenidion and 5 setae, protective setae on tarsi I piliform or crenate, rarely absent. Pretarsi I short. Tarsi II with solenidion on ventral side, proximate to ventrocentral setae. Claw on tarsi I much smaller than those of other legs. Sexual dimorphism usually well developed.

Type species: *Acarus eruditus* Schrank, 1781

***Cheyletus kunduparambensis* sp.nov.**

PLATE 95

Female: Idiosoma 364 long, 255 wide, gnathosoma 113 long and 81 wide.

Gnathosoma: Tegmen smooth, protegmen with 2 pairs of short acicular setae, one ventral and one lateral, ventral setae longer than lateral. ‘M’ shaped peritreme consists of 8 links on each side. Hypostomal setae smooth, 75 long. Palp femur 75 long and 75 wide, genu short 12 long, palp claw bears 2 strong teeth. Palp tarsus with 2 combs like and 2 sickle shaped setae, inner comb with 22 – 24 minute teeth and outer comb with 16 – 18 teeth. Number of setae on palp segments as follows: femur with 3 setae – one dorsal piliform and 2 ventral long piliform; genu with 2 slightly barbed setae; tibia

with 3 setae – 2 piliform and one feathered. Dorsal setae of palpal femur 70 long.

Dorsum – Idiosoma with 13 pairs of setae and one pair of humerals, all setae long and plumose. Propodosomal and hysterosomal shield smooth without striae and granules, lateral margin of idiosoma finely striated. Propodosomal plate trapezoidal, broader than hysterosoma measuring 156 long and 202 wide with 4 pairs of marginal long feather like setae almost equal in size, one pair of long feathery humerals also present on propodosoma. Hysterosomal plate transverse, 164 long and 126 wide. Total 9 pairs of setae present on hysterosoma of which 7 pairs on hysterosomal plate and 2 pairs set on independently out of the hysterosomal plate (1st and 5th lumbar). Dorsomedian setae arranged on the posterior end as a group of setae, d_2 long and feathery all other setae small, feathery and equal in size. Dimension of setae as follows: Vi – 50, Ve – 37, sci – 63, sce – 50, h_2 – 126, d_2 – 32, d_3 , d_4 and d_5 – 25 each. l_1 – l_2 and l_3 – 50 each, l_4 – 37 and l_5 – 63 long.

Venter: Idiosomal venter finely striated with one pair of setae between coxae II, 2 medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. One pair of anal setae simple and 2 posterior pairs of anal setae long, thickened and feathery.

Leg: Length of leg I – IV: 275, 227, 232 and 316 respectively, leg I / idiosoma = 0.8. Leg chaetotaxy : coxae 2– 3– 2– 3; trochanter 2– 2– 2– 1; femur 4– 3– 4– 3; genu 4– 4– 4– 4; tibia 1– 1– 1– 1; tarsus 1(2)– 4– 2– 4. Tarsi I – solinidion 37 long. Guard setae present.

Male: Unknown

Habitat: *Syzygium samarangense* (Blume)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kunduparamba (Kozhikode district), 18.viii.2015, ex. *Syzygium samarangense* (Blume), coll. Santhosh, (No.D.194/1). Two paratype slides with 2 ♀♀, collection details same as above (No.D. 194/2, 194/3).

Remarks: This new species closely resembles *Cheyletus malaccensis* Oudemans, 1903 in general structure, papal chaetotaxy and propodosomal setal pattern, but differs from it in the following characters.

1. A well marked striation pattern present on the idiosomal region around the propodosomal and hysterosomal shield which is absent in *C. malaccensis*.
2. Peritreme consist of 8– 9 links on each side, whereas in *C. malaccensis* it is 6– 7.
3. Hysterosomal plate bearing central setae; d_2 , d_3 , d_4 and d_5 all are equal in length (25) whereas in *C. malaccensis* central setae generally absent but may occurs sporadically in asymmetrical arrangement as very small setae with flat blade like appearance.
4. Ventral side compactly striated and anal setae a_2 and a_3 long and feathery.
5. Papal tarsus inner comb with 22 – 24 teeth and outer combs with 16 – 18 teeth whereas in *C. malaccensis* both combs with 15 tines each.
6. Leg chaetotaxy of femur– 2– 2– 2– 1, Genu– 3– 2– 2– 2 and tibia – 6– 4– 4– 4 in *C. malaccensis*, where as in the new species femur– 4– 3– 4– 3, genu– 4– 4– 4– 4 and tibia – 1– 1– 1– 1 respectively.

Genus: *Cheletomimus* Oudemans, 1904.

1904. *Cheletomimus* Oudemans, *Entomol.Bericht.Nederl.*, **1**,**18**: 160– 164.

1906. *Cheletomimus* Oudemans, *Mem.Soc.Zool.France.*, **19**: 136– 139.

1955. *Cheletomimus*, Volgin, *Akad.Nauk S.S.S.R., Zool.Inst., Opre del.p. Faune S.S.S.R.*, **59**: 171– 172

1961. *Cheletomimus*, Yunker, *Canadian Ent.*, **93** (11): 1032.

1962. *Cheletomimus*, De Leon, *Florida Ent.*, **45**(3): 134.

1964. *Cheletomimus*, Muma, *Florida Ent.*, **47**(4): 242– 243.

Diagnosis: Gnathosoma free or rather large with small but massive palpi. Palpal femora enlarged with 4 setae – one dorsal squamiform, one thickened lateral and two ventral proximate piliform. Genu with one dorsal squamiform seta. Tibia with thickened dorsal and ventral setae. Palpal claw present. Rostrum small, with distinct densely granulated dorsal shield. Peritreme broadly curved with 6 – 7 pairs of segments. Idiosoma somewhat elongated, with one large propodosomal shield and 2 small hysterosomal shield. Dorsal idiosomal setae including lateral and central setae are short, narrowly squamiform, lanceolate or fusiform. Eyes well developed. No shields on ventral side of idiosoma. Genital pore small, located at posterior margin of idiosoma. All setae of genito-anal group piliform. Legs shorter than idiosoma. Coxae of posterior legs widely separated. Femora, genua and tibia of all legs somewhat elongated, their dorsal setae narrowly squamiform, lanceolate, hastate or thickened. Femora IV with one seta. Tibia of all legs with 4 setae. Tarsi I with large dorsoapical papilla. Solinidion rather long with vestigial piliform protective seta. Ventrocentral setae on tarsi I piliform.

Type species: *Cheletomimus berlesei* Oudemans, 1904

***Cheletomimus melongenae* sp.nov.**

PLATE 96

Female: Idiosoma 190 long, 165 wide, gnathosoma 76 long and 56 wide.

Gnathosoma: Rostrum ovoid, rostral shield densely granulated, anterior apical section pointed, 2 pairs of short acicular setae, one ventral and one lateral, ventral setae longer than lateral. Bracket shaped peritreme with 5 links on each side, protegmen moderately and tegmen densely granulated on anterior apex. Palp femur longer than wide, 50 long and 38 wide, genu short 12 long, palp claw bears 6 teeth, palp tarsus with 2 combs like and 2 sickle like setae. Inner comb finely tined with 20 – 22 minute teeth, outer comb with 12– 14 teeth. Number of setae on palp segments as follows: femur with 4 setae – one dorsal squamiform, one lateral lanciolate and 2 ventral long and piliform; genu– one squamiform and tibia with 3 setae- 2 piliform and one finely barbed. Dorsal setae of palpal femur 20 long.

Dorsum: Idiosoma densely granulated on propodosomal shield, moderately granulated and finely striated on hysterosomal region. Lateral sides of idiosoma finely striated. Idiosoma bears 14 pairs of squamiform setae including humerals, eyes present, each eyes encircled with striae. Propodosomal shield 88 long and 126 wide, trapezoidal, with rounded angle and slightly convex posterior margins, thickly granulated, 6 pairs of squamiform setae – 4 pairs of marginals and 2 pairs of centrals on propodosoma, approximately equal in size. One pair of humerals present laterally on separate plate encircled by 3– 4 concentric striae. Hysterosoma with 7 pairs of squamiform setae of which one pair setae (l_2) independently set on a small, rounded hysterosomal plate, surface of shield minutely granulated. All other setae set on very small

sclerites encircled with fine striae. An entire hysterosomal plate is absent. Dimension of setae as follows: $Vi - 15$, $Ve - 15$, $sci - 15$, $sce - 15$, $h_2 - 17$, d_1 , $d_2 - 13$, $d_5 - 7$, $N_1 - 10$, $l_1 - 17$, $l_2 - 10$, $l_3 - 14$, $l_4 - 15$ and $l_5 - 25$ long.

Venter: Idiosomal venter striated on posteriorly around the coxae of leg III and IV, with one pair of setae between coxae II, two medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. A small plate bearing 3 pairs of anal setae also present.

Leg: Length of leg I – IV: 170, 113, 141 and 151 respectively, leg I/idiosoma = 0.9. Leg chaetotaxy: coxae 3 – 2– 3– 2; trochanter 1– 1– 2– 1; femur 2– 2– 2– 1; genu 2– 2– 1– 1; Tibia 4– 4– 4– 4; Tarsus 4(1) – 6– 6– 3. Tarsi I – solinidion piliform with 24 long, guard setae absent.

Male: Unknown

Habitat: *Solanum melongena* L.

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 13.x.2015, ex. *Solanum melongena* L., coll. Santhosh, (No.D.491/1). Two ♀ ♀ paratype slides marked on the slide, from the same host plant (No. D 491/2, 491/3).

Remarks: This new species closely resembles *Cheletomimus berlesei* (Oudemans), 1904 in general appearance, palpal chaetotaxy, number of setae present on hysterosomal plate etc., but differs in the following characters,

1. In the new species, 2 pairs of median setae present on propodosomal plate whereas in *C. berlesei*, it is 3 pairs.
2. Peritreme with 5 links in the new species instead of 7.

3. In the new species, idiosomal lateral margin densely striated whereas in *C. berlesei*, it is less striated.
4. Dorsal body setae 20– 35 long in *C. berlesei*, whereas in the new species it is 10 – 17 long.
5. There is a remarkable difference exist in the leg chaetotaxy of new species and *C. berlesei*. Leg setae of *C. berlesei*: Femur: 2– 2– 2– 1, genu: 3– 2– 2– 1, tibia: 5– 4– 4– 4 and tarsus: 9– 8– 7– 7 whereas in the new species, femur: 2– 2– 1– 1, genu: 2– 2– 1– 1, tibia: 4– 4– 4– 4 and tarsus: 5– 6– 6– 3 respectively.

This new species also shows similarity to *Cheletomimus duosetosus* Muma, 1964 but differs in following features.

1. In *C. duosetosus* only a pair of dorsal median setae on propodosomal shield, whereas in new species it is 2 pairs.
2. Number of setae on leg I – IV also differs in both species.

Genus: *Hemicheyletia* Volgin, 1969.

1962. *Paracheyletia* Cunliffe, *Proc.Entom. Soc.Washington*, **64**, **3**: 197– 202
1962. *Paracheyletia bakeri* Ehara, *Annotat. Zoologicae Japon.*, **35**, **2**: 106– 111.
1964. *Paracheyletia bakeri*, Muma, *Florida Ent.*, **47**(4): 245.
1969. *Hemicheyletia*, Volgin, *Akad.Nauk S.S.S.R., Zool. Inst. Opre del. p. Faune S.S.S.R.*, **101**:202– 203.
1969. *Hemicheyletia*, De Leon, *Akad.Nauk S.S.S.R., Zool.Inst.,Opre del.p. Faune S.S.S.R.*, **101**:204– 205.

1975. *Hemicheyletia*, Jefiey and Campbell, *J. Stored Prod. Res.*, **11** (2); 103–105.
1976. *Hemicheyletia*, Shiba, *Nature Life in South East Asia*, **7**: 83–229.
1994. *Hemicheyletia*, Lin *et al.* *Wuyi. Sci. J.*, **11**: 141–143.
1998. *Hemicheyletia*, Corpuz–Raros, *Internat. J. Acarol.*, **24**: 259–290.
2005. *Hemicheyletia*, Kamran, *Pak. J. Agri. Sci.*, **42**: 3–4

Diagnosis: Gnathosoma quite large, with small but massive palpi. Palpal femora convex on outer side and almost equal in length and width. Femora with 4 setae each – one dorsal, one lateral and 2 ventral; dorsal seta on femora squamiform, lateral narrowly squamiform or lanceolate and ventral piliform. Genua with one dorsal squamiform seta. All setae on palpal tibiae piliform. Palpal claw with 6 to 11 minute dentiform processes on basal half. Tarsi with 2 pectinate setae and two piliform. Rostrum small, with quite broad apical section; rostral shield densely granulated; its anterior margin straight or slightly rounded. Peritremes bracket shaped with two large granulated shields. All setae on idiosoma, including central monotypic, squamiform. Eyes well developed. Lateral setae of idiosoma squamiform. Genital pore small and situated on posterior margin of idiosoma; genital valve negligible; genitoanal region not defined; all setae on genitoanal group piliform. Legs moderate in size, notably shorter than idiosoma. Coxae of posterior legs widely separated. Tibia of all legs with 4 setae. Solinidion slender, located on small papiliform projection on basal third of tarsus I; protective setae short and piliform or absent. Dorsal setae on femora, genua and tibiae squamiform or lanceolate. Tarsi of all legs monotypic.

Type species: *Paracheyletia bakeri* Ehara, 1962

***Hemicheyletia aswini* sp.nov.**

PLATE 97

Female: Idiosoma 278 long, 253 wide, gnathosoma 113 and 75 wide.

Gnathosoma: Tegmen finely granulated with closely packed, thickened segments of broken striae, principally longitudinal, rostrum broad, protegmen similarly adorned with 2 pairs of short acicular setae, one ventral and one lateral, ventral setae longer than lateral. Peritreme arch shaped with 4 links on each side. Palp femur 50 long and 50 wide, genu 14 long. Palp claw bears 6 teeth, palp tarsus with 2 combs like and 2 sickle like setae. Inner comb with 22 – 24 minute teeth, outer comb with 13 – 15 teeth. Number of setae on palp segments is as follows: femur with 4 setae, one dorsal squamiform, one lateral lanciolate and 2 ventral piliform, genu with one squamiform, and tibia with 3 setae – one piliform and 2 thick finely barbed. Dorsal setae of palpal femur 30 long.

Dorsum: Idiosoma thickly granulated on propodosomal plate and hysterosomal plate with 18 pairs of setae including humerals. Eleven pairs of fan like idiosomal setae and others are simple. Lateral margin of idiosoma finely striated on hysterosomal region. Eyes present, protrude outward, encircled by 2– 4 concentric rows of unbroken striae. Propodosomal plate well marked laterally measuring 101 long and 189 wide with 8 pairs of setae and one pair of humerals. Hysterosomal plate shaped like inverted triangle, rounded at posterior apex 126 long and 184 wide. Total 8 pairs of setae present on hysterosoma in which 7 pairs of setae present on hysterosomal plate and one pair set on independently out of the hysterosomal plate. Dimension of setae as follows: V_i – 25, V_e – 25, sci – 22, sce – 18, h_2 – 32, d_1 ,

d_2 , and d_3 simple, d_4 absent, d_5 — 12, N_1, N_2, N_3 minute and cloudy. l_1 — 15, l_2 — 25, l_3 — 17, l_4 — 15 and l_5 — 13 long.

Venter: Idiosomal venter finely striated with one pair of setae between coxae II, two medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. A small plate bearing 4 pairs of anal setae.

Leg: Length of leg I – IV: 240, 189, 177 and 215 respectively, leg I / idiosoma = 0.9. Leg chaetotactic formula of leg as follows; coxae : 1– 1– 2– 1; trochanter: 1– 1– 1(1)– 1; femur: 1(1)– 1(1)– 2– 1; genu: 1(1)– 1(1)– 2– 2; tibia: 2(2)– 2(2)– 2(3)– 2(2); tarsus : 5(1), 5, 5, 5. Tarsi I – solinidion 37 long, guard setae absent.

Male: Unknown

Habitat: *Solanum melongena* (L.)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Thekkumthara (Wayanad district), 1.xii.2015, ex. *Solanum melongena* (L.), coll. Santhosh, (No.D.818/1). Two paratype slides with 3 ♀♀, collection details same as above. (No.D.818/2, 818/3).

Remarks: This new species closely resembles *Hemicheyletia wellsi* (Baker), 1949 in dorsal chaetotaxy, number of claws on tibial palp, teeth present on inner and outer comb but differs in the following characters,

1. In *H. wellsi*, length of idiosoma 302 and gnathosoma 105, whereas in new species it is 278 and 113 respectively.
2. In new species, peritreme with 4 links in each side whereas in *H. wellsi*, it has 6 links and first link curved outward behind its point of origin.

3. Dorsocentral setae spatulated in *H. wellsi*, whereas in new species it forms short setae.
4. Dorsomedian setae stag horn like in *H. wellsi*, whereas in the new species it is simple.
5. Length ratio of leg I / idiosoma 0.7 in *H. wellsi*, whereas in the new species, it is 0.86.
6. Number of leg setae differs in both species. In *H. wellsi*, tibia: 5– 5– 4– 4, tarsus: 9– 8– 7– 7 whereas in new species, tibia: 4– 4– 4– 4 and tarsus: 6– 5– 5– 5 respectively.

***Hemicheyletia congensis* (Cunliffe), 1962**

PLATE 98

1962. *Paracheyletia congensis* Cunliffe, *Pro. Ent. Soc. Wash.*, **64** (3): 197.

1969. *Hemicheyletia congensis* (Cunliffe), Volgin, *Akad. Nank SSSR, Zool. Inst. Opre del.* **101**: 203– 204.

Female: Idiosoma 339 long, 321 wide, gnathosoma 139 long and 75 wide.

Gnathosoma: Rostrum spade shaped with 2 pairs of short acicular setae, one ventral and one lateral, ventral setae longer than lateral. Peritreme with 6 links on each side, first pair comma shaped, curved rearward as well as outward behind median origin. All links are equal and unornamented. Protegmen and tegmen finely granulated on the centre. Hypostomal setae smooth, 30 long. Palp femur 63 long and wide, genu 37 long. Palp claw bears 8– 9 teeth. Palp tarsus with 2 combs like and 2 sickles like setae. Inner comb with 25– 27 minute teeth, outer comb with 18– 20 teeth. Number of setae on

palp segments as follows: femur 4, genu 1 and tibia 3; all piliform, smooth or finely barbed. Dorsal setae of palpal femur 37 long.

Dorsum: Idiosoma densely granulated with 15 pairs of fan like setae including humerals. Eyes present. Propodosoma squarish, 113 long, 202 wide with 7 pairs of fan like setae – 4 pairs of marginals and 3 pairs of medians and 1 pair of humerals. Hysterosoma 118 long, 139 wide with 7 pairs of setae. Hysterosomal plate shaped like inverted triangle, rounded at posterior apex with 7 pairs of setae – 6 pairs of marginals and 1 pair of median setae. First and sixth marginals set on independent platelets. Dimension of setae as follows: $V_i - 30$, $V_e - 30$, $sci - 25$, $sce - 25$, $h_2 - 37$, $d_1 - 20$, $d_2 - 20$, d_3 and d_4 absent, $d_5 - 25$, $N_1 - 27$, $N_2 - 25$. l_1 , l_2 , $l_5 - 25$ each, l_3 and $l_4 - 23$ each.

Venter: Idiosomal venter with one pair of setae between coxae II, two medioventral pairs anterior to coxae III and 3 pairs medioventral genital setae, a small plate bearing 5 pairs of anal setae.

Leg: Length of leg I – IV: 232, 207, 200 and 202 respectively, leg I / idiosoma = 0.7. Leg chaetotaxy; coxae: 2– 1– 2– 2; trochanter: 1– 2– 2– 1; femur: 2– 2– 2– 1; genu: 2(1)– 2– 2– 1; tibia: 4 (1)– 4– 4– 4; tarsus: 4(1), 7, 6, 5. Tarsi I – solinidion 30 long, guard setae present.

Male: Unknown

Habitat: *Solanum melongena* L.

Known habitat: *Acacia* sps, Australian pine, Avacado and Berlinia

Material examined: Female marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 19.ix.2015, ex. *Solanum melongena* L., coll.

Santhosh, (No.D.301/1). Four ♀♀ marked on the slide from the same habitat (No.D. 301/2, 301/3).

Distribution: Australia, Belgium

Remarks: The specimen examined agrees with *Hemicheyletia congensis* (Cunliffe), 1962 in almost all characters and hence fixed so. This is a new report from India from a new host plant viz., *Solanum melongena* (L.)

Hemicheyletia cordovensis (De Leon), 1962

PLATE 99

1962. *Cheyletia cordovensis* De Leon, *Florida Ent.* **45** (3): 129– 130.

1969. *Cheyletia cordovensis*, Volgin, Akad.Nank SSSR, *Zool.Inst., Opre del.* **101**: 204– 205.

Female: Idiosma 268, 240 wide, gnathosoma 126 long, 101 wide.

Gnathosoma: Tegmen with closely packed, thickened segments of broken striae, principally longitudinal, rostrum broad, protegmen similarly adorned with 2 pairs of short acicular setae, one ventral and one lateral, peritreme with 4– 6 links on each side. Hypostomal setae smooth 25 long, palp femur 48 long and 55 wide, genu 13 long, palp claw bears 8 teeth, palp tarsus with 2 combs like and 2 sickle like setae. Inner comb with 16 – 18 minute teeth, outer comb with 20 – 22 teeth. Number of setae on palp segments as follows: femur 4, genu 1 and tibia 3; all piliform, smooth or finely barbed. Dorsal setae of palpal femur 25 long.

Dorsum: Idiosoma finely granulated on propodosomal plate and none granulated on hysterosomal plate with total 12 pairs of fan like setae and one

pair humerals. Lateral margin of idiosoma finely striated, eyes present, comparatively large and encircled by 3 – 4 concentric rows of unbroken striae. Propodosomal plate broader than hysterosoma measuring 111 long and 177 wide with 5 pairs of fan like setae and one pair of humerals. Hysterosomal plate shaped like inverted triangle rounded at posterior apex 88 long and 139 wide. Total 7 pairs of setae present on hysterosoma of which 6 pairs of setae present on hysterosomal plate and 1 pair set on independently out of the hysterosomal plate. Dimension of setae as follows: V_i – 20, V_e – 15, sci – 17, sce – 17, h_2 – 22, d_1 – 10, d_2 – 7 and cloudy, d_3 and d_4 absent, d_5 – 7, N_1 – N_2 – absent. l_1 – 20, l_2 , l_3 – 15 each, l_4 and l_5 – 12 long.

Venter: Idiosomal venter finely striated with one pair of setae between coxae II, 2 medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. A small plate bearing 5 pairs of anal setae.

Leg: Length of leg I – IV: 215, 156, 189 and 192 respectively, leg I / idiosoma = 0.8. Leg chaetotaxy: coxae: 2– 1– 2– 2; trochanter: 1– 1– 1– 1; femur: 2– 2– 2– 1; genu: 2– 2– 2– 2; tibia: 4(1) – 4– 4– 4; tarsus: 4(1), 4(1), 5, 5. Tarsi I – solinidion 25 long. Guard setae present.

Male: Unknown

Habitat: *Averrhoa bilimbi* L.

Known Habitat: *Phoebe psychotrioides* (Mez.)

Material examined: Female marked on the slide, INDIA: KERALA: Herbal garden, Malabar Christian College (Kozhikode district), 7.xi.2015, ex. *Averrhoa bilimbi* L., coll. Santhosh, (No.D.585/1). Two ♀♀ from same habitat (No.D. 584/1, 584/2).

Distribution: Australia.

Remarks: The specimen examined agrees with *Hemicheyletia cordovens* (De Leon), 1962 in almost all characters and hence fixed so. This is a new report from India. *Averrhoa bilimbi* L. is the new host plant reported from the survey.

***Hemicheyletia parvathiae* sp.nov.**

PLATE 100

Female: Idiosoma 316 long, 301 wide, gnathosoma 139 long, 113 wide.

Gnathosoma: Larger, rostrum spade shaped with sharp stylet. Bracket shaped peritreme with 7 links on each side and unornamented. Protegmen moderately and tegmen densely granulated on anterior apex. Hypostomal setae long and smooth 50 long. Palp femora bulge notably on outer side, 55 long and 54 wide, genu 25 long, palp claw bears 7 teeth, palp tarsus with 2 combs like and 2 sickle like setae. Inner comb with 20– 22 minute teeth, outer comb with 16– 18 teeth. Number of setae on palp segments as follows: femur with 4 setae: one dorsal squamiform, one lateral lanciolate and 2 ventral long piliform. Genu with one squamiform and tibia with 3 setae –one piliform and 2 thick finely barbed. Dorsal setae of palpal femur 27 long.

Dorsum: Idiosoma densely granulated on both propodosomal and hysterosomal plate. Lateral sides covered with fine striations. Idiosoma bears 15 pairs of squamiform setae including humerals. Eyes present, each eyes encircled with 3– 4 concentric unbroken striae. Propodosoma 111 long and 202 wide, semicircular and ornamented with thick granules on entire shield, 7 pairs of squamiform setae (4 pairs of marginals and 3 pairs of medians)

present on propodosoma approximately equal size. One pair of humerals present laterally on separate plate. Hysterosomal plate 113 long, 139 wide with fine granules on entire shield, shaped like inverted triangle rounded at posterior apex with 5 pairs of setae. Lumbar setae first pair located outside the shield and sixth pair posterior to hysterosomal plate set on independent platelets. Dimension of setae as follows: V_i , V_e – 25, sci – 25, sce – 22, h_2 – 35, d_1 , d_2 – 25 each, d_3 and d_4 absent, d_5 – 15, N_1 – 25, N_2 – 22. l_1 , l_2 , l_5 – 25 each, l_3 – 27 and l_4 – 15 long.

Venter: Idiosomal venter finely striated with one pair of setae between coxae II, two medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. A small plate bearing 5 pairs of anal setae also present.

Leg: Length of leg I – IV: 240, 215, 200 and 215 respectively, leg I / idiosoma = 0.8. Leg chaetotaxy; coxae: 2– 1– 2– 2; trochanter: 1– 1– 2– 1; femur: 1(1)– 1(1)– 1(1)– 1, genu: 2– 2– 2– 1; tibia: 4– 4– 4– 4; Tarsus: 2(1), 6, 5, 5. Tarsi I – solinidion 37 long. Guard setae absent.

Male: Unknown

Habitat: *Benincasa hispida* (Thunb)

Material examined: Holotype ♀ marked on the slide, INDIA: KERALA: Kadalundi (Kozhikode district), 3.xi.2015, ex. *Benincasa hispida* (Thunb), coll. Santhosh, (No.D. 606/1). Two paratype slides with 2 ♀♀ collection details same as above (No.D. 606/2, 606/3).

Remarks: This new species closely resembles *Hemicheyletia congensis* (Cunliffe), 1962 in general appearance, papal chaetotaxy but differs in following characters,

1. In the new species, idiosoma 316 long and 301 wide whereas in *H. congensis* it is 382 and 223 respectively.
2. In *H. congensis*, hysterosomal plate is like an inverted triangular shaped with rounded posterior apex whereas in the new species posterior apex of hysterosomal plate clearly straightened and encircled with smooth striations.
3. Peritreme with 7 links in new species instead of 6.
4. In the new species, palpal claw with 8– 9 teeth, where as in *H. congensis* there is 7– 11 teeth.
5. There is a remarkable variation shown in the length ratio of leg II and III. In *H. congensis*, leg II ratio is 0.55, leg III is 0.59 whereas in new species it is 0.68 and 0.63 respectively.
6. Length ratio of gnathosoma / idiosoma of *H. congensis* is 0.50, whereas in the new species it is 0.43.
7. In the new species, hysterosomal setae more leaf like than *H. congensis*.
8. The propodosomal setae of new species less spatulate than that of the propodosomal setae of *H. congensis*.

Hemicheyletia serrula Summers and Price 1970.

PLATE 101

1970. *Hemicheyletia serrula* , new species ,Summers and Price , *The Mite family Cheyletidae, Uni. Cali. Pub. Ento.*, p. 15-16

Female: Idiosoma 283 long, 237 wide, gnathosoma 101 long and 50 wide.

Gnathosoma: Rostrum spade shaped with 2 pairs of short acicular setae, one ventral and one lateral, ventral setae longer (25) than lateral (13). Peritreme bracket shaped with 4 links on each side, all segments are equal. Protegmen and tegmen finely granulated on middle. Hypostomal setae smooth 38 long, palp femur 50 long and 50 wide, genu 13 long, palp claw bears 8 teeth, palp tarsus with 2 combs like and 2 sickle like setae. Inner comb with 20– 22 minute teeth and outer comb with 12 teeth. Number of setae on palp segments as follows: femur with 4 setae, one dorsal squamiform, one lateral lanciolate and 2 ventral piliform. Genu with one squamiform and tibia with 2 setae – all piliform, smooth or finely barbed. Dorsal setae of palpal femur 30 long.

Dorsum: Idiosoma finely striated with 15 pairs of fan like setae including humerals, eyes present. Propodosoma wider than longer, finely granulated, 106 long and 177 wide with 7 pairs of setae (4 pairs of marginals fan like and 3 pairs of medians are minute cloudy) and one pair of humerals. Hysterosomal plate (88 long, 113 wide) square shaped with 7 pairs of setae; 5 pairs of marginals and 2 pairs of medians on hysterosomal plate. Dimension of setae as follows: V_i – 20, V_e – 22, sci – 20, sce – 20, h_2 – 30, d_1 and d_2 – minute cloud like, d_3 and d_5 absent, d_4 – 12, N_1 and N_2 cloudy – l_1 – 17, l_2 , l_3 and l_4 – 23 each l_5 – 25 long.

Venter: Idiosomal venter finely striated with one pair of setae between coxae II, two medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. A small plate bearing 5 pairs of anal setae.

Leg: Length of leg I – IV: 207, 151, 169 and 202 respectively, leg I / idiosoma = 0.7. Leg Chaetotaxy: coxae 1(1)– 1– 2– 2; Trochanter 1– 1– 1– 1; Femur 1(1)– 1(1)– 1– 1; Genu 2– 1(1)– 1– 1; Tibia 4– 4– 4– 4; Tarsus 3(1), 4, 4, 6. Tarsi I – solinidion 32 long. Guard setae absent.

Male: Unknown

Habitat: *Wrightia tinctoria* (Roxb.)

Known Habitat: Rotting vegetation in rock crevice.

Material examined: Female marked on the slide, INDIA: KERALA: Botanical Garden, Calicut University (Malappuram district), 10.ix.2015, ex. *Wrightia tinctoria* (Roxb.), coll. Santhosh, (No.D.197/1). 4 ♀ ♀ from the same habitat (No.D. 197/2).

Distribution: Galapagos Islands.

Remarks: The specimen studied agrees with *Hemicheyletia serrula* (Summers and Price), 1970 in almost all characters and hence fixed so. It is a new report from India from a new habitat viz., *Wrightia tinctoria* (Roxb.)

Hemicheyletia volgini (Cunliffe), 1969.

PLATE 102

1962. *Paracheyletia volgini* (Cunliffe), *Proe. Ent. Soe. Wash.* **64** (3): 197– 198.

1969. *Hemicheyletia (Dendrocheylea) volgini* (Cunliffe), Volgin, *Aead. Nauk. SSSR., Zool. Inst., opredel.* **101**: 210– 211.

Female: Idiosoma 253 long, 225 wide, gnathosoma 126 long and 113 wide.

Gnathosoma: Stylophore extends considerably in front of peritreme as elevated protegmen. Rostrum protrude well beyond front fold of protegmen with 2 pairs of short acicular setae, one ventral and one lateral, ventral setae longer than lateral. Peritreme with 6 segments on each side, approximately horse shoeshaped, rearward bend not acute. Hypostomal setae smooth 25

long. Palp femur 45 long and 60 wide, Genu 13 long. Palp claw bears 8– 9 teeth. Palp tarsus with 2 combs like and 2 sickle like setae. Inner comb with 16 –18 minute teeth, outer comb with 20 – 22 teeth. Number of setae on palp segments as follows: femur 4, genu 1, tibia 3; all piliform, smooth or finely barbed. Dorsal setae of palpal femur 37 long.

Dorsum: Idiosoma finely granulated with 15 pairs of fan like setae including humerals. Eyes present. Propodosomal lateral margin not much evident, 111 long, 177 wide with 8 pairs of fan like setae – 4 pairs of marginals, 3 pairs of medians and one pair of humerals. Hysterosomal plate 88 long and 139 wide, highly variable, usually covering most of the hysterosoma. Dorsolateral margin not clearly shaped. Total 7 pairs of setae; 6 pairs of marginal setae and a single pair of median. First pair of marginal set on independent platelets. Dimension of setae as follows: Vi – 25, Ve – 25, sci – 25, sce – 22, h_2 – 27, d_1 and d_2 – minute and cloudy, d_3 and d_4 absent, d_5 – 17, N_1 – N_2 – minute and cloudy. l_1 – 25, l_2 and l_3 – 22 each, l_4 – 20 and l_5 – 15 long.

Venter: Idiosomal venter with one pair of setae between coxae II , 2 medioventral pairs anterior to coxae and 3 pairs of medioventral genital setae , a small plate bearing 5 pairs of anal setae.

Leg: Length of leg I– IV: 225, 187, 189 and 207 respectively, leg I / idiosoma = 0.9. Leg chaetotaxy: coxae 2– 1– 2– 2; trochanter 1– 1– 2– 1; femur 2– 2– 2– 1; genu 2– 2– 2– 1; tibia 4(1)– 4– 4– 4; tarsus 4(1), 5(1), 4(2), 3(2). Tarsi I – solinidion 40 long, guard setae not visible.

Male: Unknown

Habitat: *Solanum melongena* L.

Known Habitat: Australian Pine.

Material examined: Female marked on the slide, INDIA: KERALA: Mankavu (Kozhikode district), 13.x.2015, ex. *Solanum melongena* L., coll. Santhosh, (No.D.489/1). 5 ♀♀ marked on the slide from the same habitat (No.D. 490/1, 490/2, 490/3).

Distribution: Outside India: Congo (Kinshana), Mulunga.

Remarks: The specimen examined agrees with *Hemicheyletia volgini* (Cunliffe), 1962 in almost all characters and hence fixed so. In the present survey *Hemicheyletia volgini* was recovered from a new host plant, *Solanum melongena* (L.). It is the first report from India.

***Hemicheyletia wellsi* (Baker), 1949**

PLATE 103

1949. *Cheyletia wellsi* Baker, *Proc.US. Nat. Mus.*, **99** (3238): 300– 301

1995. *Paracheyletia wellsi* (Baker), Volgin, *Akad.Nank SSSR, Zool. Inst.,Opredel.* **59**: 169.

1964. *Paracheyletia wellsi* (Baker), Muma, *Florida Ent.* **47** (4):245– 246.

1962. *Cheyletia wellsi* Baker, De Leon, *Florida Ent.*, **45** (3) : 132.

1969. *Dendrocheyla wellsi* (Baker), Volgin, *Akad.Nank SSSR, Zool.Inst.,Opredel.* **101**: 211– 213

Female: Idiosoma 316 long, 291 wide, gnathosoma 113 long and 81 wide.

Gnathosoma: Tegmen densely granulated, protegmen similarly adorned with 2 pairs of short acicular setae, one ventral and one lateral, peritreme with 6 links on each side. Hypostomal setae smooth 50 long, palp femur 63 long, 63

wide, genu 25 long, palp claw bears 6 teeth, palp tarsus with 2 combs like and 2 sickle like setae. Inner comb with 18– 20 minute teeth, outer comb with 22 – 24 teeth. Number of setae on palp segments as follows: femur 4, genu 1, and tibia 3, of these, 2 piliform and one lanceolate. Dorsal setae of palp femur 32 long.

Dorsum: Idiosoma with 16 pairs of setae and one pair humerals densely granulated on propodosomal plate and moderately granulated on hysterosomal plate. Lateral margin of idiosoma finely striated, eyes present, comparatively large and encircled by 3– 4 concentric rows of unbroken striae. Propodosomal plate broader than hysterosoma measuring 113 long and 164 wide with 4 pairs of marginal fan like setae, 4 pairs of dorsomedian setae and one pair of humerals. Of these, 2 pairs of dorsomedian setae on propodosomal plate are aberrant, each has stubbed shaft barely projecting above the rim and possess a cluster of 10– 12 indistinct cloudy sclerites. The other 2 pairs of dorsomedian setae form a bud like appearance set on small plate. Central area of propodosoma bears several whorls of dotted striae. Hysterosomal plate is shaped like an inverted pyramid rounded at posterior apex, 113 long and 126 wide. Total 8 pairs of setae present on hysterosoma in which 6 pairs of setae are on hysterosomal plate and 2 pairs set on independent plate (1st and 6th lumbar). Dorsomedian setae (d_1 , d_2) form a bud like appearance and each set on small plate. Dimension of setae as follows: Vi – 25, Ve – 23, sci – 23, sce – 13, h_2 – 25, d_1 , d_2 , d_3 minute, and d_4 absent, d_5 – 12, N_1 – N_3 minute and cloudy. l_1 – 20, l_2 , l_3 – 15 each, l_4 – 12 and l_5 – 15 long.

Venter: Idiosomal venter finely striated with one pair of setae between coxae II, two medioventral pairs anterior to coxae III and 3 pairs of medioventral genital setae. A small plate bearing 5 pairs of anal setae.

Leg: Length of leg I – IV: 265, 202, 200 and 215 respectively, leg I / idiosoma = 0.8. Leg chaetotaxy: coxae 2– 1– 2– 2; trochanter 1– 1– 2– 1; femur 2– 2– 1– 1; genu 2–2–2–2; tibia 4(1)–4–4–4, tarsus 4(1),5(1),5,4(2). Tarsi I – solinidion 37 long, guard setae very short and minute.

Male: Unknown

Habitat: *Solanum melongena* L.

Known Habitat: *Opuntia*, grape leaves, grass, *Cynodon dactylon*

Material examined: Female marked on the slide, INDIA: KERALA: Thekkumthara (Wayanad district), 1.xii.2015, ex. *Solanum melongena* L., coll. Santhosh, (No.D.820/1). 2 ♀ ♀ slides marked from the same habitat (No.D.820/2).

Distribution: Argentina, La cruz, Chile, Australia, Chile, China (Shichuan, Fujian and Taiwan), Cuba, Hawaiian Is., India, Jamaica, Japan, Mexico, Philippines, Puerto Rico, South Africa, Takabannare Is., U.S.A and Turkey.

Remarks: The specimen studied agrees with *Hemicheyletia wellsi* (Baker), 1949 in almost all characters and hence fixed so. In the present survey *Hemicheyletia wellsi* was recovered from a new host plant, *Solanum melongena* (L.). It is the first report from Kerala.

6.2.4 Family: STIGMAEIDAE Oudemans, 1931

1931. Stigmaeidae Oudemans, *Entomol. Ber. Nederl.*, **7** (158): 252.

1952. Stigmaeidae: Baker and Wharton, *An Intro. Acarol., Mac Millan Co New York*, p. 465 .

1955. Stigmaeidae: Cunliffe, *Proc. Entomol. Wash.*, **57** (5): 209 – 218.

1955. Stigmaeidae: Summers and Schilinger, *Hilgardia*, **34** (12): 539 – 561.
1962. Stigmaeidae: Summers, *Hilgardia*, **33**: 491.
1964. Stigmaeidae: Wood, *N. Z. J. Sci.*, **7**: 579
1965. Stigmaeidae: Gonzalez, *Univ. Calif. Publ. Entomol.*, **41**: 64.
1966. Stigmaeidae: Summers, *Acarologia*, **8** (2): 230 – 250.
1968. Stigmaeidae: Wood, *N. Z. J. Sci.*, **11**: 277-279
1969. Stigmaeidae: Meyer, *Acarologia*, **11**: 227-271.
1971. Stigmaeidae: Wood, *N. Zool. J. Sci.*, **14**(1): 54 – 61.
1972. Stigmaeidae: Wood, *Acarologia*, **13**: 301.
1974. Stigmaeidae: Wood, *Acarologia*, **16**: 62.
1985. Stigmaeidae: Gupta, *Handbook. Plant Mites of India*, p.301.
1985. Stigmaeidae: Sepasgosarian, *Z. Angew. Zool.*, **72**: 440.
1987. Stigmaeidae, Ueckermann and Smith-Meyer, *Phytophylactica*, **19**: 371.
1988. Stigmaeidae, Vacante and Gerson, *Redia*, **70**: 385-401.
1989. Stigmaeidae: Barilo, *Zool. Zh.*, **68**: 134 - 138.
1990. Stigmaeidae: Cheng-ye and Lairong, *Acta Entomologica Sinica*, **15**: 461-462.
1990. Stigmaeidae: Lairong and Cheng-ye, *Entomotaxonomica*, **9**: 307-311.
1990. Stigmaeidae: Sepasgosarian, *Ent. Mtt. zool. Mus.Hamburg*, **10 NR. 139/140**: 75.
1992. Stigmaeidae: Hu-siquin-Chen-Xiwen, *J. Jiangxi Univ.*, **16**: 108-110.
1992. Stigmaeidae: Gupta, In: *State Fauna Ser. 3, Fauna of West Bengal, Part 3*, p. 117.
1994. Stigmaeidae: Hu Siquen *et al.*, *Acta Arachnologica Sinica*, **3**: 91-93.
1994. Stigmaeidae: Hu Siquin and Chen Xiwen, *Acta Arachnologica Sinica*, **3**: 1-4.

1997. Stigmaeidae: Gupta and Chatterjee, In: *State Fauna Ser.6, Fauna of Delhi*, p. 517.
2001. Stigmaeidae: Zhu *et al.*, *J. Jiangxi Inst. Edu.*, **22** (3): 50-52.
2002. Stigmaeidae: Fan and Zhang, *Sys. Appl. Acarol.*, **7**: 149-158.
2002. Stigmaeidae: Gupta, *Memoirs. Zool. Surv. India*. **19** (2): 1-159.
2003. Stigmaeidae: Fan *et al.*, *Invertebrate Sys.*, **17**:551-574
2004. Stigmaeidae: Fan and Zang, *Zootaxa*, **763**:1-28
2005. Stigmaeidae: Fan and Zang, *Fauna of New Zealand*, **52**:1-400
2008. Stigmaeidae: Ueckerman, *Internat. J. Acarol.*, **34**(2): 251-258.
2010. Stigmaeidae: Fan and Chen, *Zoosymposia*, **4**: 120-132
2011. Stigmaeidae: Donel and Dogan, *Zootaxa*, **2942**: 1-56.
2012. Stigmaeidae: Navaei-Bonab *et al.*, *Persian J. Acarol.*, **1**(2):57-76
2013. Stigmaeidae: Hajizadeh *et al.*, *Internat. J. Acarol.*, **39** (7): 571-579
2015. Stigmaeidae: Dogan *et al.*, *Internat. J. Acarol.*, **41** (4):290-299.
2015. Stigmaeidae: Ma *et al.*, *Zootaxa*, **4006**: 1-39.
2016. Stigmaeidae: Fan *et al.*, *Zootaxa*, **4176** (1): 1-199.

Diagnosis: Absence of peritreme or stigmata. Dorsum of idiosoma nude or covered by 2 shields or partially covered by 2 or more shields. Chelicerae free or may be fused, palp tibia with a prominent claw which is sometimes with a small accessory claw. Palp tarsus is a short appendage with which the main claw forms a thumb claw complex. Most of the species with 3 tined fork at the tip of palptarsus. Tracheal system originated in the middle between basal pieces of chelicerae. Genital and anal vestibules closed externally by a single pair of genitoanal covers.

Type **Genus:** *Stigmaeus* Koch, 1836

6.2.4 .1 Morphology and Terminology (Plate. 105)

A prominent claw present on Palptibia. A thumb claw complex present on the main claw of palptarsus. Most of the species with 3 tined fork at the tip of palptasus. Tracheal system originated from the basal pieces of chelicerae, having no stigmata or peritreme. A single pair of genitoanal covers for both genital and anal vestibules.

The setal nomenclature follows that of Grandjean's (1944), with modifications and additions made by Summers (1962), Gonzalez (1965) and Meyer (1969).

The following abbreviations were used:

- a and b - Dorsocentral setae
- ae - Vertical dorsal setae
- be - Preocular dorsal setae
- c - Mediozonal setae
- ce and de - Post ocular dorsal setae
- e - Central suranal setae
- he - Humeral setae
- pg₁-pg₄ - Paragenital setae
- la - Dorsolateral dorsal setae
- le - Lateral suranal setae
- lm - Lateral zonal setae
- g - Genital setae

Genus: *Agistemus* Summers, 1960

1927. *Zetzellia* Oudemans, *Ent. Ber. Amst.*, **7** (158) : 263.
1960. *Agistemus* Summers, *Proc. Ent. Soc. Wash.*, **62** : 234.
1965. *Agistemus*, Gonzalez-Rodriguez, *Univ. Calif. Pub. Ent.*, **41** : 24.
1966. *Agistemus*, Summers, *Acarologia*. **8**(2): 240.
1967. *Zetzellia*, Wood, *Trans. Roy. Soc. N. Z.*, **9**(9): 125.
1969. *Agistemus*, Meyer, *Acarologia*. **11**(2): 256.
1982. *Zetzellia*, Tseng, *Phytopath. Entomol. National Taiwan Univ.*, **9**: 5
1984. *Agistemus*, Bolland and Ueckermann, *Phytophylactica*. **16**: 201.
1985. *Agistemus*, Sepasgosarian, *Z. Angew. zool.*, **72**: 440
1985. *Agistemus*, Chaudhri and Akbar, *Univ. Agri. Faisalabad*. p. 262.
1987. *Agistemus*, Ueckermann and Smith-Meyer, *Phytophylactica.*, **19** : 381.
1992. *Agistemus*, Gupta, In: *State Fauna Ser, 3, Fauna of West Bengal. Part 3*, p. 117.
1994. *Agistemus*, Siqin and Xiwen, *Acta Arachnologica Sinica*, **3** (1): 1.
1997. *Agistemus*, Gupta and Chatterjee, In: *State Fauna Ser. 6, Fauna of Delhi*, p. 517.
2002. *Agistemus*, Matioli *et al.*, *Internat. J. Acarol.*, **28** (2): 99-120.
2005. *Agistemus*, Fan and Zhang, *Fauna of New Zealand*, **52**:1-400.

Diagnosis: This genus is characterized by 3 unpaired plates, viz., propodosomal, median and suranal, cover most of dorsum. Two pairs of paired plates viz. humerals and intercalaries. Main plates plain or reticulate, propodosoma carries 3 pairs of setae. Median plate usually entire with 5 pairs of setae. Two pairs of setae on suranal plate viz., central and lateral. Humeral

and intercalary with one seta each. One pair of eyes, one pair of ocular bodies, situated between eyes and post ocular setae. Palp tibia with long primary claw, longer than half of palp tarsus, accessory claw about half of palp tarsus. Terminal sensillum a trifold process. Subcapitular setae 2 pairs, 4 pairs of setae present on anogenital plate, 2 pairs of paragenital setae on independent platelets. Palp chaetotaxy : coxa-1, femur-3, genu-1, tibia-2, tarsus-6.

Type species: *Aligonus terminalis* Quayle, 1912

Key to the species of the genus *Agistemus* included in the present study

1. Propodosomal and median shield reticulate
 *Agistemus fleschneri* Summers
- Propodosomal and median shield smooth.....
 *Agistemus terminalis* Quayle

Agistemus fleschneri summers, 1960

PLATE 106

1960. *Agistemus fleschneri* Summers, *Proc. Ent. Soc. Wash.*, **62** : 237-240.
1965. *Agistemus fleschneri*, Gonzalez-Rodriguez, *Univ. Calif. Pub. Ent.*, **41** :
30-31
1980. *Agistemus fleschneri*, Gupta and Ghosh, *Rec. Zool. Surv. India*, **77**:
204.
1991. *Agistemus fleschneri*, Gupta, *Rec. Zool. Surv. India*, **88**: 209-210.
1992. *Agistemus fleschneri*, Gupta, In: *Contrib. Acarol. Res. India*, p. 439.
1992. *Agistemus fleschneri*, Gupta, In: *Fauna of West Bengal*, Part 3. p. 117-
118.

1995. *Agistemus fleschneri*, Gupta, In: *Fauna of Meghalaya*, Part 2, p. 42.
1995. *Agistemus fleschneri*, Mathur and Mathur, *Abst. V Nat. Symp. Acarol.*, p. 14.
1996. *Agistemus fleschneri*, Chatterjee and Gupta. *J. Beng. Nat. Hist. Soc.*, NS. **15** (2): 26. 1997. *Agistemus fleschneri*, Gupta and Chatterjee, In: *Fauna of Delhi*, p. 517.
2000. *Agistemus fleschneri*, Gupta, In: *Fauna of Tripura*. Part 2. p. 18.
2002. *Agistemus fleschneri*, Gupta, *Memoirs. Zool. Surv. India*. **19** (2): 101-102.
2010. *Agistemus fleschneri*, Roy *et al.*, *Entomon*, **34** (3): 175-180

Female: Body 303 long, 215 wide. Dorsal propodosomal shield 63 long, 101 wide and median shield 113 long, 126 wide with polygonal reticulations. Palp 5 segmented, palp tibia with claw slightly shorter than tarsus, palp femora with thickened dorsal setae which is prominently barbed. Chaetotaxy of palapl segments: femur –3, genu – 1, tibia – 2, tarsus – 3. Dorsal idiosomal setae, long, rough and barbed. Each seta touches the base of neighboring setae. Ventral idiosoma striated with 3 pairs of simple intercoxal setae. Two pairs of paragenital setae (pg₁ and pg₂) and 4 pairs of genital setae (g₁ – g₄) , all are equal in length, g₄ thick and barbed. Measurements of setae : ae - 37, be, ce – 55, de – 36, a – 30, b- 45, c – 55, la – 47, lm – 68, li – 57, le – 15, e – 50, pg₁ – 8, pg₂ – 7, g₁, g₂, g₃ and g₄ - 9 each. Measurements of leg I – IV: 258, 227, 215, 227 respectively.

Leg chaetotaxy: Coxae: 2-1-2-2; trochanter: 1-1-1-1; femur: 4-4-2-2; genu: 3-1-0-0; tibia: 5 (1)-5(1)-6 (1)-5 (1); tarsus: 6(3) – 8(1) – 6(1) - 6.

Male: Unknown.

Habitat: *Morus alba* L.

Known habitat: *Psidium guajava*, litchi, mango, lantana, papaya, wood apple, Annona, avocado, cotton, grape, Mulberry, oak, citrus, guava, *Cephalotaxus griffithii*.

Material examined: Female marked on the slide along with other 2 ♀♀, INDIA: KERALA: Pattambi (Palakkad district), 16.v.2011, ex. *Morus alba* L., coll. Santhosh (No. K 9/1, K 9/2, K 9/3).

Distribution: INDIA: Assam, Manipur, Tripura, Meghalaya, Delhi, Sikkim, Arunachal Pradesh. OUTSIDE INDIA: Canada, Chile, Costa Rica, Egypt, Guatemala, Honduras.

Remarks: The specimen examined resembles *Agistemus fleschneri* Summers, 1960 in almost all characters and hence fixed so. It is the new record from Kerala.

Agistemus terminalis (Quayle) 1912

PLATE 107

1912. *Caligonus terminalis* Quayle, *Univ. Calif. Agri. Exp. Sta. Bull.*, **234**: 499.

1914. *Caligonus terminalis*, Banks, *J. Ent. zool.*, **6**: 57.

1946. *Mediolata terminalis* Nesbitt, *Can. Ent.*, **78** : 15.

1960. *Agistemus terminalis* Summers, *Proc. Ent. Soc. Wash.*, **62**: 234.

1965. *Agistemus terminalis*, Gonzalez-Rodriguez, *Univ. Calif. Pub. Ent.*, **41**: 29.

1967. *Zetzellia terminalis*, Wood, *Trans. Roy. Soc. N. Z. zool.* **9**: 93-139.

1984. *Agistemus terminalis*, Ehara and Wongsiri, *Kyoto*, **52**(1): 117.
1985. *Agistemus terminalis*, Sepasgorian, *Z. Angew. Zool.* **72**: 461.
1992. *Agistemus terminalis*, Gupta, In: *Fauna of West Bengal*, Part 3, p. 118.
1996. *Agistemus terminalis*, Chatterjee and Gupta, *J. Beng. Nat. Hist. Soc.* NS. **15**(2): 27.
2000. *Agistemus terminalis*, Gupta, *Fauna of Tripura*, Part 2, p. 18.
2002. *Agistemus terminalis*, Mantioli *et al.*, *Internat. J. Acarol.*, **28** (2):109
2002. *Agistemus terminalis*, Gupta, *Memoirs. Zool. Surv. India.* **19** (2): 108.
2013. *Agistemus terminalis*, Yesilayer and Cobanoglu, *Turkish J. Entomol.*, **37** (1) 93-103
2015. *Agistemus terminalis*, Negm *et al.*, *Sys. Appl. Acarol.*, **20**: 965
2016. *Agistemus terminalis*, Paktinat-Saeij *et al.*, *Sys. Appl. Acarol.*, **21**: 813-819

Female: Body 265 long, 215 wide. Dorsal propodosomal shield 88 long, 139 wide and median shield 113 long and 139 wide with no reticulations. Dorsal idiosomal setae long and smooth. Palpi 5 segmented, palp tibia with claw slightly shorter than tarsus. Palp femora with long, thickened dorsal setae which is prominently barbed. Chaetotaxy of palpal segments: femur –3, genu – 1, tibia – 2 and tarsus – 4. Ventral idiosoma with 3 pairs of simple intercoxal setae, 2 pairs of paragenital setae (pg₁ and pg₂) and 4 pairs of genital setae (g₁ – g₄) present, all are equal length. Measurements of setae : ae - 28, be – 46, ce – 51, de – 47, a – 37, b- 45, c – 43, la – 37, lm – 25, li – 37, le – 61, e – 12, pg₁ – pg₄ – 8, g₁ – g₄ 9 each. Measurements of leg 1 – IV: 240, 227, 202, 215 respectively.

Leg chaetotaxy: Coxae: 2-1-2-2; trochanter: 1-1-1-1; femur: 4-4-2-2; genu: 3-1-0-0; tibia: 5 (1)-6 -5(1)-5 (1); tarsus: 6(3) – 8(1) – 5- 5.

Male: Unknown.

Habitat: *Justicia adhatoda* (L.)

Known habitat: Dahlia, beans, betel vine, juniperus, camphor, passion fruit, *Dioscorea* sp., papaya, Annona, avocado, citrus, *Hevea* sp., Tea, *Gendarussa vulgaris*, Coffee, *Camellia sinensis*, *Cryptomeria japonica*.

Material examined: Female marked on the slide along with other 4 ♀♀, INDIA: KERALA: Kadalundi (Kozhikode district), 16.v.2011, ex. *Justicia adhatoda* (L.), coll. Santhosh (No. M 410/1, 410/2, 410/3).

Distribution: INDIA: Sikkim, Mizoram, Assam, Tripura, West Bengal. OUTSIDE INDIA: USA, Mexico, Japan, Canada, Chile, China, Korea, Indonesia, Peru, Portugal, Thailand, Turkey Guatemala.

Remarks: The specimen examined resembles *Agistemus terminalis* (Quayle), 1912 in almost all characters and hence fixed so. It is new record from Kerala from a new habitat, *Justicia adhatoda* (L.).

SANTHOSH. P. P. "STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA". THESIS. DEPARTMENT OF ZOOLOGY, MALABAR CHRISTIAN COLLEGE, UNIVERSITY OF CALICUT, 2017.

PART II

FEEDING &

BREEDING BIOLOGY

INTRODUCTION

The predatory mites of the family Phytoseiidae are excellent agents for biological control as well as effective components of agricultural systems that have been recognized recently. Phytoseiids are the best known and most studied group of predatory mites, owing to their success in controlling spider mites and eggs and life stages of other small insect pests.

Biological and ecological studies on phytoseiids have realized that they are very effective for controlling several pests of agricultural importance. Many species of phytoseiid mites are good biological control agents of injurious plant feeding mites of the families Tetranychidae, Tenuipalpidae, Eriophyidae, etc. Though phytoseiids are normally known to feed and develop on phytophagous mites and insect pests, many can survive on non prey food materials like honey, nectar, plant sap, pollen etc. Phytoseiids utilise different types of food and these specialization are correlated with major ecological traits such as aggregating ability and prey density dependence (Zhang and Croft, 1994).

Based on the life style and feeding behaviour, phytoseiids are classified into 4 categories viz., Type I, Type II, Type III and Type IV predators. Type I predator consists only of *Phytoseiulus* sps., which are specialized predators usually found on heavily webbing spider mites, mostly *Tetranychus* sps., more rarely *Oligonychus* sps. They bear long dorsal setae. Type II phytoseiids feed on spider mites as well as pollen and plant exudates

but are not restricted to *Tetranychus* spp. They also possess long dorsal setae (eg: *Neoseiulus* spp.). Types III are generalists, they often prefer prey other than spider mites and readily consume pollen or plant exudates. They bear short mid dorsal and lateral setae. (eg: *Typhlodromalus*, *Typhlodromus*). Type IV species consists of only of members of *Euseius*, generalists that appears to develop and reproduce best on pollen. They carry short mid dorsal and lateral setae. Based on the findings and suggestions from many studies conducted on the life style system, McMurtry and Croft (1997) proposed new classification of life styles of phytoseiid mites identified subtypes for Type I and Type III predators.

Phytoseiids shows several advantages over other predatory mites because of high fecundity, good searching ability, dispersal rate, adaptability and high degree of prey specificity. Many phytoseiids develop within one week at 27°C and 60-90% RH (Tanigoshi, 1982). Some successful phytoseiid biocontrol agents shows functional response to their prey. They are *Phytoseiulus*, *Neoseiulus*, *Galendromous*, *Typhlodromus*, *Typhlodromalus*, *Amblyseius* and *Euseius*. Many species are commercially available for pest control and are also applied in green house farming. A fast acting predatory mite that is commercially available is *Phytoseiulus persimilis*.

The developmental stage of a phytoseiid mite consists of egg, larva, protonymph, deutonymph and adult. All immature stages of the mite enter in to a partial inactive period called as quiescence. Life cycle of a phytoseiid is short under identical temperature and humidity, usually it takes 6 to 7 days and shows reproductive diapause under low temperatures (Veerman, 1991). Phytoseiids exhibit facultative diapause by a combination of short day light and low temperatures. Although the phytoseiid lack eyes, their behavior is

affected by prevailing light conditions. The quantity and quality of food is another factor which influences the duration of development. Sex determination in most phytoseiids is by parahaploidy or pseudo-arrhenotoky (Schulten, 1985). In addition, some species shows thelytoky (Wysoki and Bolland, 1983). Males develop from fertilized eggs but have a haploid diploid mechanism. In the course of mating, male produce sex pheromone to locate female which evokes a distinctive hovering behaviour (Hoy and Smilanick, 1979). In females, deutonymph near maturity produces a pheromone that evokes an arrestment response in males (Rock *et al.*, 1976). For many species the male and female sex ratio is 1: 3. Egg production is more during early period of adult life and reproductive rates vary depending on predator species as well as many other external factors.

Phytoseiid mites are considered the most efficient natural enemies for biological control of pest mites especially those belonging to the family Tetranychidae, have not acquired considerable recognition so far India, particularly in Kerala. Several acarologist from outside have contributed to the biological control aspects of predatory mites, and a few such works have also been done from India. All these work emphasize the potential value of phytoseiids as biocontrol agents. In the present study an attempt has been done to expose the feeding and breeding biology of a new species of predatory mite *Euseius pariyarensis* sp.nov. preying upon various stages of pest mite, *T. neocaledonicus* infesting the medicinal plant, *Bauhinia acuminata*.

The feeding potential of *E. pariyarensis* sp.nov on *T. neocaledonicus* was performed at $30 \pm 2^{\circ}\text{C}$, 65 ± 10 % RH. The breeding biology of *E. pariyarensis* sp.nov. on *Tetranychus neocaledonicus* infesting the medicinal

plant, *B. accuminata* was carried out in laboratory conditions of temperatures $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$, at $65 \pm 10\%$ RH. The developmental duration of male and female life stages, longevity and life table parameters were also recorded at both temperatures. All the data were analyzed separately based on statistical methods to test its significance.

SANTHOSH. P. P. "STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA". THESIS. DEPARTMENT OF ZOOLOGY, MALABAR CHRISTIAN COLLEGE, UNIVERSITY OF CALICUT, 2017.

REVIEW OF LITERATURE

The present review of literature focused on the important works on the feeding and breeding biology of phytoseiid mites.

Phytoseiid mites are receiving increasing recognition due to their ability to control phytophagous pest mites and many insect pests. Parrot *et al.* (1906) made the first attempt to study the predatory efficiency of *Seius pomi*, a phytoseiid mite upon the blister mite *Eriophyes pyri*. Quayle (1912), Ewing (1914) and Gilliat (1935) carried out many studies on the feeding potential of phytoseiid mites in regulating pest population both laboratory and field condition. Garman (1948) pointed out the predatory value of phytoseiids in controlling the population of several plant mites including spider mites. Ballard (1954) studied the developmental stages of predatory mites *viz.*, egg, larva, protonymph, deutonymph and adult. Studies were conducted by various workers like Chant (1961), McMurtry and Scriven (1966) reported that alternate food increased the intensity of predation as well as the density of the predators. The morphological peculiarities of the eggs of *Euseius finlandicus* was noted by Satpathy and Mania (1969).

Swirski *et al.* (1970) reported that some phytoseiid species were known to develop on tetranychids, some others on pest mites and pollen and a few on pollen alone. Wei and Laing (1973) studied the oviposition behaviour of phytoseiid mites and reported that it begins after mating and frequent matings were not needed for continuous egg laying. Amano and

Chant (1978) studied the sperm transfer behavior and 2 types of basic pre-copulatory behavioural patterns of phytoseiid mites. A study conducted on developmental biology of *A. (N) longispinosus* by Shih and Shieh (1979) reported that duration of egg, larva, protonymph and deutonymph were 2.06, 0.80, 1.07, 1.73 days for females and 2.06, 0.82, 1.0 and 1.18 days for males at 24°C and 70% RH.

A study on life history of *A. (N.) longispinosus* by Saito and Mori (1981) reported that the maximum rate of egg production was noted on the tenth day after mating. Moraes and Lima (1983) studied the biology of *Euseius concordis* at 20 ± 4°C, 60± 14 % RH noted that the female had a preoviposition period of 0.8±1.3 days and oviposition period of 21.2± 8.3 days. Neelam and Sadana (1985) reported that 25°C was the suitable temperature for the development of *A. (E.) finlandicus*. Gupta (1986) noted that maximum rate of egg production of phytoseiid predator was 2.5 per day during winter season with sufficient food. According to Gillespie and Ramey (1989), the development of *N. cucumeris* took 8-9 days at 25°C when feeding on thrips larvae. Abou-Setta and Childers (1989) studied the feeding behaviour and oviposition of *E. mesembrinus* under 26°C and 75 % RH revealed that all motile stages of tetranychid mites were attacked except the adult.

Zhimo and McMurtry (1990) conducted a study on the development and reproduction of 3 *Euseius* species in the presence and absence of supplementary foods recorded that the development and oviposition rates differed among the 3 *Euseius* species on the same food or food combination in the laboratory at a constant temperature of 25°C. Tylor and James (1993) reported the generation period of *E. victoriensis* as 4-7 days at 22.5 - 40°C and it being active at the higher temperature. Takahashi and Chant (1994)

studied the fecundity of *Phytoseius persimilis* as 78 eggs per female in about 15 days at 26⁰ C and 80% RH. Grafton-Cardwell and Ouyang (1996) studied the population trends of members of the genus *Euseius* commented that they develop and reproduce best with plant pollen. According to McMurtry and Croft (1997) the genus *Euseius* is considered as specialized pollen feeders under type IV predator. Schausberger (1998) studied the mean development of *Euseius finlandicus* Oudemans, *Kampimodromus aberrans* Oudemans and *Typhlodromus pyri* Scheuten from larva to adult at 25 ± 1°C, 65 ± 5% RH and 16 h photoperiod reported the duration as 5.6 days, 13.2 days and 17.4 days respectively. Mean while, *E. finlandicus* had a higher fecundity (0.7 eggs/day/female) than *T. pyri* (0.5 eggs/female/day) and *K. aberrans* (0.4 eggs/female/day).

Broufas and Koveos (2000) conducted an experiment to assess the nutritional value and the possible effect of pollen diet on development and population dynamics of *E. finlandicus* at 20 ± 1°C reported that poppy pollens are of higher nutritional value for sustaining and increasing their population. Nomikou *et al.*, (2001) measured the life history traits of 5 predatory mites viz., *Typhlodromus athiasae*, *Neoseiulus barkeri*, *Typhlodromips swirskii*, *Euseius scutalis* and *Phytoseius finitimus* feeding on whiteflies reported that the intrinsic rates of increase (rm) ranged between 0.131 and 0.215 per day and *E. scutalis* had the highest rm than others. Gupta (2003) studied the bioecology of 7 *Euseius* spp., under 20⁰C, 25⁰C, 30⁰C and 35⁰C and different diet reported that developmental duration of each species varies with respect to temperatures and diet. Badii *et al.* (2004) studied the prey stage preference and functional response of *Euseius hibisci* to *T. urticae* on strawberry leaf arenas under laboratory conditions of 25 ± 2°C, 60 ± 5% RH and 12 h photophase reported that the predator consumed significantly

more prey eggs than other prey stages and consumption of prey deutonymphs and adults was so low. Kasap and Sekeroglu (2004) studied the life history of *E. scutalis* feeding on citrus red mite *Panonychus citri* at various temperatures reported that mean generation time was longest at 25°C (17.50 days) and shortest (9.35 days) at 30°C. Raza *et al.*, (2005) conducted a study to determine the effect of different temperatures on the development time, longevity and fecundity of *Euseius septicus* feeding on two spotted spider mite at 20, 25 and 30°C with relative humidity 60-70%, reported that the incubation period was shortened with increasing temperatures and ranged from 3.3 to 1.6 days. The longest longevity was 28.3 days at 25°C and followed by 23.1 days at 20°C and 14.1 days at 30°C. Momen and Abdel-Khalek (2008) studied the influence of diet on biology and life table parameters of the predaceous mite *E. scutalis* under $28 \pm 1^{\circ}\text{C}$ and $75 \pm 5\%$ RH reported that the development was faster and reproduction was higher in pollen diet and developmental time increased and reproduction decreased when fed on pest mite. Melo *et al.* (2009) studied the biology of *E. alatus* De Leon at different temperatures of 18, 21, 24, 27, 30 and 33°C, $70 \pm 5\%$ RH and 12 hour photophase reported that *E. alatus* showed maximum development and reproductive rates at 30°C.

Abad-Moyano *et al.* (2010) conducted a study on the effect and efficacy of *E. stipulatus*, *P. persimilis* and *N. californicus* on the suppression of two spotted spider mite, *T. urticae*, reported that the *P. persimilis* and *N. californicus* showed more predatory potential than *E. stipulatus*. Nguyen and Shih (2010) conducted the developmental study of *N. womersleyi* and *E. ovalis* feeding on tetranychid mites and pollen at 25°C reported that immature stages of both species had shorter developmental duration those feeding on other food sources than tetranychid mites. The same authors

(2011) again conducted a study on predation rates of *N. womersleyi* and *E. ovalis* feeding on tetranychid mites recorded that predation rate of *N. womersleyi* higher than *E. ovalis* and they recommended that *T. urticae* eggs are suitable for mass rearing for both predatory mites. Laboratory studies on *E. metwalliyi* under $28 \pm 2^{\circ}\text{C}$ and $74 \pm 4\%$ RH by Mostafa and El-Sayed (2012) reported that shortest development period was 4.4 days and the highest prey consumption about 18 preys when feeding on *T. urticae* larvae. McMurtry *et al.* (2013) made a study on the revision of the life style of phytoseiid mites and its implications for biological control strategies proposed that two or more subtypes for the type I and type III predators. Toledo *et al.* (2013) carried out a study on production potential of *E. alatus* on different life stages of *Oligonychus ilicis* on coffee leaves reported that adult females were most efficient stage in preying any of the stages of development of *O. ilicis*. A study on revision of the lifestyles of phytoseiid mites and implications for biological control strategies were conducted by Abou-Elella *et al.* (2014) found that survival, development and reproduction of *E. finlandicus* feed on various kinds of food substances recorded the shortest developmental time and highest oviposition rates on eriophyid mites as prey. Liyaudheen *et al.* (2014) conducted a study on feeding potential of *E. ovalis* on *T. macfarlanei* infesting Okra plant reported maximum feeding preference on the eggs of the pest mite followed by the larva and protonymph.

Puchalska and Kozak (2016) studied the influence of diet on development and reproduction of two predatory mites *Typhlodromus pyri* Scheuten and *E. finlandicus* reported that the development and reproduction were significantly affected by diet. *T. pyri* and *E. finlandicus* feeding on

juvenile stages of pest mites showed shortest developmental time and high values of population than they feeding on pollen.

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MATERIALS AND METHODS

During the present study *Tetranychus neocaledonicus* infesting *Bauhinia acuminata* L. were selected as the prey food for studying the feeding preferences of the phytoseiid mite viz., *Euseius pariyarensis* sp.nov. The above spider mite was recognized as a widely distributed pest mite on *B. acuminata* in most of the localities surveyed. The infestation by this pest mite resulted in the formation of white spots on the leaf lamina due to chlorosis. Severe infestation led to bronzing and blotching of leaves followed by premature leaf fall.

Raising of stock culture of *T. neocaledonicus* in laboratory

Seedlings of *B. acuminata* were planted in pots of 1x1x1 m³ size kept in the herbal garden of Malabar Christian College, Calicut for artificial infestation with *T. neocaledonicus*. Mite infested leaves were collected from different localities and brought to the laboratory. Adults were picked up with a moistened camel hair brush using a hand lens and transferred to the newly planted *B. acuminata* plant seedling when new leaves began to sprout.

Raising of stock culture of predatory mite *E. pariyarensis* sp.nov. in laboratory

Different stages of the predatory mite *E. pariyarensis* were also collected from *Bauhinia* plants infested with prey mites, *T. neocaledonicus*. The predatory mites were carefully transferred from the leaves to the culture

cell. Different stages of the prey mite in sufficient numbers were offered as food for rearing the predatory mites. For these, sufficient stock cultures of *E. pariyarensis* were build up in the laboratory using leaf floatation technique. When depletion of prey mites were noticed new ones were brushed off from the infested *Bauhinia* leaves which were maintained in the garden. To start with the feeding efficacy test numerous replicates of such culture cells were prepared.

Feeding preference

For studying the feeding preference of the individual stages of predatory mites to various stages of prey mites, different culture cells were maintained in the laboratory. For this, separate culture cells containing different life stages of *T. neocaledonicus* were prepared and different stages of predatory mites *E. pariyarensis* viz., larva, protonymph, deutonymph, adult male and female were released to each culture cells for recording observation on feeding preference of particular life stages. There were 5 experimental setup for each stages of the prey viz., set I- prey eggs Vs adult female predator, set II- prey eggs Vs adult male predator, set III- prey eggs Vs deutonymph, set IV- prey eggs Vs protonymph and set V- prey eggs Vs larva. Similarly different stages of prey mites were also kept in separate culture cells and different stages of predators were released to each cells separately. For this, 25 numbers of each of the life stages of the prey mites were also kept in separate culture cells were exposed to a single number of different stages of the predators viz., larva, protonymph, deutonymph, adult male and female. Observations were made on the feeding behavior of the various stages of predators, the mode of feeding of individual stages and the

feeding potential of the predators on various stages of the prey mites were taken in 24 hour basis.

Data obtained on the above parameters were recorded, tabulated and presented through appropriate figures and graphs. Photographs were also taken using digital camera attached to Olympus CX 31 Research Microscope. Data obtained on feeding preference were subjected to statistical analysis based on Scheffe test , ANOVA etc. and presented .

Developmental Studies

The developmental duration of the life stages of *E. pariyarensis* was studied by an experimental setup consisting of excised leaves of *B. acuminata* placed on cotton pads saturated with water in 10cm petridish provided with various stages of *T. neocaledonicus*. Developmental duration was studied at a temperature of $25\pm 2^{\circ}\text{C}$ and $30\pm 2^{\circ}\text{C}$, $65\pm 10\%$ RH. Periodic observations were made using Magnus stereozoom microscope. Initially, a suitable number of adult females and males of same ages were allowed to mate and lay eggs on an experimental leaf. Freshly laid eggs were removed and separately reared on new leaf disc. Repeated observations were made per hour for recording the hatching, moulting, active and quiescent stages and subsequent life stages. The time taken for completing the development of each life stages until adult emergence were also recorded. The sex of the adults that emerged after final moult was recorded. Sufficient prey mites were released into the leaf disc whenever necessary. Data obtained were subjected to ANOVA and means of the developmental durations were separated by Duncan's Multiple Range Test (1995; SPSS 10.0, 1999).

Fecundity and longevity were also measured by setting new experimental setup on newly laid eggs at $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$, $65 \pm 10\%$ RH. The newly moulted adult females were allowed to mate with freshly moulted males. Preoviposition period was calculated by taking observations on hourly basis until the females laid the first egg. The oviposition period and fecundity were calculated thereafter by observing the number of eggs laid by females. Post-oviposition period and longevity were also noted until the death of the female. Longevity of males were observed separately. The results were subjected to ANOVA. Fecundity and life tables were constructed by using the total number of adult individuals developed from the eggs as well as the total number of eggs laid by the females.

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OBSERVATION ON FEEDING BIOLOGY

Results of the field observation enabled to record the presence of *Euseius pariyarensis* sp.nov. in association with the pest mite, *Tetranychus neocaledonicus* infesting the leaves of *Bauhinia acuminata*. To study the feeding potential, tests were carried out in the laboratory under $30\pm 2^{\circ}\text{C}$, $65\pm 10\%$ RH condition. Promising results were obtained and following observations were made regarding its feeding activities.

10.1 Feeding behaviour of *E. pariyarensis* sp.nov.

The feeding activities of all stages of *E. pariyarensis* were more or less similar pattern which were initiated from the larval stages onwards. All the life stages other than the larva were seen actively moving about on the under surface of leaves in search of prey. The web found on the ribs of the leaves hinders the fast movement of predators.

Upon contact with prey, the predator was found slowly catching the prey with the help of its long forelegs and palps. While firmly holding the body of the prey with its forelegs, the predator extends its chelicera to paralyse the prey. By the help of its strongly built chelicera, predator penetrated the cuticle of the prey and initiated sucking out its internal tissue contents. During the feeding process, the muscular and pharyngeal movements of predator were clearly noticeable under high power microscope. Based on the colour of prey mites consumed, the body colour was found changing and fully fed predatory mite resembled the colour of the prey mite.

The average time taken by various stages of the predatory mites for consumption of different stages of the prey were noted. The feeding time varied with respect to the variation in the life stages of predator as well the prey mite. It was observed that the adult male of the predator took only 5 minutes to suck the internal contents of the prey eggs, where as female took 5-10 minutes for sucking. The eggs of the prey were found rolled by the combined action of chelicerae and pedipalp at the time of feeding. The adult female predator required 20-25 minutes to suck out completely the internal contents of the various stages of the pest mites. Prey eggs were the most preferred food for all stages of the predator. Adult females were noted to consume more eggs than other stages after mating. The average consumption time taken by different stages of the predator increased with progressive development of the prey.

There were also some instances where the predator feeds the life stages incompletely and moves on to the next which lies close to it. It was noticed that quiescent stages of prey mites were also preferred for feeding. When the prey density was high, random attack was evident and rate of predation was comparatively high. The feeding potential of individual stages of predatory mites found varying considerably. The average time taken for the consumption of prey mites varies with respect to the size of the body.

The consumption rate of every stages of the predator was noted after a time period of 24 hours and the results were statistically analysed. The observation revealed that the predator larva was non-feeder of larva, protonymph, deutonymph and adult stages of prey mite *T. neocalidonicus*.

The average rates of food consumed by different stages of *E. pariyarensis* were calculated and percentage of predation were noted (Table 3, 4). Sixty one percentage of the eggs of prey mite were consumed by

the female, 21% by deutonymph, 12% by protonymph followed by larva (1%). The adult female consumed higher percentage of larvae of prey mites (21%) followed by the male and deutonymph (4%). The adults of the prey mites consumed by the predator adult female were only 2% and 1% by male but this value is greater when compared to the rate consumed by other predator stages. Male of the predator was the next stage which showed a high predation percentage on the eggs (42%), larvae (16%) followed by protonymph (6%) and deutonymph (2%). Deutonymph also exhibited significant predation on various prey stages viz., eggs (21%), larvae (4%) and protonymph (1%). But the feeding of larvae restricted only on prey eggs (1%). Even though the rate of predation varies for each stage of prey, maximum predation in all cases was shown by adult female of *E. pariyarensis* (Table 4, Plate 111).

The results obtained were subjected to ANOVA for testing the significance and comparison made using Scheffe's test. The results indicated a P-value less than 0.01 and 0.05 which shows high significance.

While comparing the mean values of the feeding potential of the different stages *E. pariyarensis* viz., larva, protonymph, deutonymph and adults on the prey egg stage, it was noted to have a high significant difference at 0.01 level ($P < 0.01$). There was significant difference noted on the feeding of prey eggs between different life stages of *E. pariyarensis* except between larva and protonymph and between protonymph and deutonymph (Table 5, 6). A significant differences was noted on the feeding of prey larva by predator, except female and male, larva and protonymph, larva and deutonymph and protonymph and deutonymph (Table 5, 6).

A significant difference was noted at 0.01 level while comparing the mean values of the prey protonymph stage by the different predators except

female and male, larva and protonymph, larva and deutonymph and protonymph and deutonymph (Table 5, 6). In the case of feeding on prey deutonymph showed significant difference except female and male, larva and protonymph, larva and deutonymph and protonymph and deutonymph (Table. 6). On comparing the mean values of the feeding potential of different life stages of *E. pariyarensis* on adult prey mite noted that there were significant differences between predator stages, female and larva, female and protonymph and female and deutonymph. All other stages were not significant.

Based on the results of consumption of the predator on various stages of *E. pariyarensis* in 24 hours categorized plots and categorized normal plots were constructed to check the validity of normality assumption. In all categories, the values were close to a positive straight line, indicating a valid normality assumption (Plate 109,110).

Table 3 shows the mean values for the number of stages of prey mite *T. neocaledonicus* consumed by *E. pariyarensis* in 24 hours. Maximum consumption of eggs of prey mite was exhibited by adult female. The mean consumption rate of predators followed the order that female > male > deutonymph > protonymph > larva respectively (Plate. 111,112).

OBSERVATION ON BREEDING BIOLOGY

11.1 Developmental studies of *Euseius pariyarensis* sp.nov.

Developmental studies of *E. pariyarensis* were carried out in the laboratory by successfully rearing the mites on leaf discs maintained at a temperatures of $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$ under 65 ± 10 RH. Regular observations were made to collect data on various aspects of breeding viz., mating, pre-oviposition, oviposition, post- oviposition, fecundity and total longevity of both male and female predatory mites.

11.1.1 Mating behaviour

The process of mating was observed immediately after moulting of deutonymph to adult. Occasionally, males helped to remove the moulting skin of female for mating purpose. The males were found actively wandering on the leaf disc in search of female. On locating an active female, the male was found moving around the female 2-3 times and finally found climbing on the back of the female and stayed on the dorsum of the female for a short time. Later, it slowly slipped to the ventral side of the female through lateral side or behind until both pairs come to contact venter to venter position by facing the ventral surfaces of both the mates in the same direction. This position is noted as the initial position to start actual mating process. The hysterosomal region of the female was clasped by the legs of the male by leaving $1/3^{\text{rd}}$ of its posterior hysterosomal region seen beyond the female. By this way, male ensured a comfortable

position to press the spermatophoral process between the coxae of 3rd and 4th leg of the female where the cervix of spermatheca opens out. After a short time, slight pushing movements were noticed in this position by which male gently transferred the spermatophores. The process of mating lasted for maximum of 15-20 minutes. After mating the male separated from the female and moved in search of another mates. The female remain stationary for a few minutes (2-3 minutes) after copulation and afterwards moved around in search of prey food.

11.1.2 Pre-oviposition

Mated females were selected to test the pre-oviposition period. The females reared at $25 \pm 2^{\circ}\text{C}$ took an average time of 2.7 ± 0.26 days for laying the first egg. At $30 \pm 2^{\circ}\text{C}$ the preoviposition period was 1.5 ± 0.17 (Table 10). The pre-oviposition period was decreased in increased temperature. Adult showed feeding preference towards prey egg stage during the preoviposition period.

11.1.3 Oviposition

Females reared at $25 \pm 2^{\circ}\text{C}$ were taken 16.5 ± 0.52 days and at $30 \pm 2^{\circ}\text{C}$ was 17.5 ± 0.52 days for the completion of oviposition period (Table 10). During the oviposition process, the abdomen of the adult female became bulged, and turned slight yellowish in colour. During the process, the adult female remained stationary for sometimes and lowered the posterior hysterosoma for laying eggs. Eggs were laid singly near to the midrib, veins or anywhere on the leaf surface. They were slightly glued to the under surface of the leaf by an adhering fluid secreted by female. Rhythmic muscular activities followed by the forward stretching of first and second

legs were noticed while pushing the eggs. The females took an average of 4-6 minutes for laying eggs. It was noticed that single female was found laying an average number 2.2 ± 0.20 eggs per day at $25 \pm 2^\circ\text{C}$ and 2.4 ± 0.16 eggs per day at $30 \pm 2^\circ\text{C}$ (Table 10).

11.1.4 Post-oviposition

The cessation of egg lying was the starting point of post oviposition which extends up to death. The mean post oviposition period of females reared at $25 \pm 2^\circ\text{C}$ was 5.6 ± 0.27 and at $30 \pm 2^\circ\text{C}$ was 4.7 ± 0.30 (Table 10). It was noticed that post oviposition was decreased at increased temperature.

11.1.5 Incubation, hatching and emergence of larva

Freshly laid eggs appeared smooth, transparent and oval, measuring 180 long and 80 wide. Later it becomes light yellowish in colour, glued to the surface of leaf. The eggs becomes a light white colour when they were about to hatch. Hatching was a steady process in which a small slit appeared on the pointed end of the egg which got extended gradually to either side by the pushing of 4th pair of legs as well as the hysterosoma. As a result the 4th pair of larval legs slowly protruded out through the opening. Finally the entire larva slipped little by little out of the egg, leaving ahead the egg case. The thrusting action of propodosoma also helped to come out the entire larval body from the egg case. The process of hatching required 30–35 minutes for completion. Incubation period of eggs observed at $25 \pm 2^\circ\text{C}$ and $30 \pm 2^\circ\text{C}$ of future male individuals were 2.01 ± 0.03 and 1.85 ± 0.04 days respectively. Mean while, females had a mean incubation period of 2.25 ± 0.05 and 1.93 ± 0.06 (Table 10).

11.2 Developmental duration

The developmental duration of all stages were seen to be influenced by temperature (Table 7,8). The active stages of larva, quiescent phase of deutonymph and total developmental period were found slightly decreased with increase in temperature from 25 to 30⁰C (P<0.05)

11.2.1 Larva

The newly hatched larva was more or less oval, white coloured and easily distinguished from other life stages by the possession of 3 pairs of legs (Plate 114 A). Soon after hatching, the larva remained inactive for a few minutes confining itself to the hatching place and did not feed anything. Slowly it started to move about in search of prey stages and was seen to nibble the leaf surface without producing any feeding marks. At the end of the active period, the larva entered into the first quiescent phase. During the quiescent stage the larva stretched its first pair of legs and attained a characteristic position and appearance. The mean duration of the female larval development including quiescent stage at 25 ± 2°C was 2.03± 0.07 and males, 1.62 ± 0.04. (Table 9) The duration of female larval development at 30 ± 2°C was 1.68± 0.05 and males, 1.41± 0.05 respectively. The duration of active and quiescent stage varied at 2 different temperatures (Table 9).

11.2.1 Protonymph

The larva had undergone first moulting which led to emergence of protonymph (Plate 114 A). The protonymph was active, white in colour, characterized by the presence of 4 pairs of legs. In search of food, protonymph met with pest eggs supplemented to the culture and consumed a number of eggs. Consequently, its body colour changed from transparent to

the colour of the contents of pest egg. At the end of the active period, the protonymph entered into the second quiescent period. The average time taken for the development of protonymph at $25 \pm 2^\circ\text{C}$ and at $30 \pm 2^\circ\text{C}$ in males were 2.00 ± 0.08 , 1.85 ± 0.10 days respectively. In females, protonymph duration at $25 \pm 2^\circ\text{C}$ and $30 \pm 2^\circ\text{C}$ were 2.12 ± 0.06 and 1.82 ± 0.05 days respectively (Table 9). It was noted that protonymph duration was slightly decreased at a temperature of 30°C .

11.2.2 Deutonymph

The deutonymph was slightly larger than protonymph and more active. They were seen voraciously feeding on different stages of prey mites. After the active period, deutonymph then entered into the third quiescent phase. The total deutonymphal period lasted for 2.29 ± 0.10 and 2.00 ± 0.08 days in case of females reared at $25 \pm 2^\circ\text{C}$ and $30 \pm 2^\circ\text{C}$ respectively. In males, duration of development at two temperatures were 2.01 ± 0.05 and 1.92 ± 0.02 . The developmental duration of deutonymph was varied at both temperatures (Table 9).

The mean developmental duration of female immature stages at $25 \pm 2^\circ\text{C}$ and $30 \pm 2^\circ\text{C}$ was recorded to be 8.69 ± 0.09 and 7.44 ± 0.07 days respectively. Male immature stages had a mean developmental duration of 6.00 ± 0.11 and 5.29 ± 0.07 at temperatures of $25 \pm 2^\circ\text{C}$ and $30 \pm 2^\circ\text{C}$ respectively (Table 9).

11.3 Quiescent stage

Quiescent stage was a type of dormancy or inactive period found at the end of each active period. Thus 3 distinct quiescent stages could be

observed one each between larva and protonymph, protonymph and deutonymph and deutonymph and adult. During the period of quiescence, the individuals appeared lethargic and their feeding activity was almost ceased. Later they selected some secluded area near to feeding site and remained stationary there. At this time, the body appeared swollen, first legs stretched and mouth parts were withdrawn. The duration of quiescent period at 25⁰ C was 1.5 ± 0.04 , 1.52 ± 0.043 and 1.41 ± 0.04 for larva, protonymph and deutonymph respectively. (Table 9). In the case of 30⁰ C, it was noted, 1.44 ± 0.03 , 1.37 ± 0.03 and 0.9 ± 0.04 days for larva, protonymph and deutonymph respectively (Table 9).

11.4 Moulting and emergence of life stages

The development of *E. pariyarensis* involved 3 distinct moulting periods subsequent to each of the quiescent stages. During this process the outer cuticle turned silvery white in colour and a horizontal streak was appeared at the posterior end of hysterosoma which further progressed anteriolaterally led to the extrusion of fourth legs. After a short wriggling movement, the individuals emerged out by making slow backward movement. Occasionally, remnants of moulting skin was found attached to the body was finally removed by the aid of legs. The average time taken for moulting was 20.5 minutes.

11.5 Fecundity and Longevity

The preoviposition period, oviposition period, post oviposition period and total longevity were found to vary with the increase in temperature whereas fecundity did not show significant difference at $P < 0.05$ (Table 10). Total number of eggs laid per female at $25 \pm 2^{\circ}\text{C}$ was 36.2 ± 0.20 and 42.12 ± 0.16 at $30 \pm 2^{\circ}\text{C}$. At $25 \pm 2^{\circ}\text{C}$ average daily oviposition per female $2.2 \pm$

0.20 and 2.4 ± 0.16 at $30 \pm 2^\circ\text{C}$. Maximum mean longevity noted for females reared at $25 \pm 2^\circ\text{C}$ was 24.6 ± 0.48 followed by 23.8 ± 0.68 for those at $30 \pm 2^\circ\text{C}$. Male longevity at the two temperatures of $25 \pm 2^\circ\text{C}$ and $30 \pm 2^\circ\text{C}$ were 18.6 ± 0.76 and 17.7 ± 0.87 respectively. (Table 9)

11.6 Morphological descriptions of developmental stages

11.6.1 Egg

The freshly laid eggs of *E. pariyarensis* appeared to be smooth, oval, transparent white in colour measuring 177-201 long and 135-148 wide. (Table 11, Plate 113 A). Under high magnification egg showed a clear area of cytoplasm and yolk spherules were evenly distributed. At the final stage of incubation, the miniature larval form could be distinguished at one end.

11.6.2 Larva

Larva upon hatching was smooth, white in appearance measuring 196-240 long and 139-150 wide with 3 pairs of legs. Larva has 9 pairs of setae on the dorsal idiosoma, j_3 , Z_5 and s_4 were the longest setae and j_1 , j_3 , j_4 , and j_6 minute. z_2 , z_3 and Z_4 present all other setae absent (Table 11, Plate 113A). Measurement of setae: j_1 -25, s_4 - 68, Z_5 - 76, Z_4 - 17. Sternal setae present but shield is not visible, ST_4 absent, ventrolateral and preanal setae present but JV_5 absent. Genital and ventrianal shields were not clearly visible.

11.6.3 Protonymph

Dorsal idiosoma 197-242 long, 126-138 wide possesses more than 13 pairs of setae and had a shining appearance. Unlike the larva it has 4 pairs of legs (Table 11, Plate 113 A). Measurement of setae: j_1 -15, j_3 -11, s_4 -20, Z_5 -22, all other setae minute. Sternal, metasternal and genital setae present but shield not clearly visible. JV_5 – 13 long. Protonymph shows the presence of

ventrolateral setae and preanal setae but ventrianal shield was not clearly visible. Metapodal plates were not discernable.

11.6.4 Deutonymph

Deutonymph was similar to that of adult in appearance measuring 329-333 long, 215-231 wide. (Table 11, Plate 113 A). It has all 17 pairs of setae. Measurement of setae: j_1 -25, j_3 -13, z_2 , j_4 , j_5 , z_4 , j_6 minute, s_4 - 12, Z_1 -16, S_4 , S_5 , Z_4 -12 and Z_5 -43 and all other setae were minute. Sternal setae 13 long, genital setae 10 and JV_5 -30 long.

11.6.5 Adult

Dorsal idiosoma of female 320-338 long, 210-260 wide with 17 pairs of setae. Males also have 17 pairs of setae, are 243-265 long and 177-190 wide (Table 11, Plate 113 B). Morphological descriptions are given in chapter 6, plate 63.

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DISCUSSION

During the present study, a survey was conducted on predatory mites inhabiting medicinal plants of North Kerala. The results of the survey yielded a total of 82 species of predatory mites belonging to 11 subfamilies, 8 tribes, 23 genera under 7 families of the order Mesostigmata and suborder Prostigmata. These mites were recovered from 53 species of medicinal plants under 47 genera and 28 families grown in 40 different localities as *insitu* and *exsitu* conservation methods. The districts surveyed for the recovery of predatory mites were Kasaragod, Kannur, Wayanad, Kozhikode, Malappuram and Palakkad.

The order Mesostigmata was represented by 3 families viz., Ascidae, Blattisociidae and Phytoseiidae, while Prostigmata comprised of 4 families. In the present study, a total of 53 species were reported under the order Mesostigmata viz., Ascidae - 5, Blattisociidae- 10 and Phytoseiidae-38, of which, a total of 30 species were new to science, viz., Ascidae - 3, Blattisociidae- 9 and Phytoseiidae-18. This observation points to the fact that predatory mites of Mesostigmata represent quite unstudied group in South India, especially in Kerala and hence warrants more investigation on their taxonomic aspects. Out of the 5 species described under the family Ascidae 3 were new to science and 2 were new records from India. But in the case of Blattisociidae, 9 species were new taxa and *Lasioseius plumatus* Karg, 1980 was a new record from India. Works on Ascidae and Blattisociidae were

scanty from Kerala and new records were verified by the latest catalogue prepared by Moraes *et al.* 2016.

As far as the total number of species concerned, the family Phytoseiidae has been reported as the largest family with 38 species under 3 subfamilies, *viz.*, Amblyseiinae, Phytoseiinae and Typhlodromiinae. It appears to be quite encouraging that all the subfamilies of Phytoseiidae were reported in the present study also (Chant and McMurtry, 2007). Under the family Phytoseiidae 7 tribes and 10 genera were recovered from medicinal plants.

The phytoseiid mites, especially those belonging to the genera *Amblyseius*, *Neoseiulus*, *Typhlodromus* etc. have been considered as important biological control agents of pest mites like tetranychids, eriophyids, tarsonemids, thrips, white flies and so on (McMurtry and Rodriguez, 1989). Phytoseiid mites are the most explored and exploited group of predatory mites and its studies have led to a description of 2735 species from the world which comprised of 2452 valid species (Demite *et al.*, 2015). Currently, under the family Phytoseiidae, a total of 211 species under 21 genera, 3 subfamilies were known from India (Gupta and Karmakar, 2015).

As far as our knowledge on the phytoseiid mites of Kerala is concerned, it is really in its infancy. Mary Anitha (2002) reported 32 species of phytoseiid mite from North kerala. Despite this, 37 species of which 18 new taxa were added to the phytoseiid fauna of Kerala by Sajna Haneef (2015). *A. channabasavannai* was a species recovered from all the district surveyed indicating its dominance in distribution. Mean while, *Amblyseius* and *Euseius* were showed maximum species diversity and the genus

Gynaeseius was also reported from Kerala. Species under the genus *Euseius* included under the category of pollen feeding generalist predators (McMurtry *et al.*, 2013) but in the present study it was noted along with tetranychid mites (Nomikou *et al.*, 2001) which indicates its predatory potential and common availability.

During the present study, the suborder Prostigmata though was recognized to exhibit the maximum family diversity, its species diversity was comparatively lower than the order Mesostigmata. The families recovered under Prostigmata were Bdellidae, Cunaxidae, Cheyletidae and Stigmaeidae with 6, 12, 9 and 2 species respectively. Out of the 4 families recovered, Bdellidae supported maximum number of subfamilies *viz.*, Bdellinae, Odontoscirinae and Cytinae. The genera recovered were *Bdella*, *Bdellodes*, *Thoribdella* and *Cyta*. The family Cunaxidae was found represented by maximum number of species (12) categorized under the genera *viz.*, *Cunaxa*, *Dactyloscirus* and *Neocunaxoides*. Out of the 9 species recovered from the family Cheyletidae, 4 were appeared to be new to science and 2 were new records from India. This seems to be highly essential since most of the cheyletid mites are important predator of various mite pests and insects (Sinha, 1968). Under the family Stigmaeidae only two species *viz.*, *Agistemus fleschneri* Summers and *Agistemus terminalis* (Quayle) was recovered.

From the results of the present study it is evident that all the above families of mites still remain as relatively unstudied group in India except certain isolated examples (Gupta 1986, 1991, 2002, 2003; Mary Anitha, 2002), despite their significant role in biological control. Future studies may reflect their potential in the IPM programme. The present study not only helped in revealing the predatory mites population in Kerala but also helped

in contributing 48 new species under the order Mesostigamata and suborder Prostigmata. Several new records from Kerala also ascertain the rich biodiversity of Kerala that supports several new and interesting species of its kind.

During the present survey, a new species of *Euseius* viz., *E. pariyarensis* inhabiting *Bauhinia acuminata* selected for detailed studies on their feeding and breeding aspects. The laboratory study on feeding potential was carried out at a temperature $30 \pm 2^{\circ}$ C, $65 \pm 10\%$ RH. The feeding activities were more or less similar pattern that of any of the phytoseiid mites which were started from the larval stage onwards.

In the present study, female consumed significantly higher numbers of prey than male and other immature. Sabelis (1981), Nguyen and Shih (2011) reported the daily predation rates of gravid female higher than the male. Toledo *et al.* (2013) also reported that the higher predatory efficiency of female at the adult stage could be explained by their large size and greater energy requirement due to reproduction as compared to male and immatures. Liyaudheen *et al.*, (2014) reported that the adult female of *E. ovalis* was recognized as the most potential predator and its feeding preference increased in the order: deutonymph < protonymph < larva < egg. The feeding potential of *E. pariyarensis* also showed these preferences.

Several phytoseiid species were more positively influenced using a diet of eggs of tetranychids (Burnett 1971, Croft and Mc Murtry 1972). The present study showed that all developmental stages of *E. pariyarensis* preferred eggs for the succeeding development. It was noted that larva did not feed any stages of the prey mite except eggs of *T. neocalidonicus*. The

percentage predation of various developmental stages of *E. pariyarensis* showed that 61% of the eggs were consumed by the female followed by male (42%), deutonymph (21%), protonymph (12%) and larva (1%) respectively. The above observation helped to establish the predatory efficiency of *E. pareyarensis* other than the larval stage in the control of pest mite population.

A study on breeding biology of *E. pariyarensis* on *T. neocalidonicus* infesting *B. acuminata* was also carried at two different temperatures viz., $25 \pm 2^{\circ}\text{C}$, $65 \pm 10\%$ RH and $30 \pm 2^{\circ}\text{C}$, $65 \pm 10\%$ RH. Like any other phytoseiid mites, temperature plays a vital role in the development of *E. pariyarensis* also. Taylor and James (1993) reported that the mean generation period of *E. victoriensis* was varied 4-7 days at $22.5 - 40^{\circ}\text{C}$ respectively. Melo *et al.*, reported that the duration of development of *E. alatus* varied at a temperature of $18-33^{\circ}\text{C}$. In the present study, it was noted that temperature influenced the total duration of development and longevity except the fecundity. In this study, the mean developmental duration of female immature stages at $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$ was recorded to be 8.69 ± 0.09 and 7.44 ± 0.07 days respectively. Supplied with sufficient and suitable food many phytoseiids develop within 1 week at 27°C and 60-90% RH (Tanigoshi 1982).

In the present work, mating behavior was noted immediately after moulting which is similar to the report of Amano and Chant (1978), Hoy and Smilanick (1979). Oviposition period of *E. pareiarensis* was started 1.4 days after mating. The time was reported to be varied in different species and significantly longer oviposition period was recorded for species with multiple mating (Momen, 1993). Total number of eggs laid per female at $25 \pm 2^{\circ}\text{C}$ was 36.2 ± 0.20 was approximately similar to that of *E. scutalis* (39.7 ± 2.63) by Abou –Elella *et al.*, (2014). The fecundity at $30 \pm 2^{\circ}\text{C}$ was 42.12 ± 0.16 .

Mori and Chant (1966) reported that fecundity of phytoseiid mites usually 30-40 eggs /female under the relative humidities between 70 and 90 %, drier or more humid atmospheres may reduce fecundity (Reuveny *et al.*, 1966).

The result of immature durations of *E. pariyarensis* were found close to *E. concordis* reported by Moraes and Lima (1983). They reported 5.00 ± 0.70 days for the development of female and 4.9 ± 0.84 days for male at $25 \pm 4^{\circ}\text{C}$ and 60% RH. In the present study, male immature stages had a mean developmental duration of 6.00 ± 0.11 at $25 \pm 2^{\circ}\text{C}$ and 5.29 ± 0.07 at temperatures of $30 \pm 2^{\circ}\text{C}$, respectively. Female immature stages at $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$ were recorded to be 8.69 ± 0.09 and 7.44 ± 0.07 days respectively. Maximum mean longevity noted for females reared at $25 \pm 2^{\circ}\text{C}$ was 24.6 ± 0.48 days followed by 23.8 ± 0.68 for those at $30 \pm 2^{\circ}\text{C}$. Male longevity at the two temperatures of $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$, were 18.6 ± 0.76 and 17.7 ± 0.87 respectively. Kasap and Sekeroglu (2004) reported the longevity of *E. scutalis* feeding on *Panonychus citri* was 28.6 ± 2.18 days at $25 \pm 1^{\circ}\text{C}$.

Extensive study on the feeding and breeding aspects of these new species may serve to open new avenues in the field of biological control for the management of pest mites and also small insects to a certain extent.

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SUMMARY

Mites are tiny microscopic organisms belonging to the class Arachnida of the phylum Arthropoda. They are biologically the most diverse and dominant groups which are worldwide in distribution. The important phytophagous groups of mites recognized so far generally belong to the families Tetranychidae, Tenuipalpidae, Tarsonemidae and Eriophyidae which are of great economic importance by virtue of the various types of damages caused by them leading to heavy yield loss. Predatory mites constitute a highly significant beneficial group on account of their vital role in the maintenance of pests below economic injury level.

Predatory mites have received considerable recognition globally owing to their potential as biocontrol agents of phytophagous mites, and more recently of insect pests like thrips, aphids, scale insects and mealy bug etc. The predatory role has been attributed to various mite families like Phytoseiidae, Ascidae, Blattisociidae, Bdellidae, Cunaxidae, Cheyletidae, Stigmaeidae, Erythraeidae, Tydeidae, Anystidae and so on. Among the predatory mites, the species of Phytoseiidae are potentially important as a biotic factor in the control of phytophagous mites (McMurtry and Croft, 1997). They are efficient predators than other predatory mite families because of their shorter life cycles than the prey they feed upon, high range of reproductive potentiality, good searching capacity, ability to survive on a low prey density and their capacity to survive by feeding on alternate food like plant saps, nectar and honey dew. Mass multiplication methods have

been developed to use these predators in commercial scale on a variety of crops.

The present study includes a detailed survey of predatory mites of different families inhabiting medicinal plants from various localities in 6 districts of North Kerala (Kasaragod, Kannur, Wayanad, Kozhikode, Malappuram and Palakkad), their systematic aspects and also the feeding and breeding biology of a representative species. During the present study, a total of 82 species of predatory mites inhabiting 53 species of medicinal plants belonging to 47 genera and 28 families were surveyed and examined for studying their taxonomic characters. A total of 82 species belonging to 23 different genera, 11 subfamilies and 7 families were recovered under the suborder Prostigmata and order Mesostigmata, of these 48 species belonging to 23 genera were new to science. The predatory mite families recorded during the study were Ascidae, Blattisociidae, Phytoseiidae, Bdellidae, Cunaxidae, Cheyletidae and Stigmaeidae. The mesostigmatid mites recovered during the present study could be identified under 3 families *viz.*, Ascidae, Blattisociidae and Phytoseiidae. Under the family Ascidae, 5 species were identified, of which 3 were new to science. The family Blattisociidae represented by 10 species, all coming under the genus *Lasioseius*, of which 9 were identified as new to science and one known species *viz.*, *Lasioseius plumatus* Karg was a new record from India.

Under Phytoseiidae, a total of 38 species were recovered that could be categorized under 3 subfamilies *viz.*, Amblyseiinae, Phytoseiinae and Typhlodrominae. When compared to the families Ascidae and Blattisociidae, Phytoseiidae exhibited maximum diversity with respect to genera and species. This was evidenced by the recovery of 38 species out of the 83

collected comes under the family Phytoseiidae, of which 18 were appeared as new taxa, of which one species viz., *Amblyseius velayudhani* Santhosh and Mary Anitha, 2016 has been already published.

In the present study, 4 families of prostigmatid mites viz., Cheyletidae, Cunaxidae, Bdellidae and Stigmaeidae were recovered from different medicinal plants. Among this, family Cunaxidae represented the maximum species and generic diversity followed by Cheyletidae, Bdellidae and stigmaeidae. The family Cunaxidae was found represented by 12 species categorized under the genera viz., *Cunaxa*, *Dactyloscirus* and *Neocunaxoides* comprising 8, 1 and 3 species respectively under a single subfamily cunaxinae, of which 8 species were new to science. The family Cheyletidae formed the second with respect to species diversity accommodating 9 species under the genera *Cheyletus*, *Cheletomimus* and *Hemicheyletia* of which 5 were new to science and 2 species viz., *Hemicheyletia cordovens* (De Leon) and *Hemicheyletia serrula* Summers and Price were new report from India. The family Bdellidae was found represented by 6 species categorized under 3 subfamilies viz., Bdellinae, Odontoscirinae and Cytinae. The genera identified were *Bdella*, *Bdellodes*, *Thoribdella* and *Cyta*. Out of the 6 species, 5 were recognized as new to science. The family Stigmaeidae was found represented by only 2 known species under the genus *Agistemus*. This study explored many new species (48) and new records of predatory mites. As far as the works on predatory mites concerned, only a few works were reported from Kerala.

The predatory mites of the family Phytoseiidae are excellent agents for biological control as well as effective components of agricultural systems. Biological and ecological studies on phytoseiids have realized that they are

very effective for controlling several pests of agricultural importance. Many species of phytoseiid mites are good biological control agents of injurious plant feeding mites of the families Tetranychidae, Tenuipalpidae, Eriophyidae etc. In the present study an attempt has been done to expose the feeding and breeding biology of a new species of predatory mite *Euseius pariyarensis* sp.nov. preying upon various stages of pest mite, *Tetranychus neocalidonicus* infesting the medicinal plant, *Bauhinia acuminata*.

Developmental studies of *E. pariyarensis* were carried out in the laboratory by successfully rearing the mites on leaf discs maintained at a temperatures of $25 \pm 2^{\circ}\text{C}$ and $30 \pm 2^{\circ}\text{C}$ under 65 ± 10 RH. Regular observations were made to collect data on various aspects of breeding viz., mating, pre-oviposition, oviposition, post- oviposition, fecundity and total longevity of both male and female predatory mites. The developmental duration of all stages were seen to be influenced by temperature. The active stages of larva, quiescent phase of deutonymph and total developmental period were found slightly decreased with increase in temperature from 25 to 30°C ($P < 0.05$). The preoviposition period, oviposition period, post ovipositon period and total longevity were found to vary with the increase in temperature whereas fecundity did not show significant difference. ($P < 0.05$)

To study the feeding potential, tests were carried out in the laboratory under $30 \pm 2^{\circ}\text{C}$, $65 \pm 10\%$ RH condition. Promising results were obtained and following observations were made regarding its feeding activities. The results obtained were subjected to ANOVA for testing the significance and comparison made using Scheffe's test. The results indicated a P-value less than 0.01 and 0.05 which shows high significance.

The feeding activities of all stages of *E. pariyarensis* were more or less similar pattern which were initiated from the larval stages onwards. The consumption rate of every stages of the predator was noted after a time period of 24 hours and the results were statistically analysed. The observation revealed that the predator larva was a non-feeder of larva, protonymph, deutonymph and adult stages of the prey mite *T. neocalidonicus*. Based on the results of consumption of the predator on various stages of *E. pariyarensis* in 24 hours categorized plots and categorized normal plots were constructed to check the validity of normality assumption. In all categories, the values were close to a positive straight line, indicating a valid normality assumption. Maximum consumption of eggs of prey mite was exhibited by adult female. The mean consumption rate of predators followed the order that female > male > deutonymph > protonymph > larva respectively.

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REFERENCES

- Abad-Moyano, R., Urbaneja, A., Hoffmann, D. and Schausberger, P. 2010. Effects of *Euseius stipulatus* on establishment and efficacy in spider mite suppression of *Neoseiulus californicus* and *Phytoseiulus persimilis* in Clementine. *Exp. Appl. Acarol*, **50**: 329–341.
- Abou-Elella, G.M., Hassan, M.F., Nawar, M.S. and Zidan I.M. 2014. Survival, development and reproduction of *Euseius finlandicus* (Oudemans) (Acari: Phytoseiidae) fed on various kinds of food substances, *Archives Of Phytopathology And Plant Protection*, **47**:7, 857-868,
- Abou-Setta, M.M. and Childers, C.C. 1989. Biology of *Euseius mesembrinus* (Acari: Phytoseiidae): life tables and feeding behavior on tetranychid mites on citrus. *Environ. Entomol.* **18**: 665–669.
- Aheer, G.M., Akbar, S. and Chaudhri, W.M. 1992. Three new species of the genus *Cheletogenes* Oudemans (Acarina : Cheyletidae) from Pakistan. *Acarologia*, **33** (1): 35-43.
- Aheer, G.M., Akbar, S. and Chaudhri, W.M. 1994. The genus *Cheletomimus* (Acarina: Cheyletidae) from Pakistan. Descriptions of three new species. *Acarologia*, **35** (4): 345-351.
- Aheer, G.M., Akbar, S. and Chaudhri, W.M. 1991. Two new species of genus *Acaropsis* (Acarina: Cheyletidae) from Pakistan. *Acarologia*, **32** (4): 335-340.
- Akyol, M. and Koc, K. 2007. Four new species of the genus *Stigmaeus* (Acari: Stigmaeidae) from Turkey. *Archives des Sciences*, **60**: 41–50.

- Akyol, M. and Koc. K. 2010. Contributions to the raphignathoid fauna of Turkey, with a description of a new species of *Cryptognathus kramer* (Acari: Actinedida: Raphignathoidea). *Turkish Journal of Zoology*, **34**: 159–167.
- Alberti, G. 2002. Reproductive systems of gamasid mites (Acari, Anactinotrichida) reconsidered. In: Bernini, F., Nannelli, R., Nuzzaci, G. and de Lillo, E. (Eds.), *Acarid Phylogeny and Evolution: Adaptation in Mites and Ticks. Proceedings of the 4th Symposium of EURAAC. Siena, 2000*. Kluwer Academic Publishers, Dordrecht, 125–139 pp.
- Alberti, G. and Di Palma, A. 2002. Fine structure of the phytoseiid type sperm access system (Acari, Gamasida, Phytoseiidae). In: Bernini, F., Nannelli, R., Nuzzaci, G. & de Lillo, E. (Eds.), *Acarid Phylogeny and Evolution: Adaptation in Mites and Ticks. Proceedings of the 4th Symposium of EURAAC. Siena, 2000*. Kluwer Academic Publishers, pp., Dordrecht, 241–252. pp.
- Amano, H. and Chant, D.A. 1978. Mating behaviour and reproductive mechanisms of two species of predaceous mites *Phytoseiulus persimilis* Athias-Henriot and *Amblyseius andersoni* (Chant) (Acarina: Phytoseiidae). *Acarol*, **20**(2): 196-213.
- Arun Gupta, Chattopadhyayand, M. and Gupta, S. K. 2014. On A Collection of Mites Infesting Herbs Used As Spices And Oil Seeds In India With Special Reference To Western Ghat Areas, *Rec. zool. Surv. India*: **114**(Part-2) : 251-262.
- Athias - Henriot, C. 1960. Phytoseiidae et Aceosejidae (Acarina: Gamasina) d'Algerie, IV. Genre *Typhlodromus* Scheuten, 1857. *Bull. Soc. Hist. Nat. Afr. N.*, **51**:62-107.

- Athias-Henriot, C. 1968. L'appareil d'insemination laelapoide (Acariens anactinotriches: Laelapoidea, ♀♀). Premieres observations. Possibilite d'emploi a des fins taxonomiques. *Bulletin Scientifique de Bourgogne*, **25**: 229–274.
- Attiah, H.H. 1973. *Chelacaropsis bakeri* (Acarina: Cheyletidae), a new genus and species associated with stored food mites in Egypt. Proc. of 3rd Int. Cong. of Acarol. Prague (Aug. 31, - Sep. 6, 1971). *Milan Daniel and Bohumir Rosicky (Eds.), Pub. Junk, W., The Hague*, 349 - 352.
- Atyeo, W.T. 1958. The genus *Bonzia* in the new world. *Journal of the Kansas Entomological Society*, **19** (1): 55–61.
- Atyeo, W.T. 1960. A revision of the family Bdellidae in North and Central America (Acarina: Prostigmata). *University of Kansas Science Bulletin*, **40**: 345–499.
- Badii, M.H., Hernandez-Ortiz, E., Flores, A. and Landeros, J.N. 2004. Prey stage preference and functional response of *Euseius hibisci* to *Tetranychus urticae* (Acari: Phytoseiidae). *Exp. Appl. Acarol.*, **34**: 263-273.
- Bagheri. M., Paktinat-Saeij, S., Tatiane, M.M.G., de Castro and Moraes G.J. de. 2016. A new species of *Cunaxoides* (Acari: Trombidiformes: Cunaxidae) from Iran . *Persian J.Acarol.*, **5** (1): 1–8.
- Baker, E.W. 1949. A review of the mites of the family Cheyletidae in the United States National Museum. *Proc. U.S. Nat. Mus.*, **99** (3238): 267-320.
- Baker, E.W. and Wharton, G.W. 1952. *An Introduction to Acarology*. Mac Millan Co., New York. 465 pp.
- Ballard, R. C. 1954. The biology of the predaceous mite *Typhlodromus fallacis* (Garman) [*Phytoseiidae*] at 78°F. *The Ohio J. Sci.*, **54**: 175–179.

- Bashir, M.H and Afzal, M. 2006. Two new Species of the Genus *Dactyloscirus* (Acari:Cunaxidae) from Punjab, Pakistan. *Pakistan J. Zool.*, **38** (4): 273-278
- Bashir, M.H., Afzal, M. and Akbar, S. 2005. A new cunaxid mite of genus *Pulaeus* (Cunaxidae) from Punjab, Pakistan. *Biologia (Pakistan)*, **51** (2): 163–168.
- Bashir, M.H, Afzal, M. and Khan, B. 2008. Genus *Armascirus* (Acari: Prostigmata: Cunaxidae) from Pakistan. *Belgian. j. Zool.*, **138** (2): 115–127.
- Bashir., M.H., Afzal, M., Ashfaq, M., Ali, S., Kamran, M. and Honey, S.F. 2014. Subfamily Coleoscirinae (Acari: Trombidiformes: Cunaxidae), with description of one new species from Pakistan. *Journal of Insect Science*, **14**: 82
- *Berlese, A. 1904. Acari Nuovi. *Redia* **2**: 231–238
- *Berlese, A. 1910. Acari Nuovi. *Redia* **6**: 199–201.
- *Berlese, A. 1913. *Acarotheca Italica*. Ricci, Firenze, 221 pp.
- *Berlese, A. 1914, Acari Nuovi. *Redia*, **10**: 113-150.
- *Berlese, A.1916. Centuria prima sesta di Acari Nuovi. *Redia*, **12**: 19-67.
- *Berlese, A.1923. Centuria sesta di Acari nuovi. *Redia-Giornale di Entomologia*, **15**: 1–240.
- Bhattacharyya, S.K. 1966. Studies on Indian mites (Acarina: Mesostigmata). II. Descriptions of four species of the genus *Asca* Von Heyden. *Proceedings of the Zoological Society of Calcutta*, **19**: 31–37.
- Bhattacharyya, S.K. 1968. Studies of Indian mites (Acarina: Mesostigmata). Six records and descriptions of nine new species. *Acarologia*, **10**: 527–549.

- Bhattacharyya, S.K. 1969a. Studies of Indian mites (Acarina: Mesostigmata).
7. Six species found under bark in North East Frontier Agency. *Zoologische Jahrbucher Abteilung fur Systematik, Okologie und Geographie der Tiere*, **96**: 69–80.
- Bhattacharyya, S.K. 1969b. Two new phytoseiids from Eastern India (Acarina: Phytoseiidae). *J. Bom. Nat. Hist. Soc.*, **65** (3): 677-681.
- Bhattacharyya, S.K. 1972. Studies on Indian mites (Acarina, Mesostigmata).
9. Additional species found under bark in North East Frontier Agency, *Acarologia*, **12**: 272–279.
- Bhattacharyya, S.K. 1978. Five new species and a new record of Mesostigmata (Acari) from West Bengal, India. *Indian J. Acarol.*, **2**: 78–87.
- Bhattacharyya, A.K. and Bhattacharyya, S.K. 2001. A new species of the genus *Lasioseius* Berlese (Acari: Gamasida: Ascidae) from India. *Records of the Zoological Survey of India*, **99**: 23–26.
- Bhattacharyya, A.K. and Bhattacharyya, S.K. 2004. Two new species of the genus *Cheiroseius* Berlese, 1916 (Ascidae: Mesostigmata) from the Indian Thar Desert. *Zootaxa*, **403**: 1–11.
- Bhattacharyya, A.K. and Sanyal, A.K. 2002. New data on mites of the genus *Lasioseius* (Mesostigmata, Ascidae) in India along with the description of two new species. *Acarina*, **10**: 51–56.
- Bhattacharyya, A.K. and Sanyal, A.K. 2003. Three new species and some new records of the genus *Gamasellodes* Athias-Henriot (Acarina: Ascidae) from India. *Acarologia*, **42**: 229–238.
- Bhattacharyya A.K., Sanyal, A. K. and Bhattacharyya, T. 1997. An unusual new species of the genus *Asca* von Heyden (Mesostigmata: Ascidae) from Tripura, India. *Annals of Entomology*, **15** (2): 11–15.

- Bhattacharyya, A.K., Sanyal, A.K. and Bhattacharyya, T. 1998. Three new ascid mites (Acarina: Mesostigmata: Ascidae) from a nest of five-striped squirrel *Funambulus pennanti* Wroughton in West Bengal, India. *Acarina*, **5**: 37–43.
- Bhattacharyya, A.K., Sanyal, A.K, Bhattacharyya, T. 2000. Two new species of the genus *Lasioseius* (Mesostigmata:Ascidae) from India. *Rec. Zool. Surv. India*, **98**: 93–99.
- Bochkov, A.V. 2004. Mites of the family Cheyletidae (Acari: Prostigmata): phylogeny, distribution, evolution and analysis of host-parasite relationships, *Parasitologia*, **38**: 122–138.
- Bochkov A. V. and Abramov, V.M. 2016. To fauna of the free-living Cheyletidae (Acariformes: Cheyletoidea) of the European part of Russia. *Sys. Appl. Acarol.*, **21**(3): 335–346 .
- Bochkov, A.V. and Fain, A. 2001. Phylogeny and system of the Cheyletidae (Acari:Prostigmata) with special reference to their host-parasite associations. *Bulletin del'Institut Royal des Sciences Naturelles de Belgique Entomologie*, **71**: 5–36.
- Bochkov, A. V. and Otto. J. 2010. Five new species of predaceous cheyletid mites (Acari: Prostigmata: Cheyletidae), *Zootaxa*, **2727**: 1–20.
- Bochkov, A.V. and Saboori, A. 2005. A review of the Iranian Cheyletidae (Acari :Prostigmata) *Belgian journal of Entomology*, **7**: 99-109
- Bregetova, N.G. 1977. Family Aceosejidae Baker and Wharton, 1952 (sensu Evans, 1958). In: Ghilyarov, M.S. & Bregetova, N.G. (Eds.), *Key to the Soil Inhabiting Mites. Mesostigmata*. Nauka, Leningrad, 169–226. [in Russian]

- Britto, E.P.J., Lindquist, E.E. and Moraes, G.J. de 2011. Redescription of *Lasioseius floridensis* Berlese, 1916 (Acari: Mesostigmata: Blattisociidae), with notes on closely related species. *Zootaxa*, **2905**: 1–15.
- Britto, E.P.J., Lopes, P.C. and Moraes, G.J. de 2012. *Blattisocius* (Acari, Blattisociidae) species from Brazil, with description of a new species, redescription of *Blattisocius keegani* and a key for the separation of the world species of the genus. *Zootaxa*, **3479**: 33–51.
- Broufas, G. and Koveos, D. S. (2000). Effect of Different Pollens on Development, Survivorship and Reproduction of *Euseius finlandicus* (Acari: Phytoseiidae). *Env. Entomol.* **29**(4):743-749
- *Canestrini, G. and Fanzago, F. 1876. Nuovi Acari Italiani. *Atti della Società Veneto-Trentina di Scienze Naturali, Padova*, **5** (1), 99 –111.
- *Canestrini, G. and Fanzago, F. 1878. Intorno agli acari Italini. *Atti del Reale Istituto Veneto di Scienze Lettere ed Arti.*, **4** (5), 69-208.
- Chant, D.A. 1959 a. Phytoseiid mites (Acarina: Phytoseiidae). I. Bionomics of seven species in south-eastern England. II. A taxonomic review of the family Phytoseiidae, with descriptions of 38 new species. *Canadian Entomol.*, **91**: (Suppl. 12) : 45 - 164.
- Chant, D.A. 1959 b. Observations sur la famille des Phytoseiidae. *Acarologia*, **1**: 11-22.
- Chant, D.A. 1961. An experiment in biological control of *Tetranychus telarius* (L.) (Acarina: Tetranychidae) in a greenhouse using the predaceous mite *Phytoseiulus persimilis* Athias-Henriot (Phytoseiidae). *Can. Ent.* **93**: 437–443.

- Chant, D.A. 1963. The subfamily Blattisocinae Garman (Aceosejinae Evans) (Acarina: Blattisocidae Garman) (Aceosejidae Baker and Wharton) in North America, with descriptions of a new species. *Canadian Journal of Zoology*, **41**: 243–305.
- Chant, D.A. 1965. Generic concepts in the family Phytoseiidae (Acarina: Mesostigmata). *Canadian Entomol.*, **97**: 351-374.
- Chant, D. A. and McMurtry, J. A. 1994. A review of the subfamilies Phytoseiinae and Typhlodrominae (Acari: Phytoseiidae). *Internat. J. Acarol.*, **20** (4): 223-310.
- Chant, D. A. and McMurtry, J. A. 2004. A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part IV. tribe Amblyseiini Wainstein, subtribe Arrenoseiina Chant and McMurtry. *Internat. J. Acarol.*, **30** (4): 291-312.
- Chant, D. A. and McMurtry, J. A. 2005. A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part VII. Typhlodromipsini n. tribe. *Internat. J. Acarol.*, **31**(4): 315-339.
- Chant, D. A. and McMurtry, J. A. 2006a. A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part VIII. the tribes Macroseiini Chant, Denmark and Baker, Phytoseiulini n. tribe, Afroseiulini n. tribe and Indoseiulini Ehara and Amano. *Internat. J. Acarol.*, **32**(1): 13-25.
- Chant, D. A. and McMurtry, J. A. 2006b. A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part IX. an overview. *Internat. J. Acarol.*, **32** (2): 1-27.
- Chant, D.A. and McMurtry, J. A. 2007. *Illustrated Keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata)*. Indira Publishing House, West Bloomfield, 1-220.

- Chant, D.A. and McMurtry, J.A. 2003. A review of the subfamily Amblyseinae Muma (Acari:Phytoseiidae): Part II. The tribe Kampimodromini Kolodochka, *Internat. Jo. Acarol.*, **29** (3): 179- 224.
- Chant, D.A. and Yoshida-Shaul, E. 1989. Adult dorsal setal patterns in the family Phytoseiidae (Acari: Gamasina). *Internat.J.Acarol.*, **15** (4): 219-233.
- Chant, D. A. and Yoshida -Shaul E. 1991. Adult ventral setal patterns in the family Phytoseiidae(Acari: Gamasina). *Int. J. Acarol.*, **17** (3): 187-199.
- Chant, D. A and Yoshida-Shaul, E, 1992. Adult idiosomal setal patterns in the family Phytoseiidae (Acari : Gamasina), *Internat. J. Acarol*, **18** (3): 177-193.
- Chant, D.A., Hansell, R.I.C. and Rowell, H.J. 1978. A study of the family Phytoseiidae (Acarina: Mesostigmata) using the methods of numerical taxonomy. *Canadian J. Zool.* **56** (6): 1330 – 1347.
- Chaudhri, W.M. 1968. Three new mites of the genus *Ledermuelleria* (Stigmaeidae). *Pak. J.Agr. Sci.*, **5** (1), 9–17.
- Chaudhri, W. M. 1974. Taxonomic studies of the mites belonging to the families Tenuipalpidae, Tetranychidae, Tuckerellidae, Caligonellidae and Phytoseiidae. *Tech. Bull.* No. **1**: 1-250.
- Chaudhri, W. M., Akbar, S. and Rasool, A. 1979. Studies on the predatory leaf inhabiting mites of Pakistan. Project No. PK-ARS-30, University of Agriculture, Faisalabad, Pakistan, 123 pp.
- Cheng, H. and Fan, Q. H. 2008. A catalogue of the Chinese Raphignathoidea (Acari: Prostigmata). *Sys.Appl. Acarol.*, **13**: 256–278.
- Chillar, B. S., Gulati, R. and Bhatnagar, P. 2007. *Agricultural Acarology*. Daya Publishing House, Delhi, 355pp.

- Chinniah, C. and Mohanasundaram, M. 1995. Record of new ascid mites (Ascidae: Acari) infesting insects in Tamil Nadu, India. *Entomon*, **20**: 233–236.
- Chinniah, C. and Mohanasundaram, M. 2001a. Five new species of predatory mites (Acarina: Phytoseiidae) from Kerala, India. *Entomon.*, **26** (1): 65–77.
- Chinniah, C. and Mohanasundaram, M. 2001b. New species of acarine fauna (Acarina: Mesostigmata) from Shevroy Range of Eastern Ghats of Tamil Nadu, India. *Zoo's Print Journal*, **16** (7): 523–531.
- Christian, A. and Karg, W. 2008. A revised setal nomenclature based on ontogenetic and phylogenetic characters and universally applicable to the idiosoma of Gamasina (Acari, Parasitiformes). *Soil Organisms*, **80**: 45–79.
- Corpuz-Raros, L. A. 1998. Twelve new species and one new record of Cheyletidae (Acari) from Philippines. *Internat. J. Acarol.*, **24**(4): 259–290.
- Corpuz-Raros, L.A. and Garcia, R.C. 1995. Philippine predatory mites of the family Cunaxidae (Acari). 1. Genus Cunaxa Von Heyden. *Philippine Entomologist*, **9** (6): 605–624
- Demite, P.R., McMurtry J.A. and Moraes G.J. 2014. Phytoseiidae Database: a website for taxonomic and distributional information on phytoseiid mites (Acari). *Zootaxa*, **3795**: 571–577.
- Demite, P.R., Moraes, G.J.de., Mc Murtry, J.A, Denmark, H.A. and Casteho, R.C. 2015. Phytoseiidae database. Available from: [www.lea.esalq.easq.ups. br /Phytoseiidae](http://www.lea.esalq.easq.ups.br/Phytoseiidae) (accessed 14.11.2015)
- Den Heyer, J. 1975. A new genus *Cunabdella* (Prostigmata: Acari) with a description of a new species from the Ethiopian Region. *Acarologia*, **16** (4): 664–670.
- Den Heyer, J. 1977. Bonzinae, a new subfamily of the Cunaxidae (Prostigmata: Acari). *Acarologia*, **19** (4): 601–618.

- Den Heyer, J. 1978. Coleoscirinae, a new cunaxid subfamily and two new South African species of *Coleoscirus* Berlese, 1916 (Prostigmata: Acari). *Acarologia*, **20**(4): 522–541.
- Den Heyer, J. 1979a. *Rubroscirus*, a new cunaxid genus (Prostigmata: Acari) with three new species from the Ethiopian Region. *Acarologia*, **20**(1): 70–92.
- Den Heyer, J. 1979b. *Scutopalus*, a new cunaxid genus from the Ethiopian Region (Prostigmata: Acari). *Acarologia*, **21**: 187–193.
- Den Heyer, J. 1979c. *Pulaeus*, a new cunaxid genus (Prostigmata: Acari). *Acarologia*, **21**(1): 18–31.
- Den Heyer, J. 1980. A new classification system for the family Cunaxidae (Actinedida: Acarida). *Publications of the University of the North Series A*, **23**: 1–12.
- Den Heyer, J. 1981a. The Afrotropical species of *Cyta* von Heyden (Bdellidae: Actinedida). *Phytophylactica*, **13**: 31–41.
- Den Heyer, J. 1981b. Systematics of the family Cunaxidae Thor, 1902 (Actinedida: Acarida). *Publications of the University of the North, Series A*, **24**: 1–19.
- Den Heyer, J. 2013. BdelloideaBase: Bdellid & Cunaxid Databases (version Sep 2011). In: Roskov Y, Kunze T, Paglinawan L, Orrell T, Nicolson D, Culham A, Bailly N, Kirk P, Bourgoin T, Baillargeon G, Hernandez F, De Wever A. (Eds) Species 2000 & ITIS Catalogue of Life, 2013 Annual Checklist DVD; Species 2000: Reading, UK.
- Den Heyer, J. and Castro, TMMG. 2009. Four new cunaxoidine genera (Acari: Prostigmata: Cunaxidae) and the description of two new Neotropical species. *Zootaxa*, **2140**: 1–15.
- Denmark, H. A. 1992. Two new species of *Typhlodromus* (Acari: Phytoseiidae) from North America. *Israel J. Entomol.* XXV-XXVI, 13-18.

- Denmark, H. A. Welbourn, W. C. 2002. Revision of the genera *Amblydromella* Muma and *Anthoseius* De Leon (Acari: Phytoseiidae). *Int. J. Acarol.* **28**(4): 291-316.
- Dicke, M. and Sabelis, M.W. 1988. How plants obtain predatory mites as bodyguards. *Neth. J. Zool.*, **38**: 148–165.
- Dogan, S. 2007. Checklist of raphignathoid mites (Acari: Raphignathoidea) of Turkey. *Zootaxa*, **1454**: 1–26
- Dogan, S., Bingul, M., Dilkaraçlı and Fan, Q.H. 2015. Description of a new species of the genus *Stigmaeus* Koch (Acari: Stigmaeidae) from Turkey, with a list of described species in the world. *Internat. J. Acarol.*, **41**(4): 290–299.
- Doker, I., Kazak, C. and Karut. K. 2016. Contributions to the Phytoseiidae (Acari: Mesostigmata) fauna of Turkey: morphological variations, twelve new records, re-description of some species and a revised key to the Turkish species. *Sys. Appl. Acarol.*, **21**: 505–527.
- Donel, G. and Dogan, S. 2011. The stigmaeid mites (Acari: Stigmaeidae) of Kelkit Valley (Turkey). *Zootaxa*, **2942**: 1–56.
- Duncan, D.B. 1995. "Multiple range and multiple F tests". *Biometrics*. **11**: 1–42.
- Dubinin, V.B. 1957. New classification of mites of the superfamilies Cheyletoidea W. Dub. and Demodicoidea W. Dub. (Acariformes: Trombidiformes). *Ahd. Nauk S.S.S. R.* 2001. *Inst. Parazitol. Sbornik*, **17**: 71 - 136.
- Duges, A. 1834. Recherches sur l'ordre des Acariens en générale et la famille des Trombidiés en particulier. *Annales des Sciences Naturelles*, **2**: 5–46.
- Eghbalian, A.H., Khanjani, M., Safaralizadeh, M.H. and Ueckermann, E.A. 2014. Two new species of *Cyta* (Acari: Prostigmata: Bdellidae) from Western Iran, *Zootaxa*, **3847**(4): 567–575.

- Ehara, S. 1962. Notes on some predatory mites (Phytoseiidae and Stigmaeidae). *Japanese J. Appl. Entomol. Zool.*, **6** (1): 53–60.
- Ehara, S. 1966. A tentative catalogue of predator mites of Phytoseiidae known from Asia, with descriptions of five new species from Japan. *Mushi*, **39**: 9-30.
- Ehara, S. and Amano, H. 1998. A revision of the mite family Phytoseiidae in Japan (Acari: Gamasina), with remarks on its biology. *Species Diversity*, **3** (1): 25-73.
- Evans, G.O. 1957. An introduction to the British Mesostigmata (Acarina) with keys to families and genera. *Journal of the Linnean Society Zoology*, **43**: 203–259.
- Evans, G.O. 1958. A revision of the British Aceosejinae (Acarina: Mesostigmata). *Proceedings of the Zoological Society of London*, **131**: 177-229.
- Evans, G.O. 1963. Observations on the chaetotaxy of the legs in the free-living Gamasina (Acari: Mesostigmata). *Bulletin of British Museum. (Natural History), Zoology*. **10**: 277-303
- Evans, G.O. 1992. Principles of Acarology. CAB International, Wallingford, UK., 563 pp
- Evans, G.O. and Hyatt, K.H. 1960. A revision of the Platysejinae (Mesostigmata: Aceosejidae) based on material in the collections of the British Museum (Natural History). *Bulletin of the British Museum (Natural History), Zoology*, **6** (2): 27–101.
- Ewing, H.E. 1914. The common red spider mite or spider mite. *Oregon Agric. Ex. Sta. Bull.* **121**: 95.
- Fain, A. 1979. Notes on the genera *Cheletoides* Oudemans and *Metacheletoides* Fain (Acarina: Cheyletidae) with description of three new species. *Revue de Zoologie . AJiicaine*, **93**(4): 1 0 1, 1 - 1 025.

- Fain, A. 1979a. Cheyletidae (Acari, Prostigmata) parasitic on Afrotropical primates, Carnivora and rodents. *Revue de Zoologieafricaine*, **93**: 621-632.
- Fain, A, 1979b. New Cheyletidae from Afrotropical swifts(Apodidae). *International Journal of Acarology*, **5**: 253-258.
- Fain, A, 1979c. Idiosomal and leg chaetotaxy in the Cheyletidae. *International Journal of Acarology*, **5**: 305-310.
- Fain, A. and Ardeshtir, F. 2000. Notes on the genus *Neoeucheyla* Radford 1950 (Acari: Cheyletidae) with description of a new species from Iran. *Internat. J.Acarol.*, **26** (4): 329-333.
- Fain, A. and Bochkov, A.V. 2001. A taxonomical review of the genus *Cheyletus* LATREILLE, 1776 (Acari: Cheyletidae). *Bulletin de l'Institut royal des Sciences naturelles Belgique (Entomology)*, **3**: 291-301.
- Fan, Q.H. and Flechtmann, C.H.W. 2015. Chapter 7. Stigmaeidae. In: Carrillo, D., Moraes, G.J. de and Peña, J. (eds.), *Prospects for Biological Control of Plant Feeding Mites and Other Harmful Organisms*. Springer, NY, pp. 185–206.
- Fan, Q.H., Flechtmann. C. H.W. and De Moraes G. J. 2016. Annotated catalogue of Stigmaeidae (Acari: Prostigmata), with a pictorial key to genera, *Zootaxa*, **4176** (11):1-199
- Fain, A., Smiley, R.L. and Gerson, U. 1997. New observations on the chaetotaxy and the solenidiotaxy in the Cheyletidae (Acari: Prostigmata). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique Entomologie*, **67**: 65-87.

- Faraji, F. and Ueckermann, E.A. 2005. A new species of *Stigmaeus* Koch from Iran (Acari:Stigmaeidae). *Sys. Appl. Acarol.*, **11**: 69-72.
- Faraji, F. and Ueckermann, E.A. 2006. A new species of *Stigmaeus* from Spain, redescription of *S. corticeus* Kuznetzov and Wainstein and a key to the European species of *Stigmaeus* (Stigmaeidae). *Acarologia*, **46** (1, 2): 87-94.
- Fenda, P. and Kaluz, S. 2009. Distribution and ecology of the ascid mites in Slovakia (Gamasina). *Abhandlungen und Berichte des Naturkundemuseums Gorlitz*, **77** (2): 99-250.
- Fisher, J.R., Skvarla M.J, Bauchan, G.R, Ochoa, R. and Dowling A.P.G. 2011. *Trachymolgus purpureus* sp. n., an armored snout mite (Acari, Bdellidae) from the Ozark highlands: morphology, development, and key to *Trachymolgus* Berlese. *ZooKeys* **125**: 1-34.
- Garman, P. 1948. Mite Species from Apple trees in Connecticut. *Bull. Conn. Agri. Expt. Sta.*, **520**: 27 pp.
- Gerson, U. 1994. The Australian Cheyletidae (Acari: Prostigmata). *Invertebrate Taxonomy*, **8**:435-447.
- Gerson, U, Fain .A. and Smiley, R.L. 1999. Further observations on the Cheyletidae (Acari), with a key to the genera of the Cheyletinae and a list of all known species in the family. *Bulletin De L'institut Royal Des Sciences Naturelles De Belgique, Entomologie*, **69**: 35-86.
- Ghai, S. 1964. Mites. In: Entomology in India. *Entomological Society of India*, 384-396 pp.
- Ghai, S. 1965. A contribution to our knowledge of the taxonomy of Indian mites of the families Phytoseiidae and Aceosejidae (Acarina). Ph.D. thesis, IARI, New Delhi.

- Ghai, S. and Menon, R.M.G. 1967. Taxonomic studies on Indian mites of the family Phytoseiidae (Acarina). 1. New species and new records of the genus *Amblyseius* Berlese from India (Acarina: Phytoseiidae) with a key to Indian species. *Ori. Ins.*, **1**(1-2): 65-79.
- Ghai, S. and Menon, R.M.G. 1969. Taxonomic studies on India mites of the family phytoseiidae (Acarina). Two new genera and species of Phytoseiidae. *Ori. Ins.*, **3**(4): 347-352.
- Gillespie, D.R. and Ramey, C.A. 1989. Life history and cold storage of *Amblyseius cucumeris* (Acarina: Phytoseiidae). *J. entomol. Soc. Brit. Columbia*, **85**: 71-76.
- Gilliat, F.C. 1935. Some Predators of the European red mite, *Paratetranychus pilosus* C. and F in Nova Scotia. *Can. J. Res.* **13**: 19-38.
- Gonzalez-Rodríguez, R.H. 1965. A taxonomic study of the genera *Mediolata*, *Zetzellia* and *Agistemus* (Acarina: Stigmaeidae). *University of California Publications in Entomology*, **41**: 1-64.
- Grafton-Cardwell, E.E. and Ouyang, Y. 1996. Influence of citrus leaf nutrition on survivorship, sex ratio and reproduction of *Euseius tularensis* (Acari: Phytoseiidae). *Env. Entomol.*, **25**: 1020-1025.
- Grandjean, F. 1938. Observations sur les Bdelles (Acariens). *Annales de la Societe Entomologique de France*, **107**: 1-24.
- Grandjean, F. 1944. Observations sur les acariens de la famille des Stigmaeidae. *Archives des Sciences Physiques et Naturelles*, **26**: 103-131.
- Gupta, S.K. 1969 a. Description of a new species of *Typhlodromus* Scheuten (Acarina: Phytoseiidae) from India. *Sci. and Cult.* **35**: 277-278.
- Gupta, S.K. 1969b. Three new species of the genus *Phytoseius* (Acarina: Phytoseiidae) from India. *Israel J. Agric. Res.* **19** (3): 115-120.

- Gupta, S.K. 1969c. Three new species of the genus *Amblyseius* Berlese (Acarina: Phytoseiidae) from West Bengal, India, *Bull. Ent. Soc. India*. **10** (2): 126-129.
- Gupta, S.K. 1970 b. Some predatory mites of the family Phytoseiidae from West Bengal, India, (Acarina: Mesostigmata). *Ori. Ins.* **4** (2): 185-191.
- Gupta, S.K. 1970a. Preliminary note on plant mites (Acarina) from West Bengal. *Sci. Cult.*, **36**: 98-99.
- Gupta, S.K. 1978 . Studies on Indian Phytoseiidae (Acarina: Mesostigmata): Some *Typhlodromus* mites from South India with descriptions of new species. *Bull. Zool. Surv. India*, **1** (1): 47-54.
- Gupta, S.K. 1980 a. New species of *Iphiseius* Berlese and *Paraamblyseius* Muma from India (Acarina: Phytoseiidae). *Entomol. mon. Mag.* **115**: 213-218.
- Gupta, S.K. 1980 b. New species and new record of *Paraamblyseius* Muma (Acarina, Phytoseiidae) from India. *Entomol. mon. Mag.*, **116**: 33-36.
- Gupta, S.K. 1981. Phytoseiidae (Acari: Mesostigmata) from Jammu and Kashmir, India, with descriptions of five new species. *Indian J. Acarol.*, **5**: 37-49.
- Gupta, S.K. 1985. Handbook: Plant Mites of India. *Zool. Surv. India*,, Calcutta, 520 pp.
- Gupta, S.K. 1986. Fauna of India (Acari: Mesostigmata) Family: Phytoseiidae, *Zoo. Surv. India*, 350 pp.
- Gupta, S.K. 1991. Studies on the predatory prostigmatid mites of Northeast with descriptions of new species and new records from India. *Rec. Zool. Surv. India*,, **88** (1-4): 207-239.

- Gupta S.K. 1992. Arachnida: Plant mites (Acari). In: Saha SK. (Ed) State Fauna Series 3, Fauna of West Bengal, Part 3. *Zool. Surv. India, Calcutta, India*, 61–211.
- Gupta, S.K. 2002. A monograph on plant inhabiting predatory mites of India. Part 1: Orders: Prostigmata, Astigmata and Cryptostigmata. *Memoirs: Zool.Surv. India*, **19** (2): 1–183.
- Gupta, S.K. 2003. A monograph on plant inhabiting predatory mites in India. Part II: Order: Mesostigmata. *Mem. Zool. Surv. India*, **20** (1): 185 pp.
- Gupta, S.K. and Arun Gupta, 1999. Progress of taxonomic research on Indian mites upto the end of twentieth century and prospectus of research in the next millennium. *J. Acarol.*, **159** (1-2): 8-83.
- Gupta, S.K and Chattopadhyay, S. 1978 Studies on Acari associated with bird nests in Bengal, India. *Internat. J. Acarol.*, **2**: 77–86.
- Gupta, S.K. and Ghosh, S.K. 1980. Some prostigmatid mites (Acarina) from Andaman and Nicobar Islands. *Rec. Zool. Surv. India*, **11**:189–213.
- Gupta, S. K. and K. Karmakar. 2011. Diversity of mites (Acari) on medicinal and aromatic plants in India. *Zoosymposia*, **6**: 57–62.
- Gupta, S.K. and Karmakar, K. 2015. An updated checklist of Indian Phytoseiid mites (Acari: Mesostigmata) In: *Rec. Zool. Surv. India*, **115** (1): 51-72.
- Gupta, S.K. and Paul, K. 1985. Some mites associated with bird's nests in West Bengal, with descriptions of eleven new species. *Bull. Zool.Surv. India*, **7** (1): 1–23.
- Gupta, S.K., Ghosal, S., Choudhury, A. and Mukherjee, B. 2004. Phytophagous and predatory mite fauna of Sundarbans biosphere reserve: II Some predatory mites occurring on mangrove vegetation of Agri-Horticultural crops. *Rec. zool. Serv. India*. **103** (3–4): 33–45.

- Hajizadeh, J., Khanjani, M., Faraji, F and Ueckermann, E. A. 2013. Stigmaeid mites of Guilan Province of Iran with description of a new species and a checklist for Iranian stigmaeid mites (Prostigmata:Stigmaeidae) *Internat. J. Acarol.*, **39** (7): 571-579.
- Halliday, R.B., Walter D.E. and Lindquist, E.E. 1998. Revision of the Australian Ascidae (Acarina: Mesostigmata), *Invert. Tax.*, **12**: 1-54.
- Haneef, P.K.S. and Mary Anithalatha, S. 2015. Description of a new species of predatory mite (Acari: Phytoseiidae: Mesostigmata) from Kerala, India, *J. Threat. Taxa*, **7**(5): 7164: 7167.
- Henning, W. 1950. Grundziige einer Theorie der phylogenetischen Systematik (Deutscher Zentralverlag), Berlin, 370 pp
- Hermann, J.F. 1804. III Ciron (Scirus). *Mémoire Aptérologique*, p.60–62.
- Hernandes, F.A. Skvarla, M.J. Fisher, J.R. Dowling Ashley, Ronald Ochoa, P.G. Ueckermann E. A and Bauchan G. R. 2016. Catalogue of snout mites (Acariformes: Bdellidae) of the world, *Zootaxa*, **4152** (1): 001–083.
- Hernandes, F.A., Daud, R.D. and Feres, R.J.F. 2008. Two new species of Bdellidae (Acari: Prostigmata) from Brazil. *Internat. J. Acarol.*, **34** (3): 259–266.
- Hirschmann, W. 1962. Gangsystematik der Parasitiformes. *Acarol. Schrift. Verg. Milb.*, Hirschmann-Verlag. Furth/Bay, **5** (5-6), p. 80.
- Hoy, M.A. and Smilanick, J.M. 1979. A sex pheromone produced by immature and adult females of the predatory mite, *Metaseiulus occidentalis*, Acarina: Phytoseiidae. *Entomol. Exp. Appl.*, **26**: 291–300.
- Hu, S.J. 1997. Cunaxid mites recorded in China. *Journal of Ninbo Teachers College* **15** (1): 56–59.

- Inayatullah and Shahid, M. 1989. Two new predatory mites of genus *Neocunaxoides* Smiley (Acarina: Cunaxidae) from Pakistan. *Pakistan Journal of Zoology*, **21**(3): 221–228.
- Jeppson, L. R., Keifer, H.H. and Baker, E.W. 1975. Mites for injurious to economic plants. Berkeley, University of California Press, 614p.
- Kaluz, S. and Fenda, P. 2005. Mites (Acari, Mesostigmata) of the family Ascidae of Slovakia. Institute of Zoology, Slovak Academy of Sciences, NOI Press, Bratislava, 168 pp.
- Kapaxidi, E.V. and Papadoulis, G.Th. 1999. New records of stigmaeid mites from Greece with description of a new species (Acari: Stigmaeidae). *Internat. J. Acarol.*, **25**(2): 141–144.
- Karg, W. 1961. Zur Kenntnis der Typhlodromiden (Acarina, Parasitiformes) aus Acker und Grünlandboden. *Z. Angew. Entomol.*, **47** (4): 440–452.
- Karg, W. 1965. Larval systematische und phylogenetische Untersuchung sowie Revision des Systems der Gamasina Leach, 1915 (Acarina, Parasitiformes). *Mitteilungen aus dem Zoologischen Museum in Berlin*, **41**: 193–340.
- Karg, W. 1971. Acari (Acarina), Milben, Unterordnung Anactinochaeta (Parasitiformes). Die freilebenden Gamasina (Gamasides), Raubmilben. *Die Tierwelt Deutschlands*, **59**: 1–475.
- Karg, W. 1980. Die Raubmilbengattung *Lasioseius* Berlese, 1916. *Zool. Jb. Syst.* **107**: 344–367.
- Karg, W. 1993. Acari (Acarina), Milben Parasitiformes (Anactinochaeta) Cohors Gamasina Leach. Raubmilben. *Die Tierwelt Deutschlands*, **59**: 1–523.
- Kasap, I. and Sekeroglu, E. 2004. Life history of *Euseius scutalis* feeding on citrus red mite *Panonychus citri* at various temperatures. *Bio-Control*, **49**: 645–654.
- Kazemi, S. H. and Rajaei, A. 2013. An annotated checklist of Iranian Mesostigmata (Acari), excluding the family Phytoseiidae. *Persian Journal of Acarology*, **2** (1): 63–158.

- Kethley, J. 1990. Acarina: Prostigmata (Actinedida) In: Dindal, D.L. (Ed). Soil Biology Guide. New York:John Wiley and Sons. pp 667-756
- Khanjani, M., Pishehvar, S. Mirmoayedi, A.N and Khanjani, M. 2012. Two New Eyeless Mite Species of the Genus *Stigmaeus* Koch (Acari: *Stigmaeidae*) from Western Provinces of Iran and Description of the Male *Stigmaeus Pilatus* Kuznetzov. *Internat. J. Acarol.*, **386** (1):504-513.
- Khaustov, A. A. 2014. New species and new records of mites of the genus *Stigmaeus* (Acari: Prostigmata: *Stigmaeidae*) from Crimea. *Zootaxa*, **3794** (2): 237–253.
- Khaustov, A. A. 2015. New Species and New Records of Mites of the Genus *Stigmaeus* (Acari: Prostigmata: *Stigmaeidae*) from Western Siberia with Redescription of *S. Livshitsi* Kuznetsov, 1977, *Sys. Appl. Acarol.* , **6** (30): 681–692.
- Koc, K. 2005. Two new species of the genus *Stigmaeus* (Acari: *Stigmaeidae*) from Turkey. *Archives des Sciences*, **58**: 43–48.
- *Koch, C.L. 1838. Deutschlands Crustaceen, Myriapoden und Arachniden (D.C.M.A.), 20.21, 20.22, 20.23 and 20.24.
- Krantz, G.W. 1978. *A Manual of Acarology*. Second edition. Corvallis, Oregon State University Bookstore, 509 pp.
- Krantz, G. W. and Walter, D. E. (Eds.) 2009. *A Manual of Acarology*. Third Edition. Texas Tech University Press; Lubbock, Texas, 807 pp
- Kreiter S., Tixier M.S. Sahraoui H. Lebdi Grissa, K. BenChaabane, S. Chatti, A. Chermiti., B. Khoualdia, O. Ksantini, M. 2010. Phytoseiid mites (Acari: Mesostig-mata) from Tunisia: Catalogue, biogeography and keyfor identification, *Tun. J. Plant Prot.* **5**: 151-178.

- Krishnamoorthy, A. 1982. Mass rearing technique for a indigenous predatory mite *Amblyseius tetranychivorous* Gupta (Acarina:Phytoseiidae) in the laboratory. *Entomon*, **7**: 47-49.
- Kuznetsov, N.N. 1977. A contribution to the fauna of the family Stigmaeidae (Acariformes) in the Central-Chernozem zone. *Zoologicheskii Zhurnal*, **56** (6): 953–956.
- Kuznetsov, N.N. 1978. Revision of the genus *Stigmaeus* (Acariformes, Stigmaeidae). *Zoologicheskii Zhurnal*, **57**(5): 682– 694.
- Kuznetsov, N.N. and Barilo, A.B. 1984. Four new species of the family Bdellidae (Acariformes) from middle Asia. *Zoologicheskii Zhurnal*, **63** (3): 934–937.
- Kuznetsov, N.N., Khaustov, A.A. and Perkovsky, E.E. 2010. First record of mites of the family Stigmaeidae (Acari, Raphignathoidea) from Rovno amber with description of a new species of the genus *Mediolata*. *Vestnik zoologii*, **44**(6), 545–547.
- Latreille, P.A. 1795. Observations sur la variete des organes de la bouche des tiques, et distribution methodique des insectes de cette famille d'apres les caracteres etablis sur la conformation de ces organes. Magasin Encyclopédique, *Journal des Sciences, des Lettres et des Arts*, **4**:15–20. Paris
- Leach, W.E. 1815. A tabular view of the external characters of animals, which Linne arranged under Insecta etc. *Transactions of the Linnean Society of London*, **11**: 306–400.
- Lin, J.Z. and Zhang, Z.Q. 2010. Bdelloidea of China: a review of progress of systematics and biology, with a checklist of species. *Zoosymposia*, **4**: 42–50.
- Lin, J.Z., Zhang, Y.Z, and Ji, J. 2001. Three new species of Cunaxidae from Fujian, China. *Sys. Appl. Acarol.*, **6**: 145–153.

- Lindquist, E.E. and Chant, D.A. 1964. A redescription of *Aceodromus* Muma and its transfer to the Blattisociinae (Acarina:Blattisociidae). *The Canadian Entomologist*, 96, 500–507.
- Lindquist, E.E. and Evans, G.O. 1965. Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). *Memoirs of the Entomological Society of Canada*, **47**: 1–65.
- Lindquist, E.E. and Makarova, O.L. 2012. Review of the mite subfamily Arctoseiinae Evans with a key to its genera and description of a new genus and species from Siberia (Parasitiformes, Mesostigmata, Ascidae) *Zookey*, **233**: 1-20
- Lindquist, E.E. and Moraza, M.L. 2010. Revised diagnosis of the family Blattisociidae (Acari: Mesostigmata: Phytoseiidea), with a key to its genera and description of a new fungus-inhabiting genus from Costa Rica. *Zootaxa*, **2479**: 1–21.
- Lindquist, E.E. and Moraza, M.L. 2012. A new genus of fungus-inhabiting mites of the family Blattisociidae (Acari Mesostigmata Phytoseiidea) from Costa Rica, with an updated key to genera of the subfamily Blattisociinae. *Redia*, **95**: 9–19.
- Lindquist, E.E. and Moraza, M.L. 2016. A new genus of mites of the subfamily Platyseiiinae associated with Azteca ant galleries in Cecropia trees in Costa Rica (Acari: Mesostigmata: Blattisociidae). *Acarologia*, **56** (3):3-29.
- Lindquist, E.E., Krantz, G.W. and Walter, D.E. 2009. Order Mesostigmata. In: Krantz, G.W. & Walter, D.E. (Eds.), A Manual of Acarology. 3rd Edition. Texas Tech University Press, Lubbock, Texas, 1–807 pp.
- Linnaeus, C. 1758a. *Systema Naturae. Regnum Animale*. 10th edition, facsimile reprint 1956, British Museum, London, 640 pp.

- Linnaeus, C. 1758b. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tomus I. 10th ed. pp.[1–4], 1–824. Holmiae. (Salvius).
- Liyaudheen, C.K.M., Rekha, P.K., Anitha, K. and Ramani, N. Feeding potential of *Euseius ovalis* (Evans) (Acaridae: Phytoseiidae) on *Tetranychus macfarlanei* Baker and Pritchard (Acaridae: Tetranychidae) infesting okra. *J. Biopest* 7 (Supp.): 148-151.
- Lo, K.C., Ho, C.C. and Chen, S.T. 1979. Artificial propagation of *Amblyseius taiwanicus* and its tolerance to some pesticides. *Journal of Agricultural Research China*, **28**: 251-259.
- Mary Anithalatha, S. 2002. Studies on Acarine predators of North Kerala, India, Ph.D. Thesis, University of Calicut, Kerala.
- Mary Anithalatha S. 2005. Two new species of predatory mites (Acarina: Phytoseiidae) from Kerala (India). *Uttar Pradesh J. Zool.* **25** (1): 81-84.
- Mary Anithalatha, S. 2006 a. A new species of predatory mites (Acarina: Phytoseiidae: *Amblyseius*) from Kerala. *J. Entomol. Res.*, **30** (1): 179-181.
- Mary Anithalatha, S. 2006 b. A new species of predatory mites of the genus *Amblyseius* (Acarina: Phytoseiidae) from Kerala, India. *Geobios*, **33**: 188-190.
- Mary Anithalatha, S. and Ramani, M. 2007. A new species of predatory mite of the genus *Amblyseius* (Acarina: Phytoseiidae) from Kerala, India, *J. Ecobiol.*, **20** (3): 215-218.
- Maslov, S.I. and Khaustov, A.A. 2013. A new species of mites of the genus *Bdella* (Acari, Bdellidae) from Ukraine. *Vestnik Zoologii*, **47** (2): 52–56.

- McMurtry, J.A. and Rodriquez, J.G. 1978. Nutritional ecology of Phytoseiid mites. In: *Nutritional Ecology of Insects, Mites and Spiders* (Ed.by F.Slansky and J.G. Rodriquez) . John Wiley, New York. 609-44
- McMurtry, J.A. and Croft, B.A. 1997. Life styles of phytoseiid mites and their roles in biological control. *Annual Review of Entomology*, **42**: 291–321.
- McMurtry, J. A. and Scriven, G. T. 1966. The influence of pollen and prey density on the number of prey consumed by *Amblyseius hibisci* (Chant) (Acarina: Phytoseiidae). *Ann. Ent. Soc. Amer.* **59**: 147-49.
- McMurtry, J.A. Moraes, G.J de. and Sourassou. N.F 2013. Revision of the life styles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. *Sys.Appl. Acarol.*, 18(4): 297–320.
- Melo, JWS., Domingos, C.A., Galvao, A.S., Gondim, MGC. and de Moraes G.J. 2009. Biologia do ácaro predador *Euseius alatus* De Leon (Acari: Phytoseiidae) em diferentes temperaturas. *Acta Sci Agron.* **31**:391–396.
- Meyer, M.K.P. 1969. Some stigmatid mites from South Africa (Acari: Trombidiformes). *Acarologia*, **11** (2): 227–271.
- Momen, F.M. 1993. Effect of single and multiple copulation on fecundity, longevity and the sex ratio of the predaceous mite *Amblyseius bakeri* (Hugh.) (Acari, Phytoseiidae). *Anz.Schadl.Pflanzen.Unwelt.* **66**:148-50
- Momen, F.M. and Abdel-Khalek, A. 2008. Influence of diet on biology and life table parameters of the predaceous mite *Euseius scutalis* (A. H.) (Acari: Phytoseiidae). *Archives of Phytopathology and Plant Protection*, **41**: 418–430.
- Moraes, G.J. de. and Lima, H.C. 1983. Biology of *Euseius concordis* (Chant) (Acarina: Phytoseiidae) a predator of the tomato russet mite. *Acarologia*, **24**: 251-255.
- Moraes, G.J. de., Mc Murtry, J.A. and Denmark, H.A. 1986. A catalogue of the mite family Phytoseiidae: references to taxonomy, synonymy, distribution and habitat. Embrapa - DDT. Brazil, 356. pp.

- Moraes G.J., Britto E. P., Mineiro, J. L. and Halliday, B. 2016. Catalogue of the mite families Ascidae Voigts & Oudemans, Blattisociidae Garman and Melicharidae Hirschmann (Acari: Mesostigmata). *Zootaxa*, **4112** (1):1-299.
- Moraes, G.J. de., McMurtry, J.A., Denmark, H.A. and Campos, C.B. 2004. A revised catalogue of the mite family Phytoseiidae. *Zootaxa*, **434**: 1–494.
- Moraes, G.J. de., Zannou, I.D., Oliviera, A.R., Yaninek. J.S. and Hanna, R. 2006. Phytoseiid mites of the subtribes Typhlodromalina and Euseiina (Acari:Phytoseiidae: Euseiini) from sub-Saharan Africa. *Zootaxa*, **1114**: 1-52
- Mori, H. and Chant, D.A. 1966. The influence of prey density, relative humidity, and starvation on the predacious behaviour of *Phytoseiulus persimilis* Athias-Henriot (Acarina: Phytoseiidae). *Can. J. Zool.* **44**: 483-491.
- Mostafa, M. and El-Sayed. 2012. Laboratory studies on *Euseius metwallyi* a predator of the spider mite *Tetranychus utricae* on fruit trees in Egypt (Acarina: Phytoseiidae: Tetranychidae). *J.Entomol.*, **9**(2): 107-114.
- Muhammad, T. Chaudhri, W.M. 1993. Descriptions of two new species of the genus *Rubroscirus* Den Heyer (Cunaxidae: Acarina) from Pakistan. *Pakistan J. Agr. Sci.*, **30** (1): 108–114.
- Muma, M. H. 1961. Subfamilies, genera and species of Phytoseiidae (Acarina: Mesostigmata). *Fla. St. Mus. Bull. Biol. Sci.*, **5**: 267-302.
- Muma, M.H. and Denmark, H.A. 1962. Intraspecific variation in Phytoseiidae (Acarina: Mesostigmata) *The Florida Entomologist*, **45**: 57-65
- Neelam, K.S. and Sadana, G.L 1985. Influence of temperature on the development of the predatory mites *Amblyseius finlandicus* (Acari: Phytoseiidae). *Indian J. Acarol.*, **9**: 57-62.
- Negm, M.W. and Mesbah, A. E. 2014. Review of the mite family Cheyletidae (Acari: Trombidiformes: Cheyletoidea) of Egypt. *Internat. J. acarol.*, **40**(5): 390-396.

- Nemati, A., Riahi, E. Mohseni, M. and Gwiazdowicz, D.J. 2012. Catalogue of the Iranian Mesostigmatid Mites Part 2: Family Blattisociidae. *International Journal of Agriculture and Crop Sciences*, **4** (19): 1415-1420.
- Nesbitt, H. H. J. 1951, A taxonomic study of the Phytoseiinae (Family Laelaptidae) predaceous upon Tetranychidae of economic importance. *Zool. Verh.*, **12**: 1-64.
- Nguyen, T.V. and Shih, CIT. 2010. Development of *Neoseiulus womersleyi* (Schicha) and *Euseius ovalis* (Evans) feeding on four tetranychid mites (Acari: Phytoseiidae, Tetranychidae) and pollen. *Journal of Asia-Pacific Entomology*, **13**(4): 289–296.
- Nguyen, T.V. and Shih, CIT. 2011. Predation rates of *Neoseiulus womersleyi* (Schicha) and *Euseius ovalis* (Evans) feeding on tetranychid mites (Acari: Phytoseiidae, Tetranychidae). *J. Asia-Pacific Entomol.*, **14** (4): 441–447.
- Nomikou, M., Janssen, A., Schraag, R. and Sabelis, M.W. 2001. Phytoseiid predators as potential biological control agents for *Bemisia tabaci*. *Exp. Appl. Acarol.* **25**: 271-291.
- Omukunda, E., Theron, P.D. and Ueckermann, E.A. 2007. Six new species of the genus *Biscirus* Thor (Acari: Bdellidae) from South Africa. *Acarina*, **15** (2): 269–282.
- Ostovan, H. and Kamali, K. 1995. Some snout mites (Acari: Bdellidae) from Iran and a key for their identification. *J. Agr. Sci.*, **1**: 29–43.
- *Oudemans, A.C. 1902. Classificatie der Acari. *Tijdschrift voor Entomologie*, **45**: 58–60.
- *Oudemans, A.C. 1904. Acarologische Aanteekeningen. XII. *Entomologische Berichten Nederlands Entomologie*, **1**: 160-164.

- *Oudemans, A. C. 1905. *Ent. Ber.*, **21**: 207–210.
- Oudemans, A. C. 1931. Acarologischen aantekeningen CVIII. *Ent. Ber. Nederland. Ent. Ver.* **8**: 351-363.
- Paktinat-saeij, S. Bagheri, M. Tatiane, M.M.G, De Castro, Saboori, A. Gholamhossein, Gharekhani and Ghobar, H. 2016. Coleoscirinae mites (Acari: Trombidiformes: Cunaxidae) from Iran with description of a new species of *Neobonzia*. *Systematic and Applied Acarology*, **21** (9): 1185–1193.
- Parrott, P.J., Hodgkiss, H.E. and Schoene, W.J. 1906. The apple and pear mites. *New York Agr. Exp.St.Bull.*, **283**: 281-381.
- Prasad, V. 1974. A catalogue of mites of India. Indira Acarology Publishing House, Ludhiana, Punjab, India, p. 320.
- Prasad, V. 2012. Checklist of Phytoseiidae of the World (Acari: Mesostigmata). Indira Publishing House, West Bloomfield, Michigan, USA, 1063 pp.
- Puchalska, E.K. and Kozak, M. 2016. *Typhlodromus pyri* and *Euseius finlandicus* (Acari: Phytoseiidae) as potential biocontrol agents against spider mites (Acari: Tetranychidae) inhabiting willows: laboratory studies on predator development and reproduction on four diets. *Exp. Appl.Acarol.*, **68**: 39.
- Putatunda., B N. Mathur, R.B and Mathur, S. 2002. Mites associated with some fruit trees in Hissar (Haryana). *Indian J. Agr.Res.*, **36** (2): 88-95.
- Quayle, H.J. 1912. Red spiders and mites of citrus tree. *Calif. Agr. Exp. Sta. Bull.* **234**: 483 – 530.
- Rahul, M.P., Mary Anithalatha Sadanandan, and Santhosh, P.P. 2016. A new species of phytoseiid mite (Acari: Phytoseiidae) from Kerala, India, *J.Adv.Zool.* **37** (7): 75-79.

- Ramaraju. K. and Mohanasundaran, M. 2009. Two new cheyletid Mites (Acari: Cheyletidae) from Tamil Nadu, India. *Internat. J. Acarol.*, **25** (2): 121-127.
- Raza, A.B.M., Afzal, M. and Bashir, M.H. 2005. Biology of *Euseius septicus* Chaudhari (Acari: Phytoseiidae) preying on two spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae) at different temperatures. *Pak. Entomologist*, **27**: 85–88.
- Reuveny, H., Palevsky, E. and Gerson, U. 1996. Laboratory life history studies of the predaceous mite *Typhlodromus athiasae* (Acari: Phytoseiidae). *Syst. Appl. Acarol.*, **1**: 45-53
- Rocha, M.D.S., Rodrigues, E.N.L and Ferla, N.J. 2015. New species and records of cunaxid mites (Acari: Cunaxidae) from soil in Southern Brazil. *Zootaxa*, **3981** (1): 056-070.
- Rock, G.C., Monroe, R.J. and Yeargan, D.R. 1976. Demonstration of sex pheromone in the predaceous mite *Neoseiulus fallacis*. *Environ. Entomol.*, **5**: 264.
- Rowel, H. J., Chant, D. A. and Hansell, R. I. C. 1978. The determination of setal homologies and setal patterns on the dorsal shield in the family Phytoseiidae (Acarina: Mesostigmata). *Can. Entomol.*, **110**: 859-876.
- Roy, I., Gupta, S.K. and Saha, G. K. 2008. A new species and a new record of phytoseiid mites infesting medicinal plants of West Bengal, India. *Proc. Zool. Soc., Calcutta*, **61**(1&2): 1-4.
- Ryu, M.O. and Seo, H.Y. 2011. Taxonomic review of the subfamily Typhlodrominae (Acari: Phytoseiidae) with generic recombinations and one newly recorded species in Korea. *Korean J. Appl. Entomol.*, **50** (4): 295–299.
- Saeed, S.P., Bagheri, M., Saboori, A. and Ueckermann, E. A. 2014. *persiaensis* sp. nov. (Acari: Prostigmata: Bdellidae) as a first new species of the genus *Hexabdella* from Asia. *Internat. J. Acarol.*, **40** (5): 384-389.

- Saeed, S. P. Bagheri, M. Saboori, A. Seilsepour. N. and Ueckermann, E. A .
2015. A new snout mite, *Spinibdella tabarii* sp. nov. (Trombidiformes: Bdellidae) from Iran, with a summary of *Spinibdella* distributions worldwide. *Sys. Appl. Acarol.*, **20**(6):693-706.
- Saito, Y. and Mori, H. 1981. Parameters related to potential rate of population increase of three predacious mites in Japan (Acarina: Phytoseiidae). *Appl. Entomol. Zool.*, **16**: 45–47.
- Sajna Haneef, P.K. 2015. Studies On Phytoseiid Mites (Acari:Phytoseiidae) of North Kerala, Ph.D. Thesis, University of Calicut, Kerala.
- Sajna, H. and Mary Anithalatha, S. 2013. Survey of predatory mites (Acari: Phytoseiidae) associated with economically important plants of North Kerala. *Biological Forum- An Internat. J.*, **5** (2): 119–122.
- Santhosh, P. P. and Mary Anithalatha, S. 2016. A new species of *Amblyseius* Berlese (Acari:Phytoseiidae) from Kerala, India. *Entomon*, **41**(1): 67-70.
- Satpathy, J.M. and Mania, P.K. 1969. New record of a Phytoseiidae mite, *Amblyseius finlandicus* occurring on sugarcane with notes on its life history and binomics. *J. Bom.Nat. hist.Soc.*, **66**(3): 648-655.
- Schausberger, P. 1998. Survival, development and fecundity in *Euseius finlandicus*, *Typhlodromus pyri* and *Kampimodromus aberrans* feeding on the San Jose Scale (*Quadraspidotus perniciosus*). *J. Appl. Entomol.*, **122**: 53–56.
- Schruft, G. 1971. *Haleupalus oliveri* nov.spec., eine Dornpalpenmilbe an Reben (*Vitis* spec.) (Acari; Cunaxidae). *Deutsche entomologische Zeitschrift*, **18**: 377–382
- Schulten, G. G. M. 1985. Pseudo-arrhenotoky. In: Helle, W. and Sabelis, M. W. (eds) *Spider Mites. Their Biology, Natural Enemies and Control*, pp. 67-71.

- Schuster, R. O. and Pritchard, E. 1963. Phytoseiid mites of California. *Hilgardia*, **34**: 191-285.
- Sepasgosarian, H. 1984. The world genera and species of the family Cunaxidae (Actinedida: Acarida). *Zeitschrift für Angewandte Zoologie*, **71**: 135–153.
- Sepasgosarian, H. 1985. The world species of the superfamily Raphignathoidea. *Zeitschrift für Angewandte Zoologie*, **72**(4): 437–478.
- Sepasgosarian, H. 1990. I. Addendum of the world species of the superfamily Raphignathoidea (Acari). *Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg*, **10**(139–140): 75–84.
- Sergeyenko, A.L. 2006. New species and new record of mites of the genus *Rubroscirus* Den Heyer, 1979 (Acarina: Prostigmata: Cunaxidae) from Ukraine. *Acarina*, **14** (1): 103–107.
- Shih, C.I.T. and Shieh, J.N. 1979. Biology, life table, predation potential and intrinsic rate of increase of *Amblyseius longispinosus* (Evans). *Plant Prot. Bull.*, **21**: 175-183.
- Sinha, R.N. 1968. Adaptive significance of mycophagy in stored-product arthropoda. *Evolution*. **23**(4): 785-798.
- Sionti, P.G, and Papadoulis, G.T. 2003. Cunaxid mites of Greece (Acari: Cunaxidae). *Internat.J. Acarol.*, **29** (4): 315–325.
- Skvarla, M.J. and Dowling, APG. 2012. Some New Armascirine Cunaxids (Acari: Prostigmata: Cunaxidae) from the Eastern United States. *Zootaxa*, **3194**: 1–34.
- Skvarla, M.J., Fisher, J.R. and Dowling, APG. 2014. A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses of subfamilies and genera, keys to world species, and some new locality records. *Zookeys*. **418**: 1–103.

- Smiley, R. 1975. A generic revision of the mites of the family Cunaxidae (Acarina). *Annals of the Entomological Society of America*. **68** (2): 227–244.
- Smiley, R.L. 1992. The predatory mite family Cunaxidae (Acari) of the world with a new classification. *Indira Publishing House, West Bloomington, Michigan*, 356 pp.
- Smiley, R.L. and Whitaker, J.O. 1981. Studies on the idiosomal and leg chaetotaxy of the Cheyletidae (Acari) with descriptions of a new genus and four new species. *Internat. J. Acarol.*, **7**: 109- 127.
- Soliman, Z.R. 1977. Three new species of cheyletid mite from Egypt with a key to genera (Acari: Prostigmata). *Deutsche Entomologische Zeitschrift*. **24** (1-3):207-2 12.
- Summers, F. M. 1962. The genus *Stigmaeus* (Acarina : Stigmaeidae). *Hilgardia*, **33**: 491-537.
- Summers, F.M. 1966. Genera of the mite family Stigmaeidae Oudemans (Acarina). *Acarologia*, **8**(2): 230–250.
- Summers, F.M. 1976. A new genus for several cheyletid mites formerly in *Acaropsis* (Acarina: Cheyletidae). *Proc. Entomol. Soc. Wash.*, **78** (2): 190-194.
- Summers, F.M. and Price, D.W. 1970. Revision of the mite family Cheyletidae. Univ. Calif. Publ. 95pp.
- Suresh,S., Thangairaj, R. and Ramaraju, K. 2014. New predatory mite, *Eusieus coimbatorensis* sp.nov (Acari: Phytoseiidae) from coconut ecosystem of Tamil Nadu, *India Journal of Entomological Research*, **38** (3): 223- 226

- Swift, S.F. 1996. Two new species of *Dacyloscirus* (Acari: Prostigmata: Cunaxidae) in the Hawaiian Islands. *Anales del Instituto de Biología Universidad Nacional Autónoma de México, Series Zoología*, **67**(2): 225–237.
- Swirski, E., Amitai, S and Dorzia, N. 1970. Laboratory studies on the feeding habits, post embryonic survival and oviposition of the predaceous mites *Amblyseius chilensis* Dosse and *Amblyseius hibisci* Chant (Acari: Phytoseiidae) on various kinds of food substances. *Entomophaga*, **15**: 93-106.
- Takahashi, F. and Chant, D.A. 1994. Adaptive strategies in the genus *Phytoseiulus* Evans (Acari: Phytoseiidae). II. Survivorship and reproduction. *Int. J. Acarol.* **20**: 87–97.
- Tanigoshi, L.K. 1982. Advances in knowledge of the biology of Phytoseiidae, pp. 122. In M.A.Hoy [ed.], Recent advances in knowledge other Phytoseiidae. University of California Publication.3284.
- Taylor, A. and James, D.G. 1993. Effect of temperature on development and survival of *Typhlodromus doreenae* Schicha (Acari: Phytoseiidae). *Int. J. Acarol.* **19** (2):185–188.
- Thor, S. 1902. On the systematic representation of the Acarinen familien Bdellidae Koch, 1842, Grube, 1859, Eupodidae Koch, 1842 and Cunaxidae Sig Thor, 1902. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien, **52**: 159–165.
- Thor, S. 1931. Bdellidae, Nicoletiellidae, Cryptognathidae. *Das Tierreich*, 56, 87 pp.
- Toledo, M.A.D., Reis, P.R., Silveira, ECD., Marafeli, PDP. and Souza-Pimentel, GCD. 2013. Predatory potential of *Euseius alatus* (Phytoseiidae) on different life stages of *Oligonychus ilicis* (Tetranychidae) on coffee leaves under laboratory conditions. *Neotropa Entomol.*, 42: 185-190.

- Trouessart, E. 1892. Considerations generales sur la classification des Acariens, suivies s'un essai de classification nouvelle. *Revue des Sciences Naturelles de l'Ouest*, **2**: 330–331.
- Tseng, Y.H. 1978. Mites of the family Bdellidae from Taiwan (Acarina: Prostigmata). *Journal of the Agricultural Association of China*, **104**:25–51.
- Tseng, Y. H. 1982. Mites of the family Stigmaeidae of Taiwan with key to genera of the world (Acarina: Prostigmata). *Phytopathologist and Entomologist of the National Taiwan University*, **9**: 1–52.
- Vacante, V. and Gerson, U. 1988. Three species of *Eryngiopus* (Acari: Stigmaeidae) from Italy, with key to species and summary of habitats. *Redia*, **70**: 385–401.
- van der Hammen, L. 1972. A revised classification of the mites (Arachnidea, Acarida) with diagnoses, a key, and notes on phylogeny. *Zoologische Mededelingen*, **47**: 273–292.
- Veerman, A. 1991. Physiological aspects of diapause in plant inhabiting mites. In: R. Schuster and P.W. Murphy (Editors), *The Acari: Reproduction, Development and Life History Strategies*. Chapman and Hall, London, pp. 245–265.
- Vizthum, H. von. 1941. Acarina. In: *Klassen und Ordnungen des Tierreichs 5 Akadem*, (Ed., H. G. Bronns). Verlag, Leipzig, Germany, pp. 764–767.
- Voigts, H. and Oudemans, A. C. 1905. Zur Kenntnis der Milben-Fauna von Bremen. *Abhandlungen herausg. voiu Naturwissenschaftlichen Vereine zu Bremen*, **18**:199-252.
- Volgin, V.I. 1960. On the taxonomy of the predatory mites of the family Cheyletidae. II. *Cheyletiella* Canestrini. *Parazitol Sbornic.*, **19**: 237–248.

- Volgin, V.I. 1961. On the taxonomy of predatory mites of the family Cheyletidae III. Genus *Cheletacarus* Volgin Gen. nov. *Akad, Nauk. S.S.S.R. Zool. Inst. Parazitol. Sbomik*, **20**: 248-256.
- Volgin, V. 1. 1969. Acarina of the family Cheyletidae, world fauna. *Operedel Fauna S.S.R.*, **101** : 1-432.
- Von Heyden, C. 1826. *Versuch einer systematischen eintheilung der Acariden*. In: Isis von Oken, **18** (6): 608–613.
- Wainstein, B. A., 1972. On the system of entomoparasitic mites of the family Otopheidomenidae Treat, 1955 (Parasitiformes). *Parazitologiya*, **6** (5): 451-456.
- Wainstein, B.A., Kuznetsov, N.N. Livshits, I.Z. and Sosnina, E.F. 1978. Family Bdellidae. In: Gilyarov, M.S. (Ed) Identification key to soil-inhabiting mites, Trombidiformes. Nauka, Moscow, 133–143.
- Wallace, M.M.H. and Mahon, J.A. 1972. The taxonomy and biology of Australian Bdellidae (Acari). I. Subfamilies Bdellinae, Spinibdellinae and Cytinae. *Acarologia*, **14** (4): 544–580.
- Wallace, M.M.H. and Mahon, J.A. 1976. The taxonomy and biology of Australian Bdellidae (Acari). II. Subfamily Odontoscirinae. *Acarologia*, **18** (1): 65–123.
- Walter, D.E. 2003. The genus *Gamasellodes* (Acari: Mesostigmata: Ascidae) : New Australian and North American species . *Systematic and Applied Acarology Special Publication*, **15**: 1-10.
- Walter, D.E. and Lindquist, E.E. 1997. Australian species of *Lasioseius* (Acari: Mesostigmata: Ascidae): the *porulosus* group and other species from rainforest canopies. *Invertebrate Taxonomy*, **11**: 525-547.
- Walter, D.E., Halliday, R.B. and Lindquist, E.E. 1993. A review of the Genus *Asca* (Acarina: Ascidae) in Australia, with description of three new leaf inhabiting species. *Invertebrate Taxonomy*, **7**: 1327-1347.

- Walter, D.E., Lindquist, E.E. Smith, I.M. Cook, D.R. and Krantz, G.W. 2009. Chapter thirteen Order Trombidiformes. In: Krantz, G.W. and Walter, D.E. (Eds.), *A Manual of Acarology*, 3rd edition. Texas Tech University Press, Lubbock, pp. 233–420.
- Wei-Lan, M. and Laing, J.E. 1973. Biology, potential increase and prey consumption by *Amblyseius chilensis* (Dosse) (Acarina: Phytoseiidae) . *Entomophaga*, **18**(1): 47-60.
- Willmann, C. 1938. Beitrag zur Kenntnis der Acarofauna des Komitates Bars. *Annales Musei Nationalis Hungarici*, Budapest, **31**: 144-172.
- Wood, T.G. 1964. A new genus of Stigmaeidae (Acarina, Prostigmata) from New Zealand. *New Zealand Journal of Science*, **7**(4): 579–584.
- Wood, T.G. 1967. *New Zealand mites of the family Stigmaeidae* (Acari, Prostigmata). Transactions of the Royal Society of New Zealand, **9** (9): 93–139.
- Wood, T.G. 1970. Stigmaeidae (Acari: Prostigmata) from Campbell Island. *Acarologia*, **12**(4): 677–683.
- Wood, T.G. 1971. New species and records of Stigmaeidae (Acari: Prostigmata) from New Zealand. II. The genera *Apostigmaeus* Grandjean, *Summersiella* Gonzalez, *Pseudostigmaeus* Wood and *Eryngiopus* Summers. *New Zealand Journal of Science*, **14**: 406–418.
- Wood, T.G. 1973. Revision of Stigmaeidae (Acari: Prostigmata) in the Berlese collection. *Acarologia*, **15**: 76–95.
- Wu, W.N., Liang, L.R, Fang, X.D. and Ou, F.J. 2010. Phytoseiidae (Acari: Mesostigmata) of China: A review of Progress with a check list. In Zhang Z-Q., Hong , X-Y and Fan, QH (Eds), Xin Jie -Liu Centenary. *Progress in Chinese Acarology, Zoosymposia*, **4**: 288-315

- Wysoki, M. Bolland, H.R. 1983. Chromosome studies of phytoseiid mites (Acari: Gamasida). *Int. J. Acarol.*, **9** (2): 91-94.
- Yi-Hsiung Tseng. 1981. The mite family Ascidae from Taiwan (II) – Genus *Asca* Heyden (Acarina : Mesostigmata). *Chinese J. Entomol.* **2**: 7-15.
- Zaheer, M.A. and Soliman, Z.R. 1967. The family Cheyletidae (Acarina) in the U.A.R. with a description of four new species. *Bull. Soc. Entomol. Egypt*, **51**: 21-26.
- Zhang, X. 1993. Acari: Stigmaeidae. In: Huang, C.-M. (ed.), *Animals of Longqi Mountain. Beijing. China Forestry Publishing House*, pp. 770–774.
- Zhang, Z.Q. and Croft, B.A. 1994. A comparative life history study of immature *Amblyseius fallacis*, *Amblyseius andersoni*, *Typhlodromus occidentalis*, and *Typhlodromus pyri* (Acari:Phytoseiidae) with a review of larval feeding patterns in the family. *Exp. Appl. Acarol.* **18**:631–657.
- Zhang, Z.Q., Fan, Q.H., Pesic, V., Smit, H., Bochkov, A.V., Khaustov, A.A., Baker, A., Wohltmann, A., Wen, T., Amrine, J.W., Beron, P., Lin, J., Gabrys, G. and Husband, R. 2011. Order Trombidiformes Reuter, 1909. In: Zhang, Z.-Q. (Ed.) *Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. Zootaxa*, **3148**, 129–138.
- Zhimo, Z. and McMurtry, J. A. 1990. Development and reproduction of three *Euseius* (Acari: Phytoseiidae) species in the presence and absence of supplementary foods. *Exp. Appl. Acarol.*, **8**(4): 233-242.
- Zhu, X.C., Nie, L. and Hu, S.Q. 2001. A checklist; superfamily Raphignathoidea from Jiangxi Province. *Journal of Jiangxi Institute of Education, Natural Sciences*, **22** (3): 50–52.

*Not referred to original.

SANTHOSH. P. P. "STUDIES ON PREDATORY MITES INHABITING MEDICINAL PLANTS OF NORTH KERALA". THESIS. DEPARTMENT OF ZOOLOGY, MALABAR CHRISTIAN COLLEGE, UNIVERSITY OF CALICUT, 2017.

TABLE 9**Developmental time (in days) (Mean±SE) of immature stages of *Euseius pariyarensis* sp.nov. * (n=10)**

Temperature (°C)	Sex	Egg	Larva		Protonymph		Deutonymph		Total
			Active	QI	Active	QII	Active	QIII	
25	Female	2.25±0.05a	0.50±0.03a	1.53±0.04a	0.60±0.03a	1.52±0.03a	0.88±0.07a	1.41±0.04a	8.69±0.09b
	Male	2.01±0.03a	0.40±0.03a	1.22±0.01a	0.50±0.08a	1.32±0.01a	0.75±0.07a	1.01±0.02a	7.46±0.06a
30	Female	1.93±0.06b	0.24±0.02b	1.44±0.03a	0.45±0.02a	1.37±0.03a	1.06±0.04a	0.94±0.04b	7.44±0.07a
	Male	1.85±0.04b	0.20±0.03b	1.21±0.02a	0.41±0.05a	1.20±0.02a	1.04±0.01a	0.83±0.02b	6.74±0.09b

*Means within the same column followed by same letters are not significantly different at $P<0.05$, Student- Newman-Keuls test.

TABLE NO. 10**Duration (in days) and Rate of Reproduction (Mean±SE) of *Euseius pariyarensis* sp.nov Adult Females *(n=10)**

Parameters	Temperature (°C)	
	25	30
Pre-oviposition period	2.7±0.26a	1.5±0.17b
Oviposition period	16.5±0.52a	17.5±0.52b
Post-oviposition period	5.6±0.27a	4.7±0.30b
Total longevity of female	24.6±0.48a	23.8±0.68b
Total longevity of male	18.6±0.76a	17.7±0.87b
Average No. of eggs/female/day	2.2±0.20a	2.4±0.16a

*Means with in a row followed by same letters are not significantly different at $P<0.05$, Student-Newman-Keuls test.

TABLE NO. 7

Developmental duration of *E. pariyarensis* sp.nov.in hours ($25 \pm 2^{\circ}\text{C}$, $65 \pm 10\%$ RH)

Sl. No.	Incubation	Larval Period		Protonymphal period		Deutonymphal period		Total
		Active	QI	Active	QII	Active	QIII	
1	52.02	12.03	40.15	14.3	36	22	28.18	204.68
2	55.05	14.1	39.03	12.04	38	20.12	36.25	214.59
3	53.05	10.25	37.12	12.5	37.02	18.45	32.08	200.47
4	60.32	8.45	40.06	14	35.28	16.15	36.01	210.27
5	58.14	12.28	36.16	16.15	33.1	14.36	38.15	208.34
6	53.23	10.48	32.35	18.17	34.2	18.45	32.28	199.16
7	45.09	9.1	38.1	14.3	36.12	22.16	35.1	199.97
8	54.34	14.02	33.08	12.1	38.08	33.02	34.58	219.22
9	52.15	16	38.1	13.45	37.01	21.36	36.18	214.25
10	57.03	11.48	34.2	15.1	40.25	26.16	30.02	214.51
Mean	54.042	11.819	36.835	14.211	36.506	21.223	33.883	208.546

TABLE NO.8

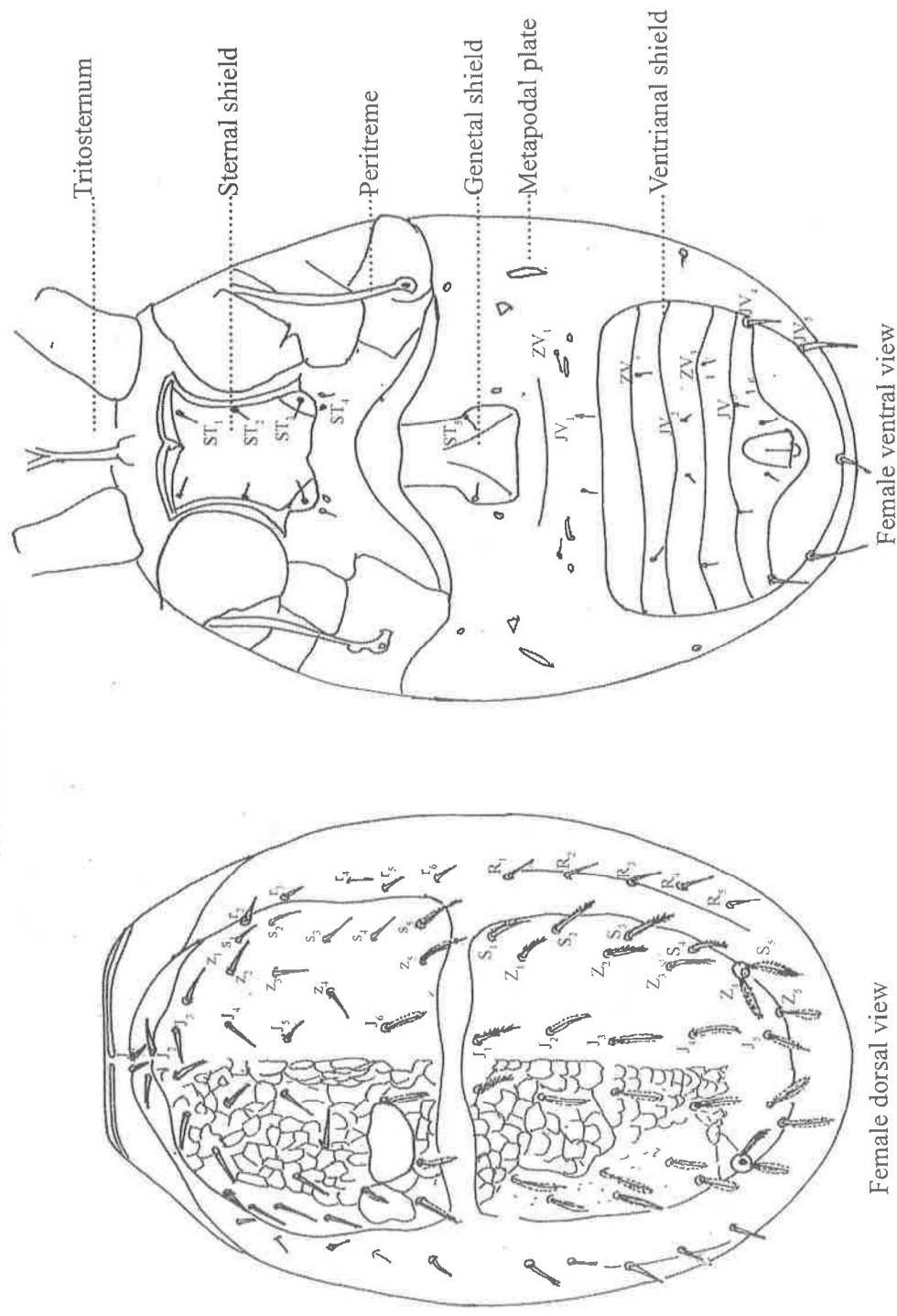
Developmental duration of *E. pariyarensis* sp.nov.in hours ($30 \pm 2^{\circ}\text{C}$, $65 \pm 10\%$ RH)

Sl. No.	Incubation	Larval Period		Protonymphal period		Deutonymphal period		Total
		Active	QI	Active	QII	Active	QIII	
1	49.14	8.21	36.2	9.12	34.1	24.07	22.08	182.92
2	42.24	5.5	34.05	12.2	30	26.13	19.15	169.27
3	40.47	6.1	38	15	36.05	22.37	24.09	182.08
4	44.43	4.45	33.55	10.45	30.06	27.15	28.32	178.41
5	48.24	5	36.09	11.2	35.27	22.12	20.54	178.46
6	40.15	6.1	34.05	8.34	31.34	31.23	25.2	176.41
7	49.52	7.2	32.01	11.41	34.08	24.34	21.43	179.99
8	45.34	5.3	37.23	10.2	33.45	28.19	20.46	180.17
9	50.25	4.27	30.45	9.54	30.2	25.35	20.45	170.51
10	54.3	6.3	33.34	10.04	34.13	23.1	25	186.21
Mean	46.408	5.843	34.497	10.75	32.868	25.405	22.672	178.443

TABLE 11**Measurements of life stages of *E. pariyarensis* sp.nov (in μm)**

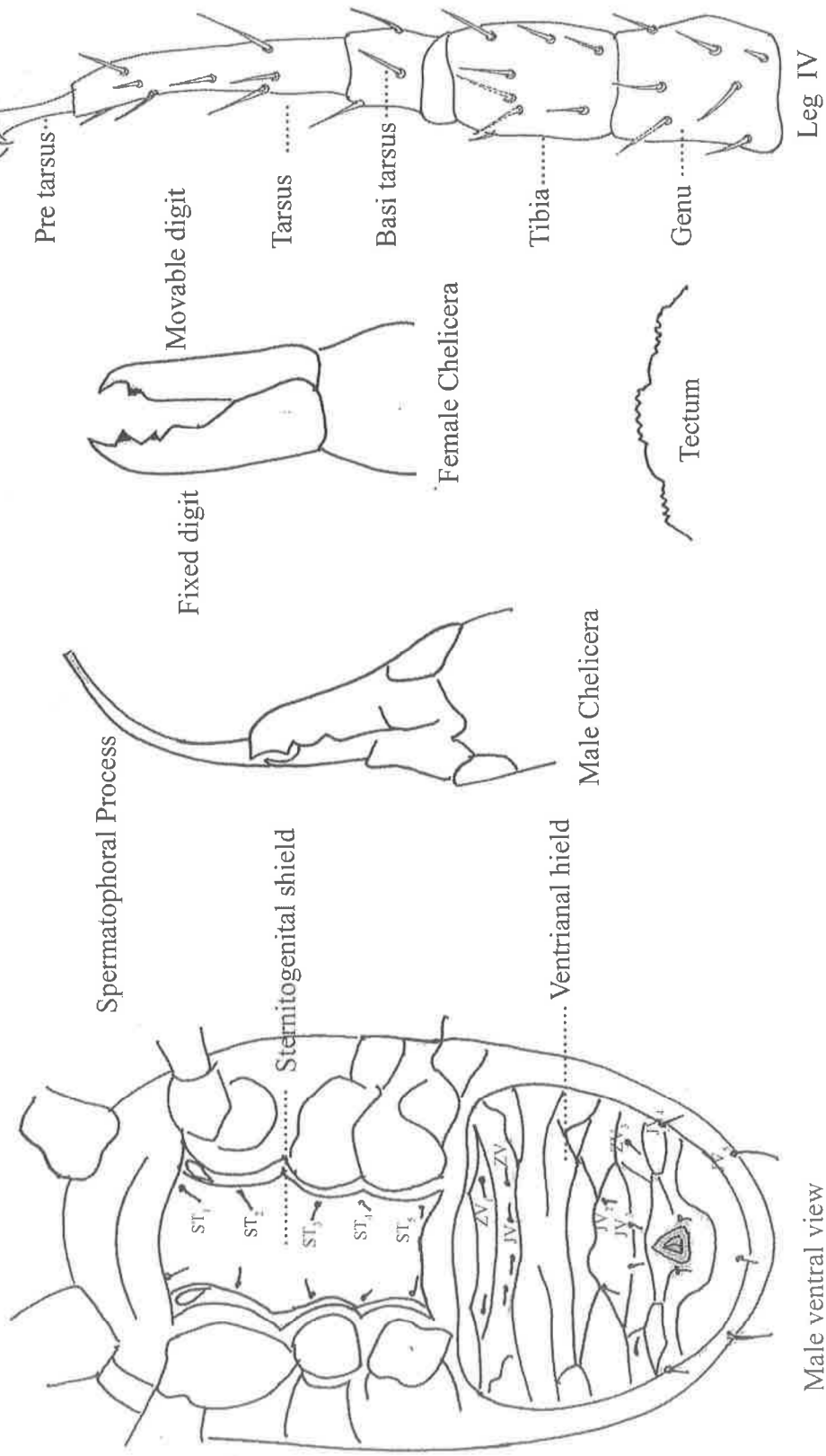
SI NO	EGG		LARVA		PROTONYMPH		DEUTONYMPH		FEMALE		MALE	
	L	W	L	W	L	W	L	W	L	W	L	W
1.	177	145	196	142	197	132	332	225	329	260	248	177
2.	182	135	205	139	208	137	329	215	320	212	243	180
3.	196	140	235	140	215	126	330	220	335	240	250	182
4.	181	142	222	146	220	130	295	228	325	234	265	179
5.	180	137	200	142	225	135	302	230	338	218	255	190
6.	198	142	208	148	238	128	297	218	335	245	250	185
7.	190	144	224	150	240	130	310	231	322	222	254	177
8.	185	141	240	141	242	129	315	218	336	200	245	186
9.	195	148	210	144	200	138	333	220	330	225	248	190
10.	201	147	238	138	210	135	298	215	334	238	262	178
RANGE	177-201	135-148	196-240	139-150	197-242	126-138	329-333	215-231	320-338	210-260	243-265	177-190

PLATE 14A



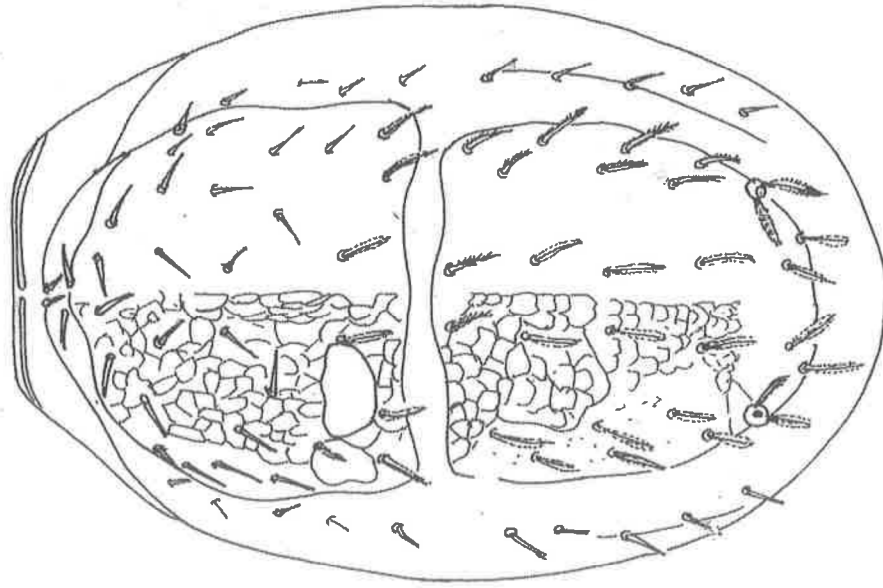
Morphological and Taxonomical characters of the family Ascidae Voigts and Oudemans, 1905

PLATE 14B

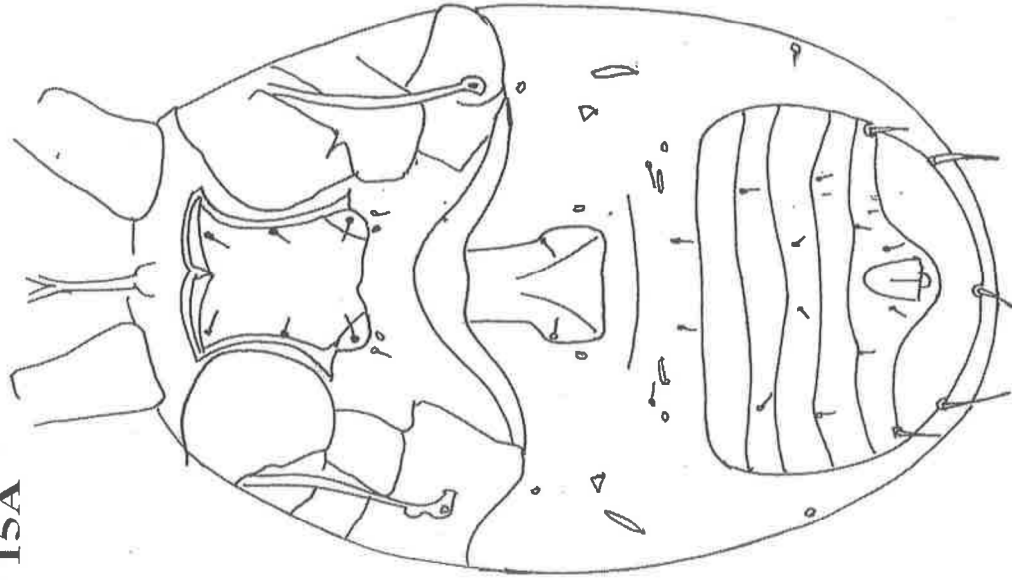


Morphological and Taxonomical characters of the family Ascidae Voigts and Oudemans, 1905

PLATE 15A



DF

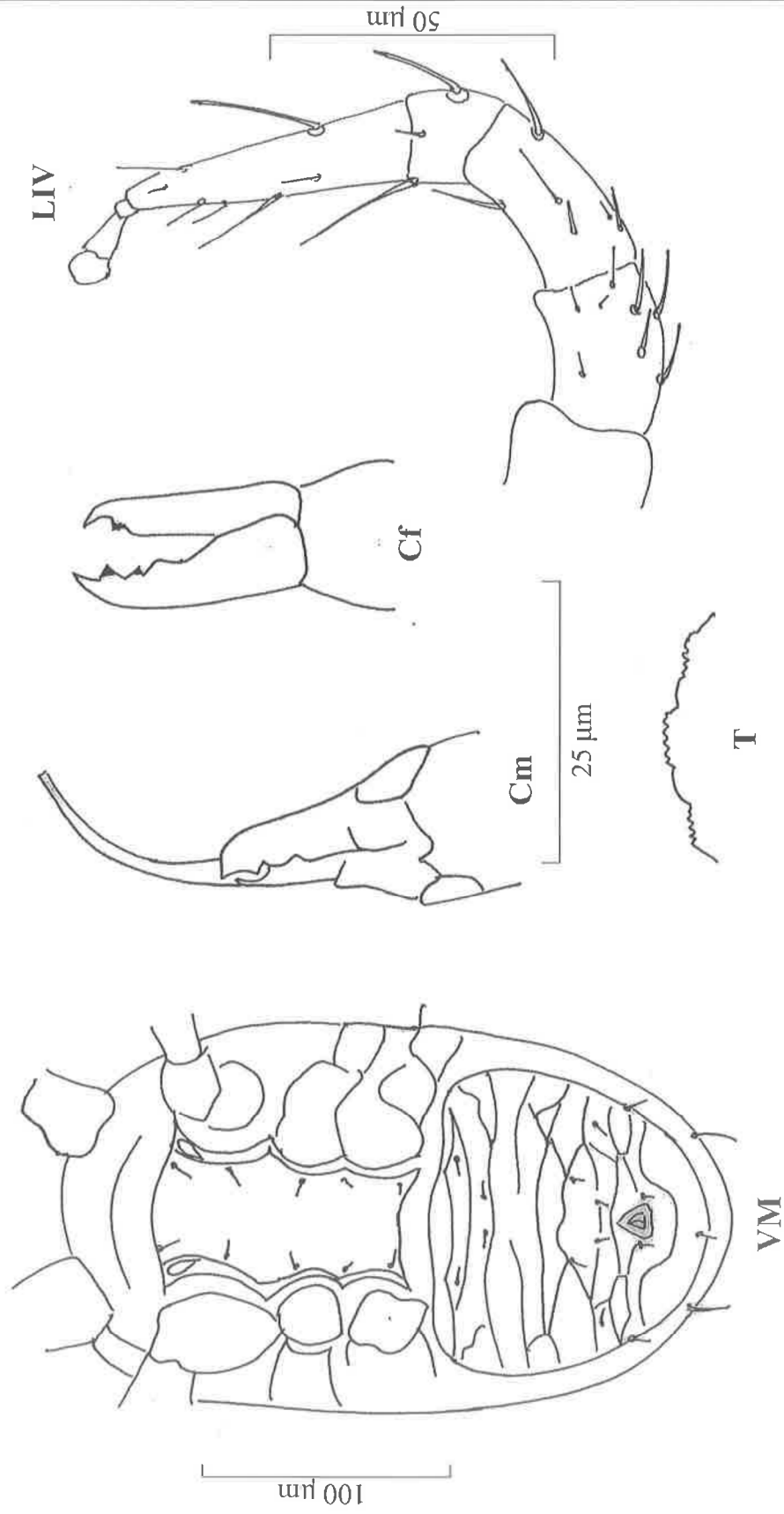


100 μ m

Asca devadasi sp. nov.

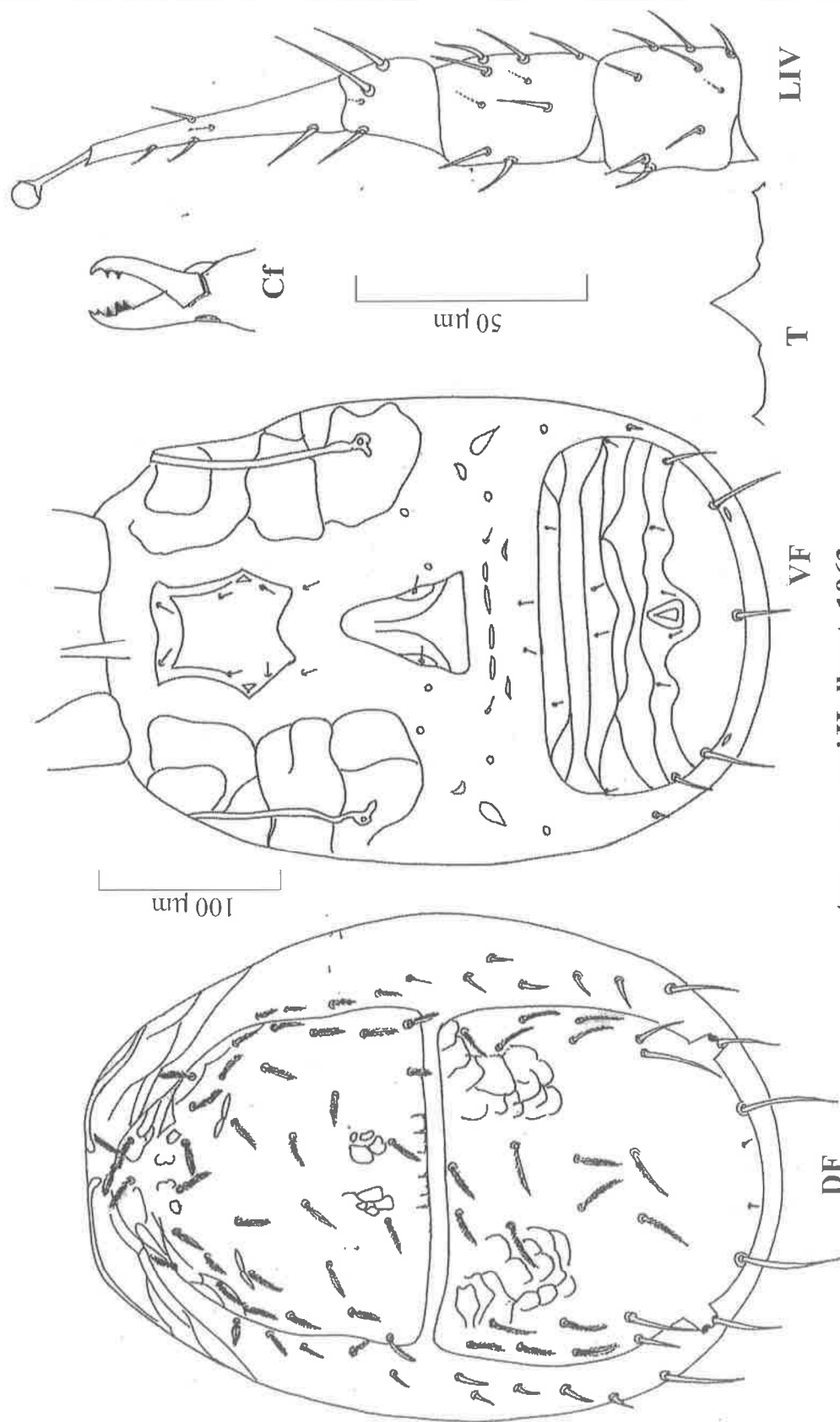
VF

PLATE 15B



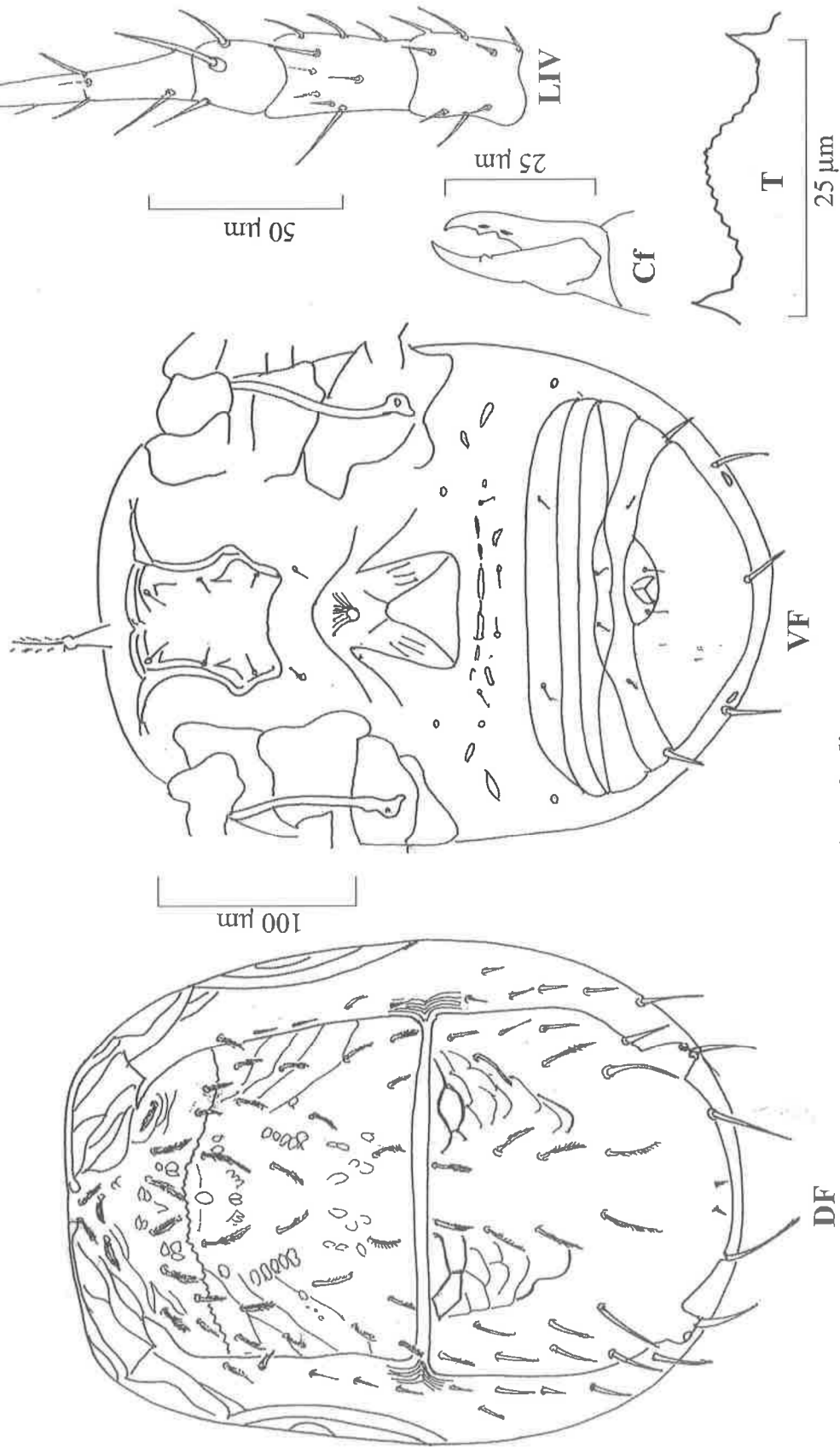
Asca devadasi sp. nov

PLATE 16



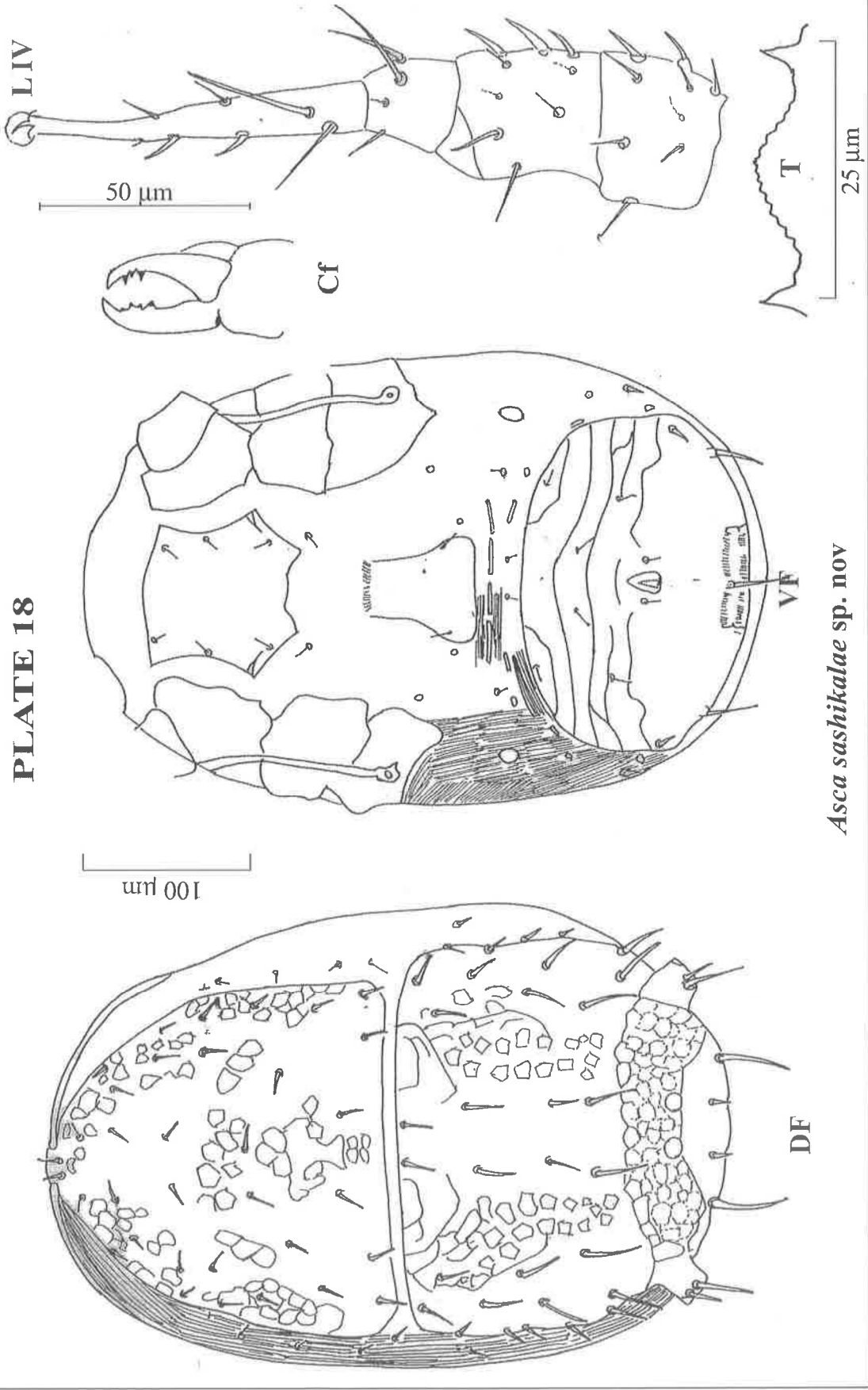
Asca garmani Hulburt, 1963

PLATE 17



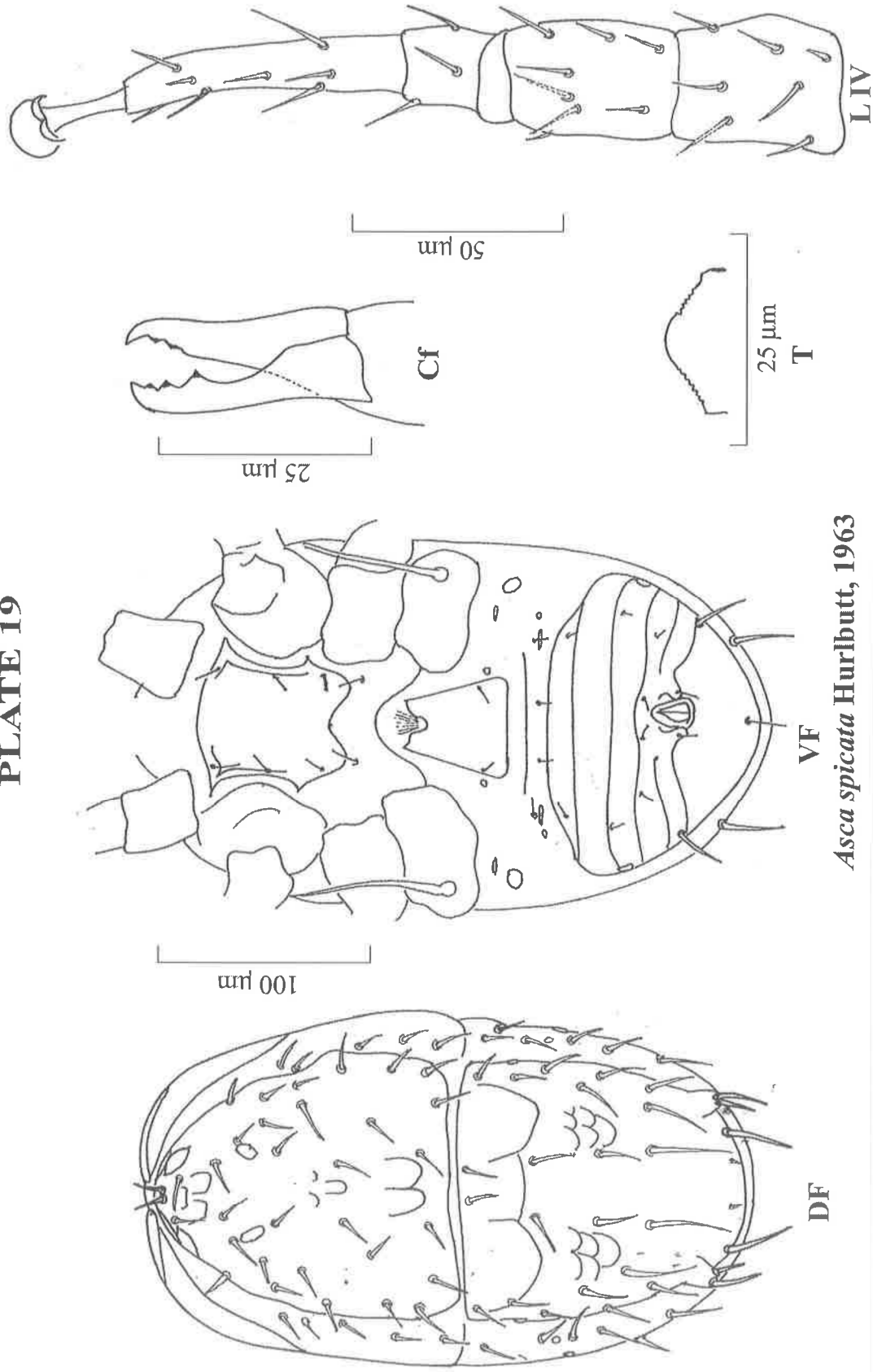
Asca indirae sp. nov.

PLATE 18



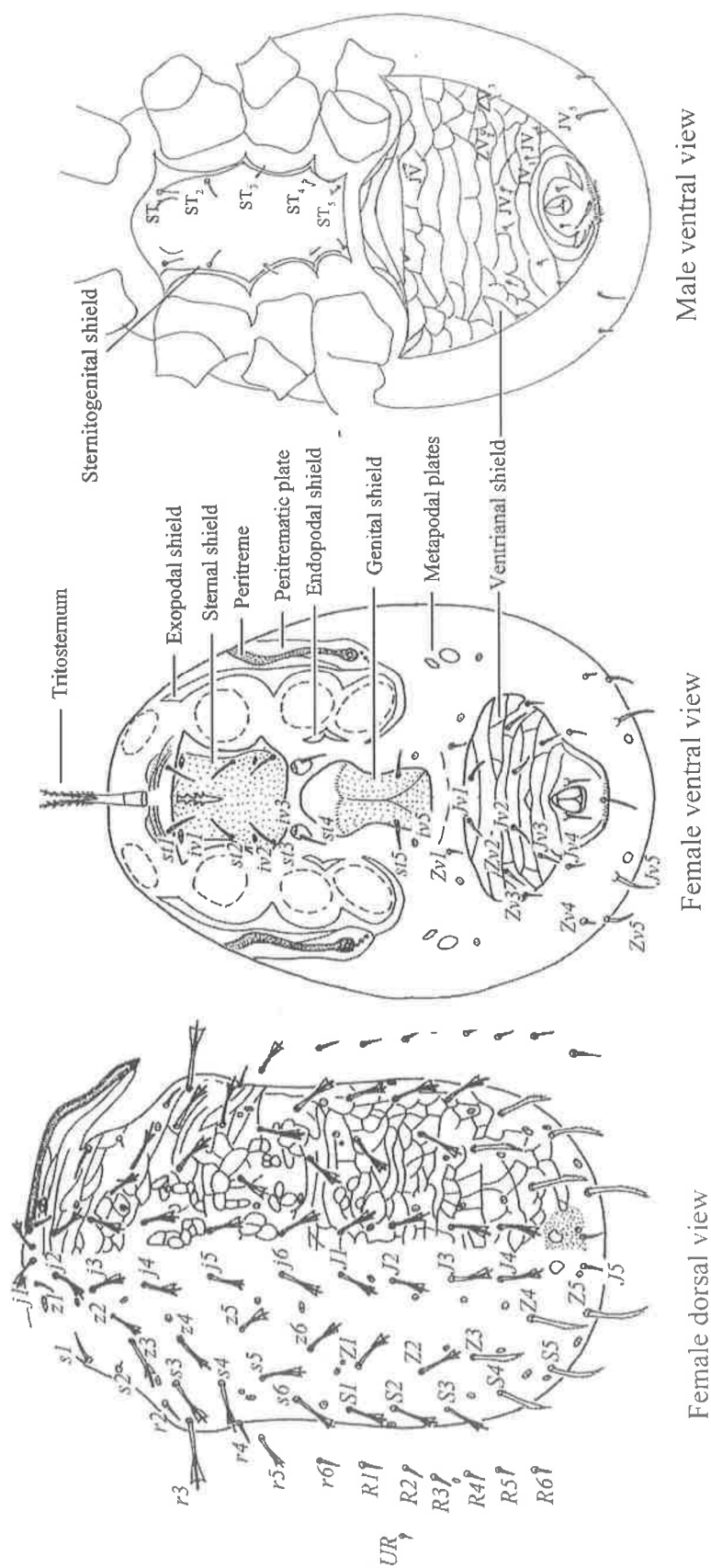
Asca sashikalae sp. nov.

PLATE 19



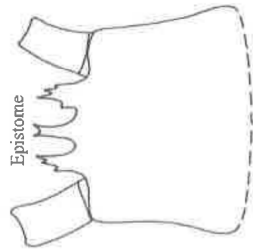
Asca spicata Hurlbutt, 1963

PLATE 20A

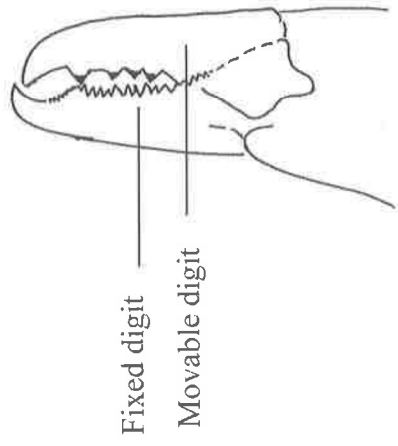


Morphological and Taxonomical characters of the family Blattisociidae Garman, 1948

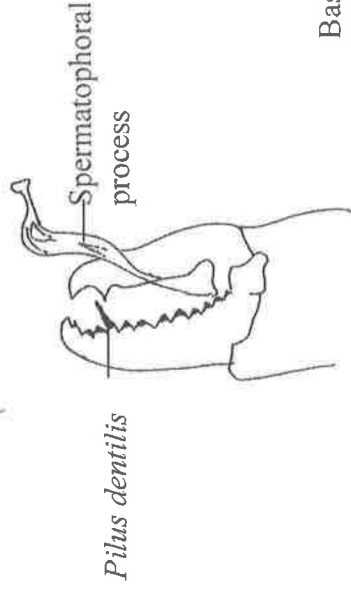
PLATE 20B



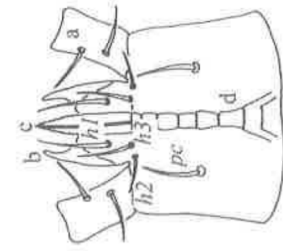
Gnathosoma dorsal



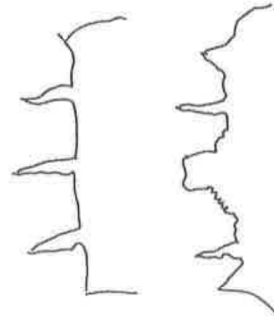
Chelicera female



Chelicera male



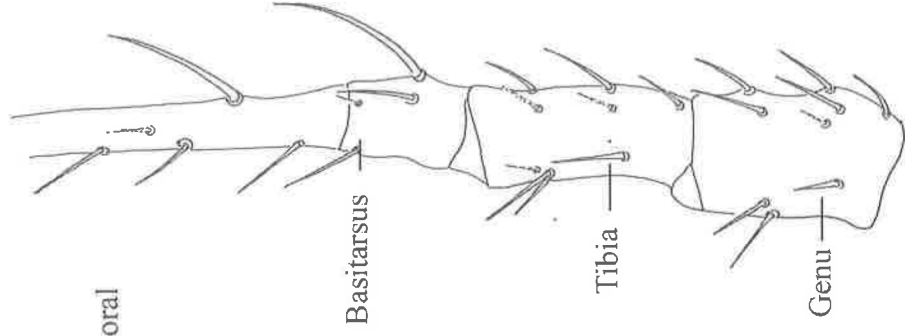
Gnathosoma ventral



Tectum



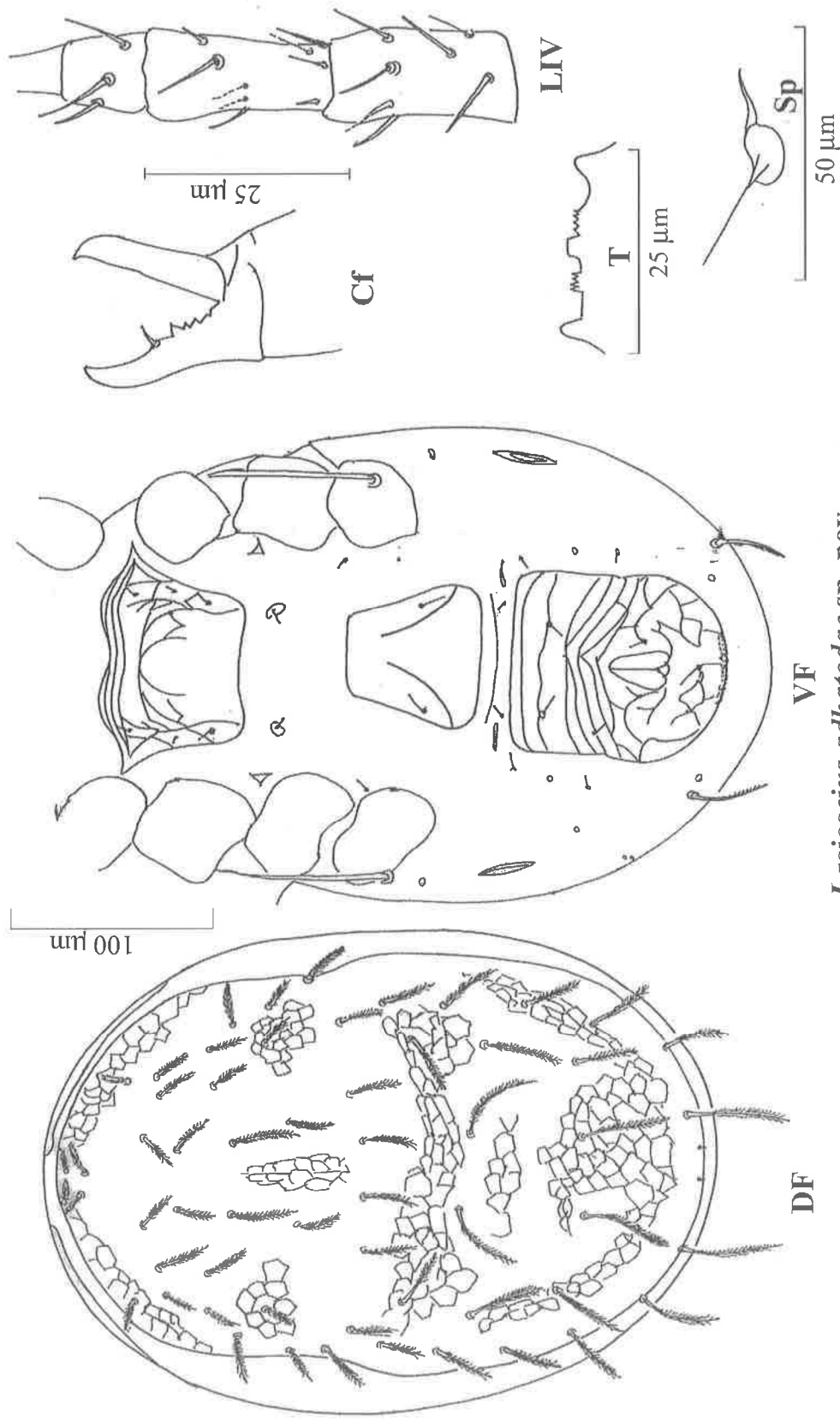
Spermatheca



Leg IV

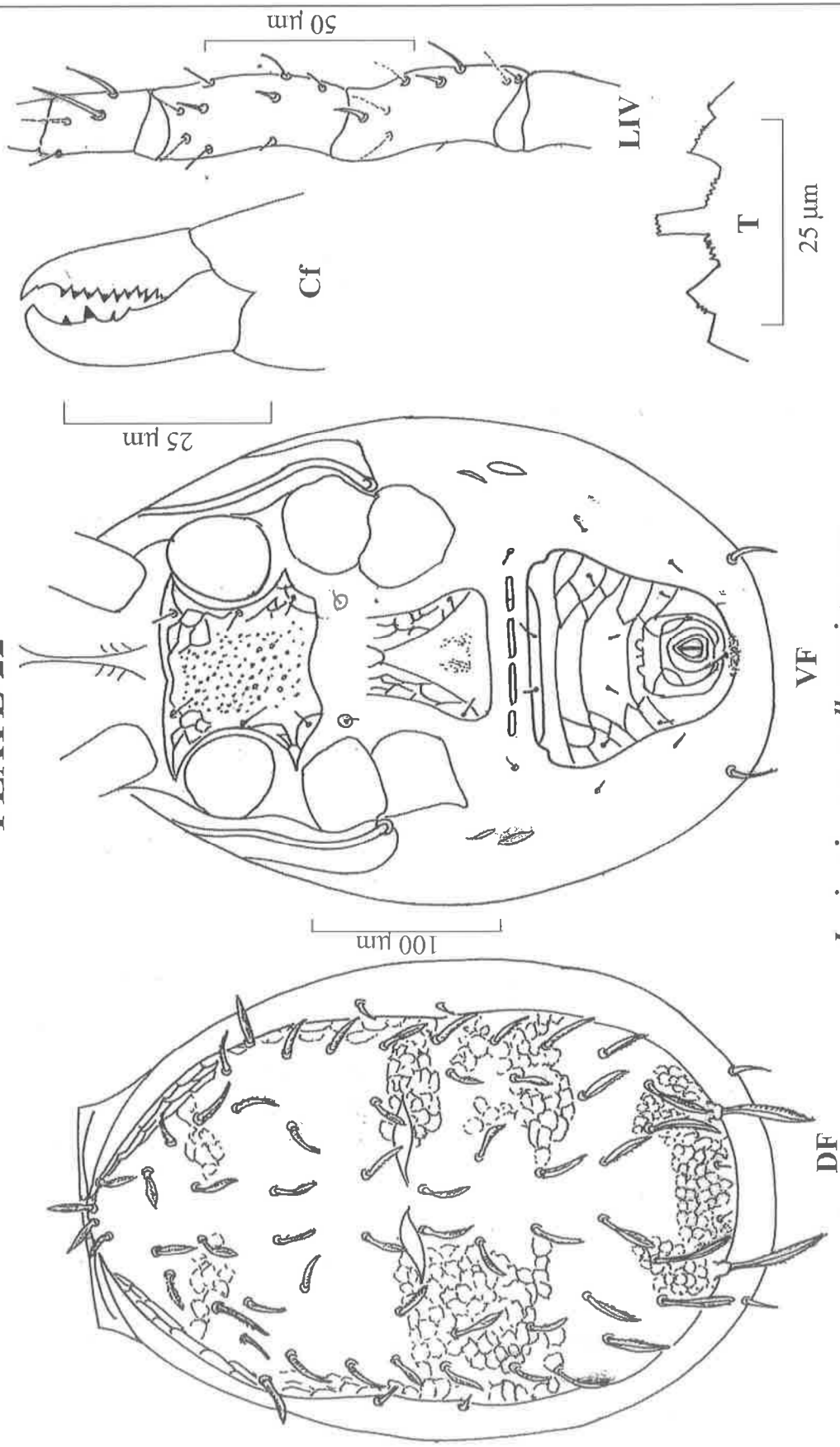
Morphological and Taxonomical characters of the family Blattisociidae Garman, 1948

PLATE 21



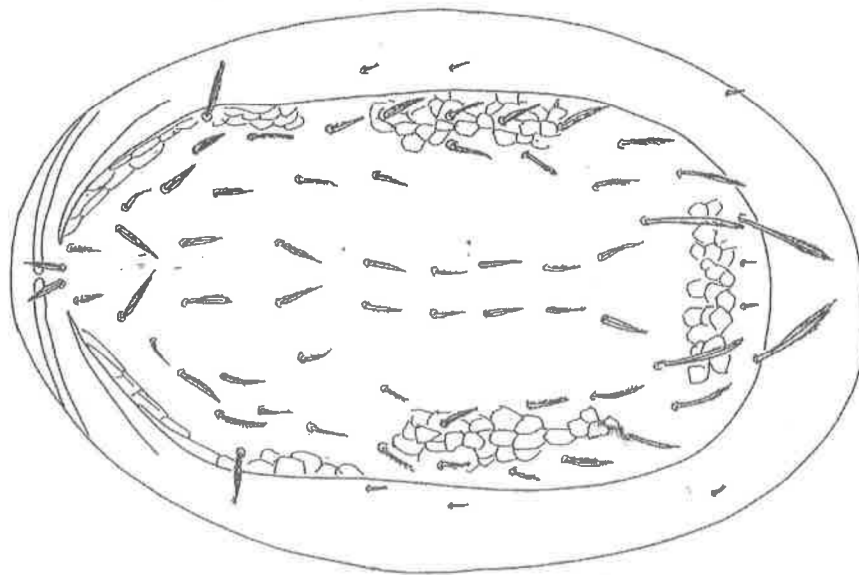
Lasioseius adhatodae sp. nov

PLATE 22

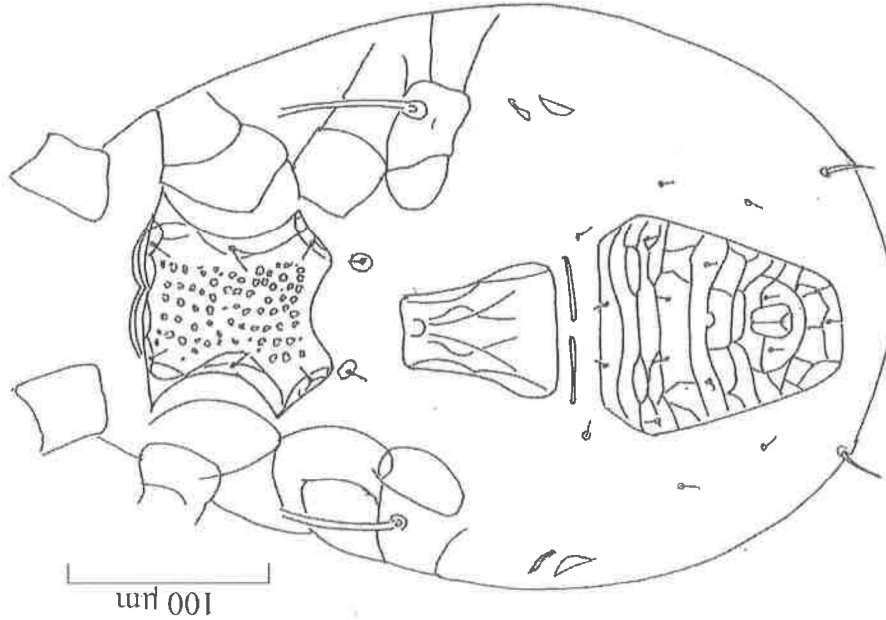


Lasioseius gangadharani sp. nov.

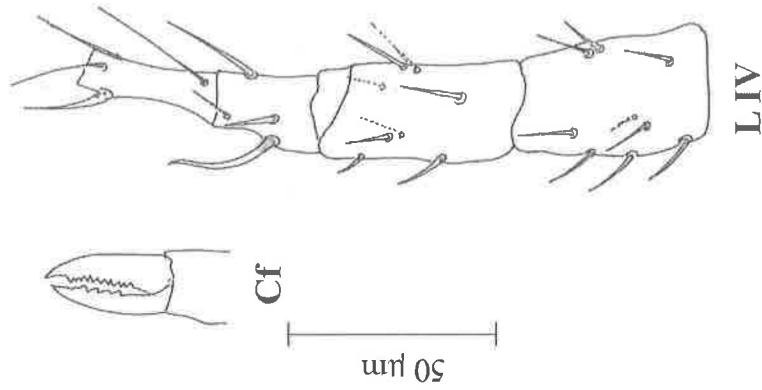
PLATE 23



DF



VF



LIV

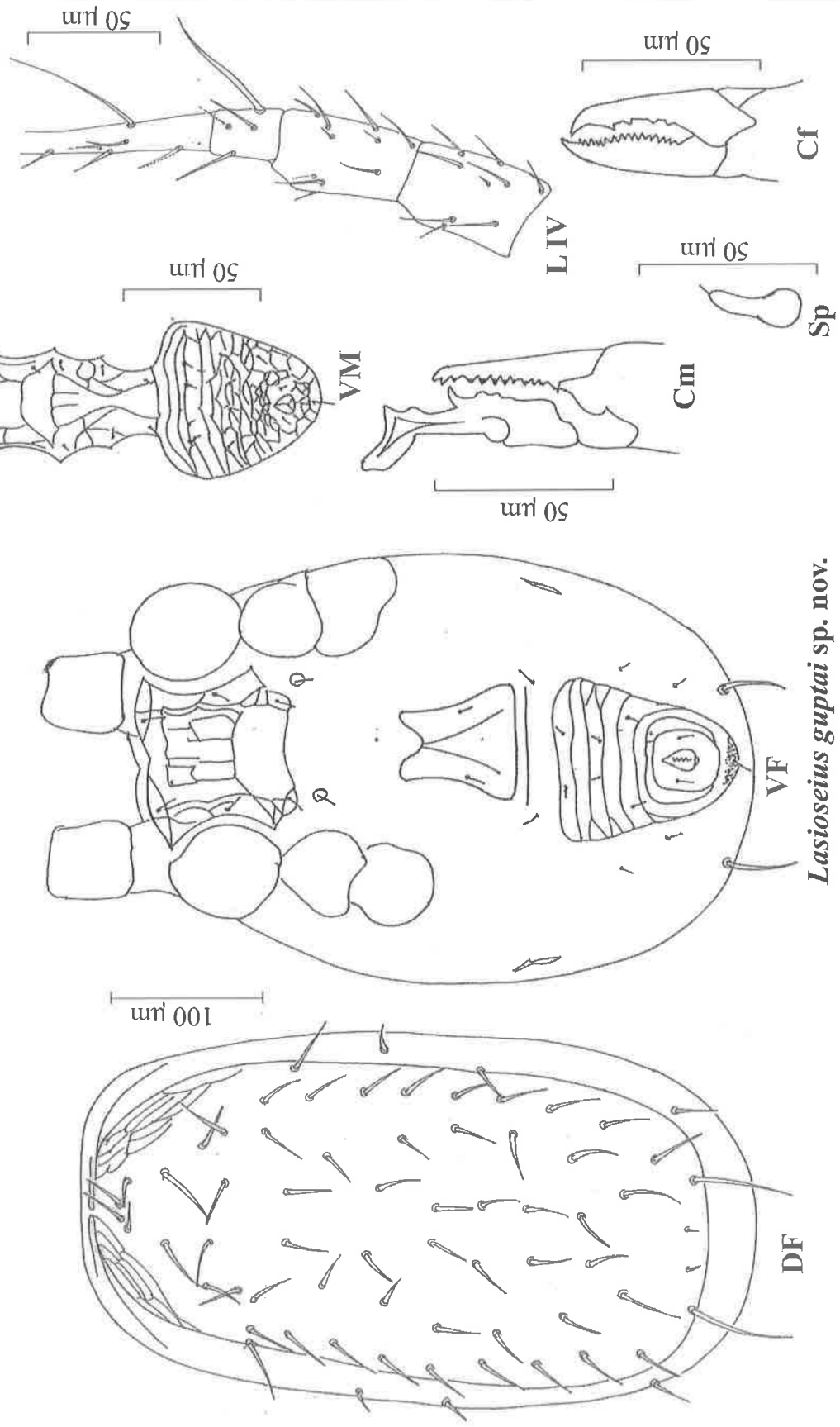
Cf

50 µm

T

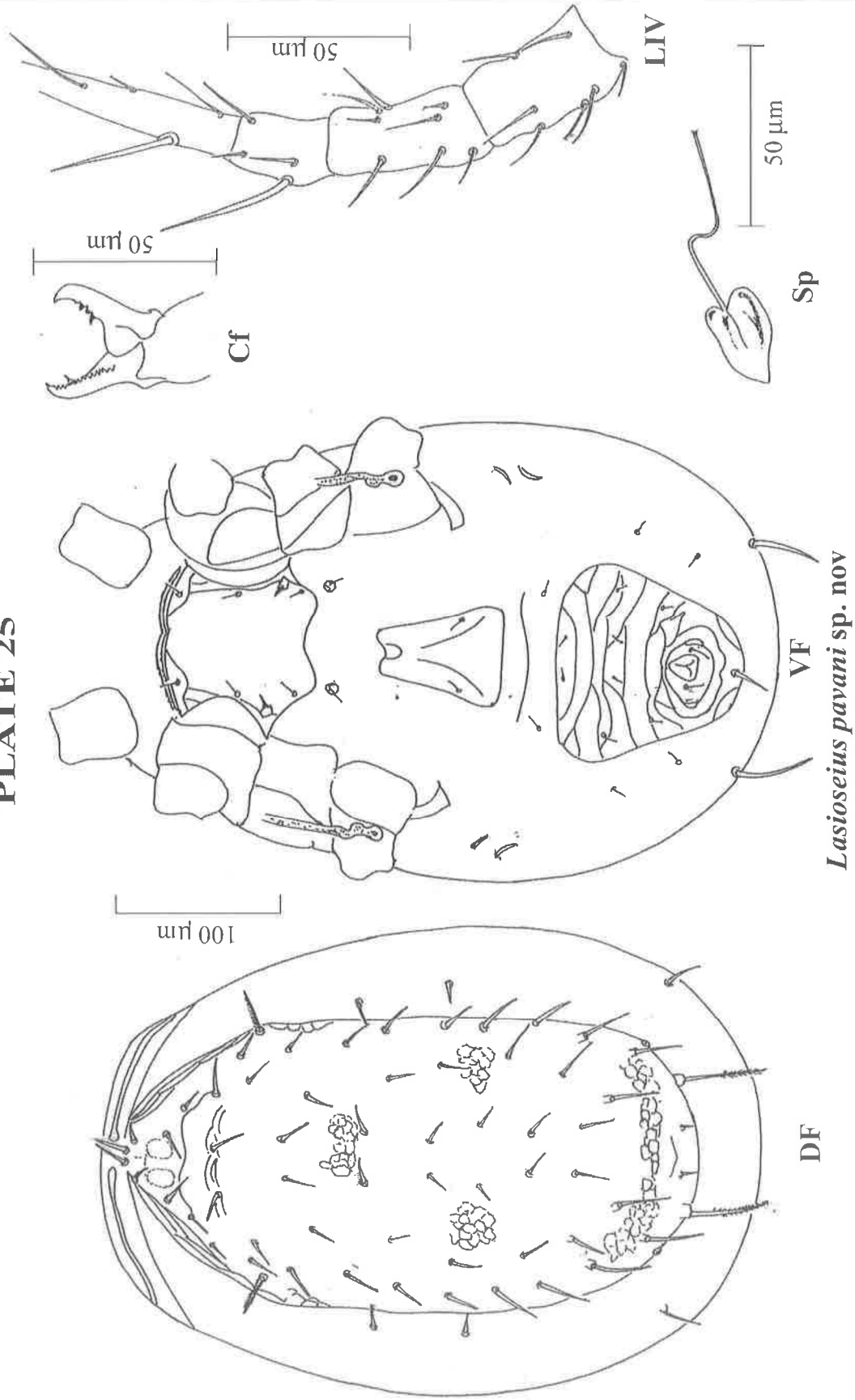
Lasioseius gokuldasi sp. nov.

PLATE 24



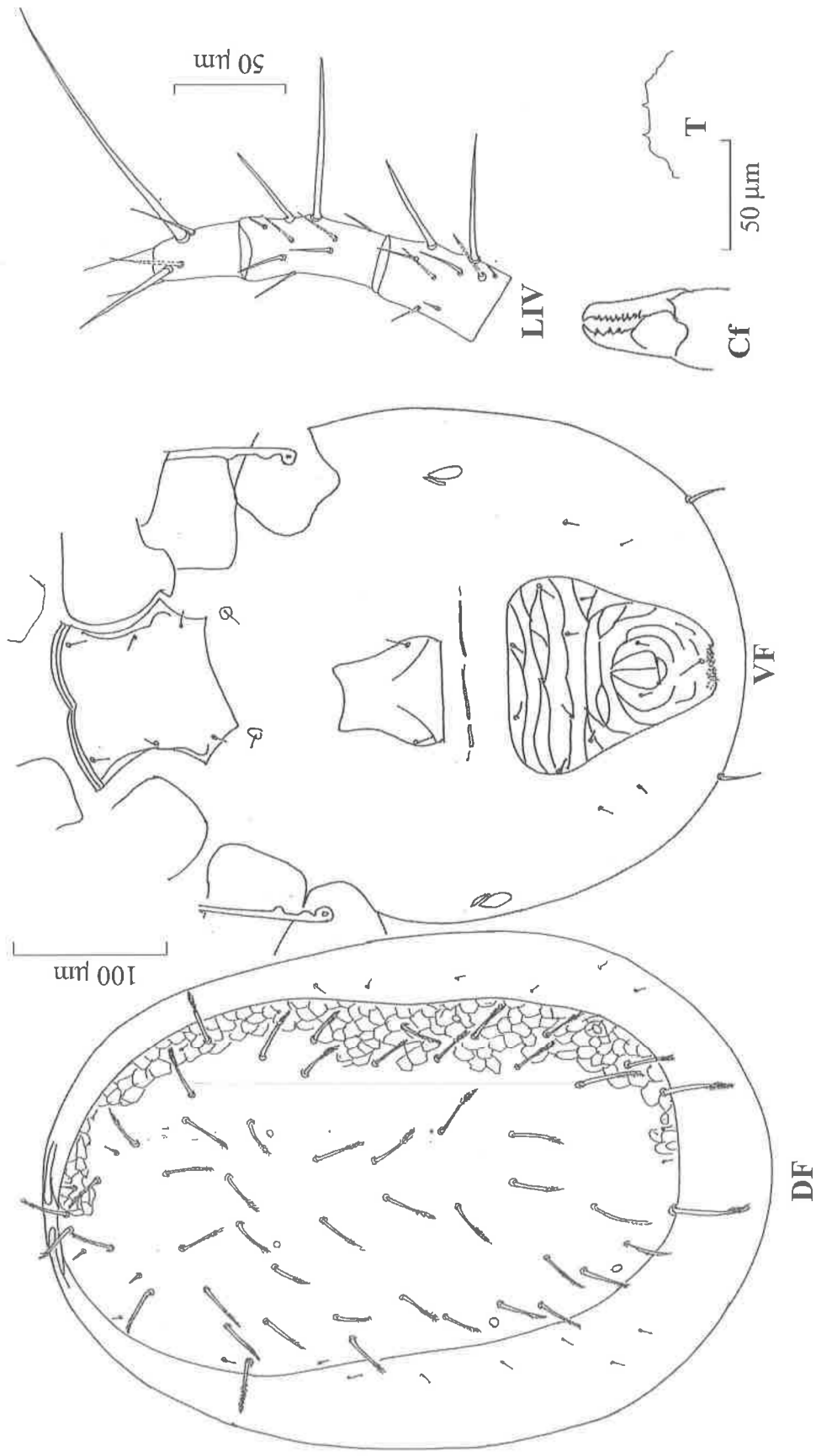
Lasioseius guptai sp. nov.

PLATE 25



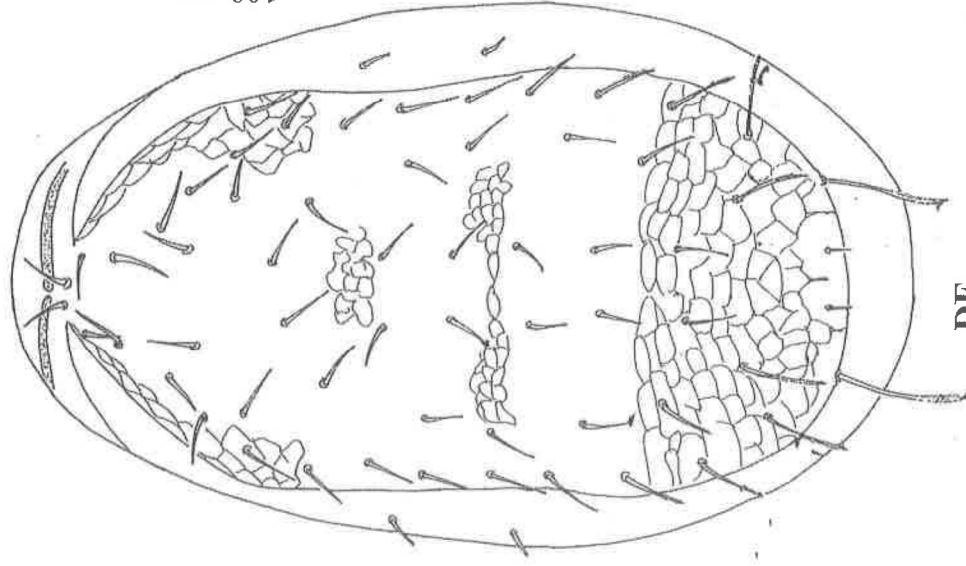
Lasioseius pavani sp. nov

PLATE 26

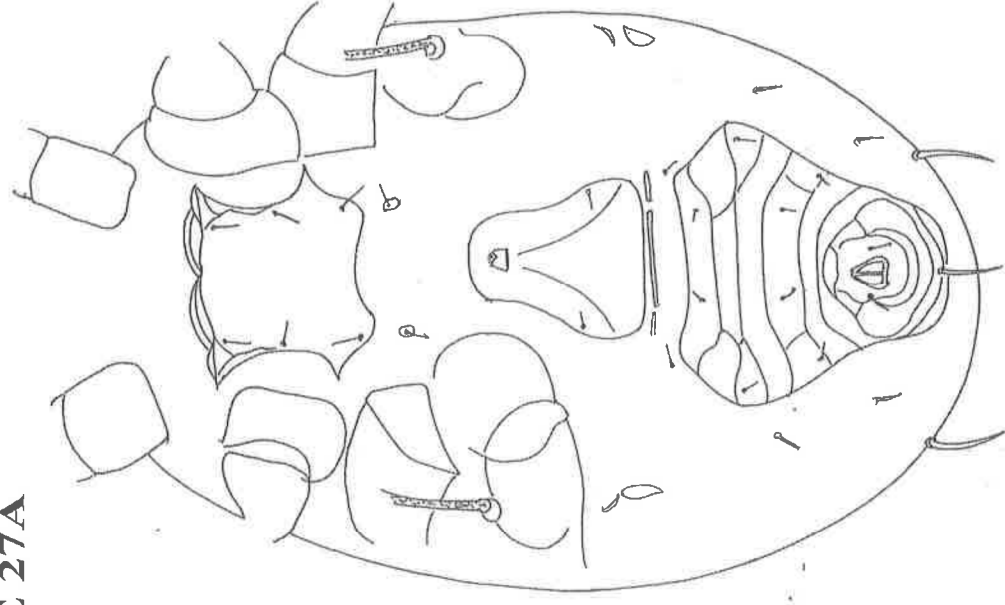


Lasioseius pazhurensis sp. nov

PLATE 27A



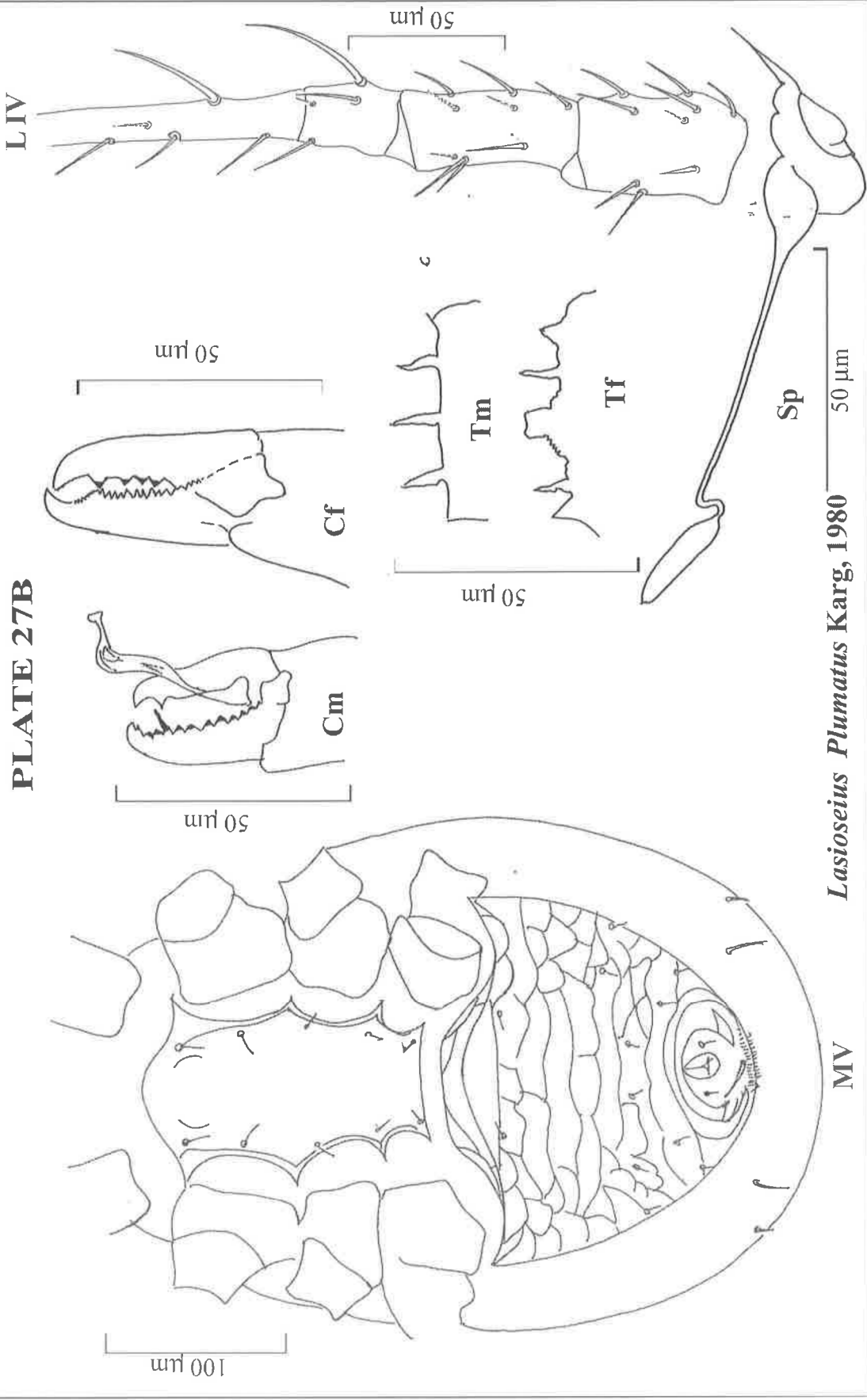
DF



VF

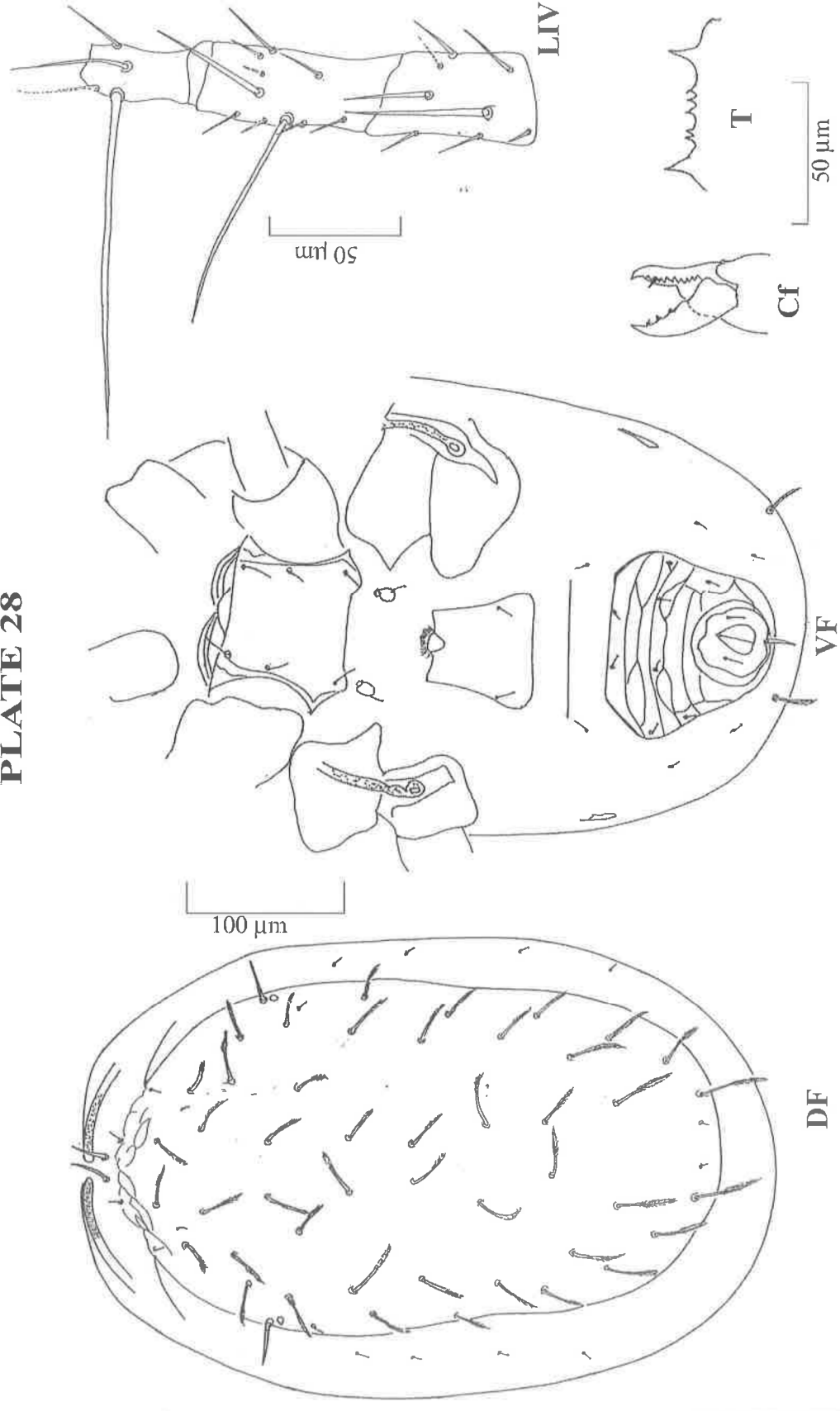
Lasioseius plumatus Karg, 1980

PLATE 27B



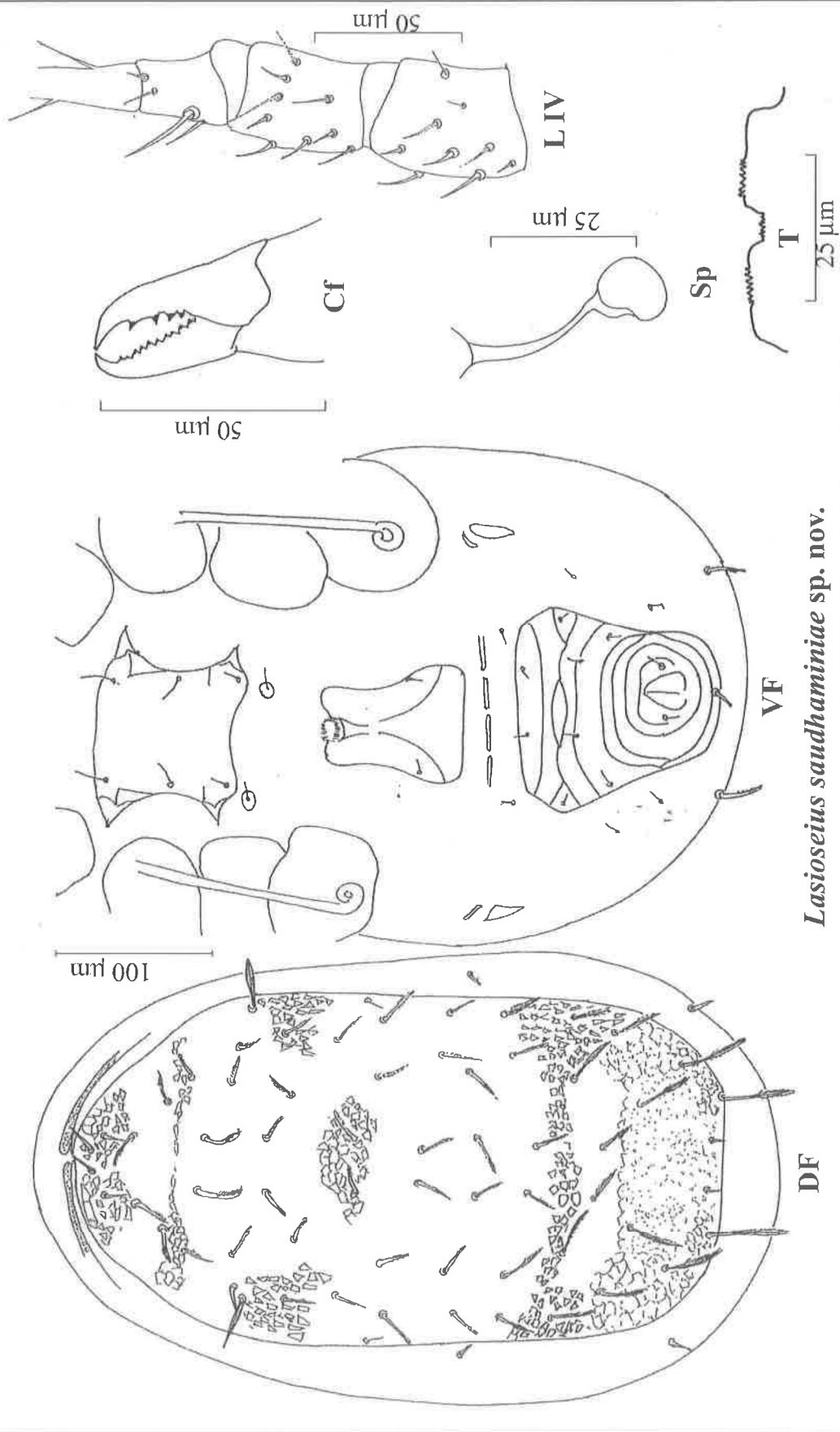
Lasioseius Plumatus Karg, 1980

PLATE 28



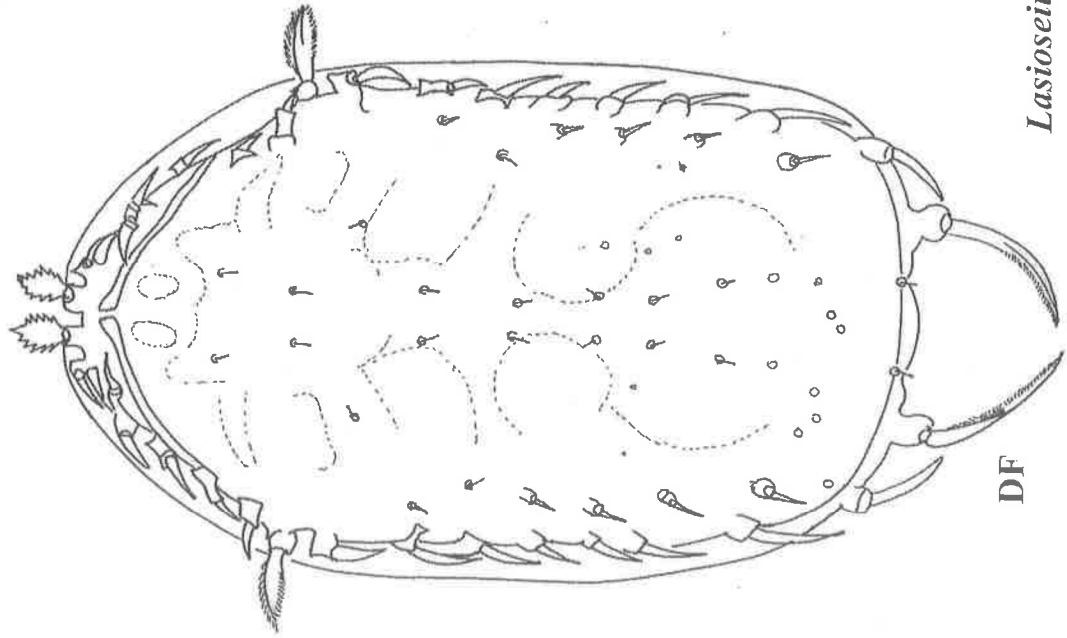
Lasioseius kurachundensis sp. nov.

PLATE 29



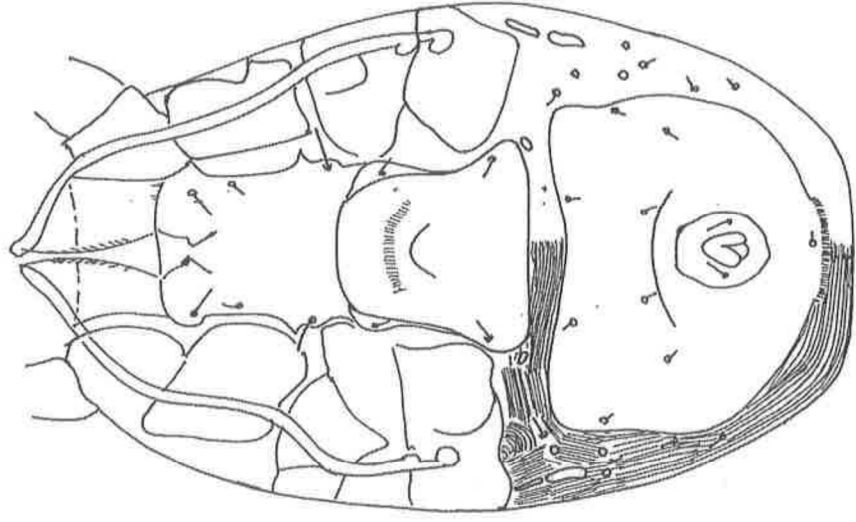
Lasioseius saudhaminia sp. nov.

PLATE 30A



DF

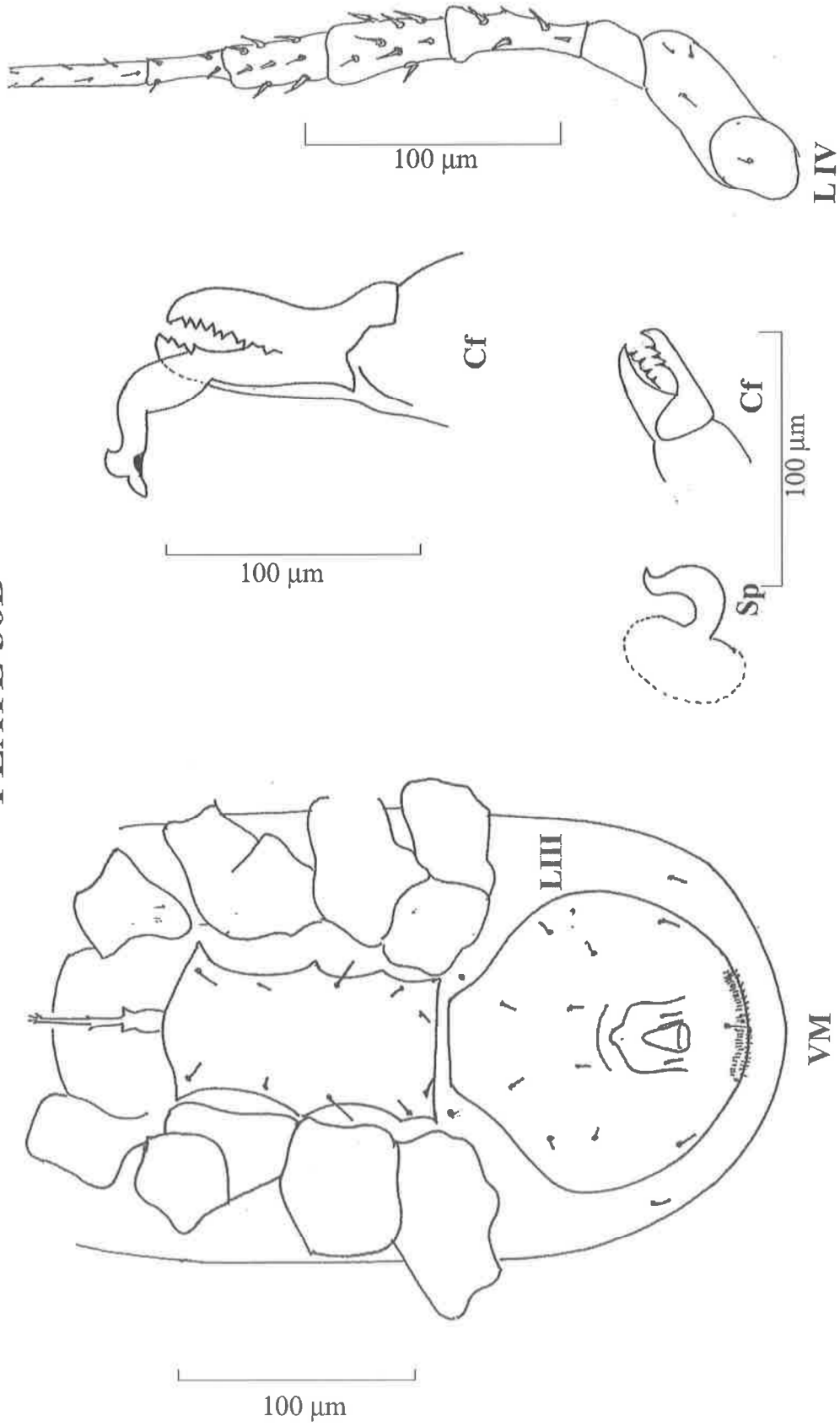
100 μ m



VF

Lasioseius wayanadensis sp. nov

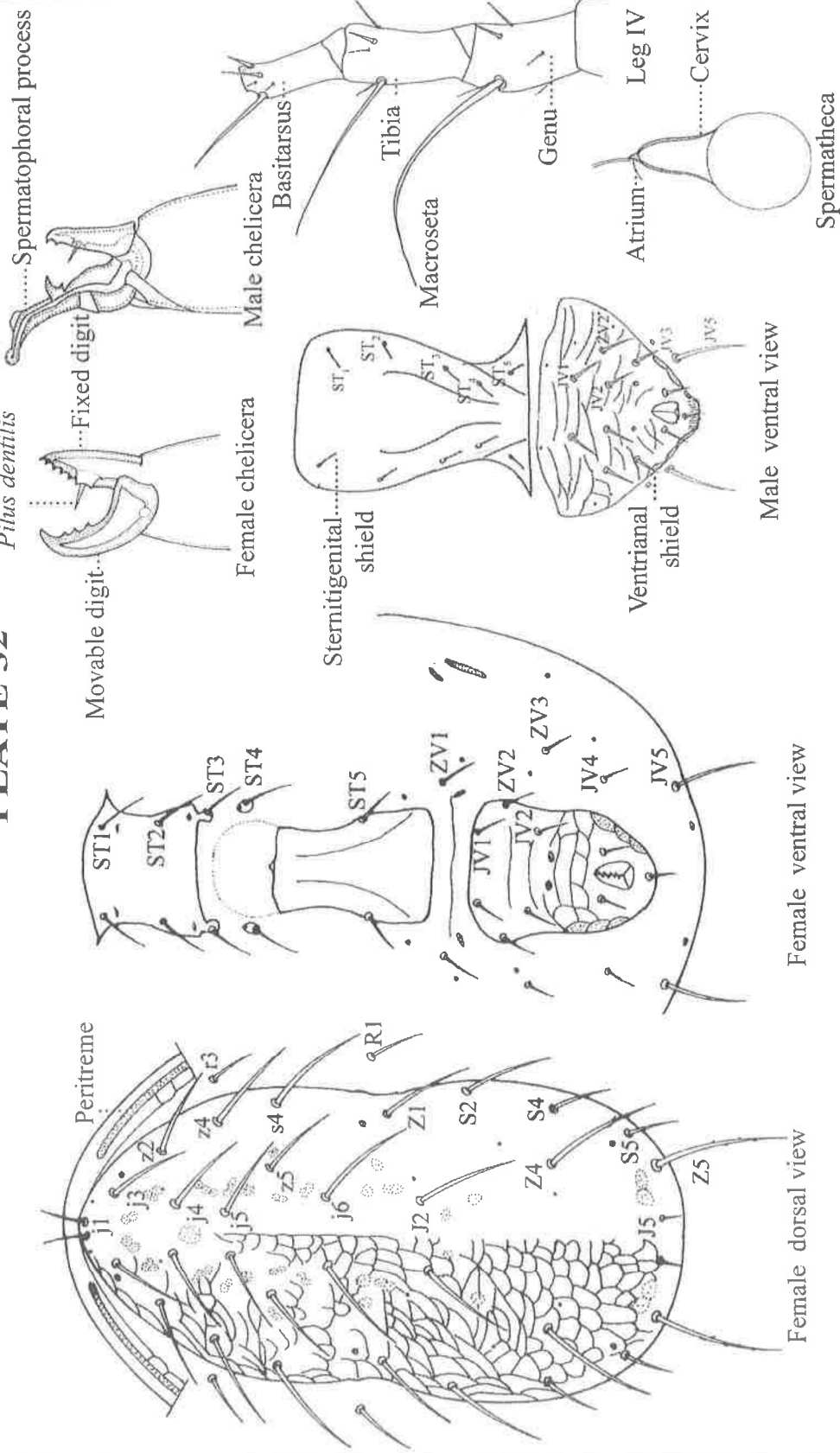
PLATE 30B



Lasioseius wayanadensis sp. nov

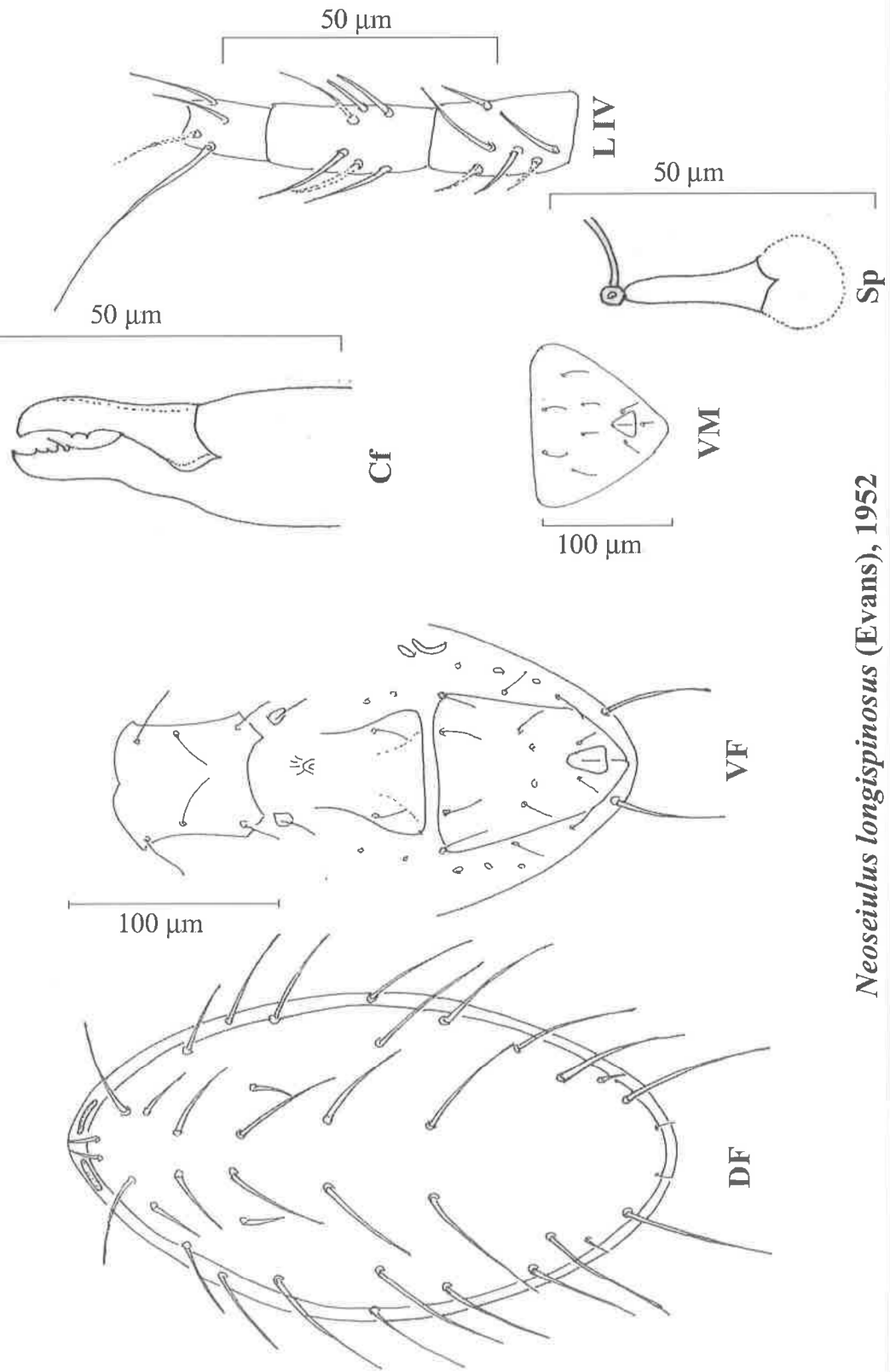
PLATE 32

Pilus dentilis



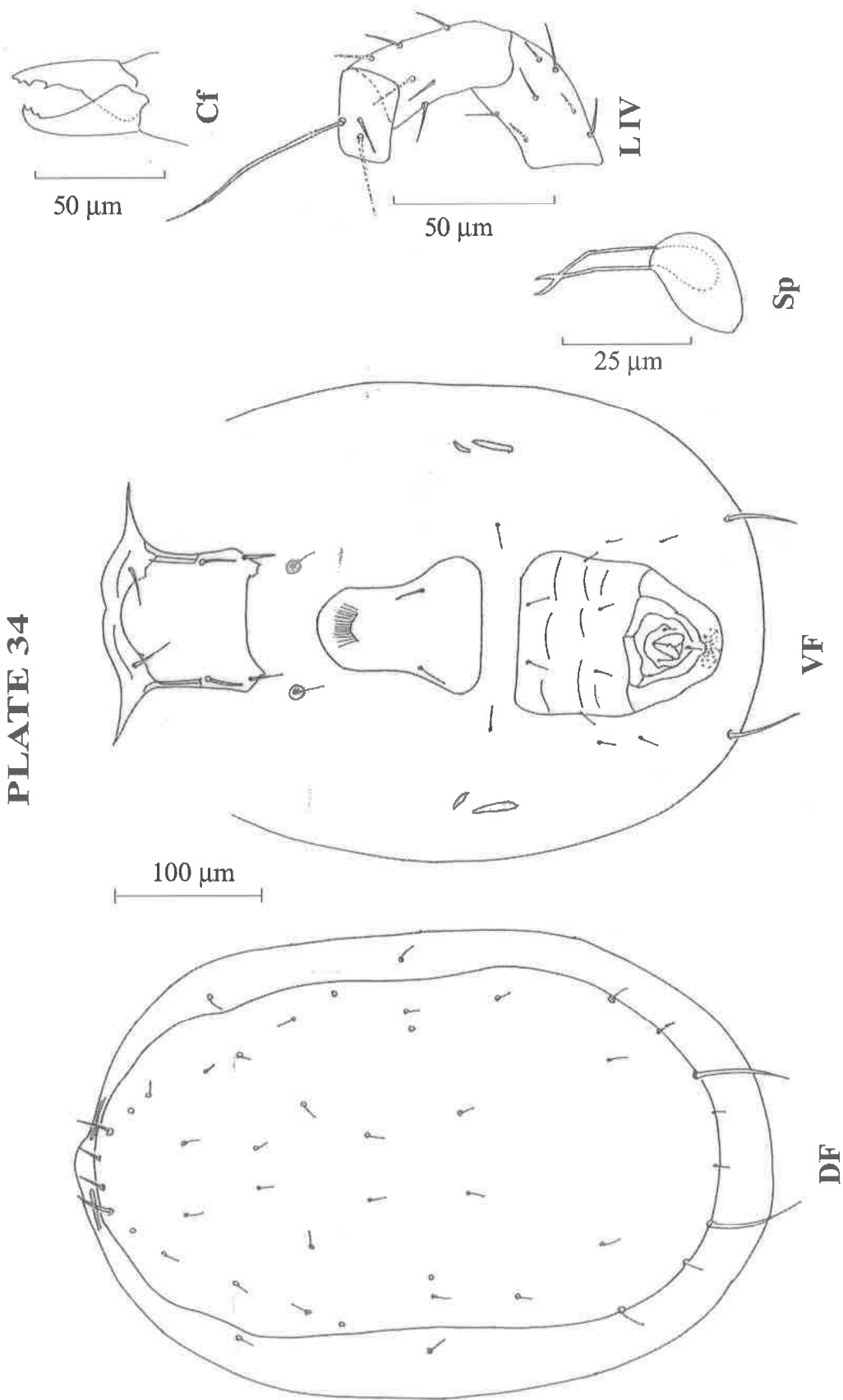
Morphological and Taxonomical characters of the family Phytoseiidae Berlese, 1916

PLATE 33



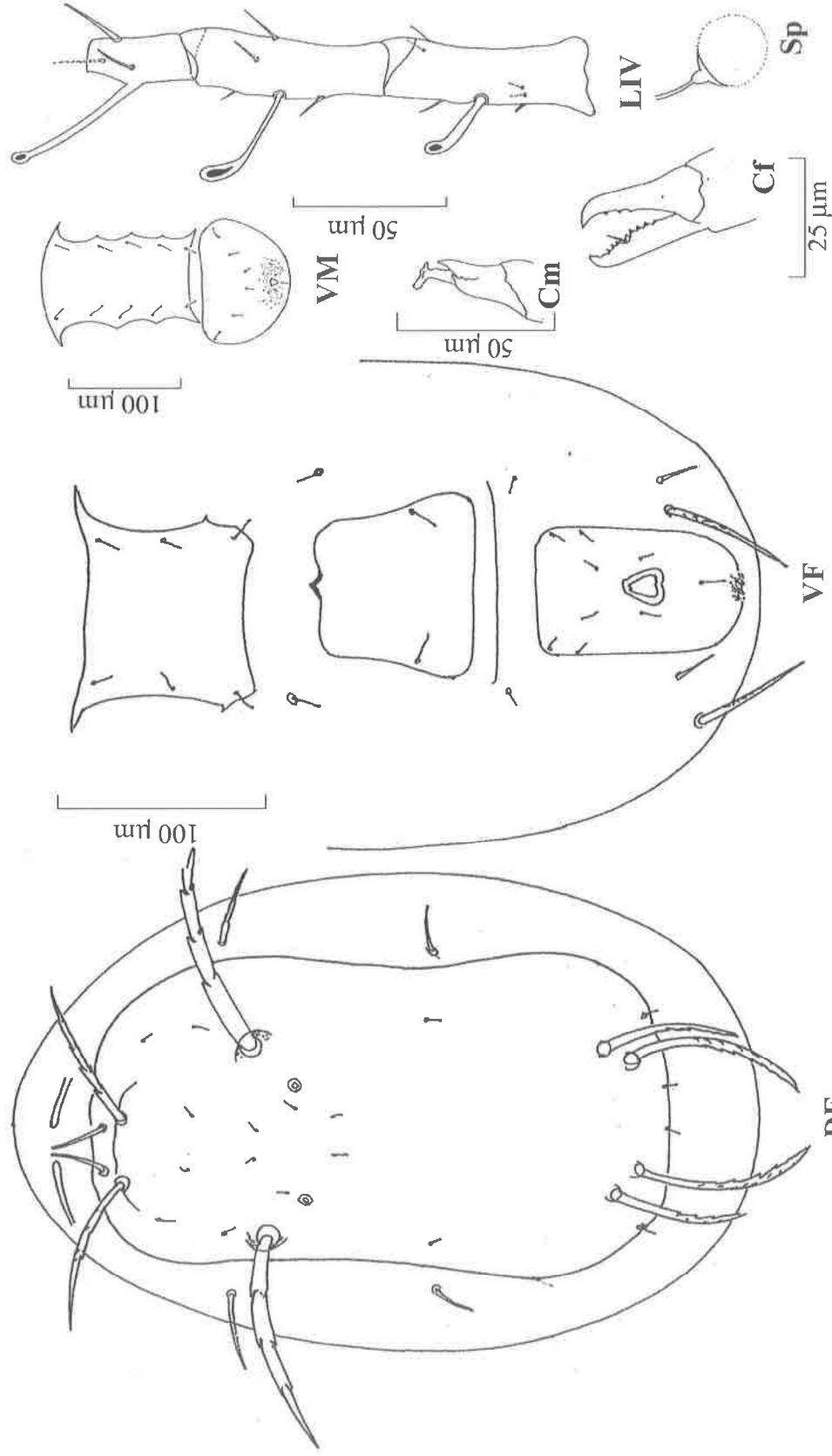
Neoseiulus longispinosus (Evans), 1952

PLATE 34



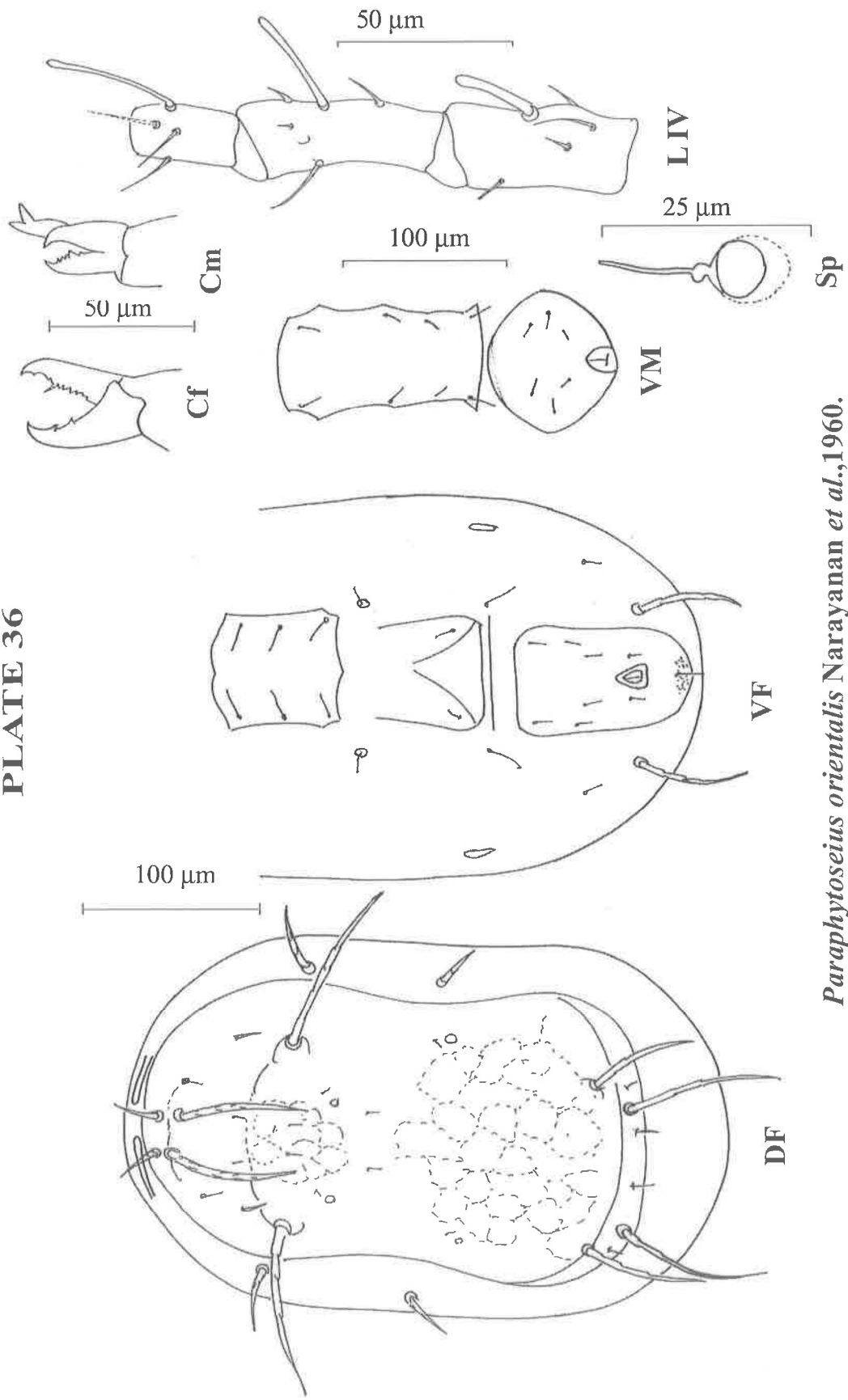
Neoseiulus radhamaniae sp. nov.

PLATE 35



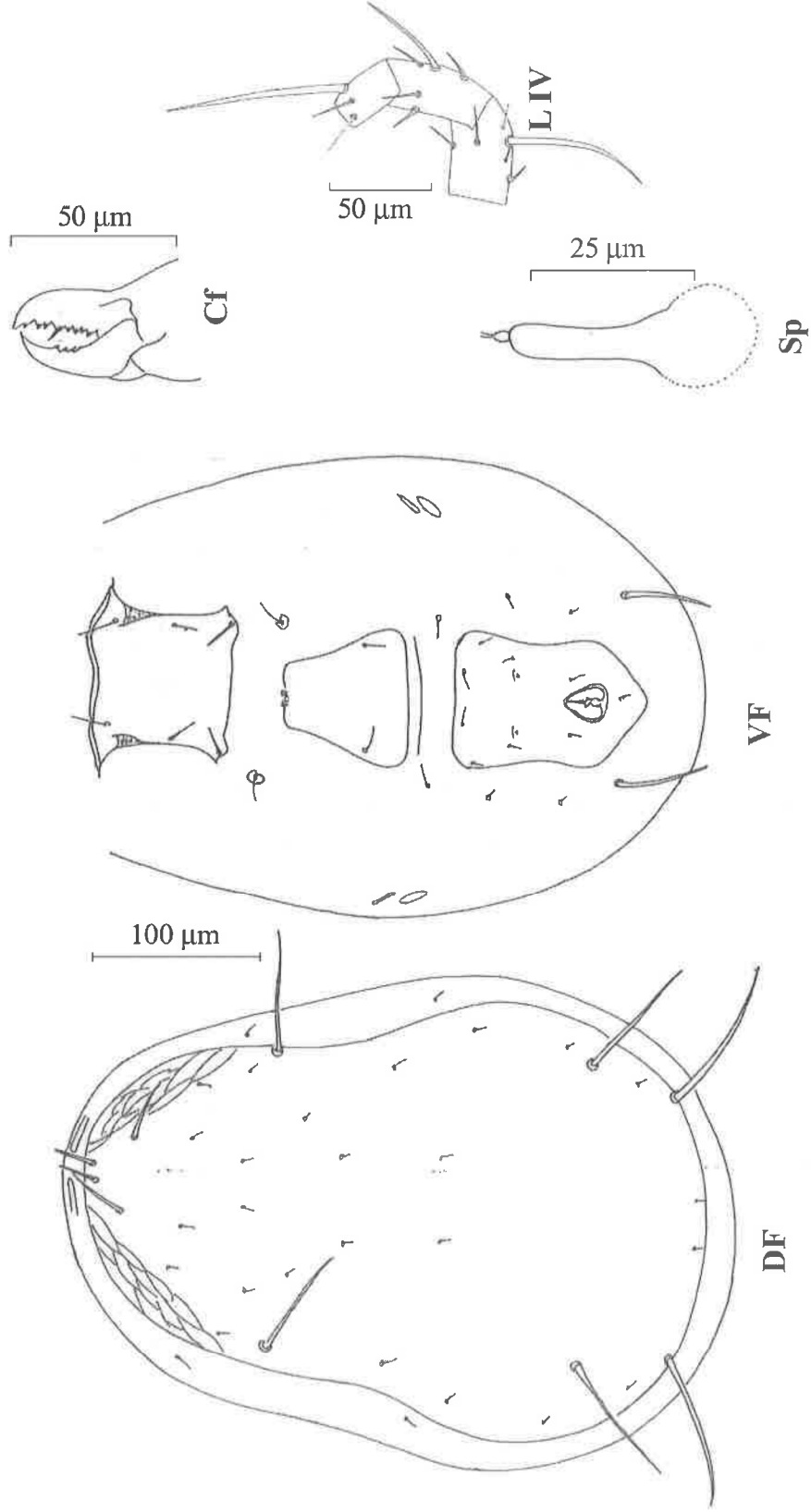
Paraphytoseius bhadrakaliensis (Gupta), 1969

PLATE 36



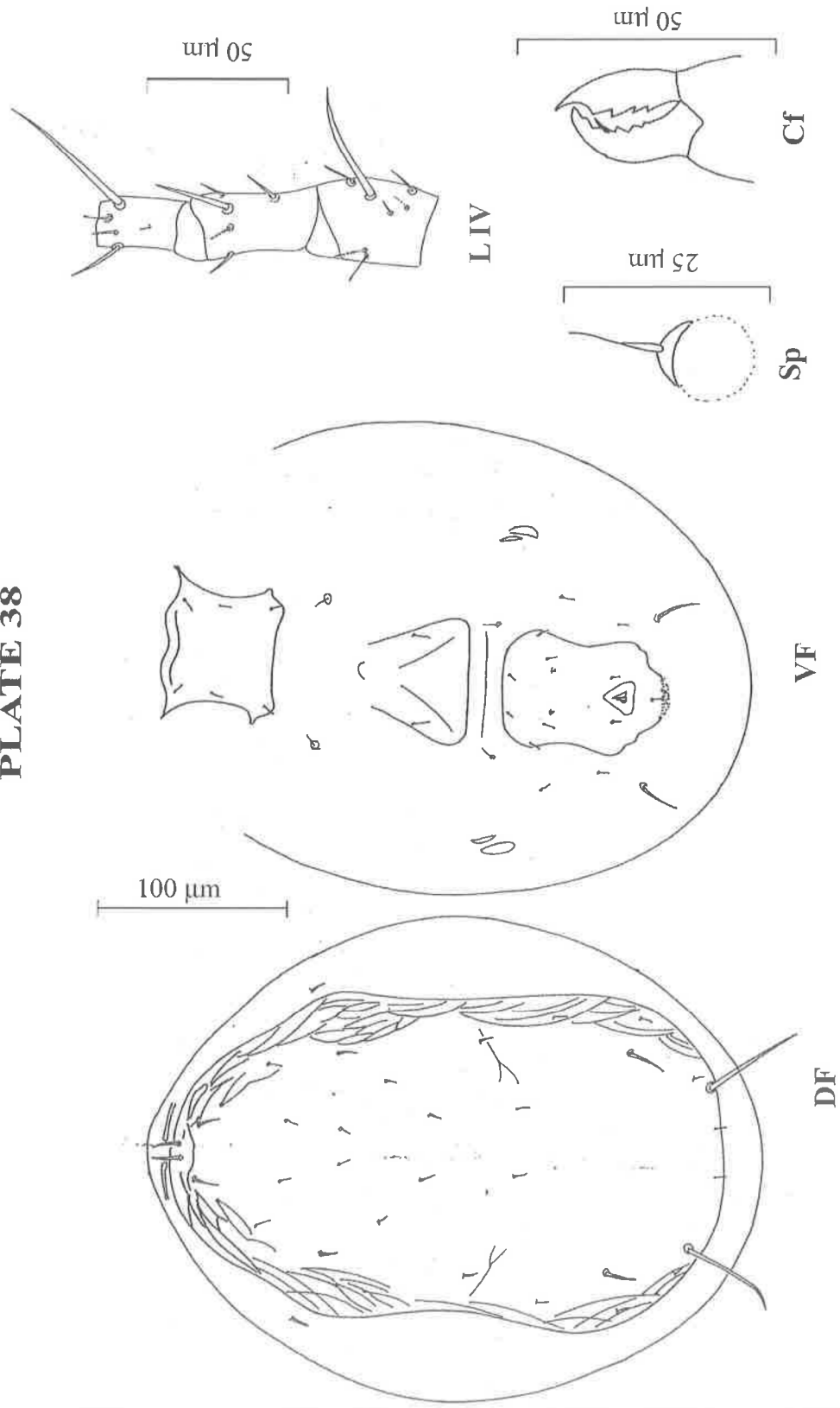
Paraphytoseius orientalis Narayanan *et al.*, 1960.

PLATE 37



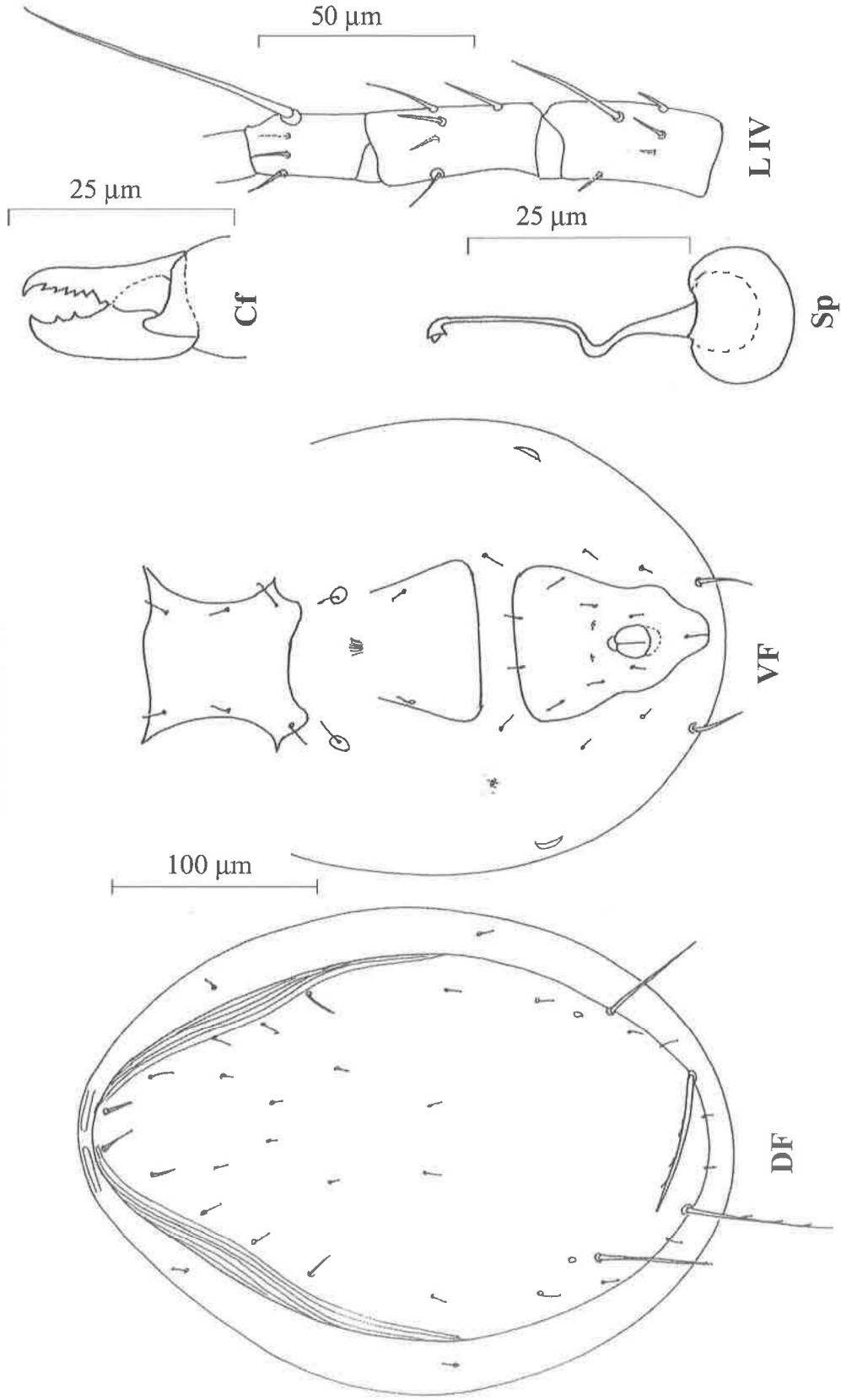
Typhlodromips mathai sp. nov.

PLATE 38



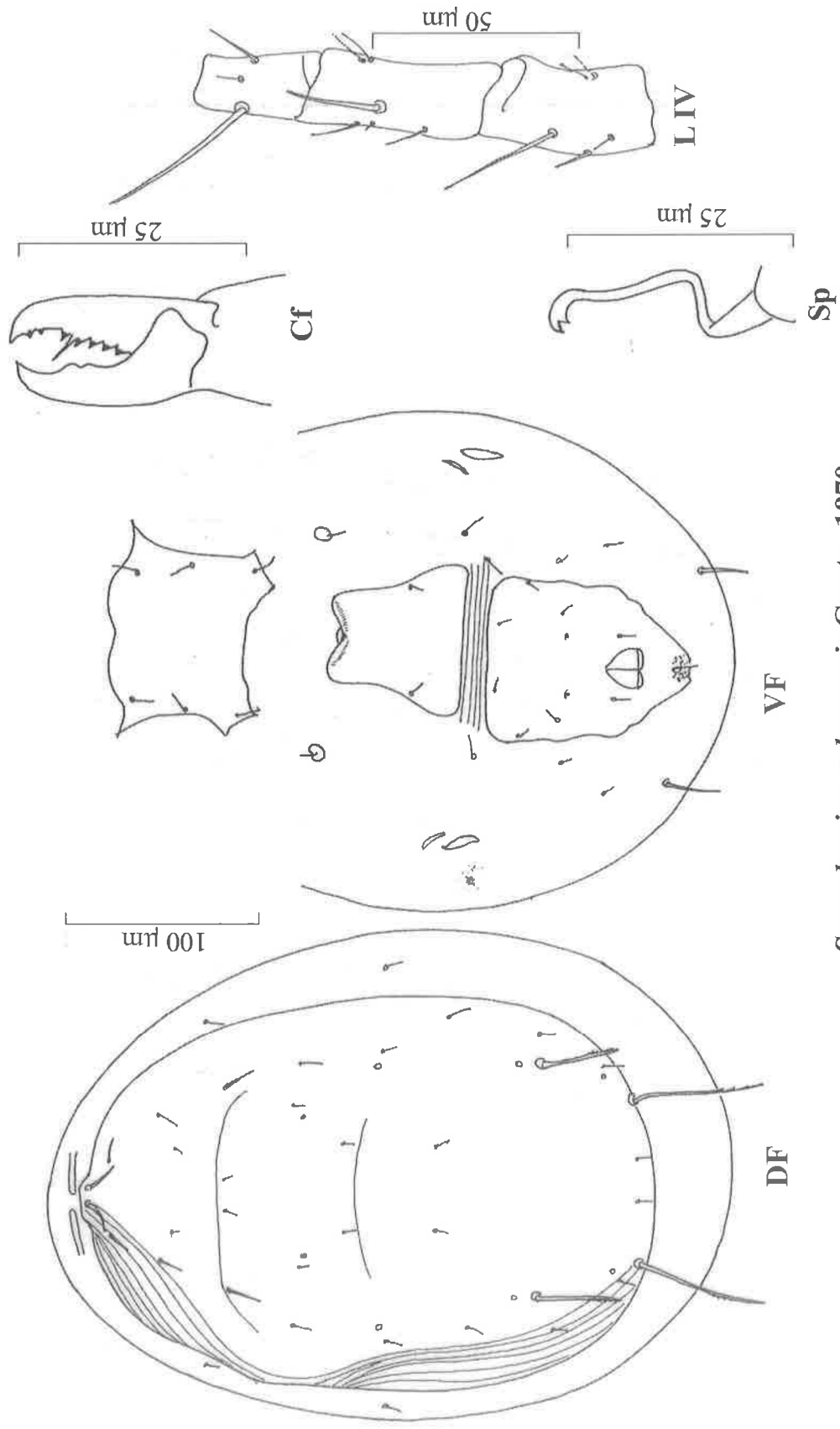
Typhlodromips syzygii Gupta, 1975

PLATE 39



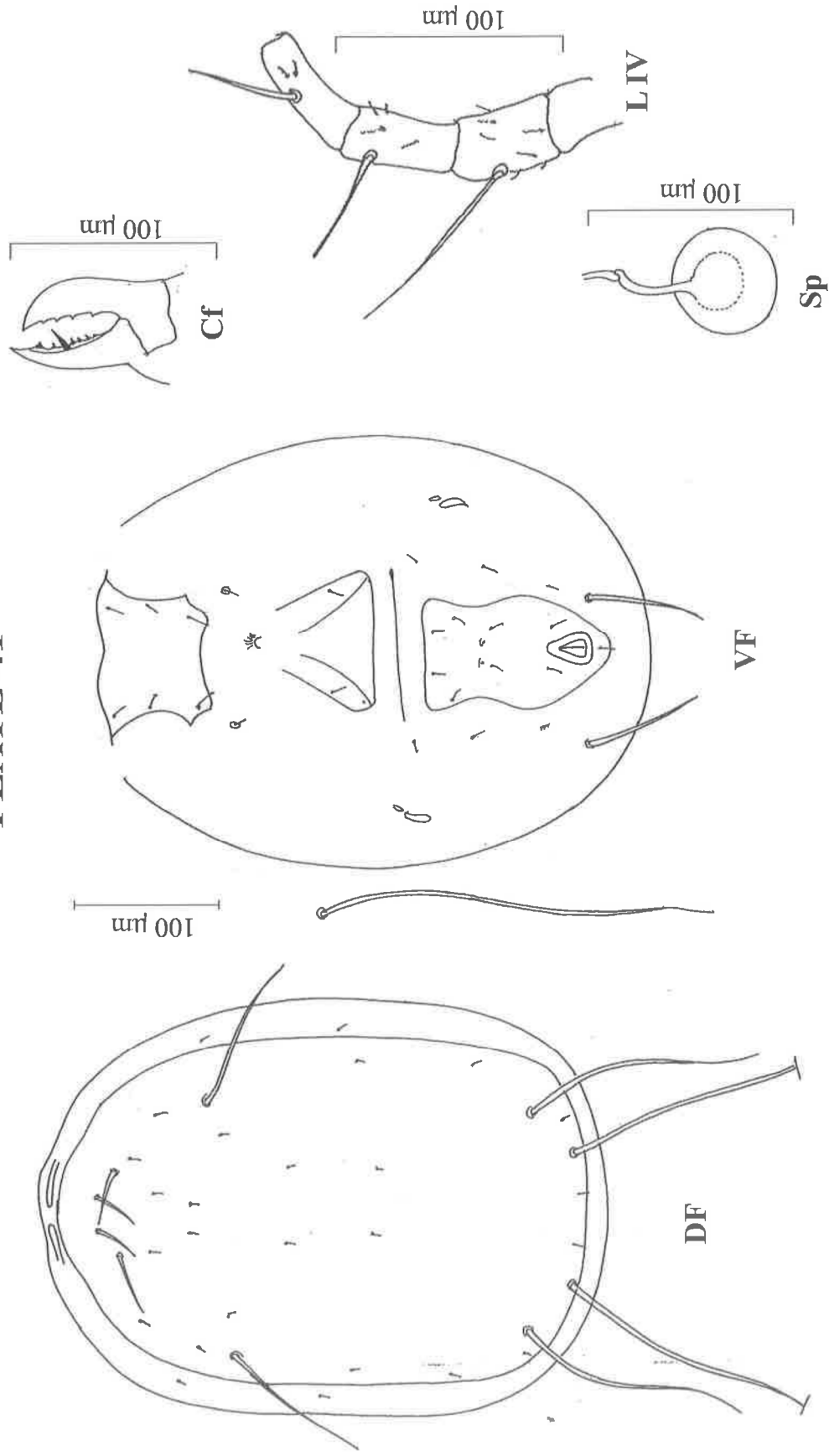
Scapulaseius mohanasundarami sp. nov.

PLATE 40



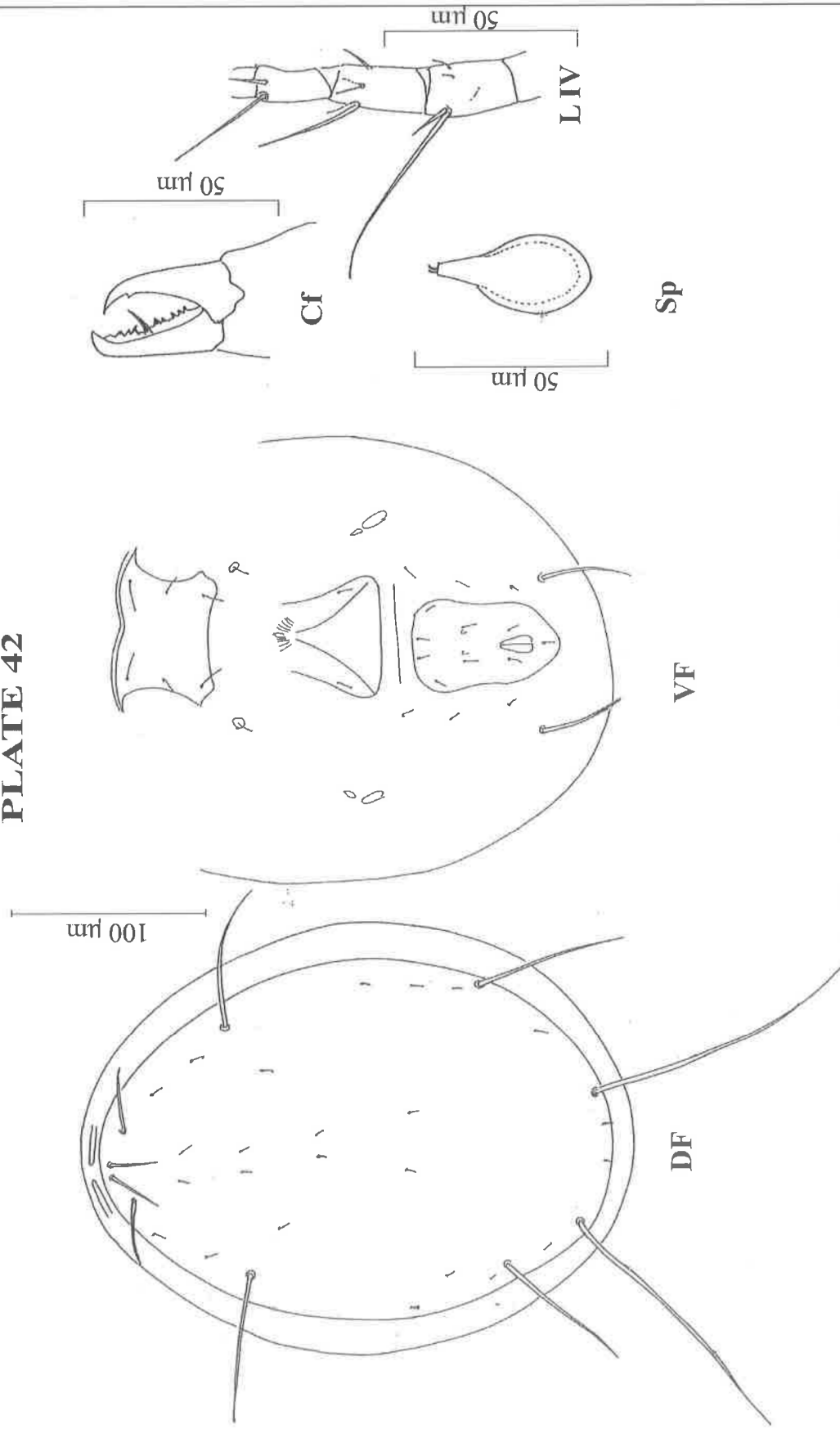
Scapulaseius suknaensis Gupta, 1970

PLATE 41



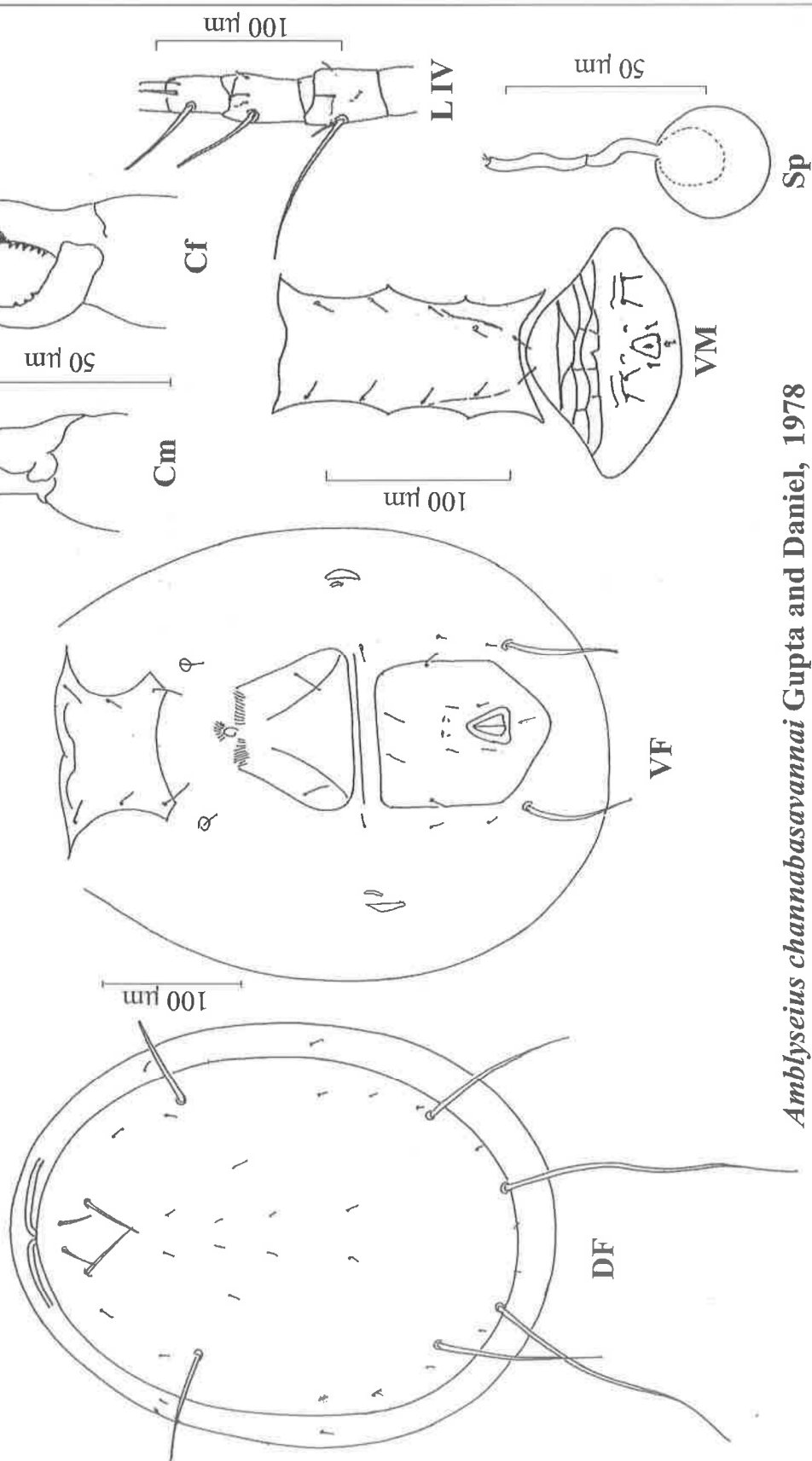
Amblyseius aerialis (Muma), 1955

PLATE 42



Amblyseius cucurbitae Rather, 1985

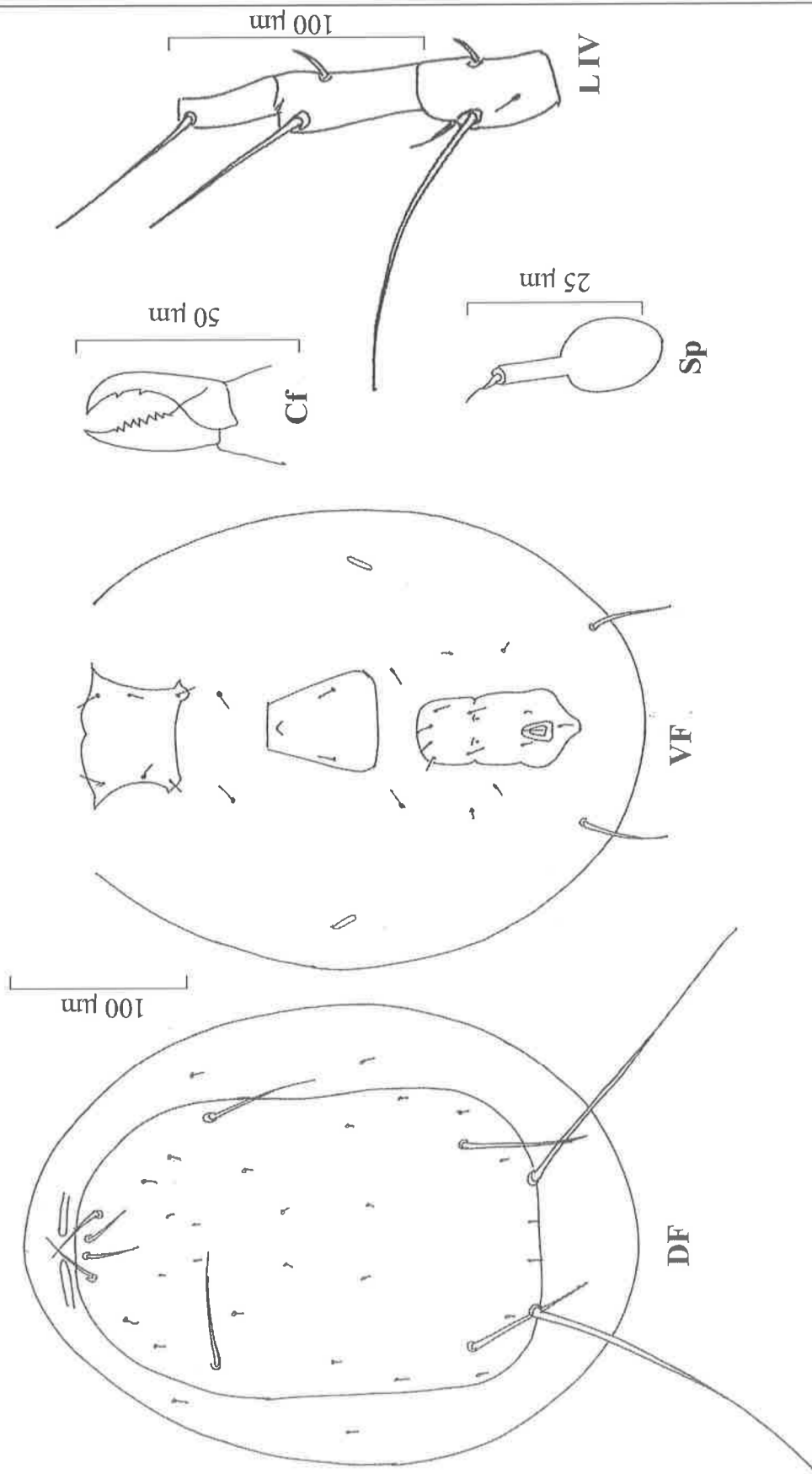
PLATE 43



Amblyseius channabasavannai Gupta and Daniel, 1978

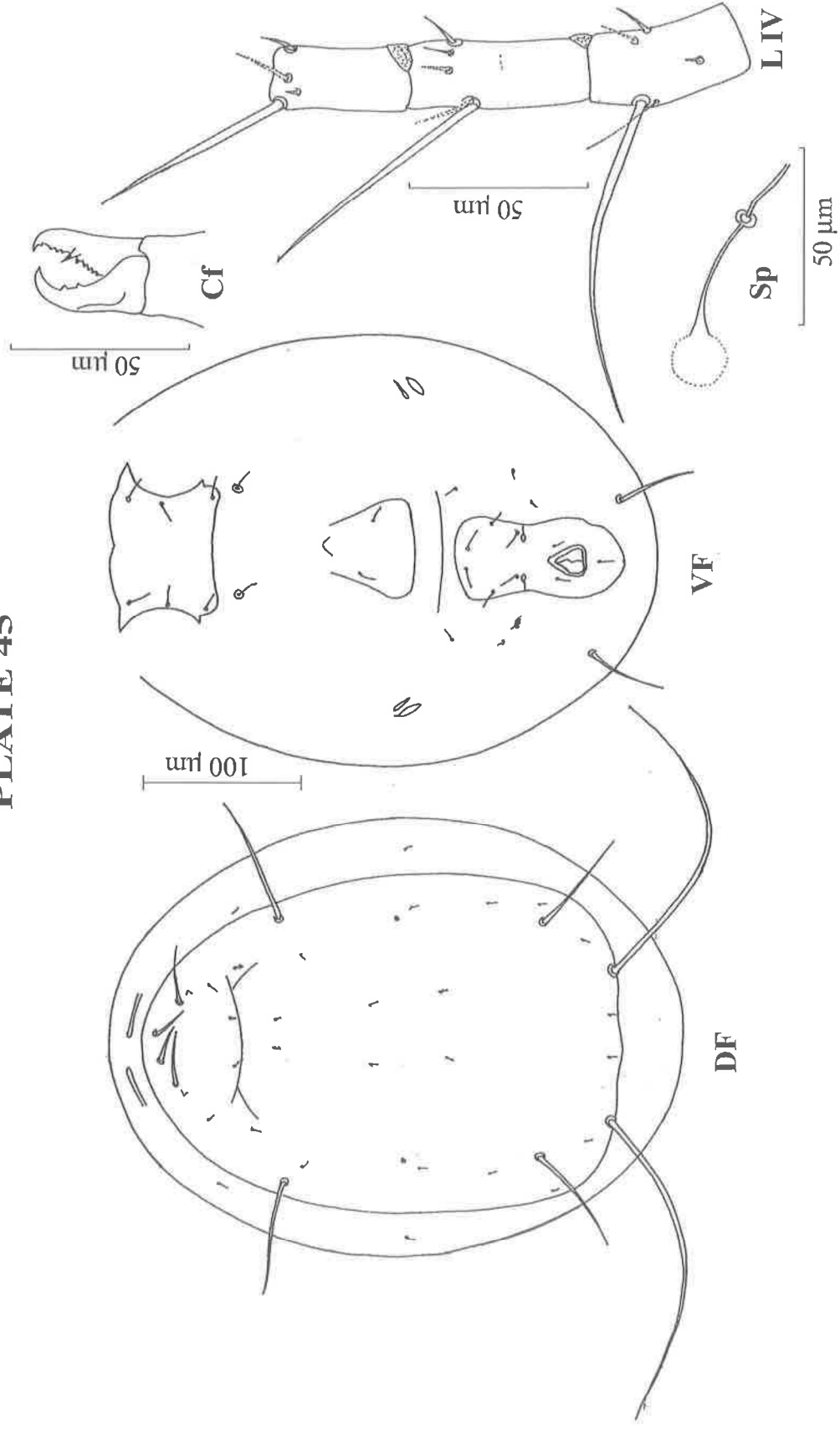
Sp

PLATE 44



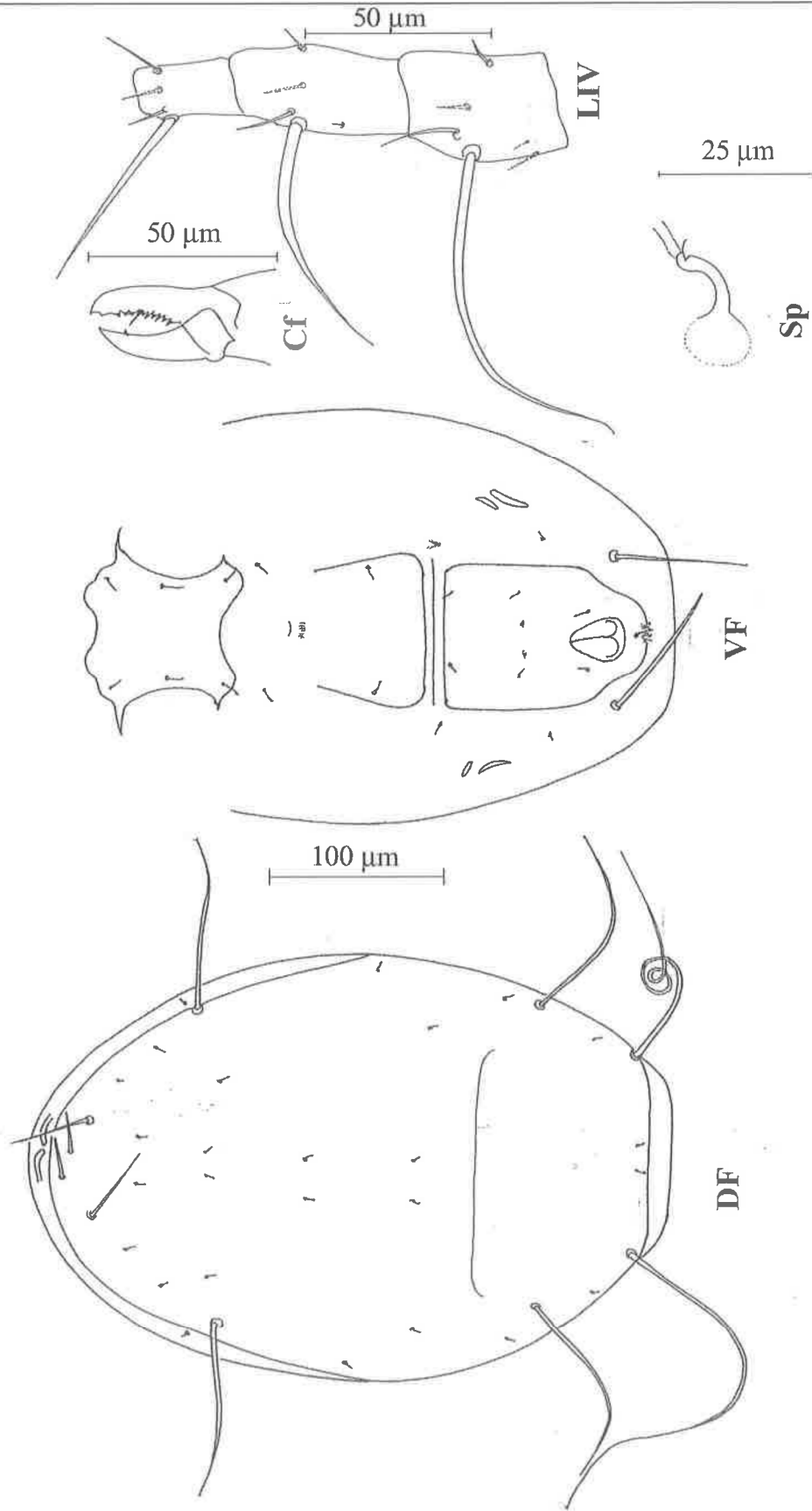
Amblyseius devakiae sp. nov.

PLATE 45



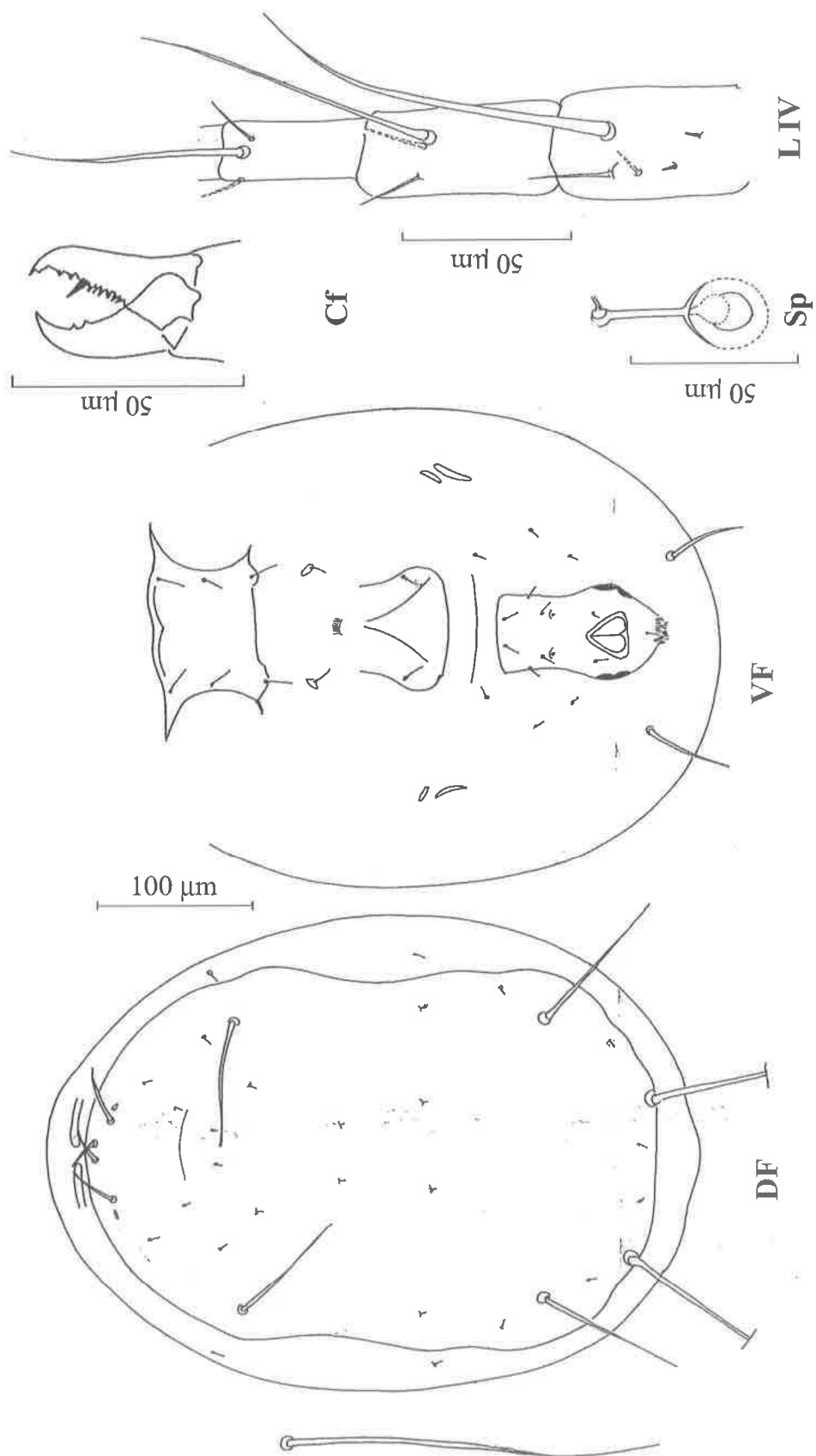
Amblyseius kadalundiensis sp. nov

PLATE 46



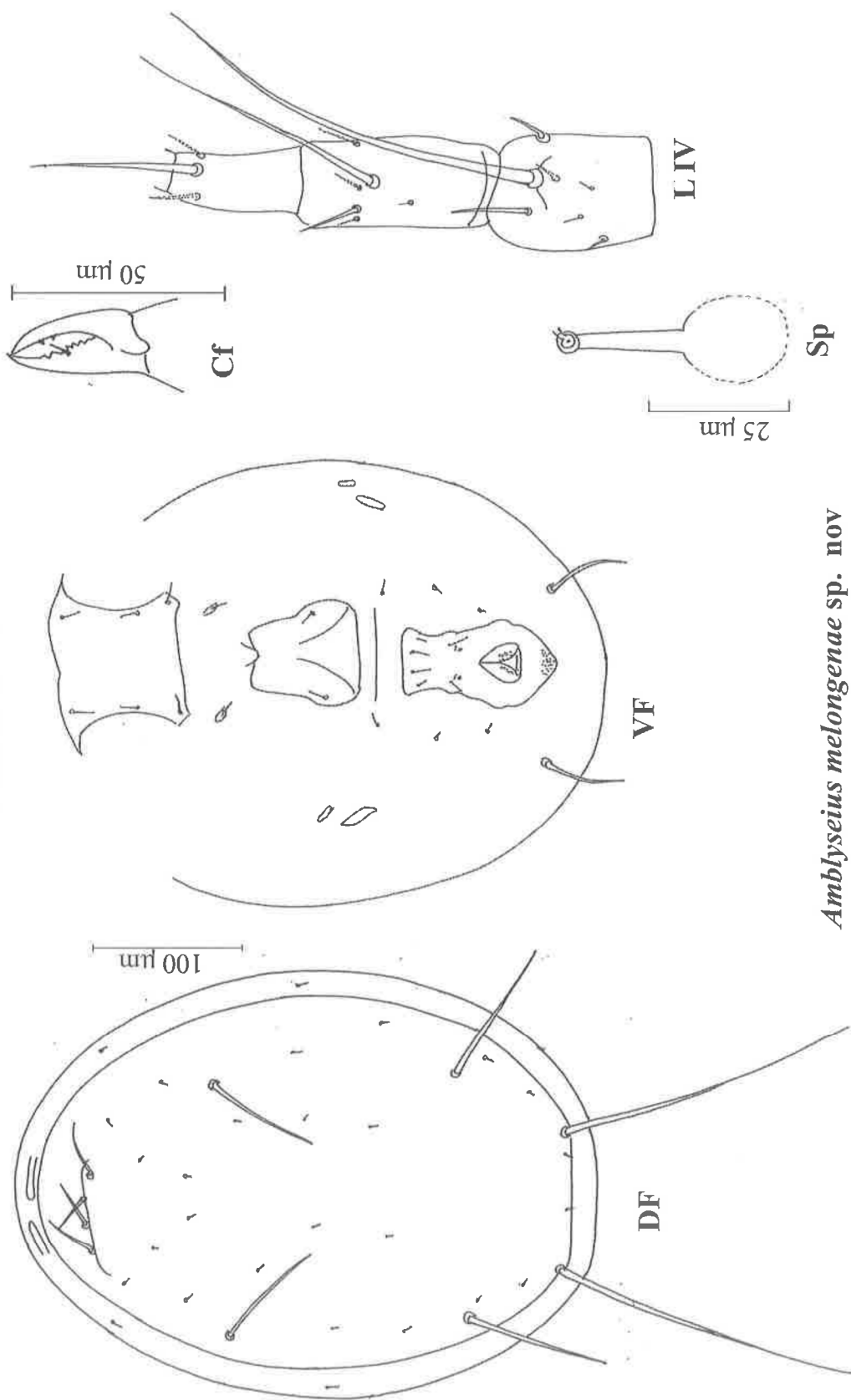
Amblyseius kavumvattamsis sp. nov.

PLATE 47



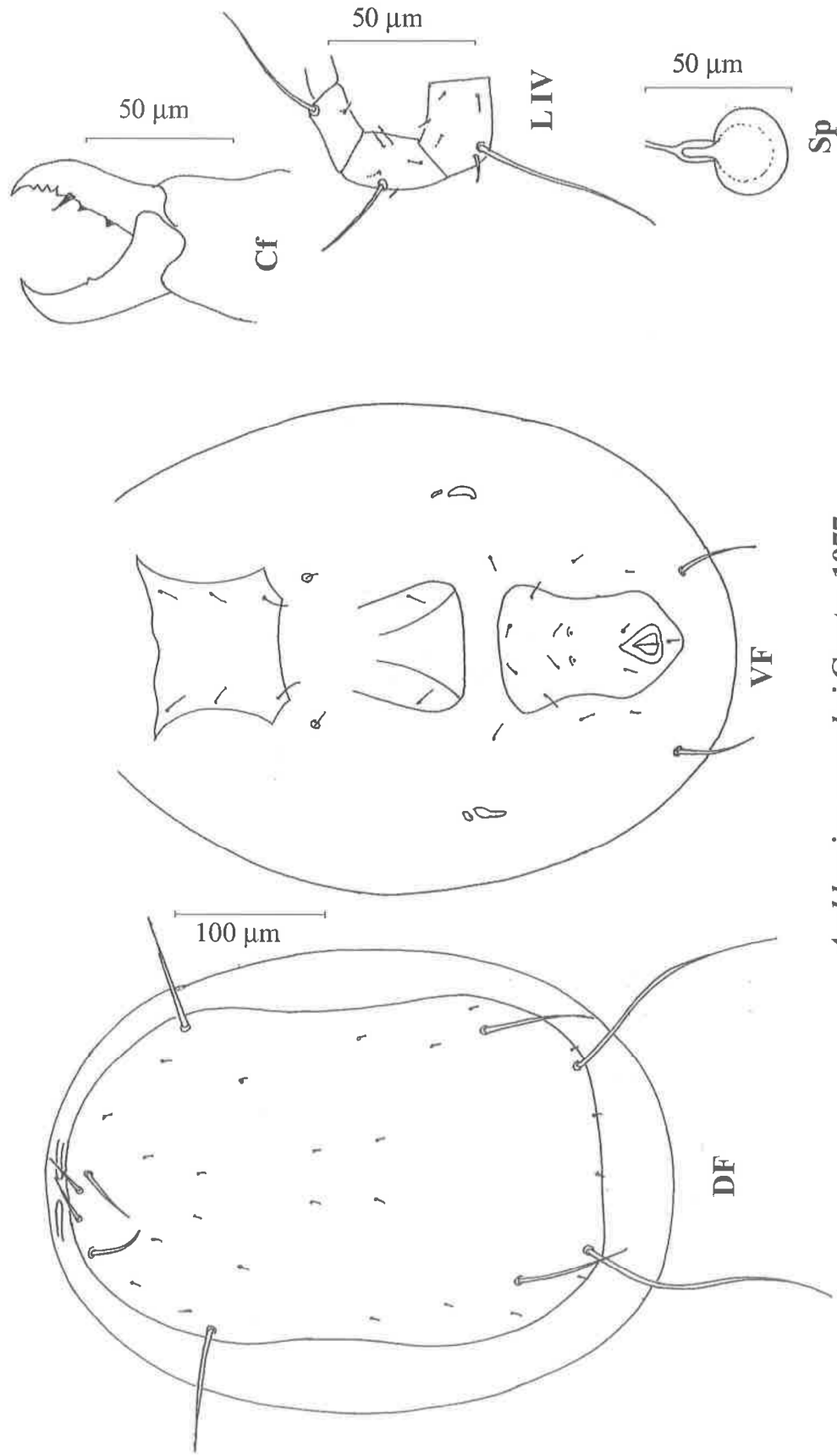
Amblyseius largoensis (Muma), 1955

PLATE 48



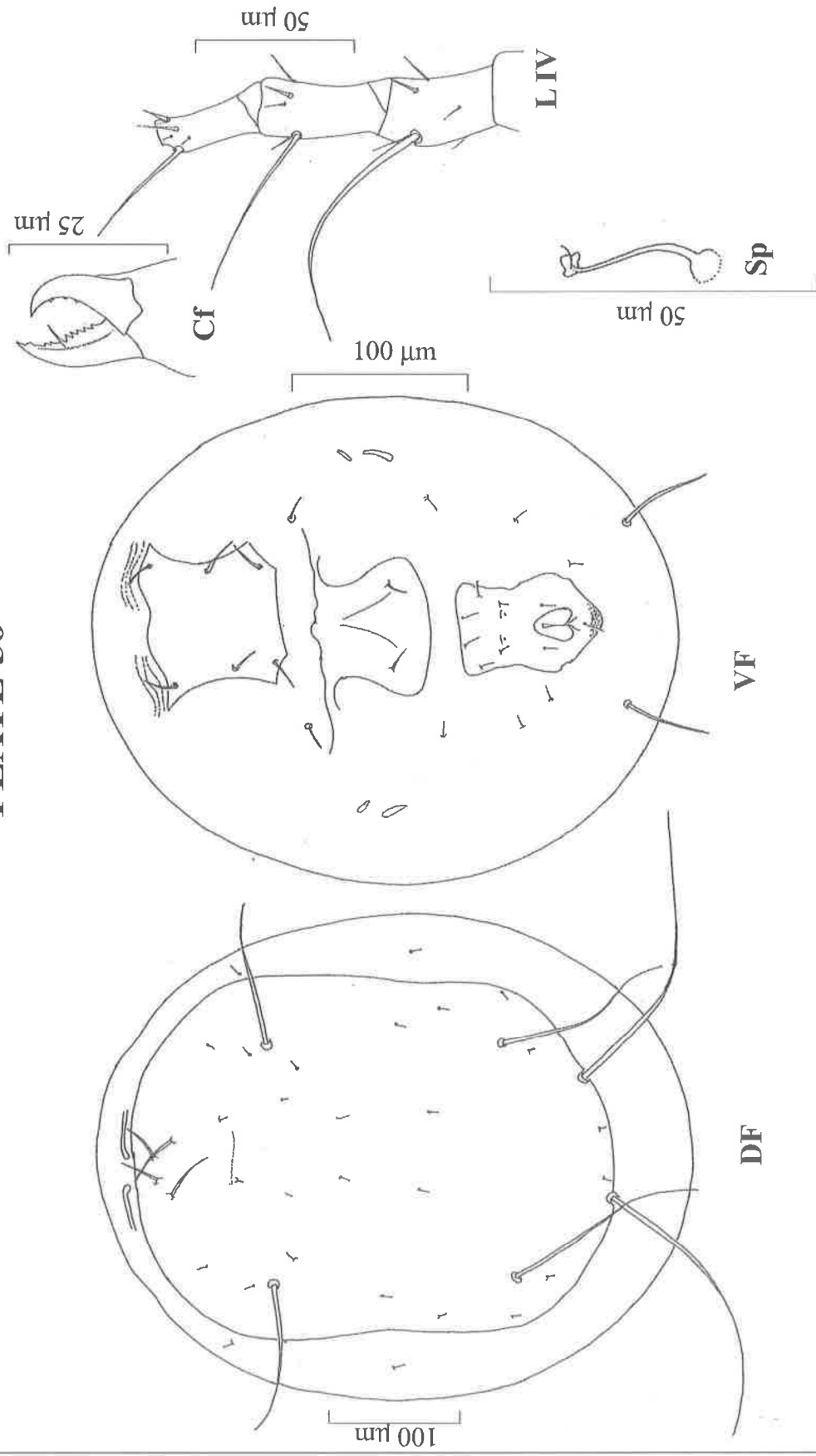
Amblyseius melongenae sp. nov

PLATE 49



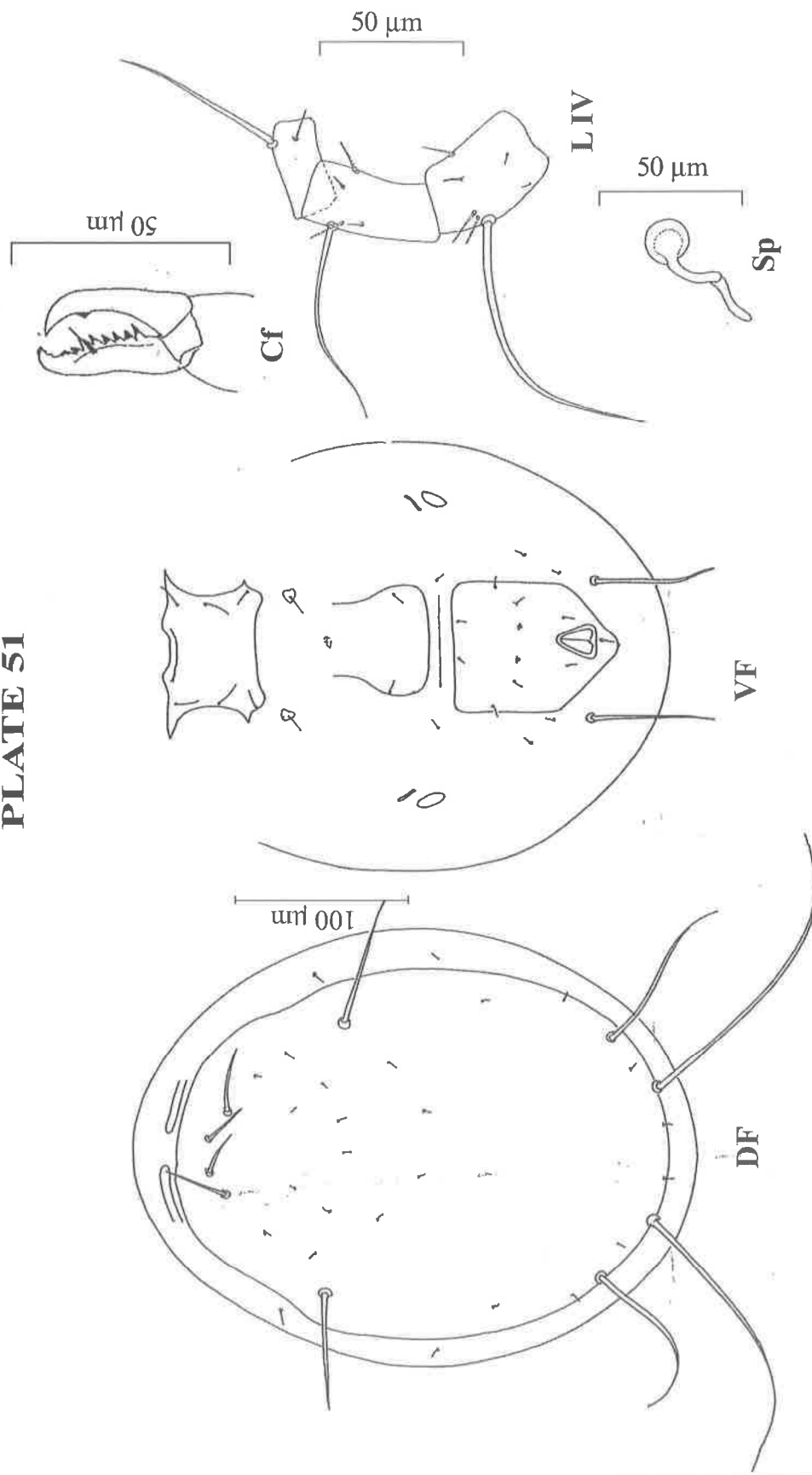
Amblyseius neorykei Gupta, 1977

PLATE 50



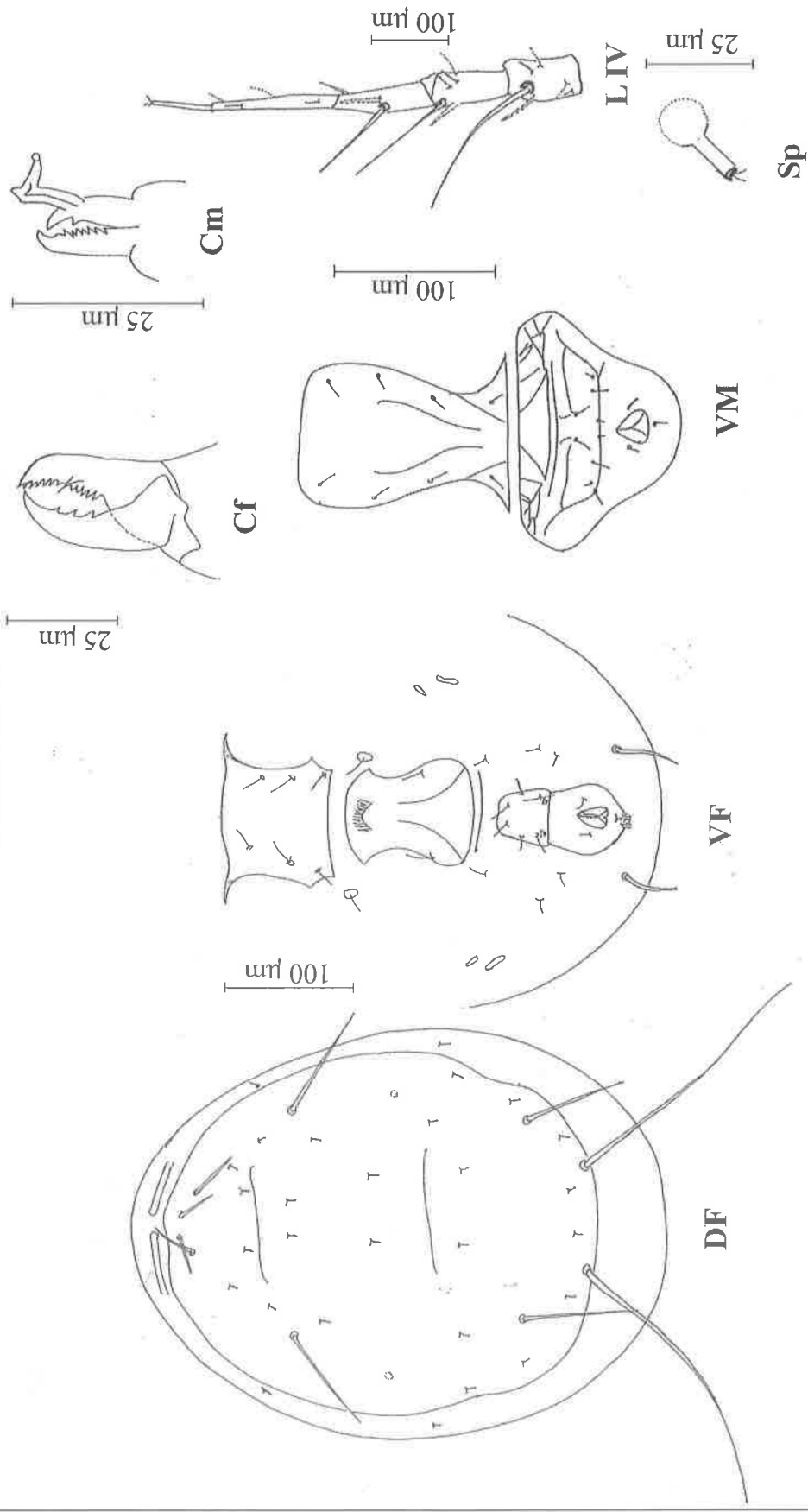
Amblyseius ramaniae sp. nov

PLATE 51



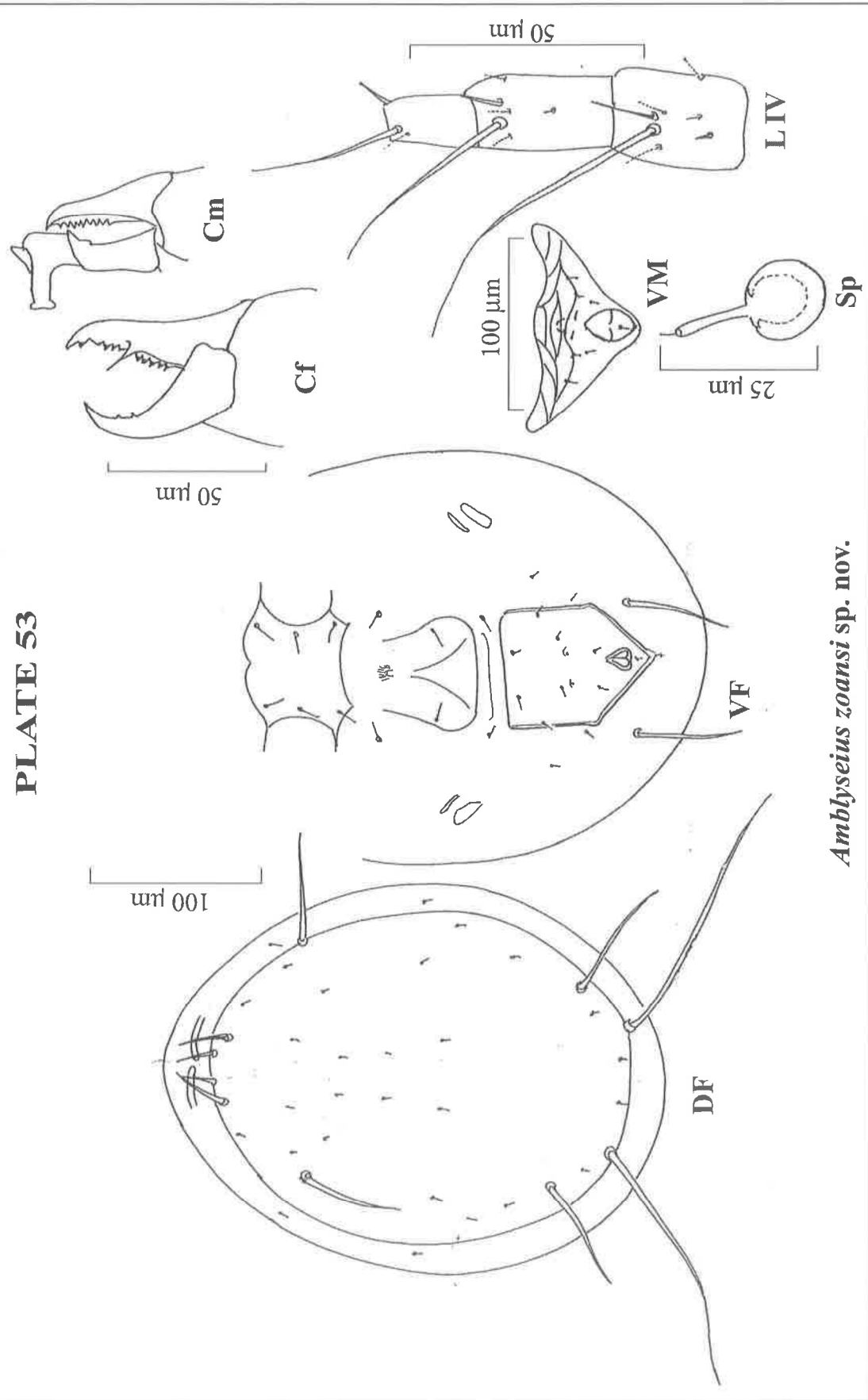
Amblyseius thejassi sp. nov

PLATE 52



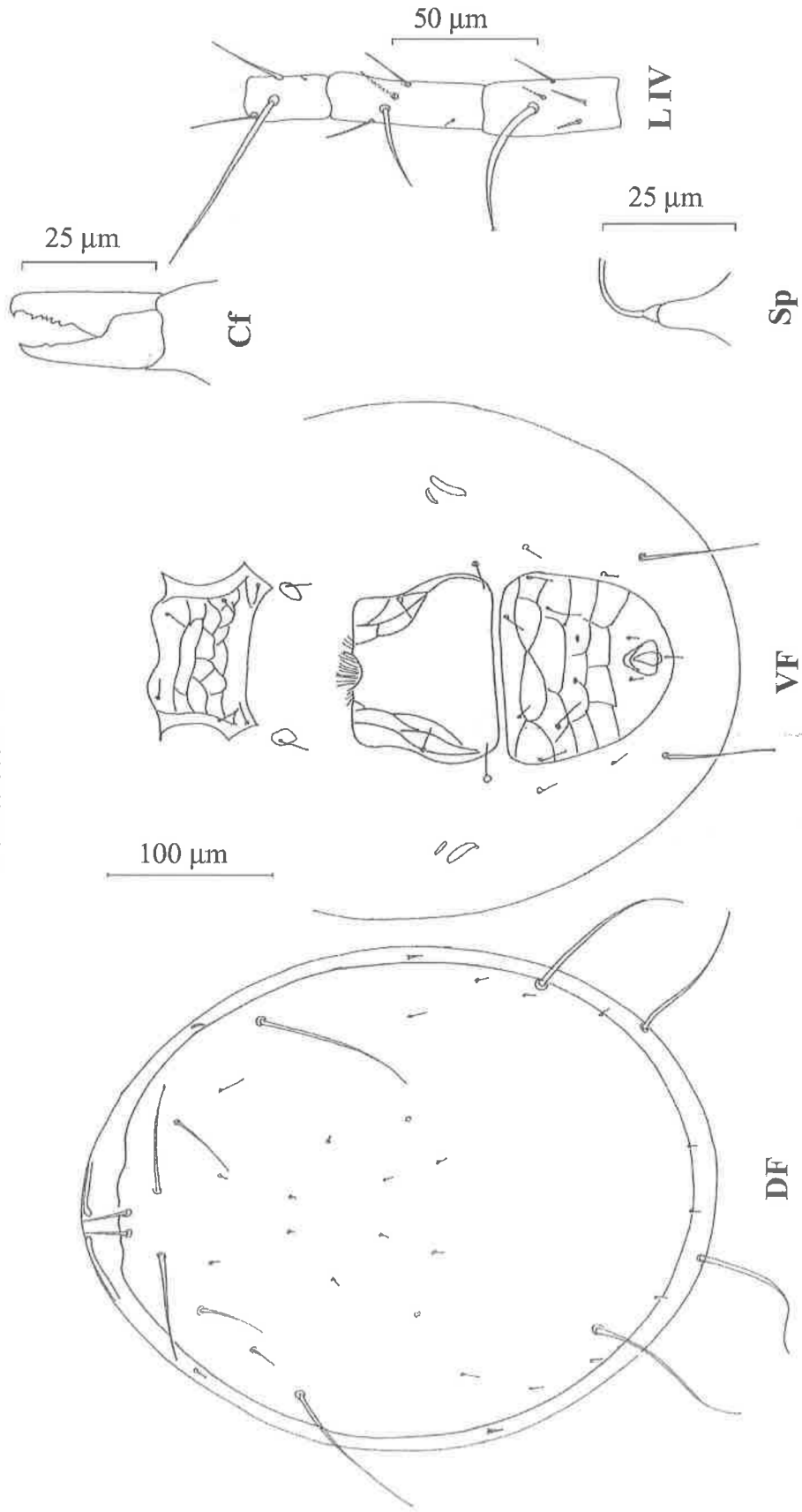
Amblyseius velayudhani Santhosh and Mary Anitha, 2016

PLATE 53



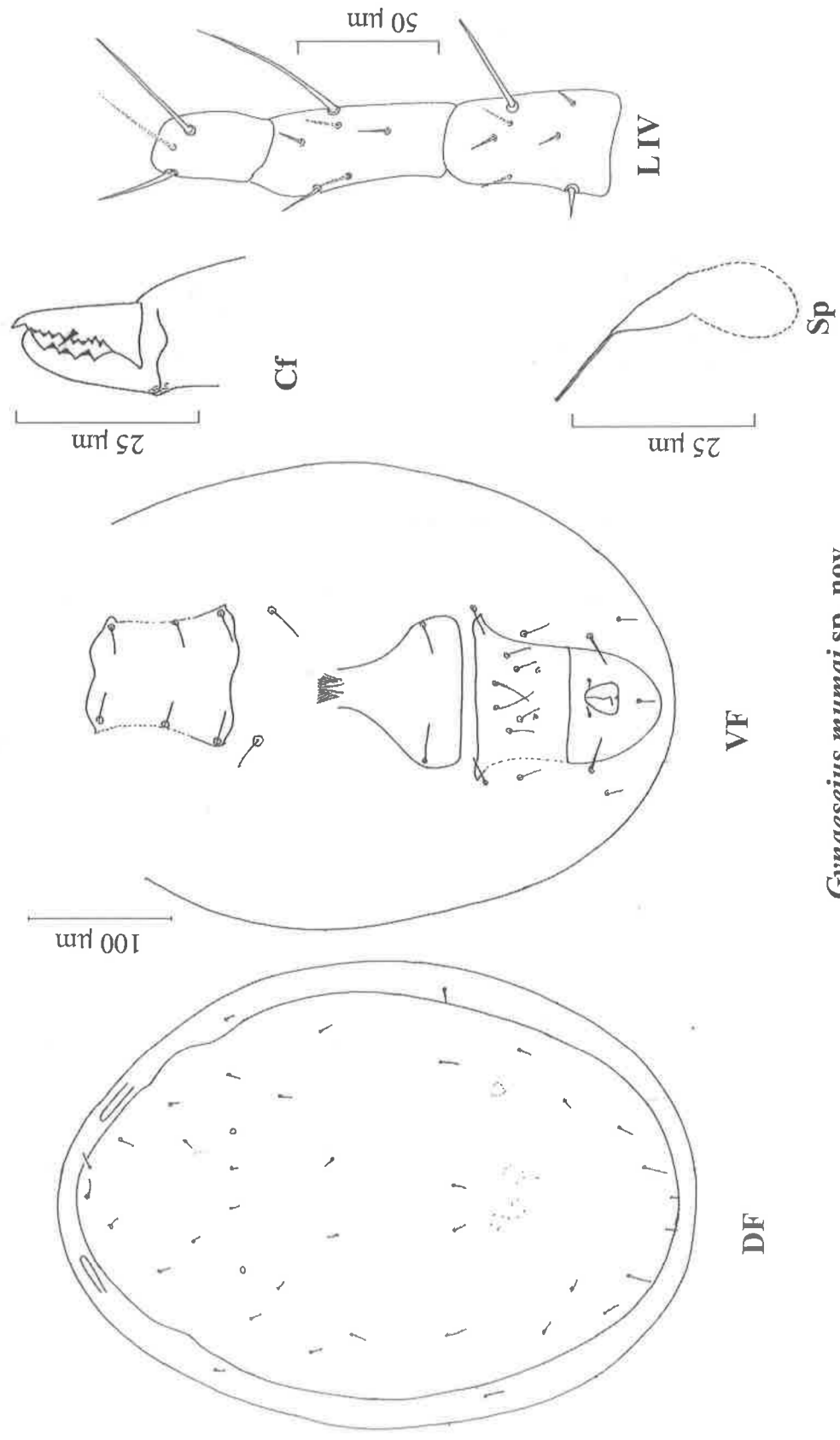
Amblyseius zoansi sp. nov.

PLATE 54



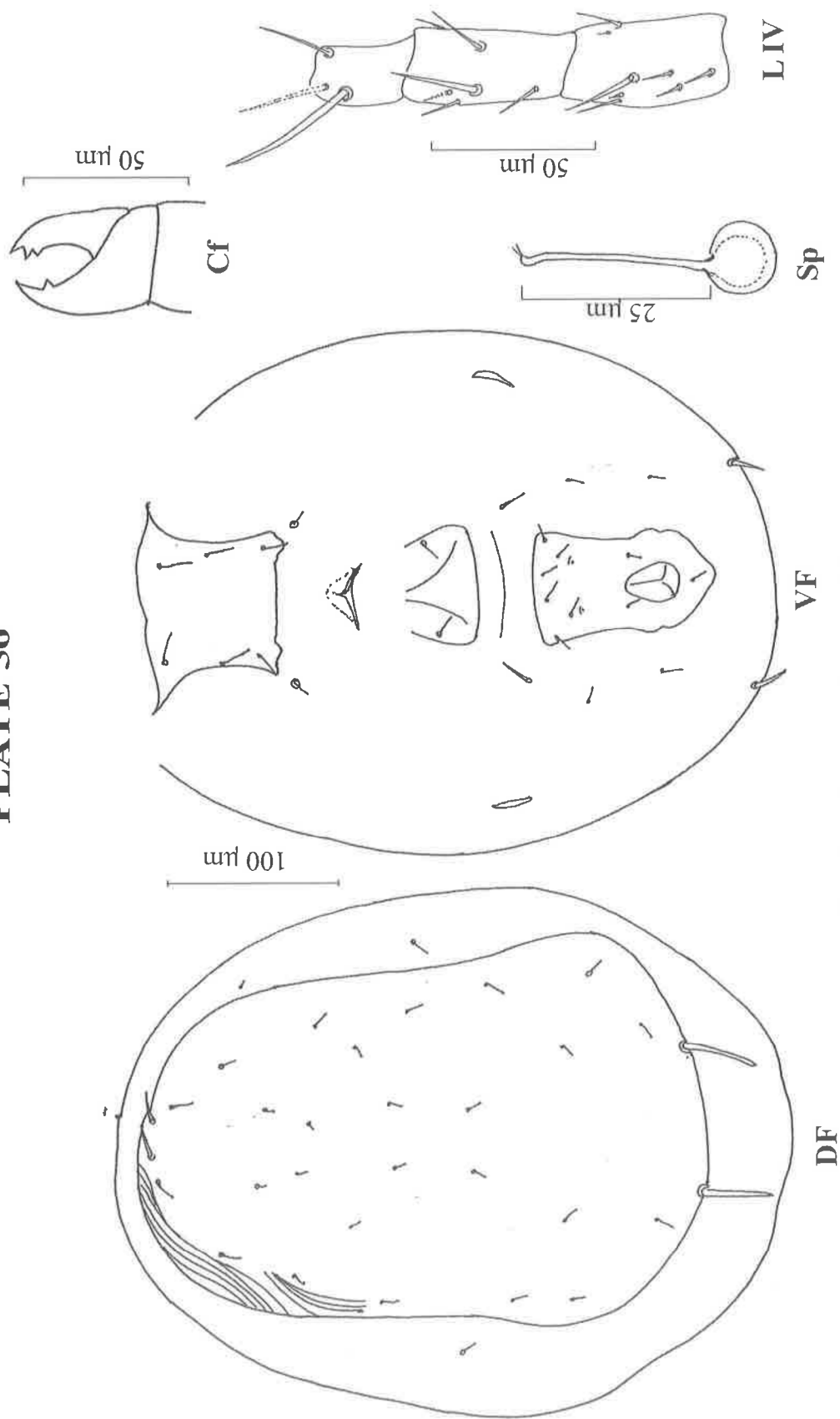
Propriozeiopsis peltatus Van der Merwe, 1968

PLATE 55



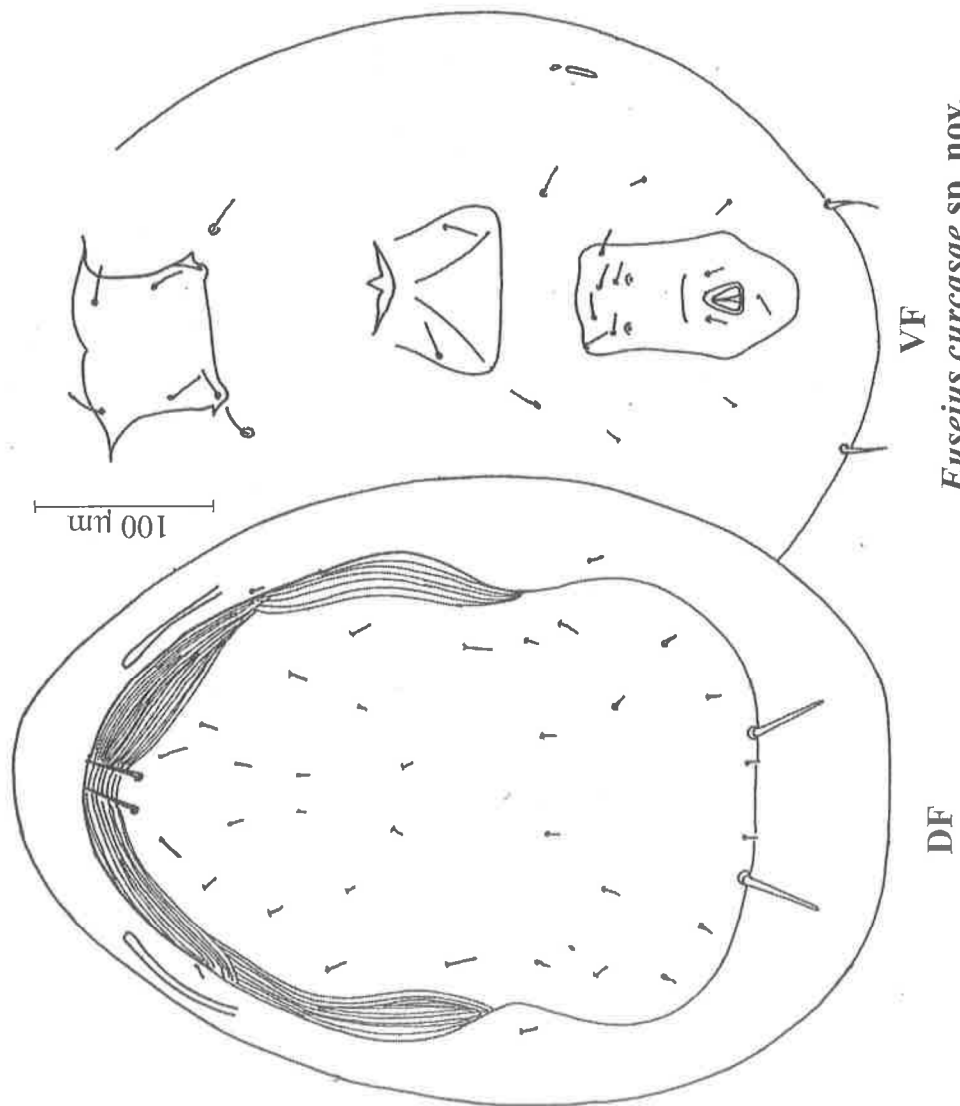
Gynaeseius mumai sp. nov.

PLATE 56



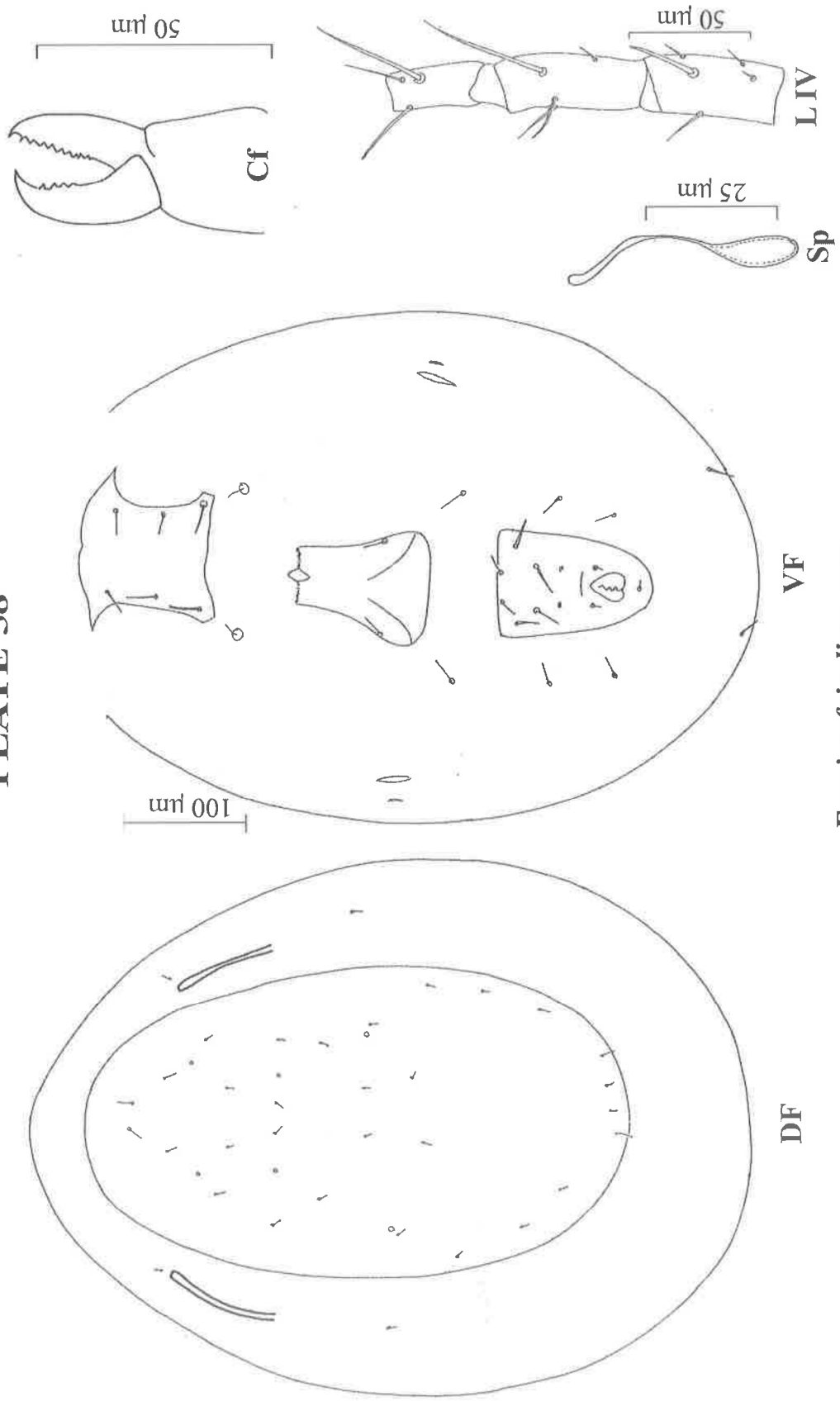
Euseius alstoniae Gupta, 1975

PLATE 57



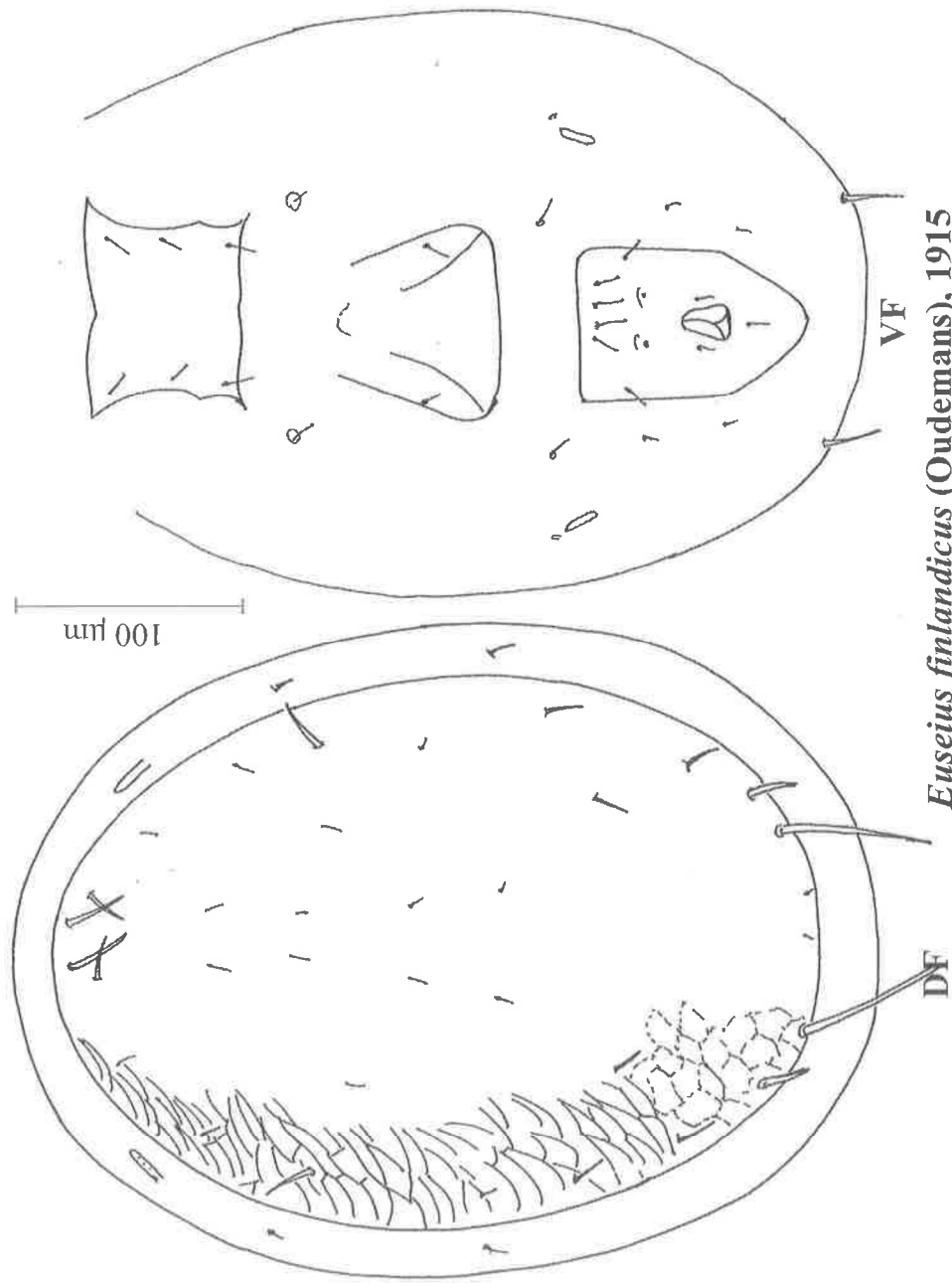
Euseius curcasae sp. nov.

PLATE 58



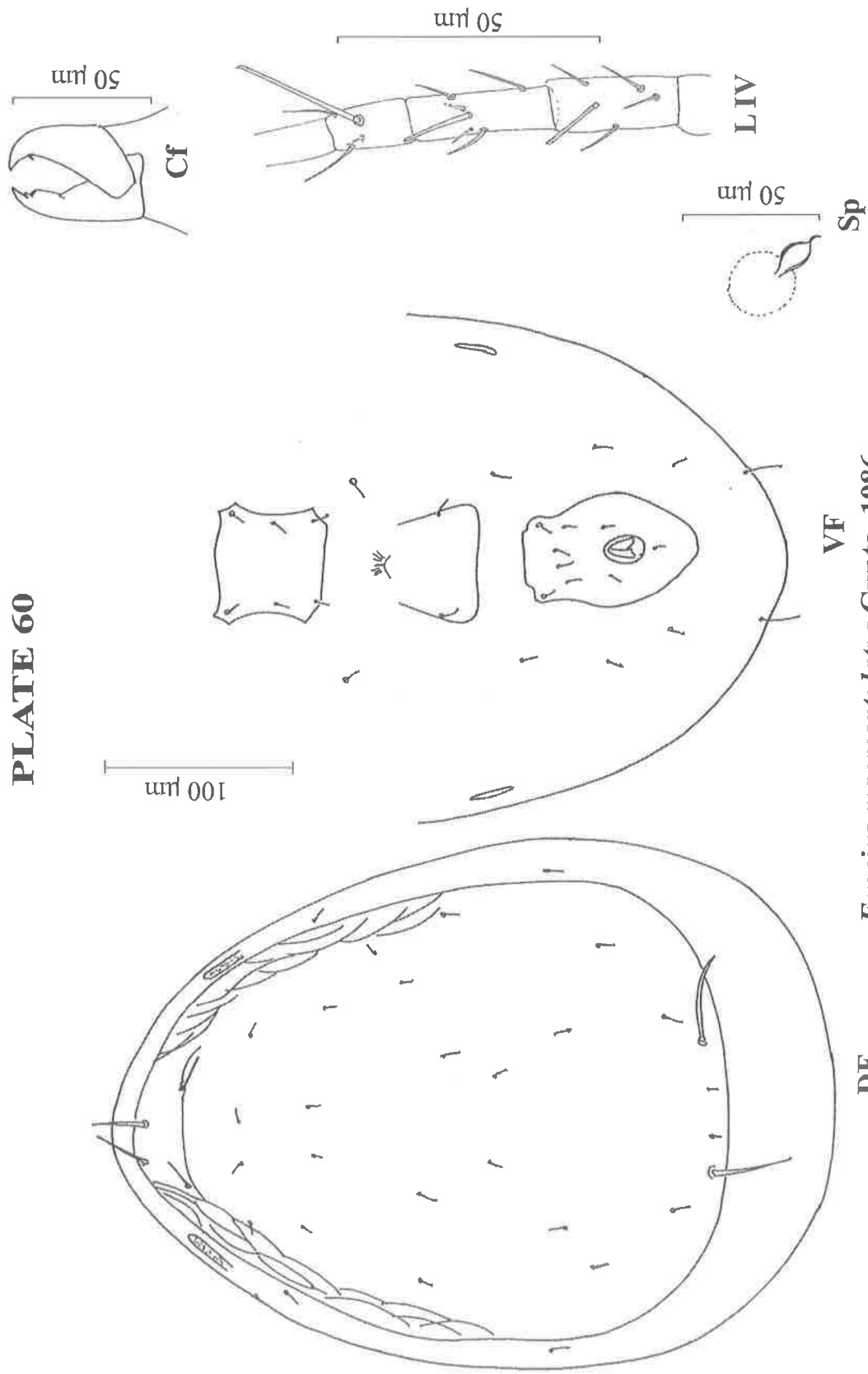
Euseius faisali sp. nov

PLATE 59



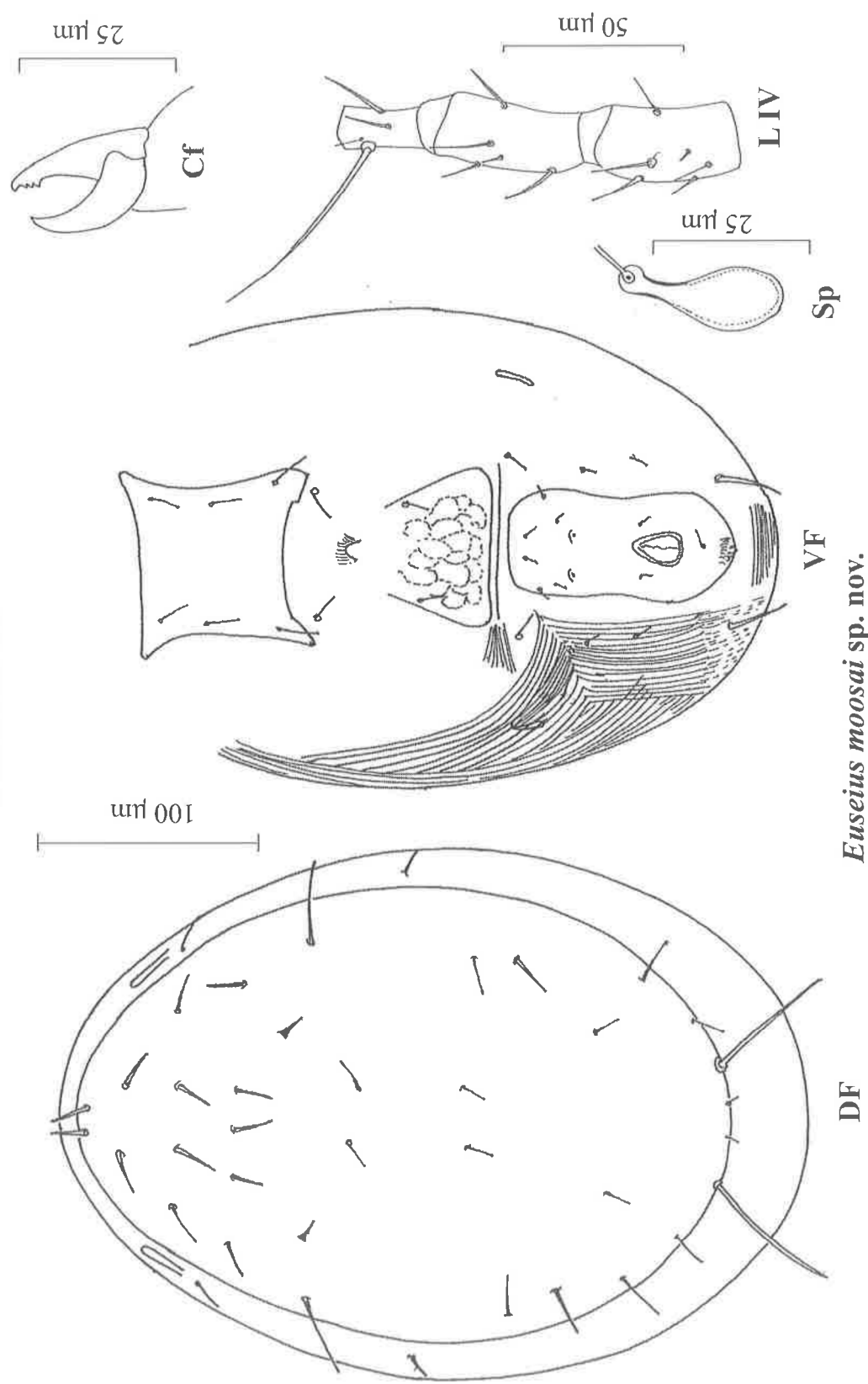
Euseius finlandicus (Oudemans), 1915

PLATE 60



Euseius macrospatulatus Gupta, 1986

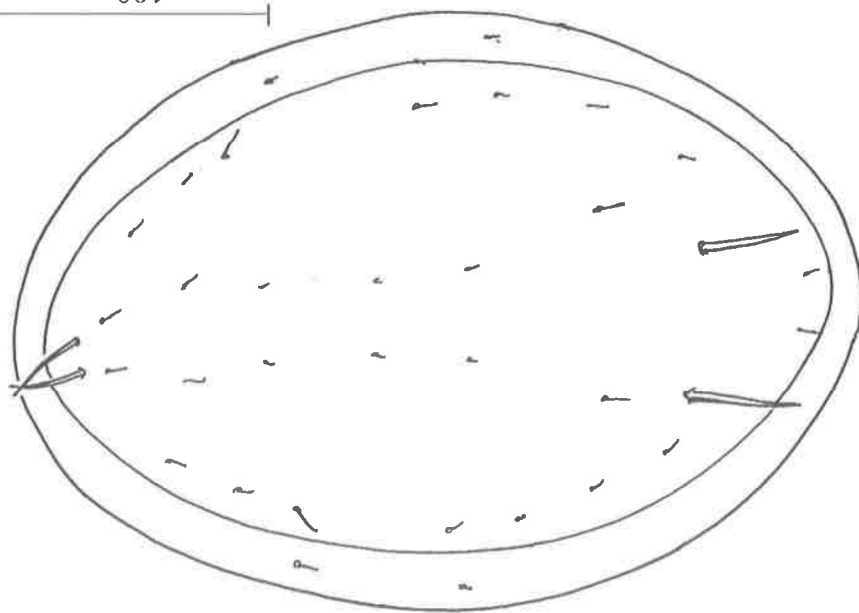
PLATE 61



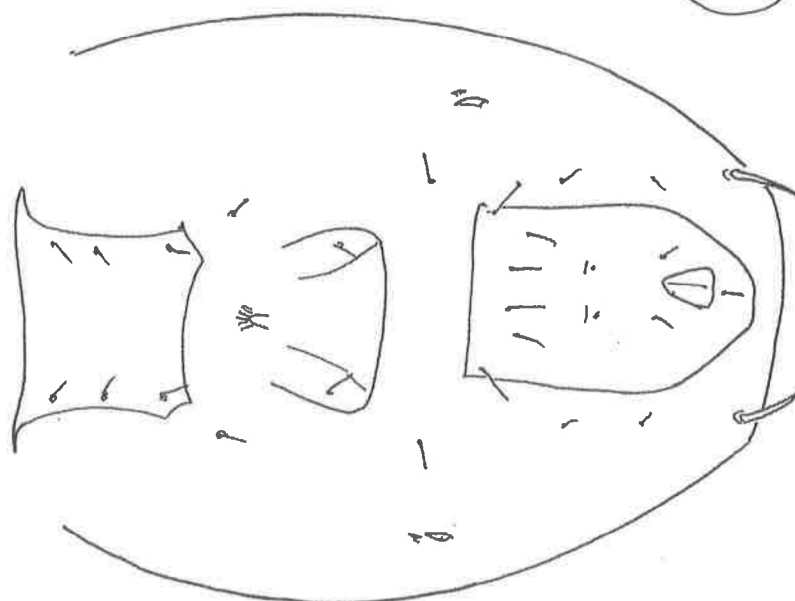
Euseius moosai sp. nov.

PLATE 62

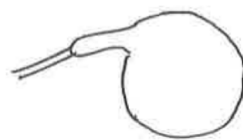
100 μ m



DF

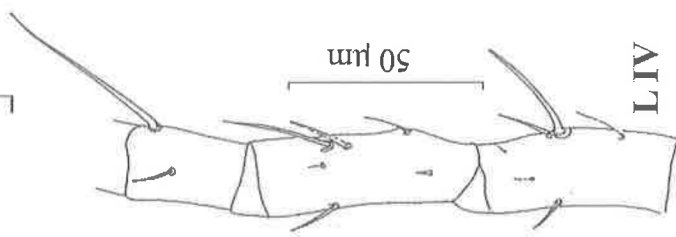


VF



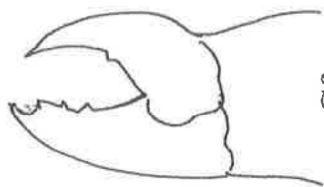
Sp

50 μ m



LIV

50 μ m

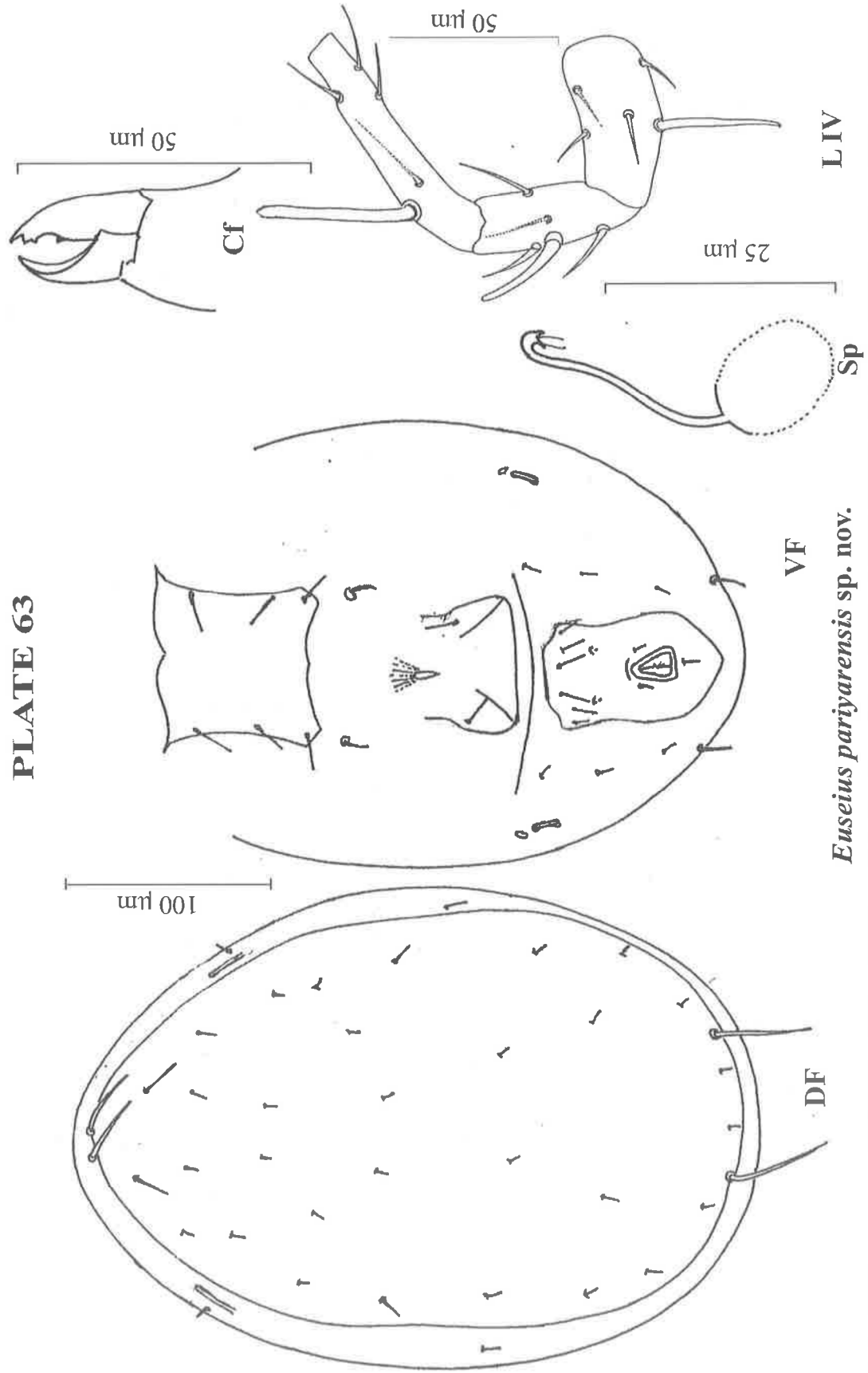


Cf

50 μ m

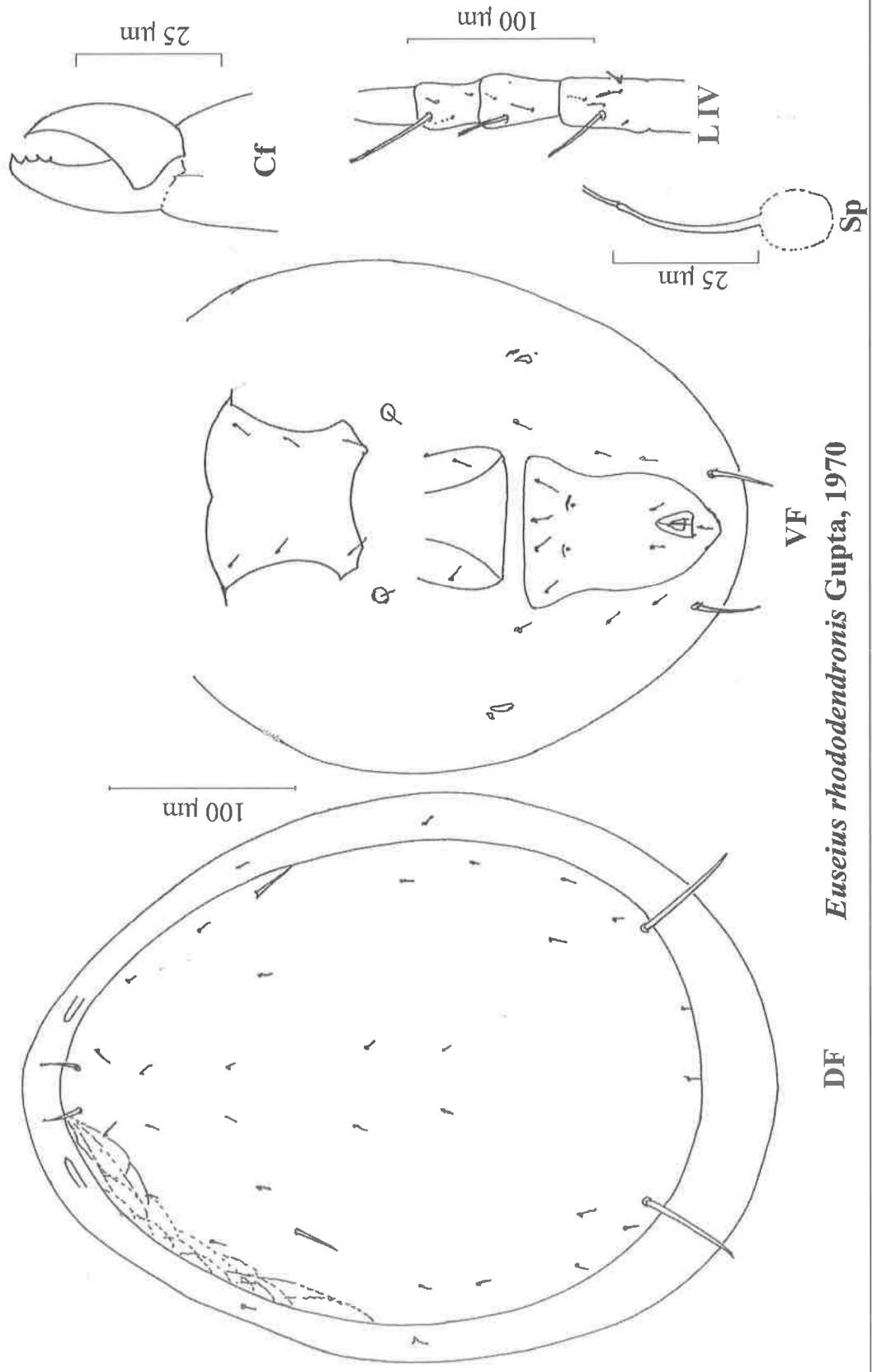
Euseius ovalis (Evans), 1953

PLATE 63



Euseius pariyarensis sp. nov.

PLATE 64



Euseius rhododendronis Gupta, 1970

DF

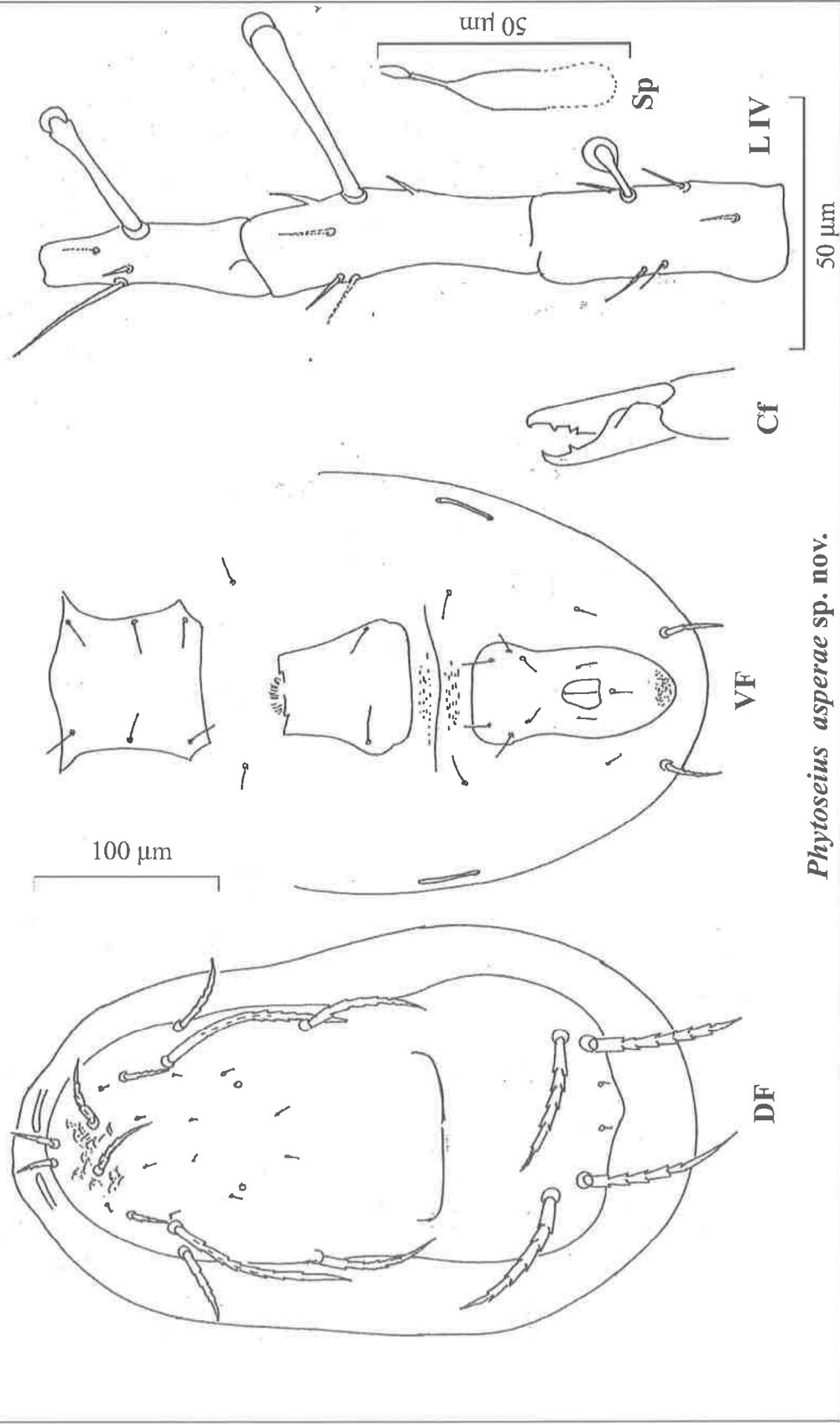
VF

LIV

Sp

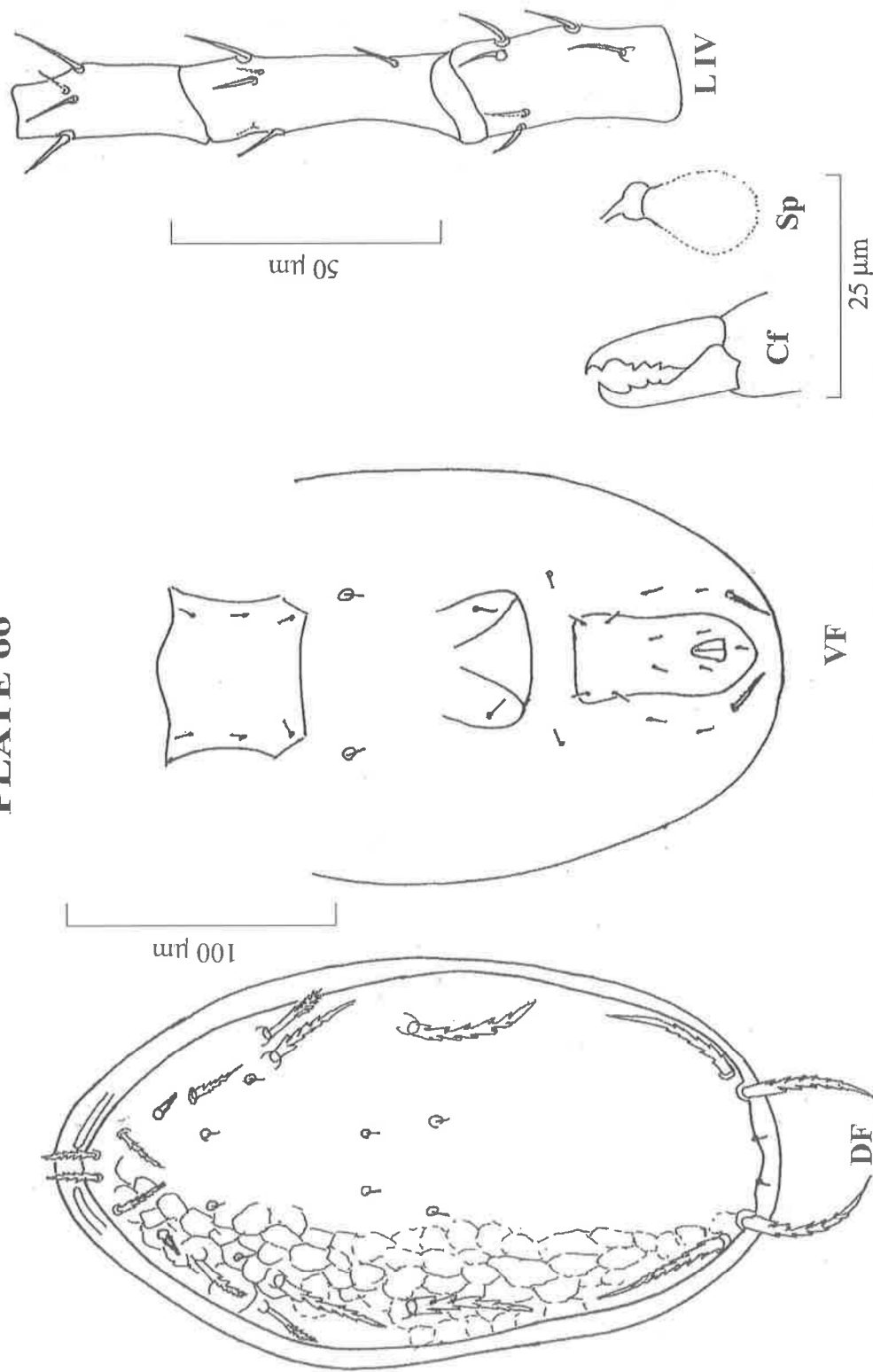
Cf

PLATE 65



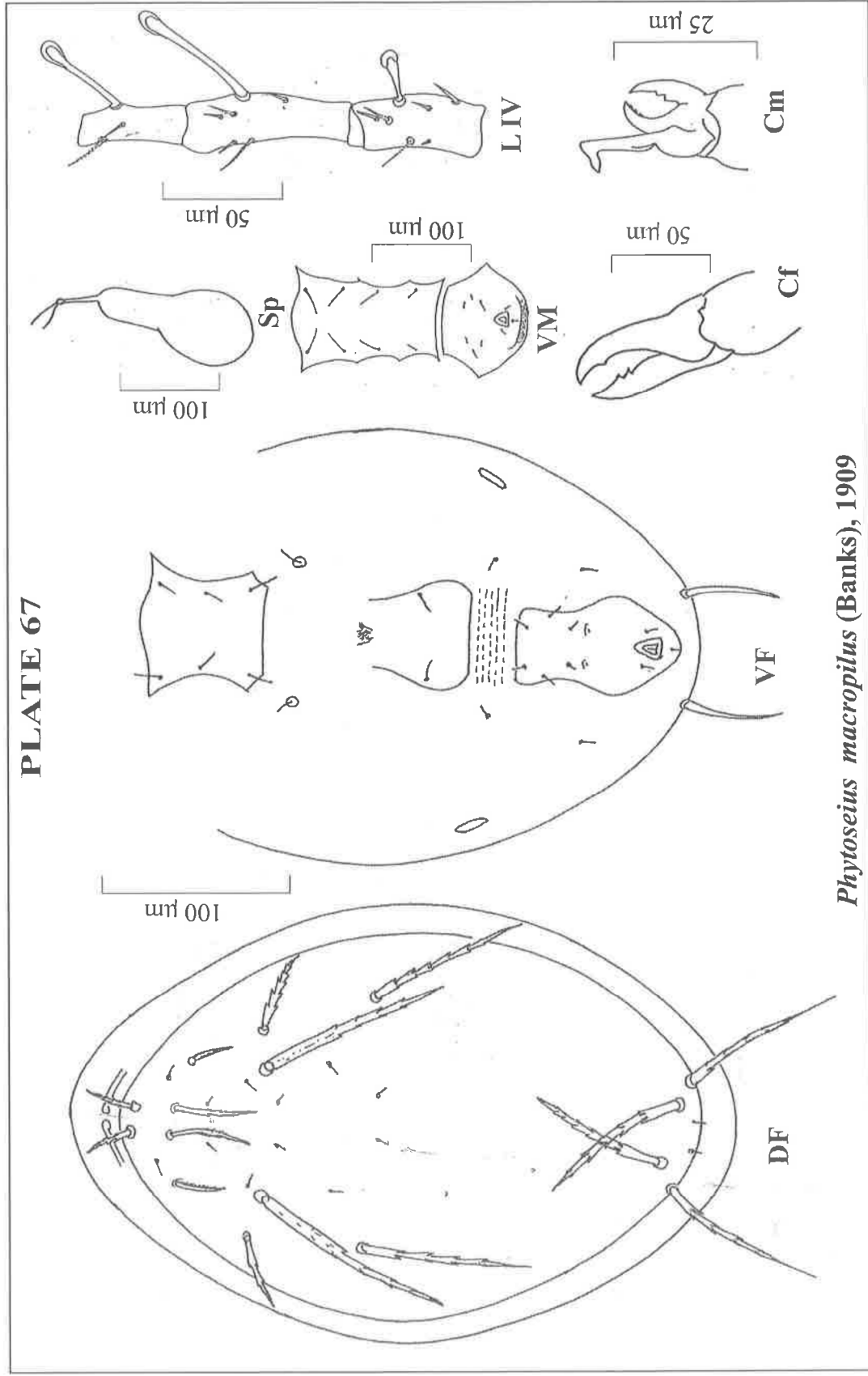
Phytoseius asperae sp. nov.

PLATE 66



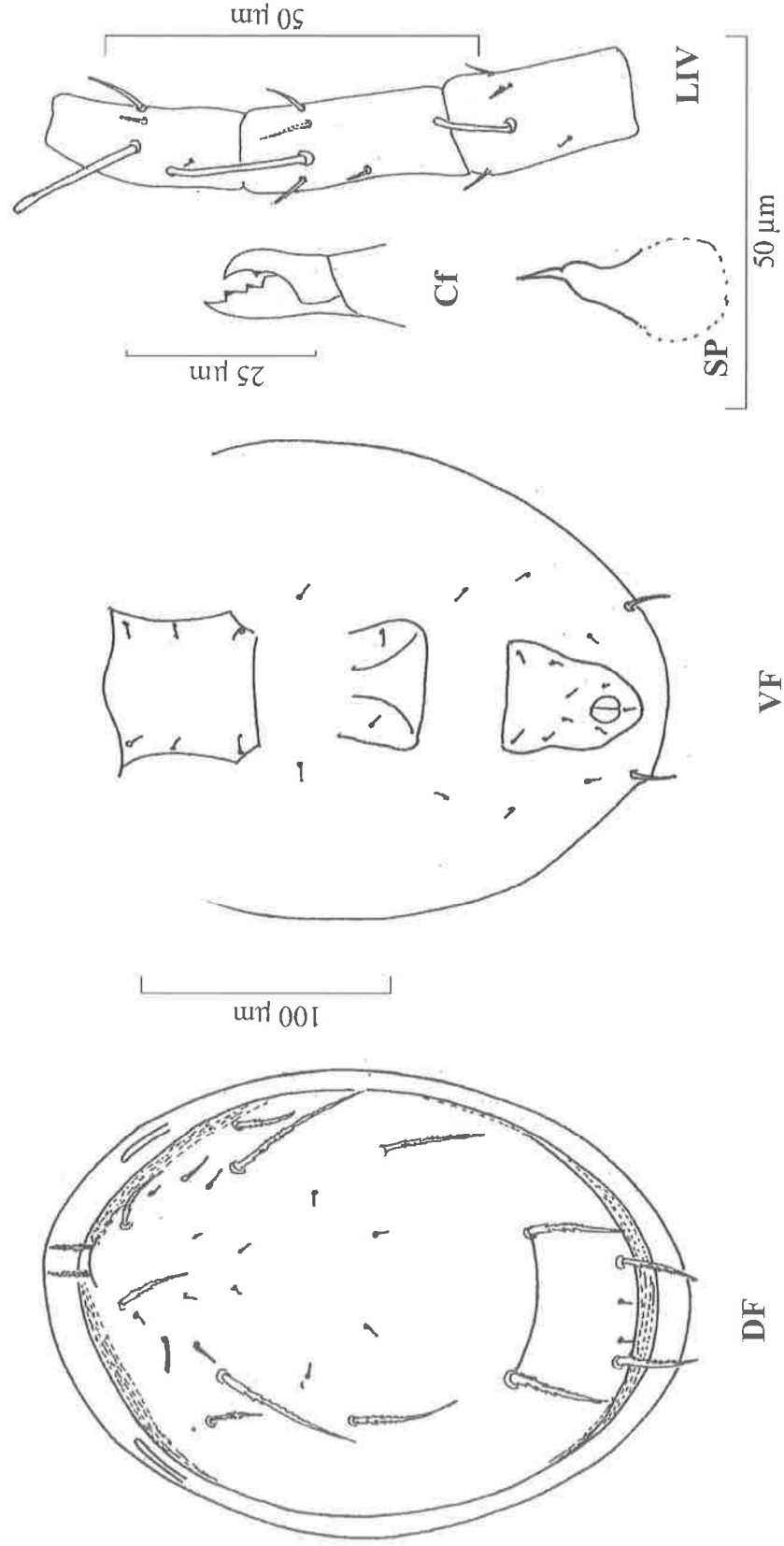
Phytoseius intermedius Evans and Macfarlane, 1962

PLATE 67



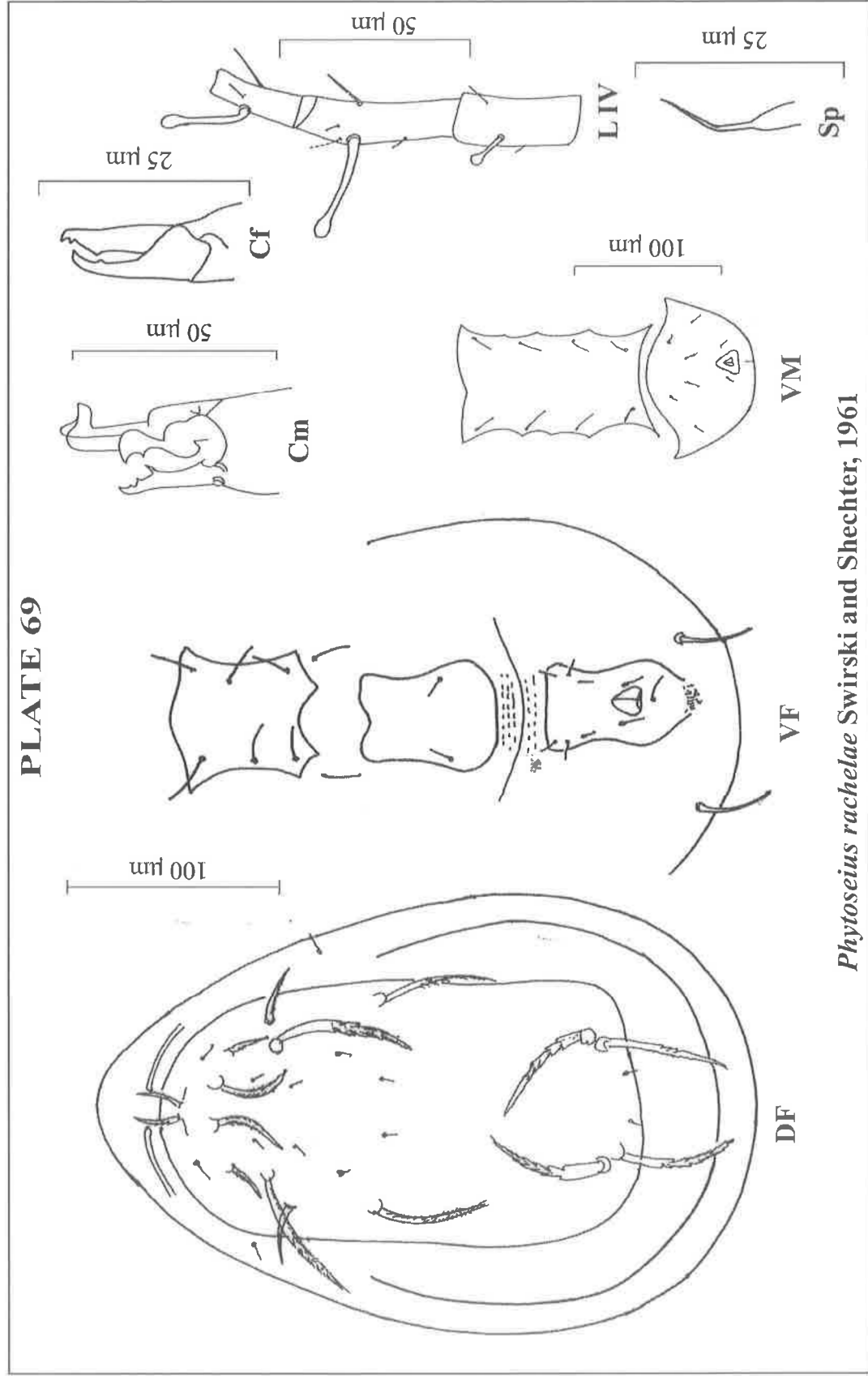
Phytoseius macropilus (Banks), 1909

PLATE 68



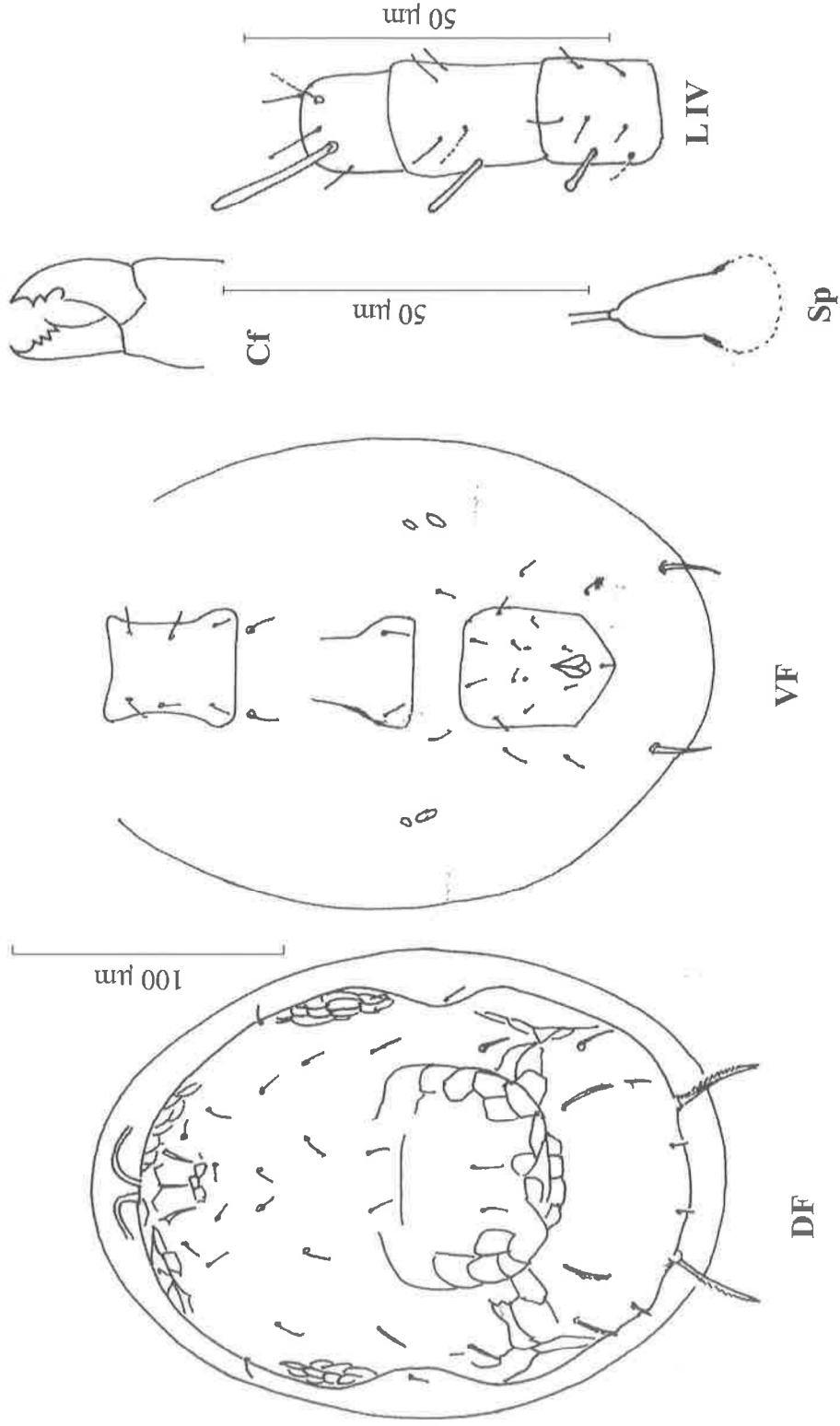
Phytoseius prakasani sp. nov.

PLATE 69



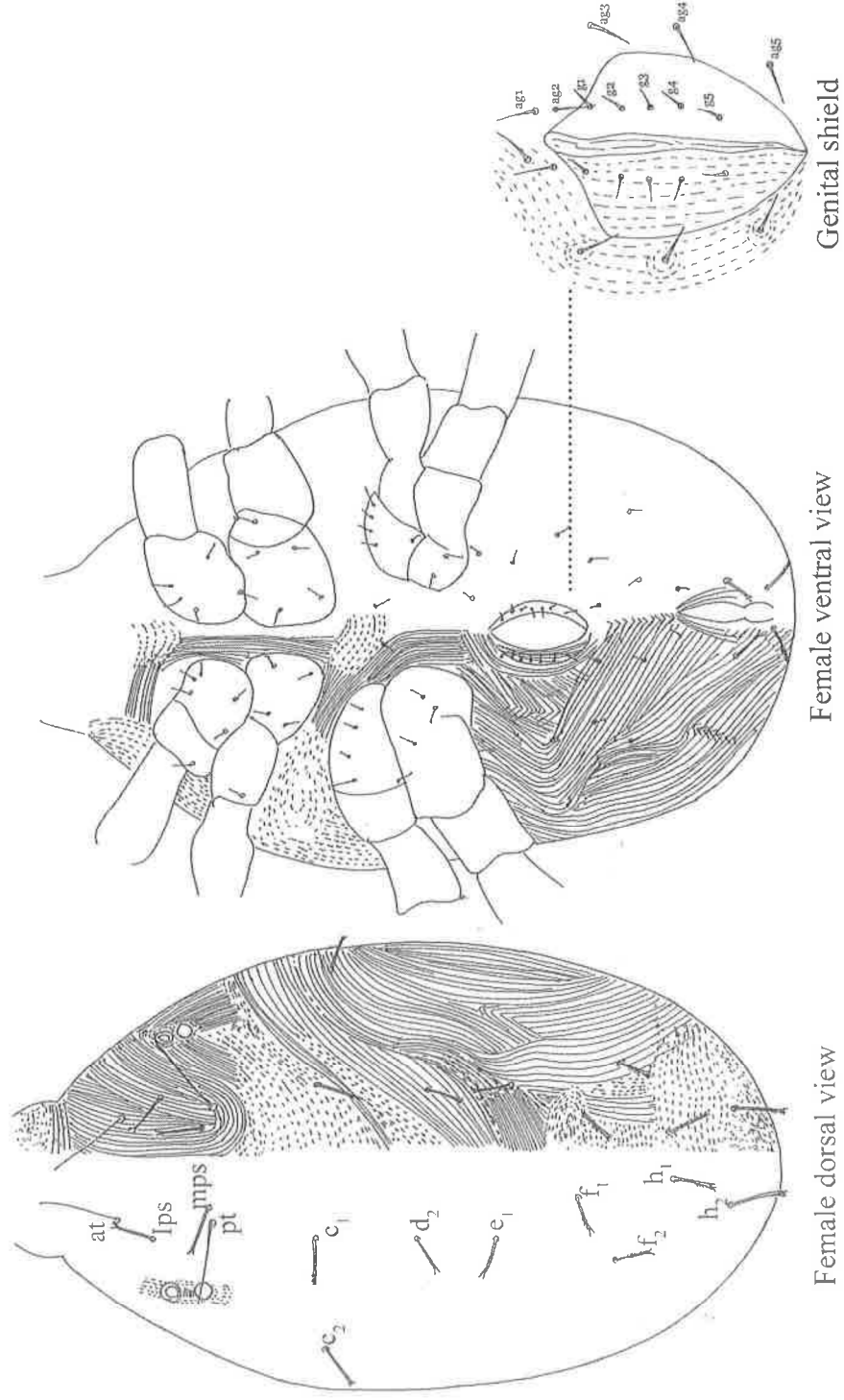
Phytoseius rachelae Swirski and Shechter, 1961

PLATE 70



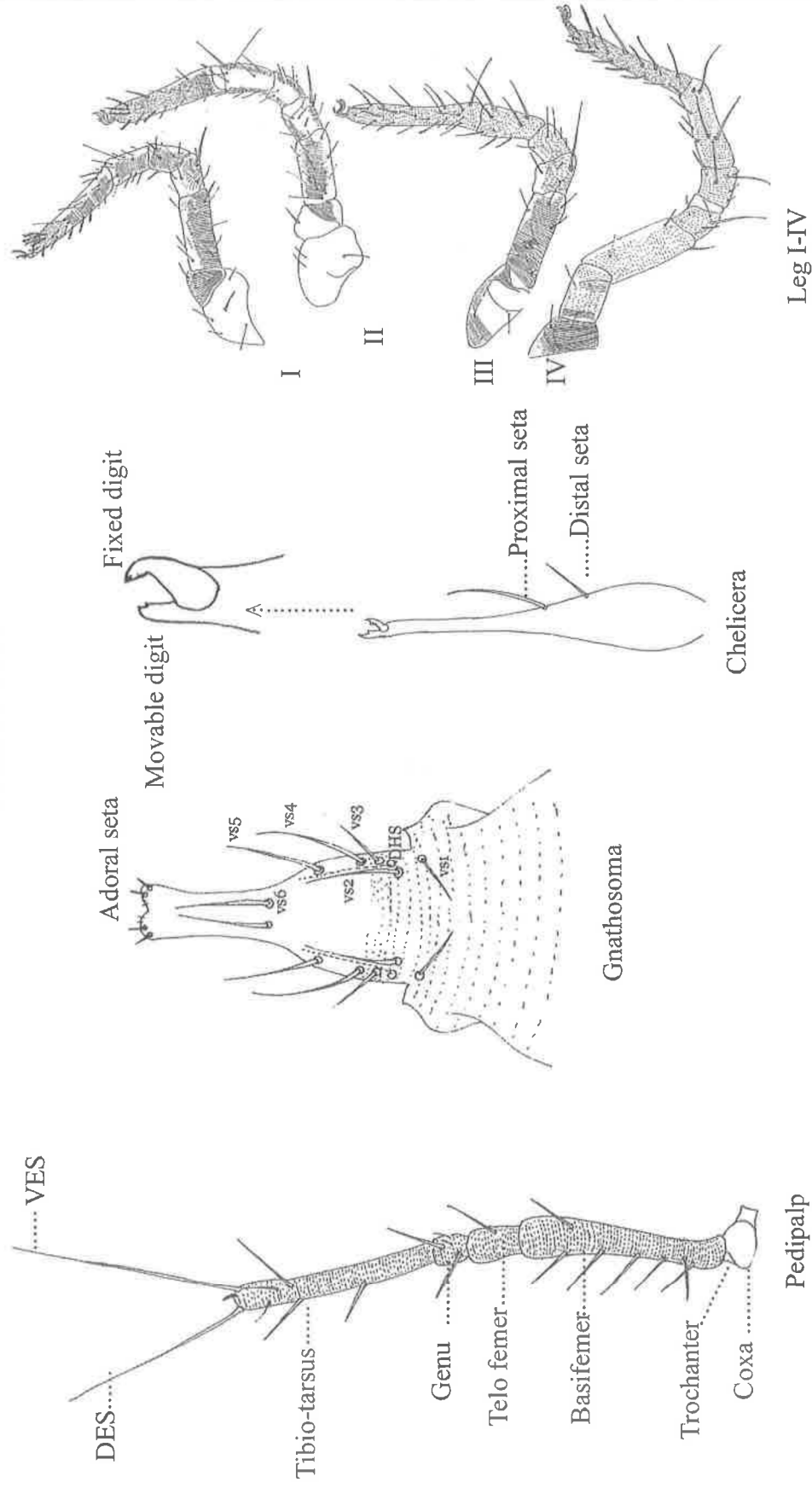
Typhlodromus (Anthoseius) bambusicolus Gupta, 1977

PLATE 72A



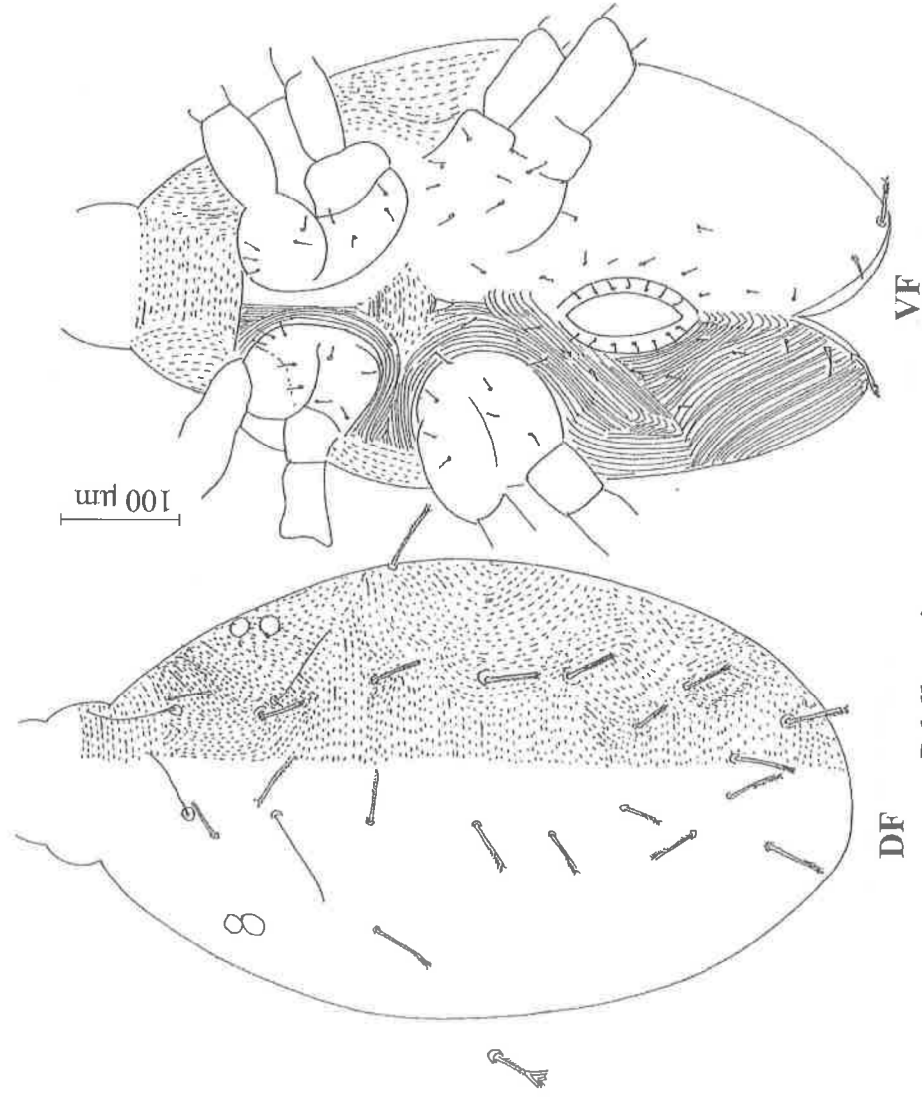
Morphological and Taxonomical characters of the family Bdellidae Duges, 1834

PLATE 72B



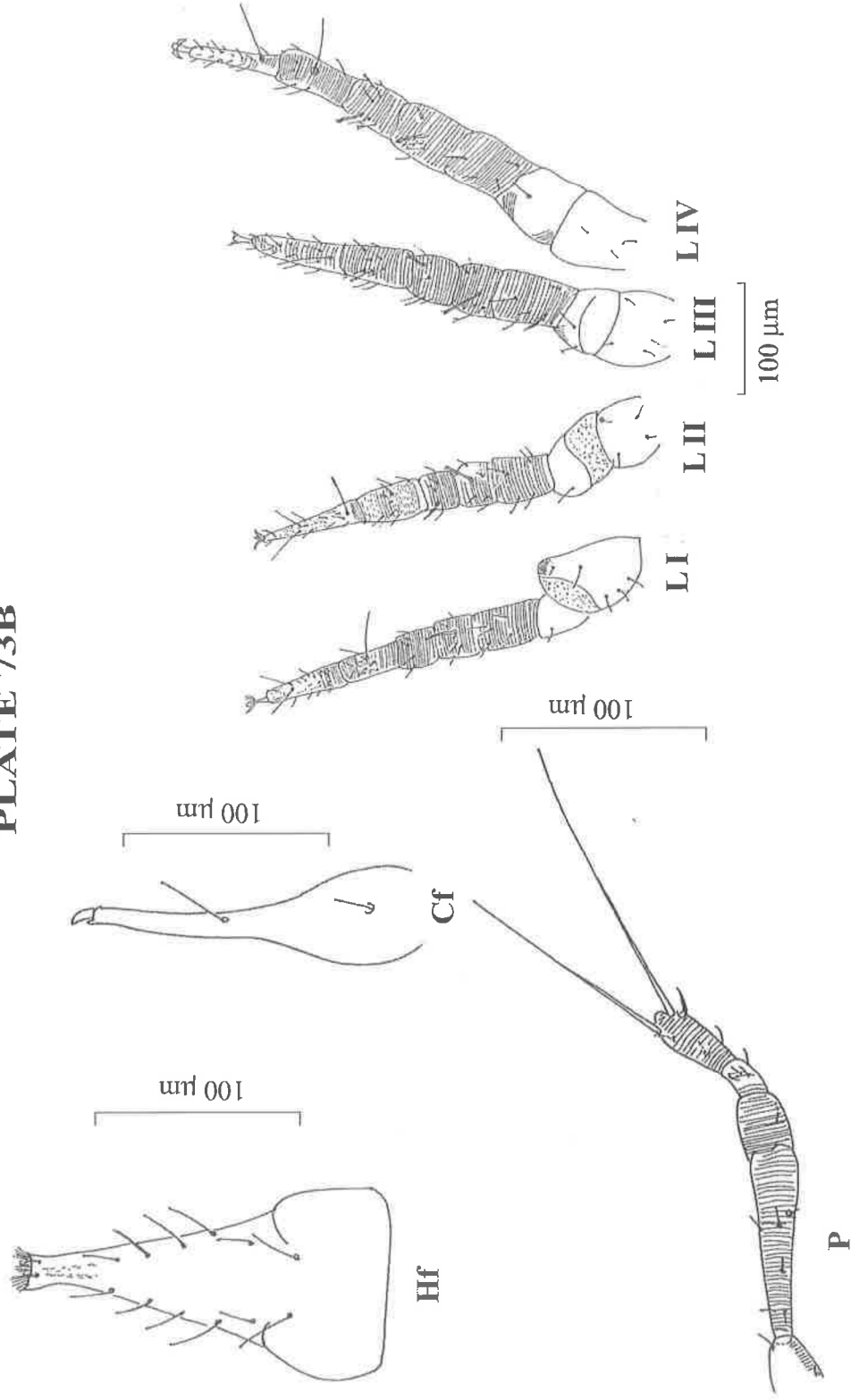
Morphological and Taxonomical characters of the family Bdellidae Duges, 1834

PLATE 73A



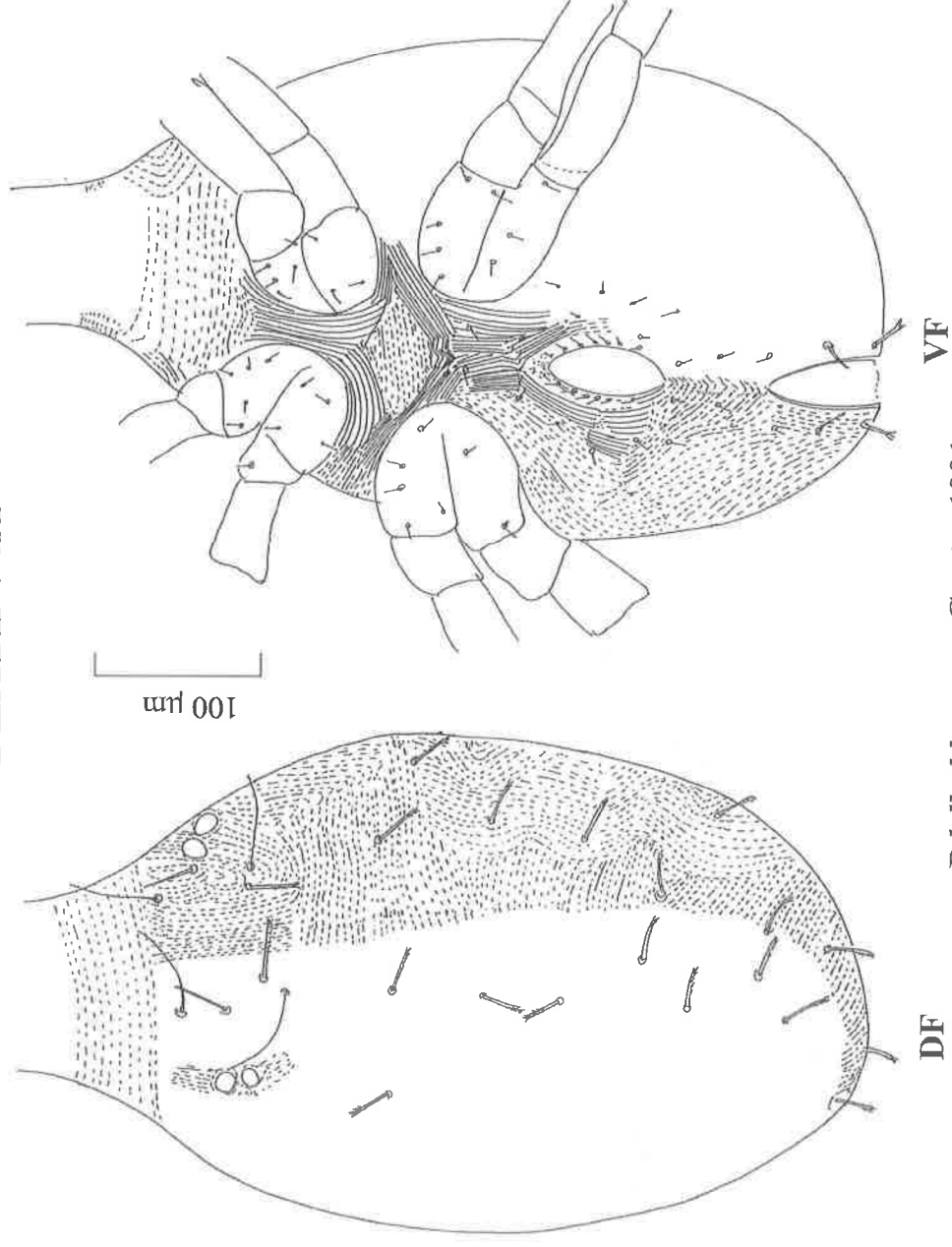
Bdella aniyammae sp. nov.

PLATE 73B



Bdella aniyammae sp. nov.

PLATE 74A

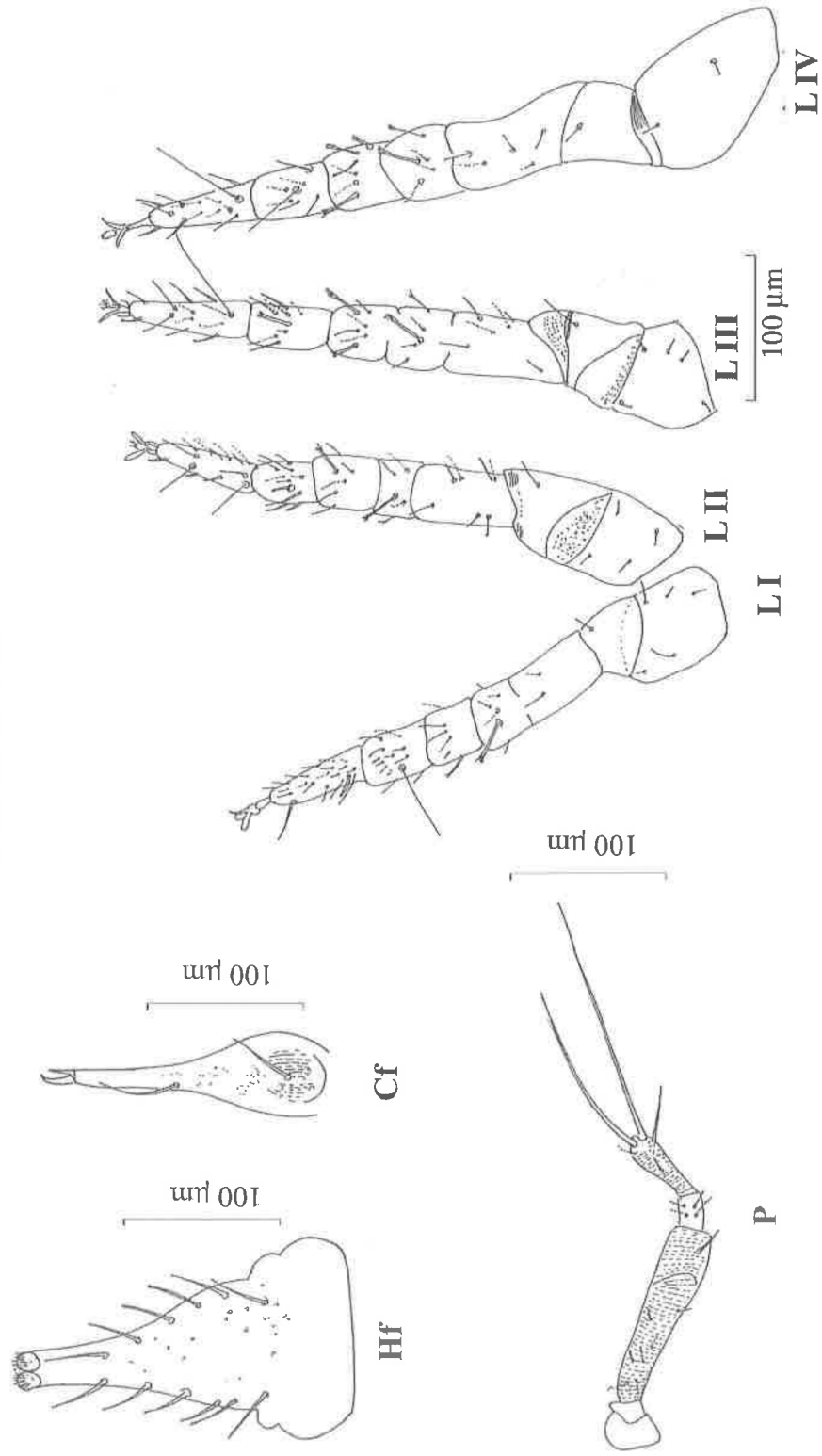


VF

DF

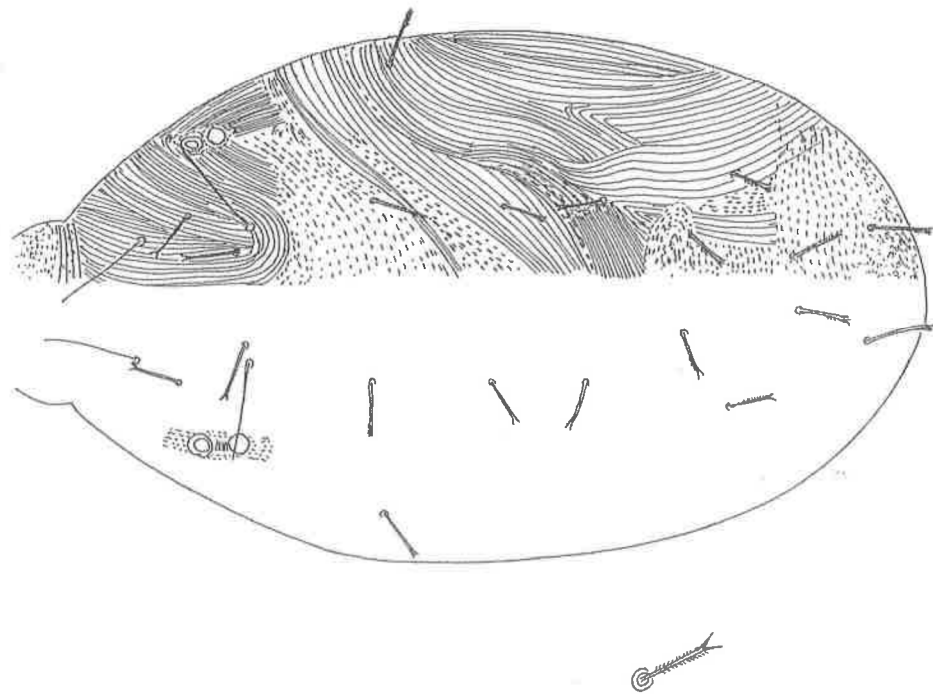
Bdella khasyana Gupta, 1991

PLATE 74B

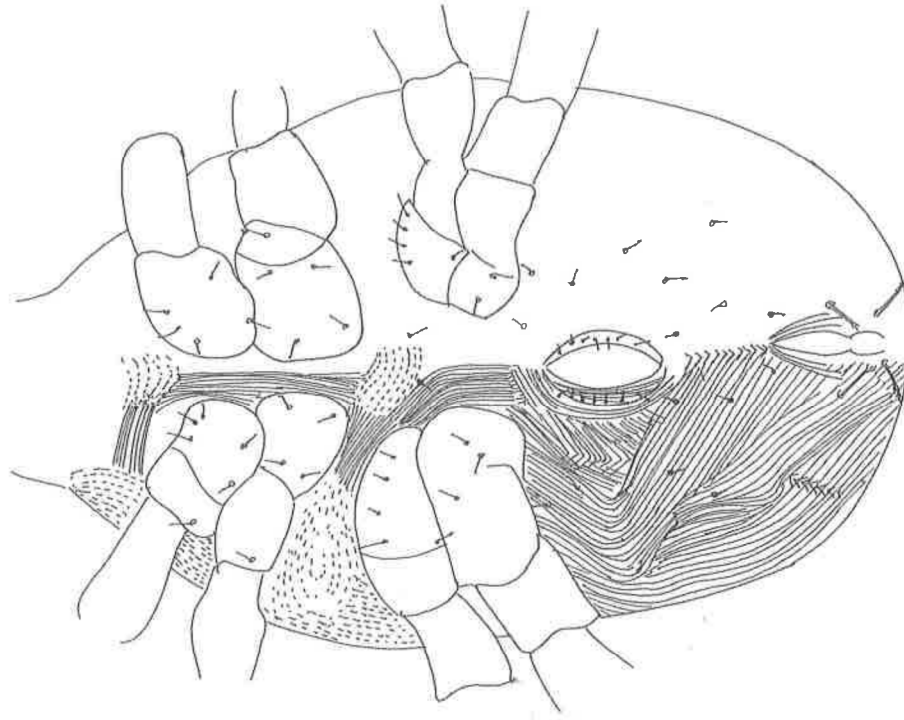


Bdella khasyana Gupta, 1991

PLATE 75A



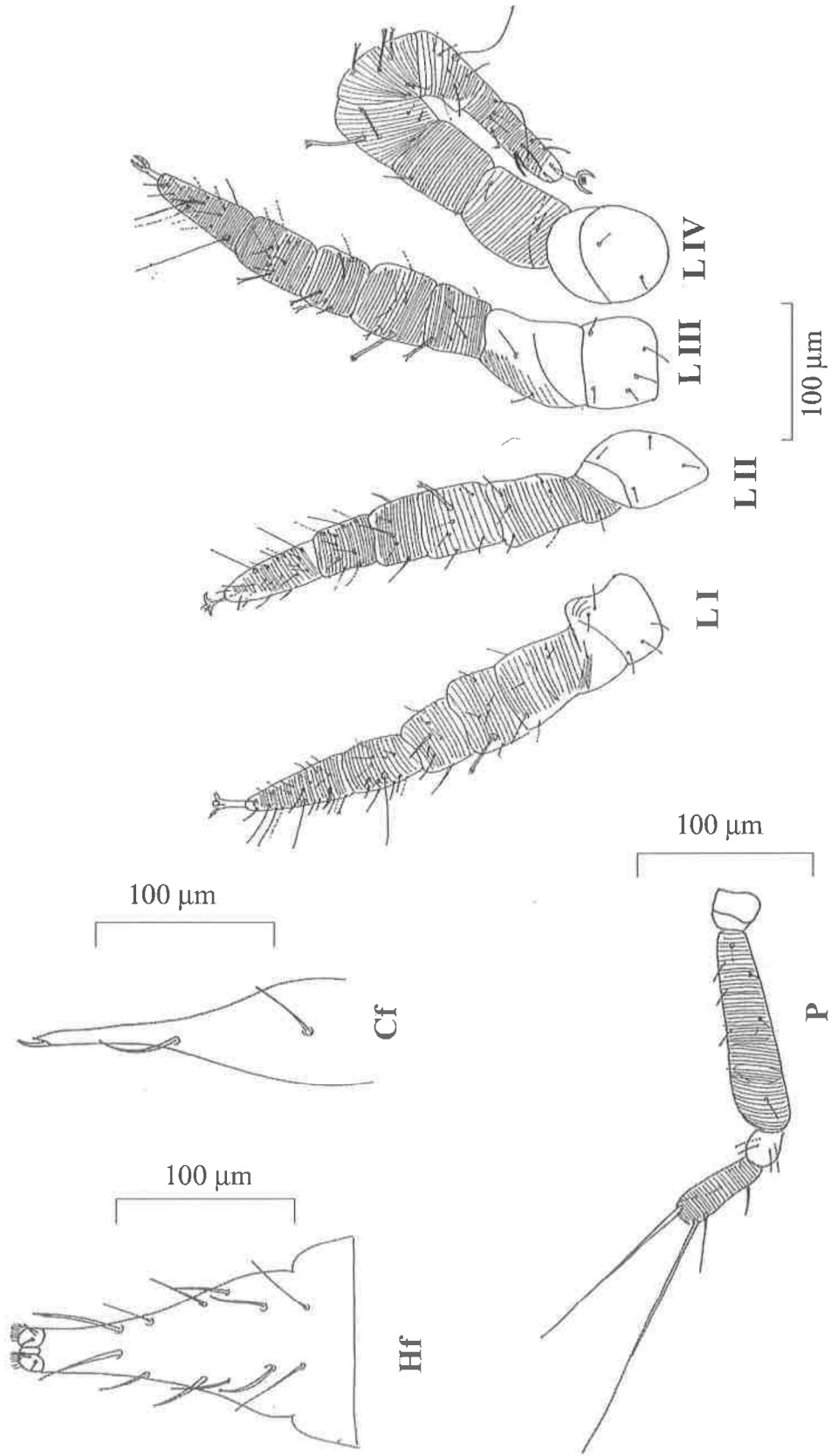
DF



VF

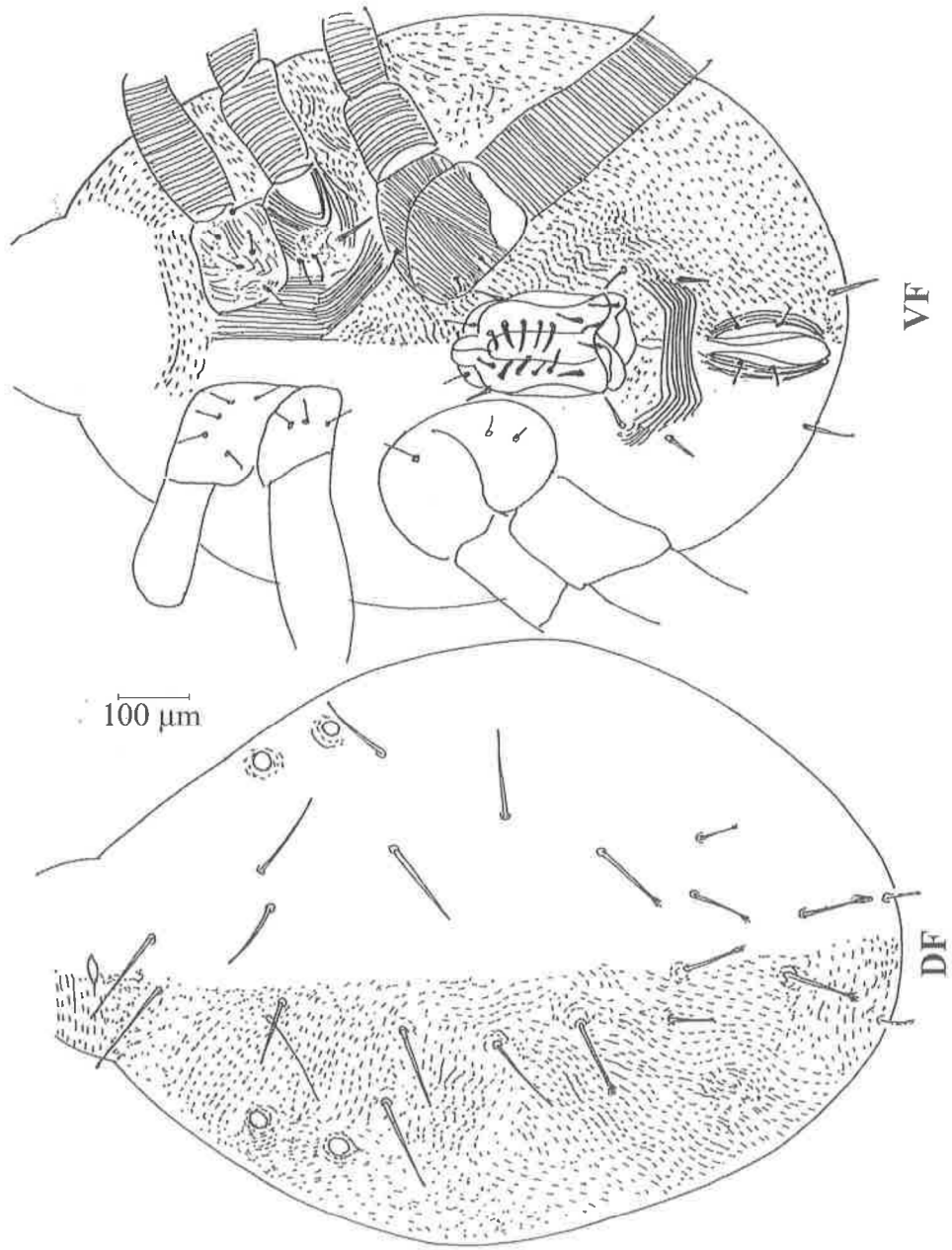
Bdella vincenti sp. nov.

PLATE 75B



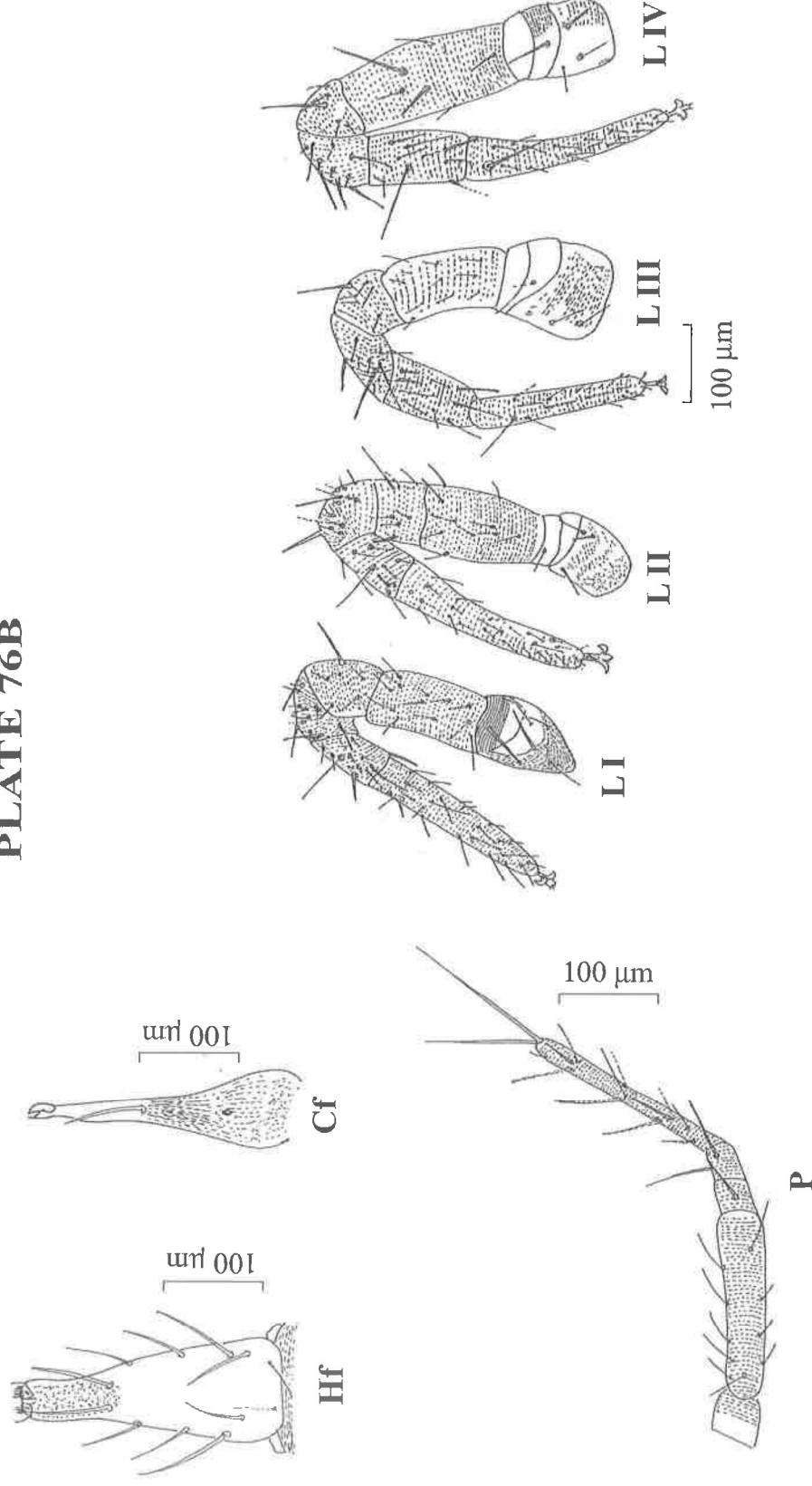
Bdella vincenti sp. nov.

PLATE 76A



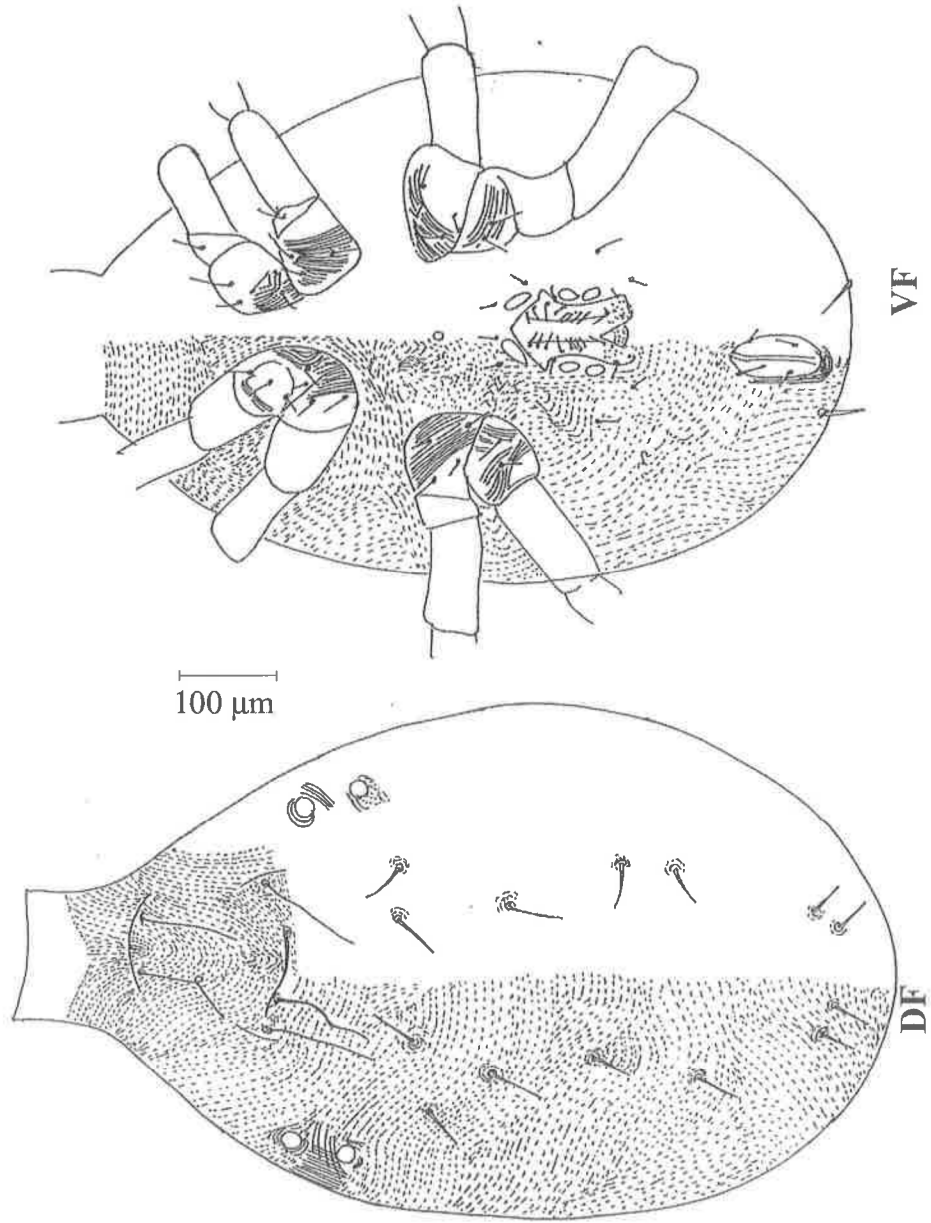
Bdellodes thankamaluae sp. nov.

PLATE 76B



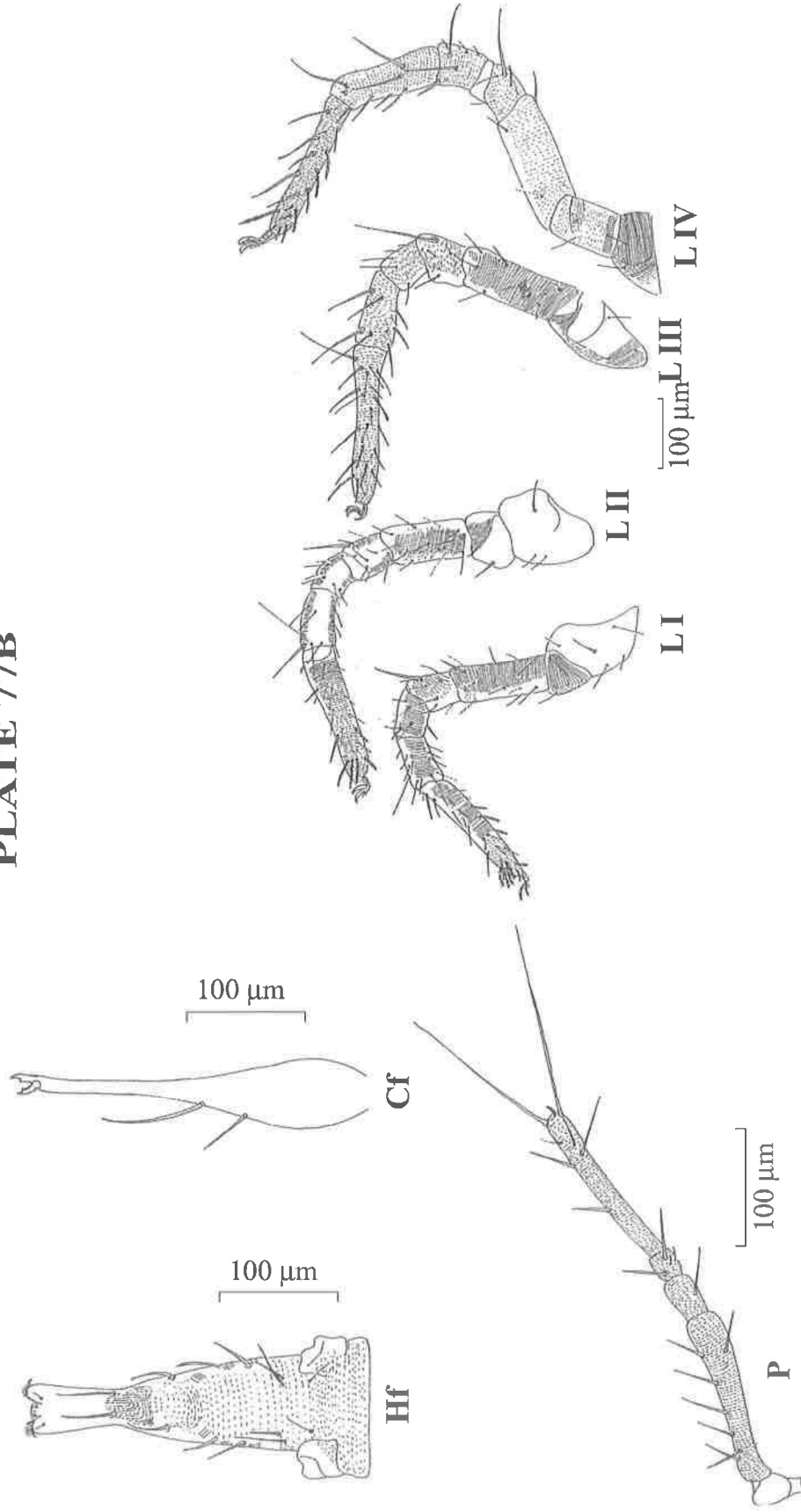
Bdellodes thankamaluae sp. nov.

PLATE 77A



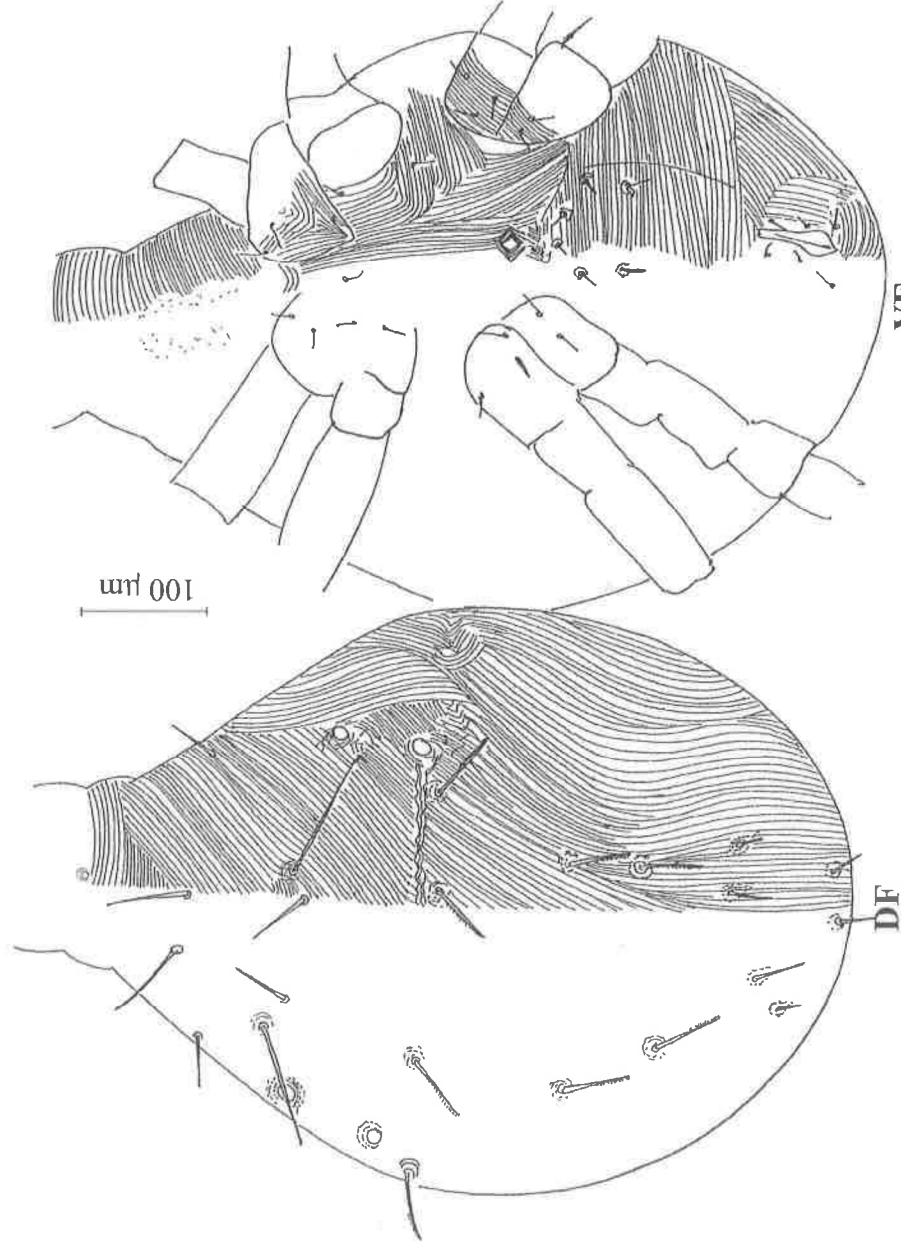
Thoribdella citrifoliae sp. nov.

PLATE 77B



Thoribdella citrifoliae sp. nov.

PLATE 78A

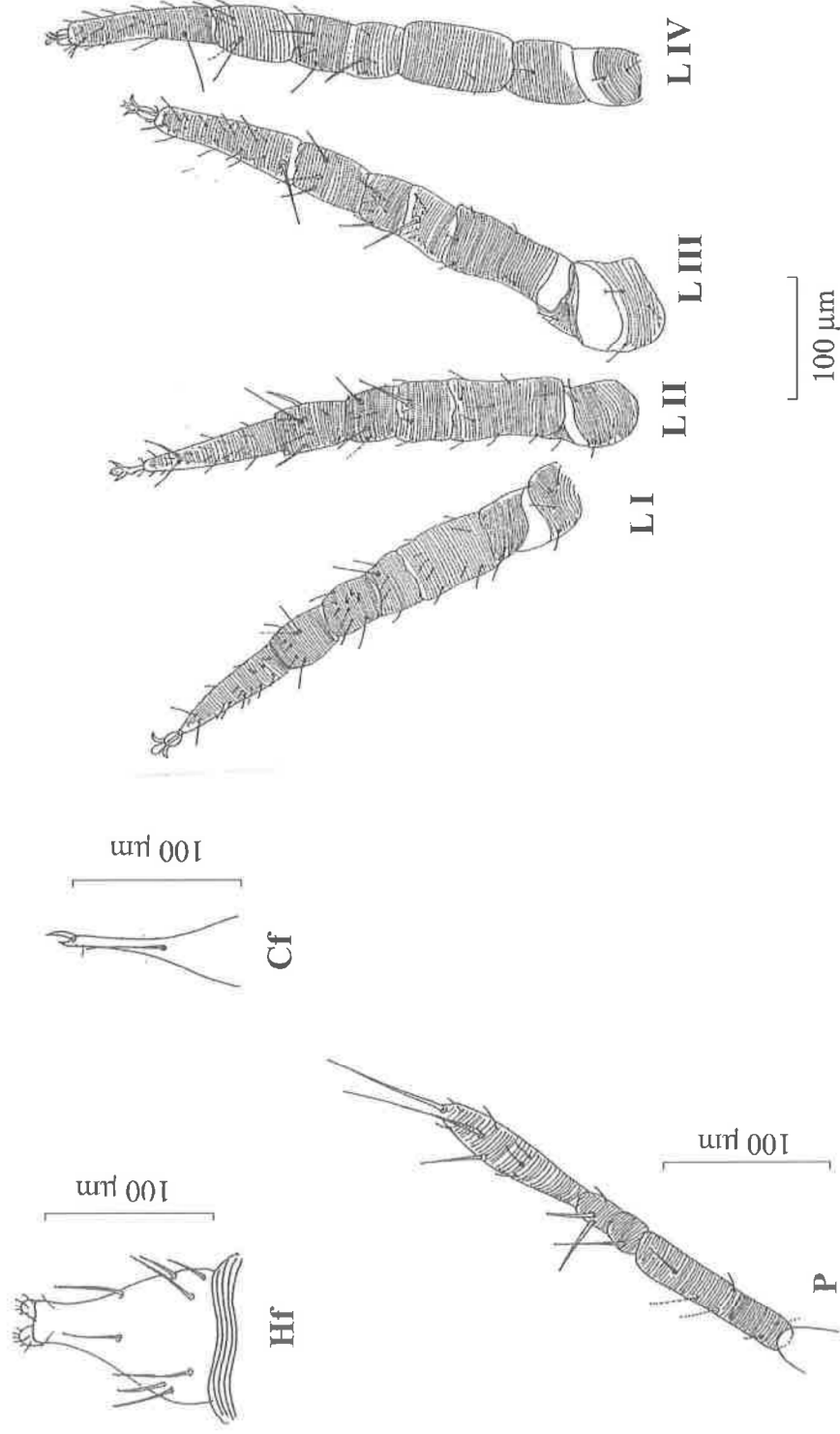


Cyta troglodyte Hernandes, 2011

VF

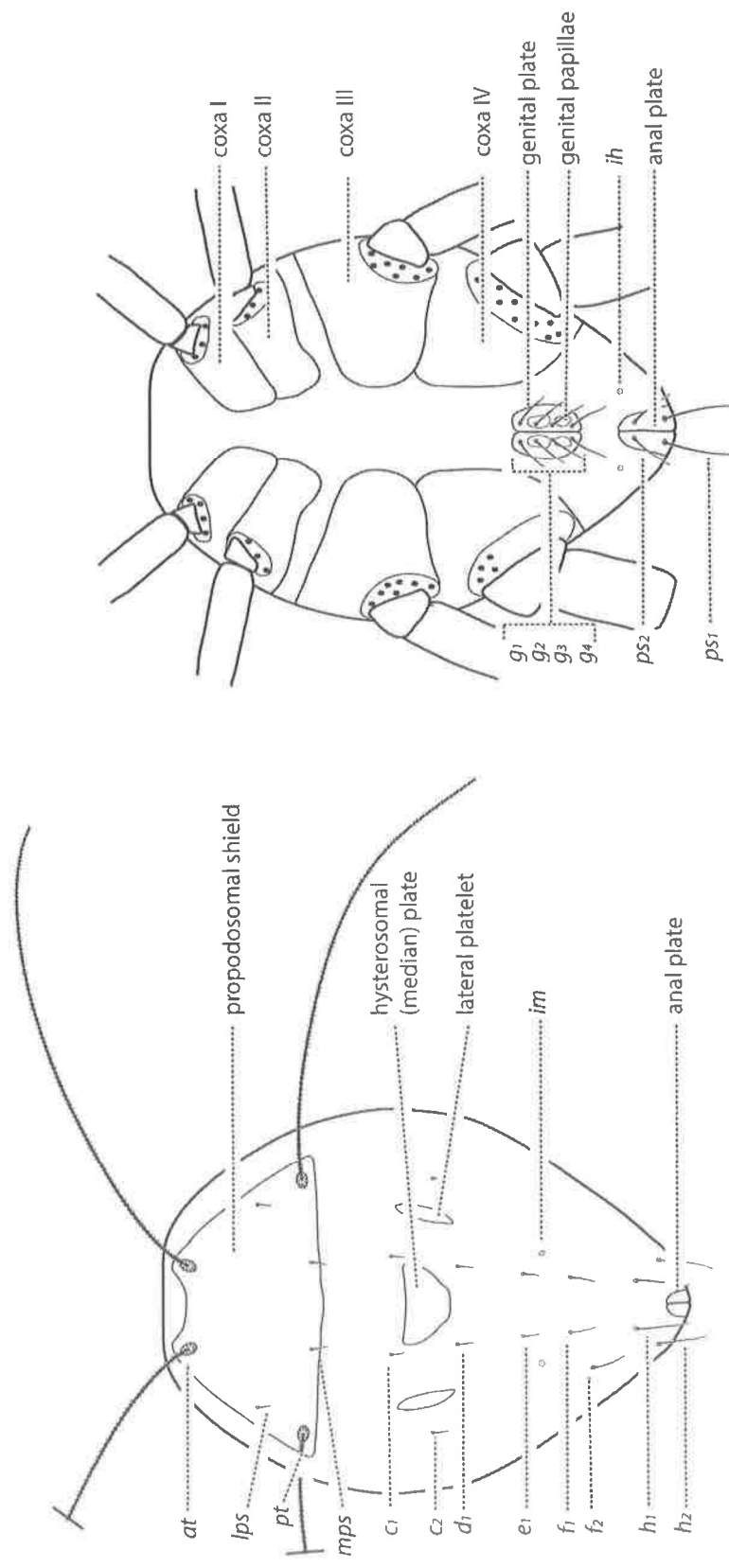
DF

PLATE 78B



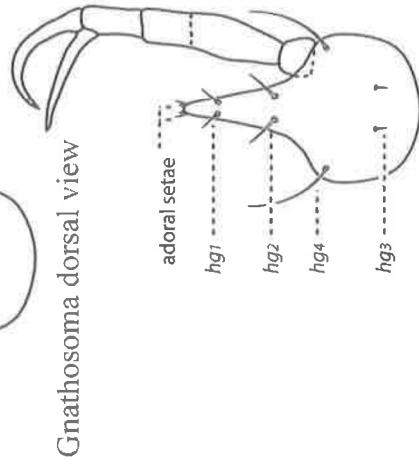
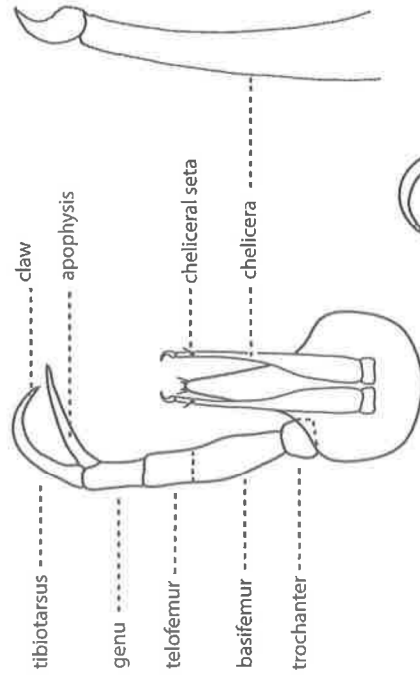
Cytia troglodyte Hernandez, 2011

PLATE 80A

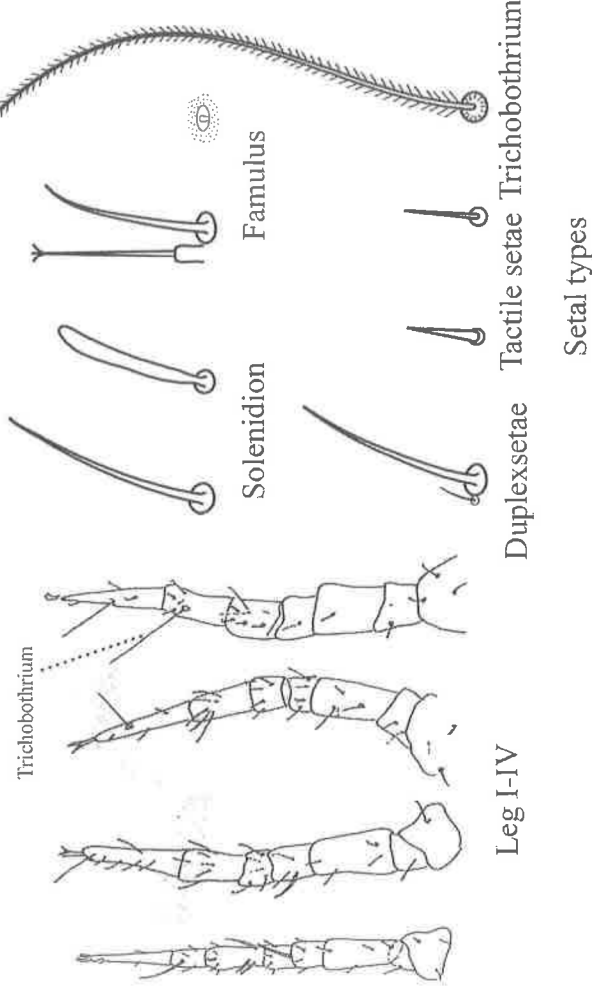


Morphological and Taxonomical characters of the family Cunaxidae Thor, 1902

PLATE 80B

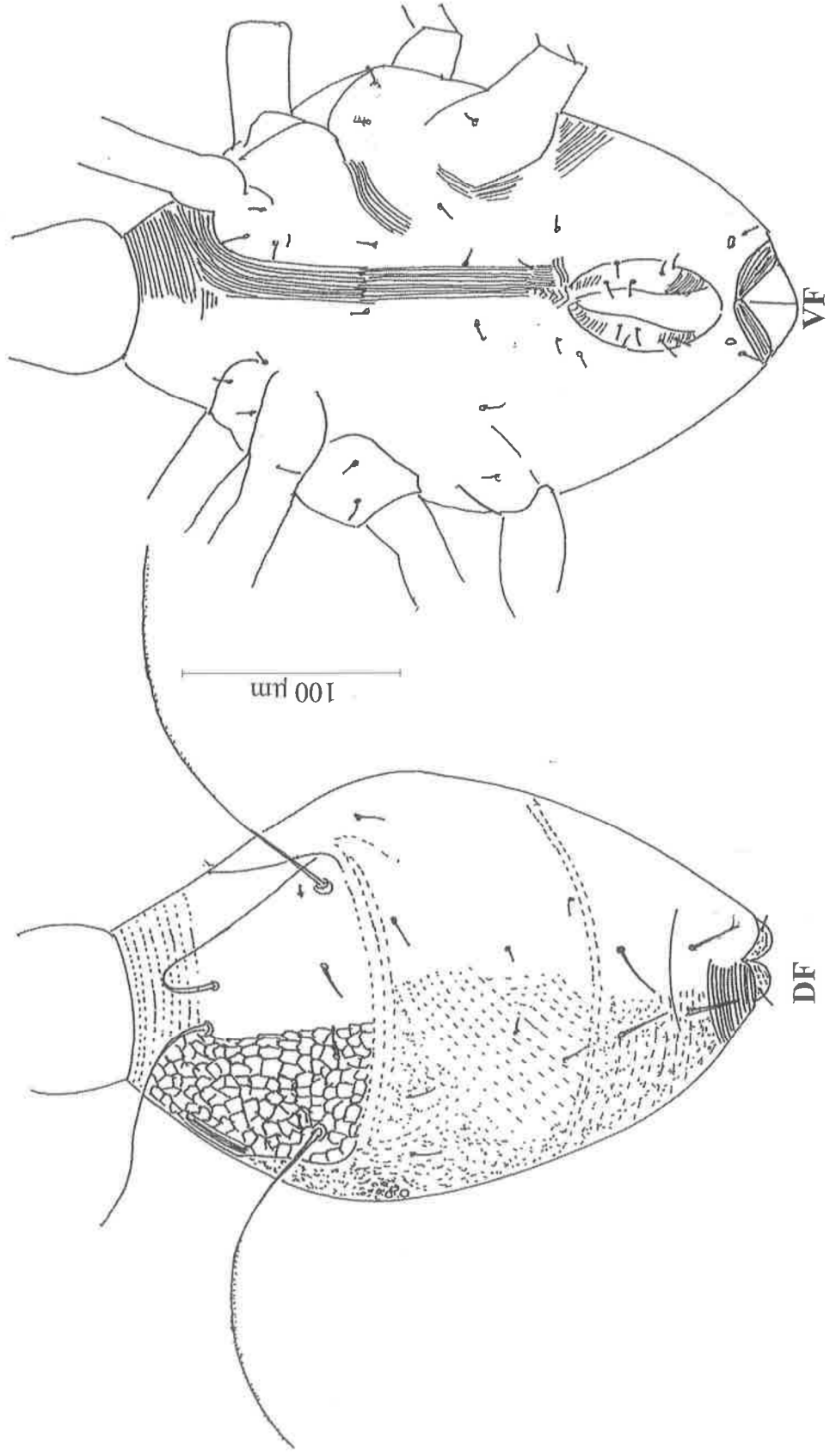


Gnathosoma ventral view



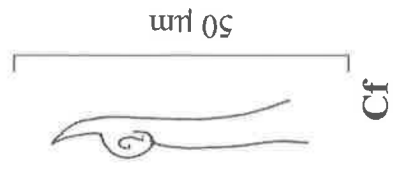
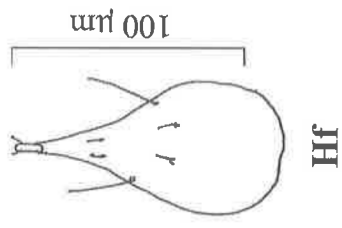
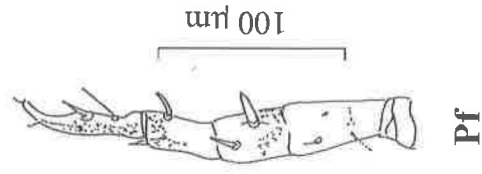
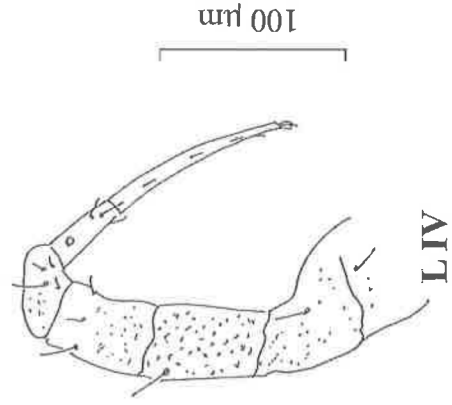
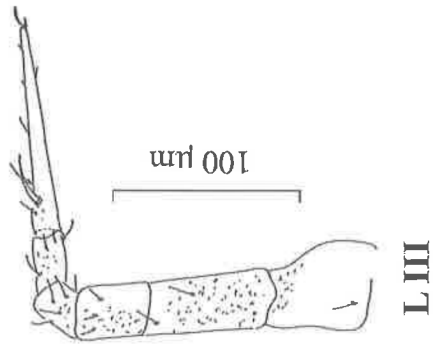
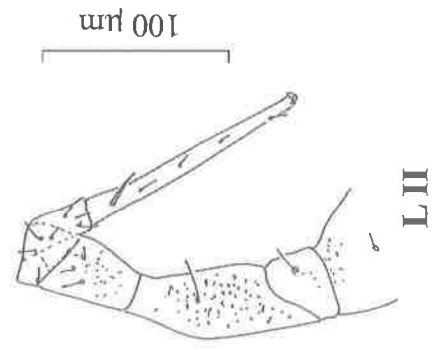
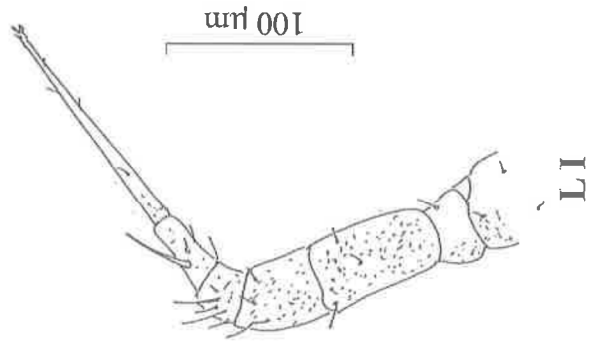
Morphological and Taxonomical characters of the family Cunaxidae Thor, 1902

PLATE 81A



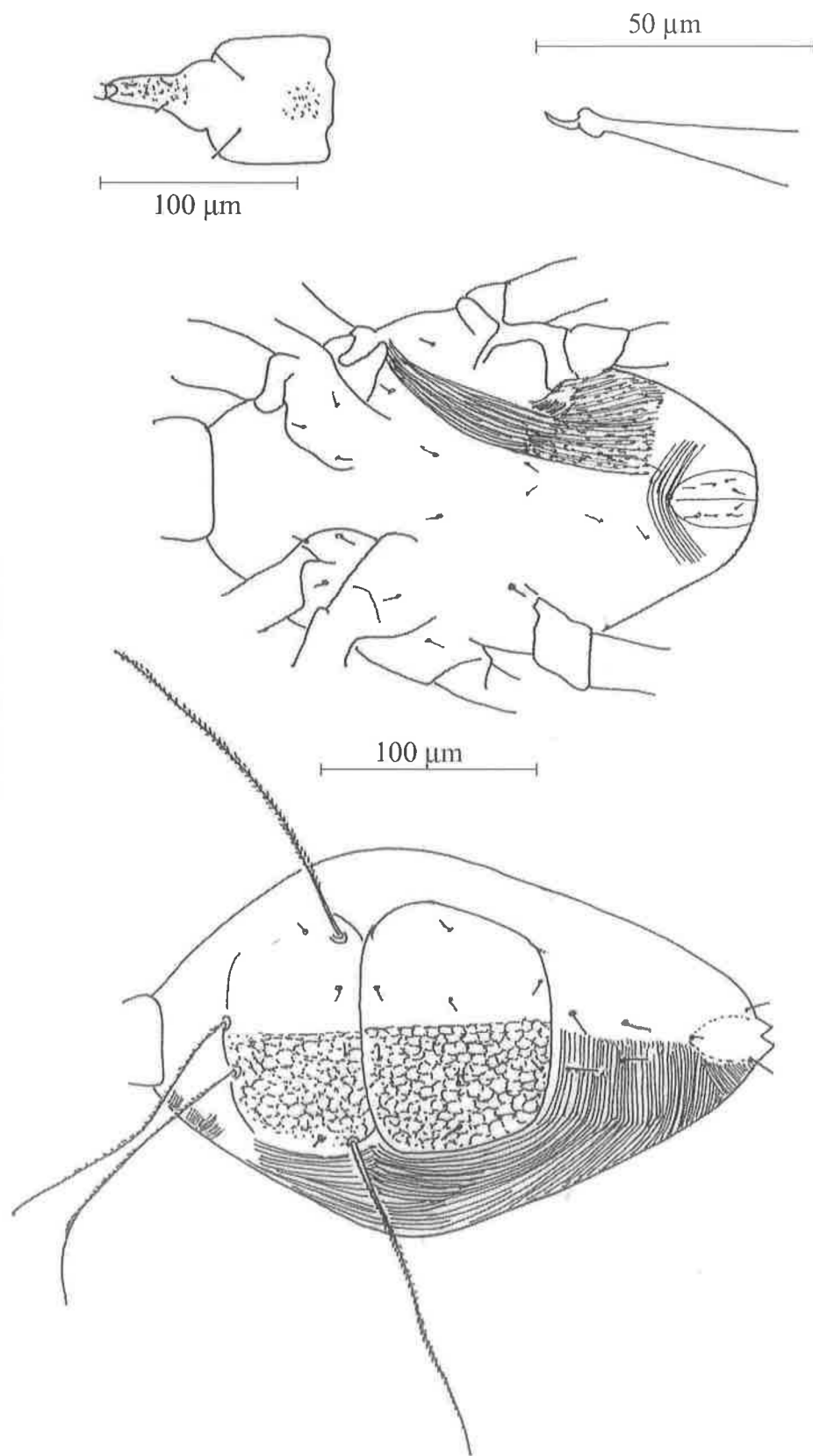
Cunaxa jayasreeae sp. nov.

PLATE 81B



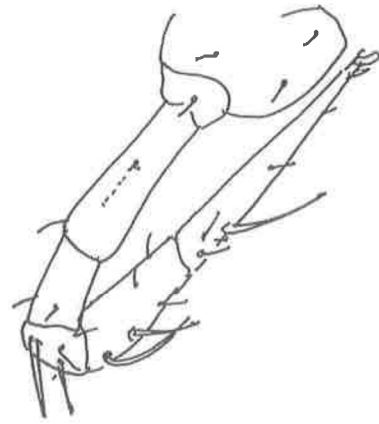
Cunaxa jayasreeae sp. nov.

PLATE 82A

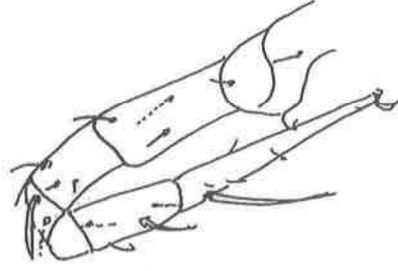


Cunaxa justiciae sp. nov.

PLATE 82B

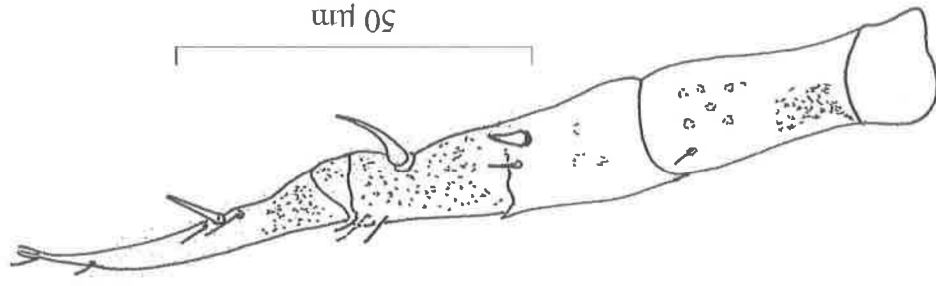


LI



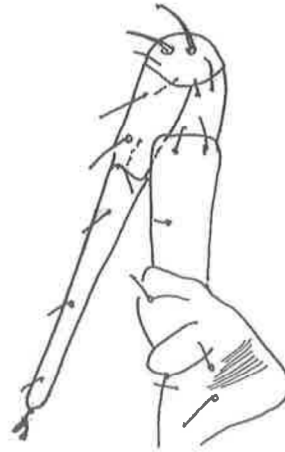
LII

100 μ m

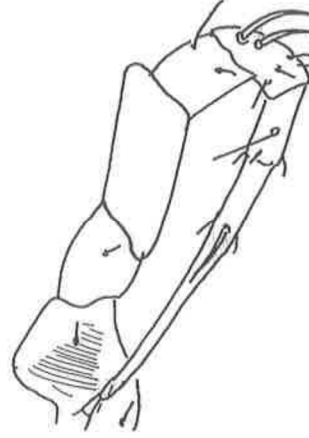


Pf

50 μ m



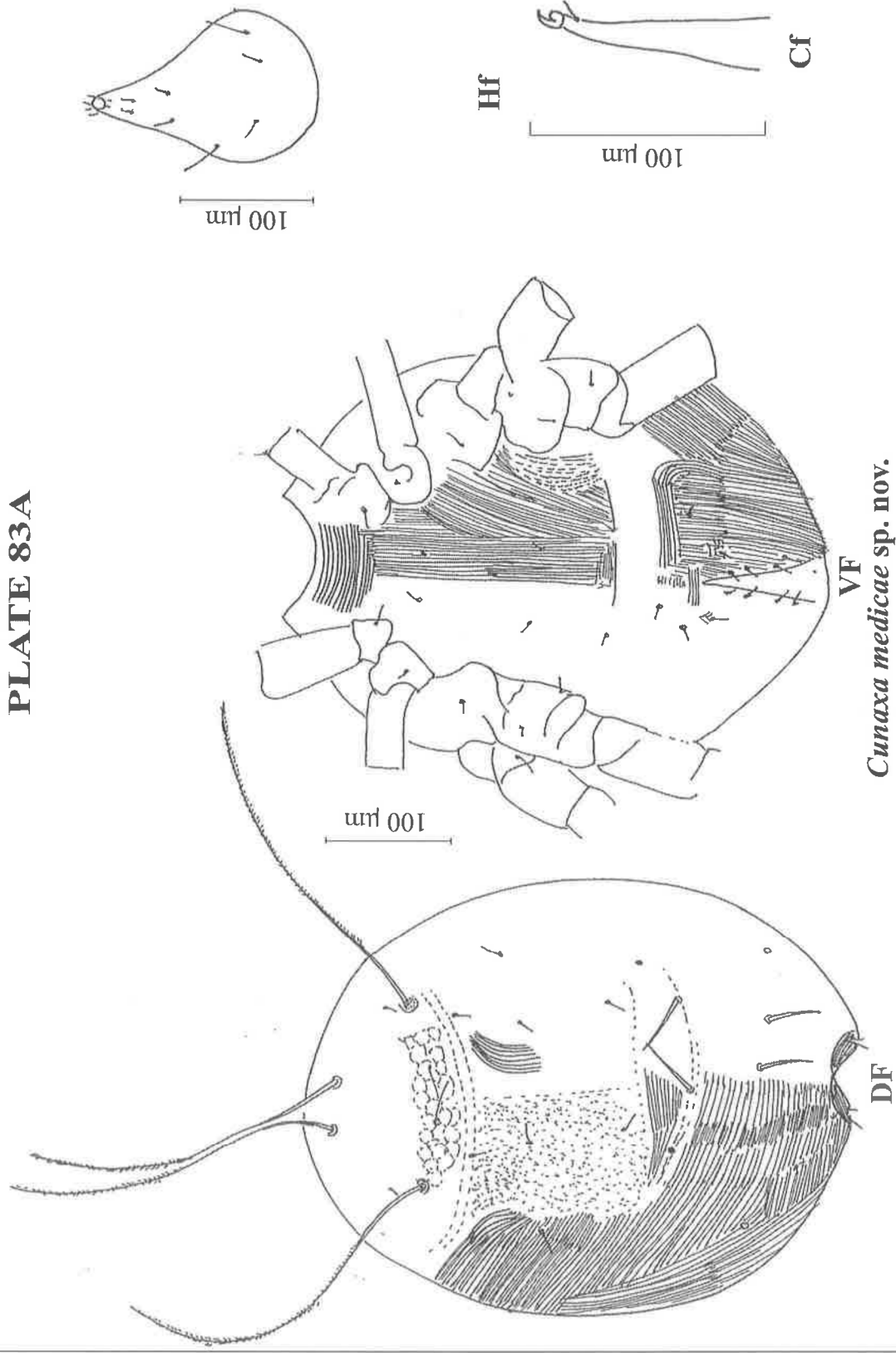
LIII



LIV

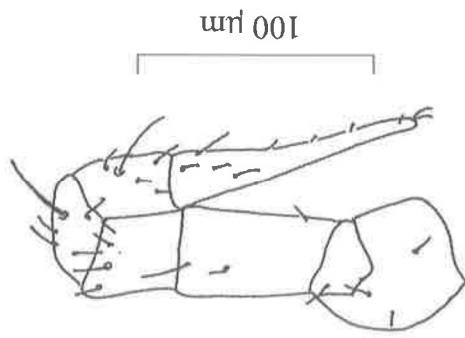
Cunaxa justiciae sp. nov.

PLATE 83A

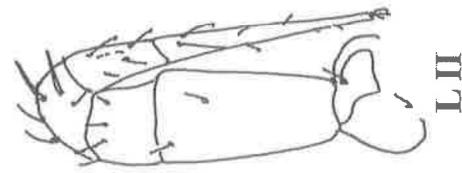


Cunaxa medicae sp. nov.

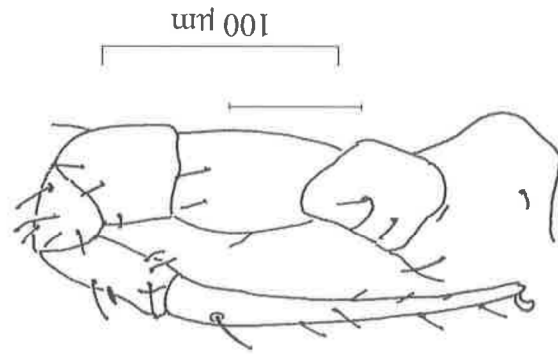
PLATE 83B



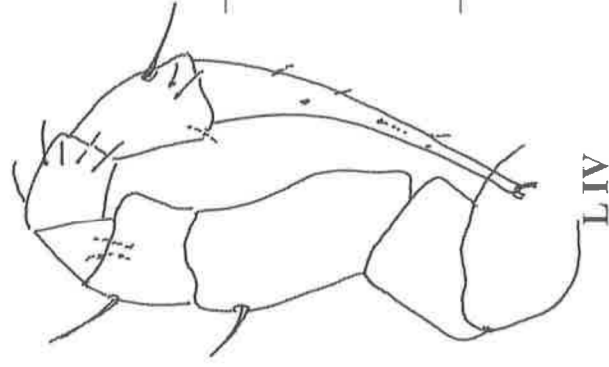
L I



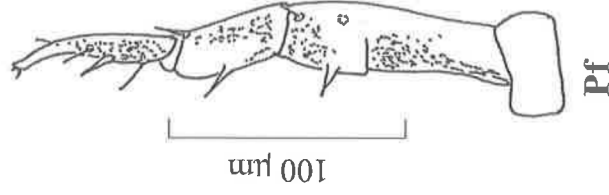
L II



L III



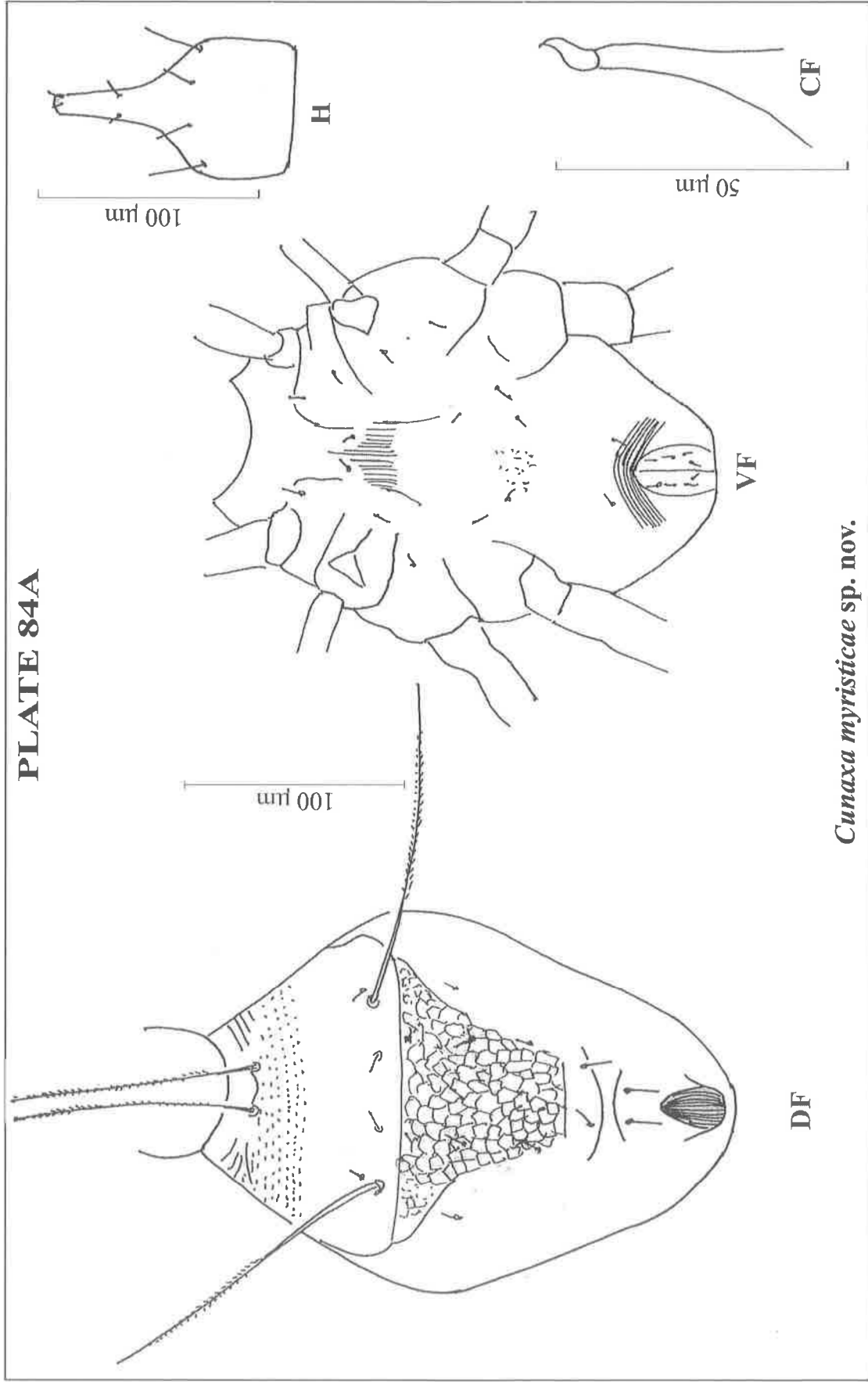
L IV



Pf

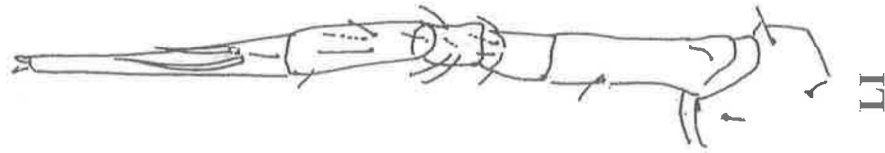
Cunaxa medicae sp. nov.

PLATE 84A

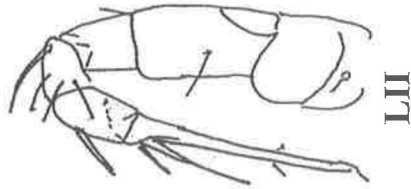


Cunaxa myristicae sp. nov.

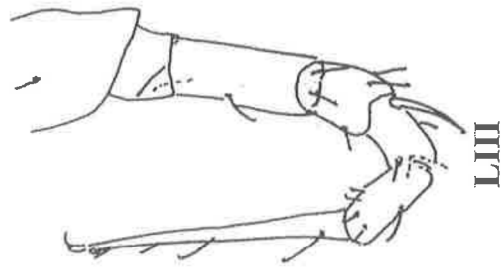
PLATE 84B



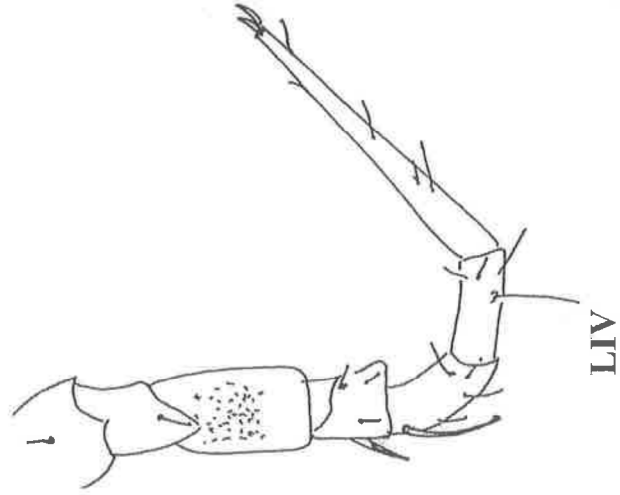
LI



LII

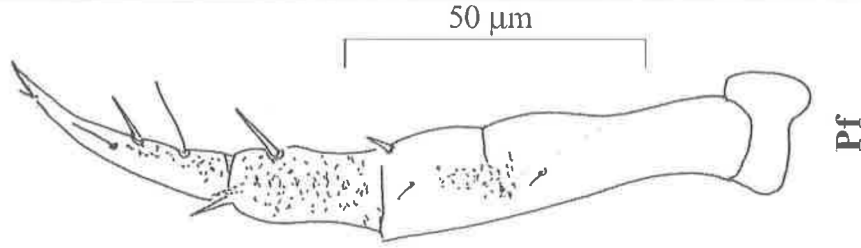


LIII



LIV

100 μ m

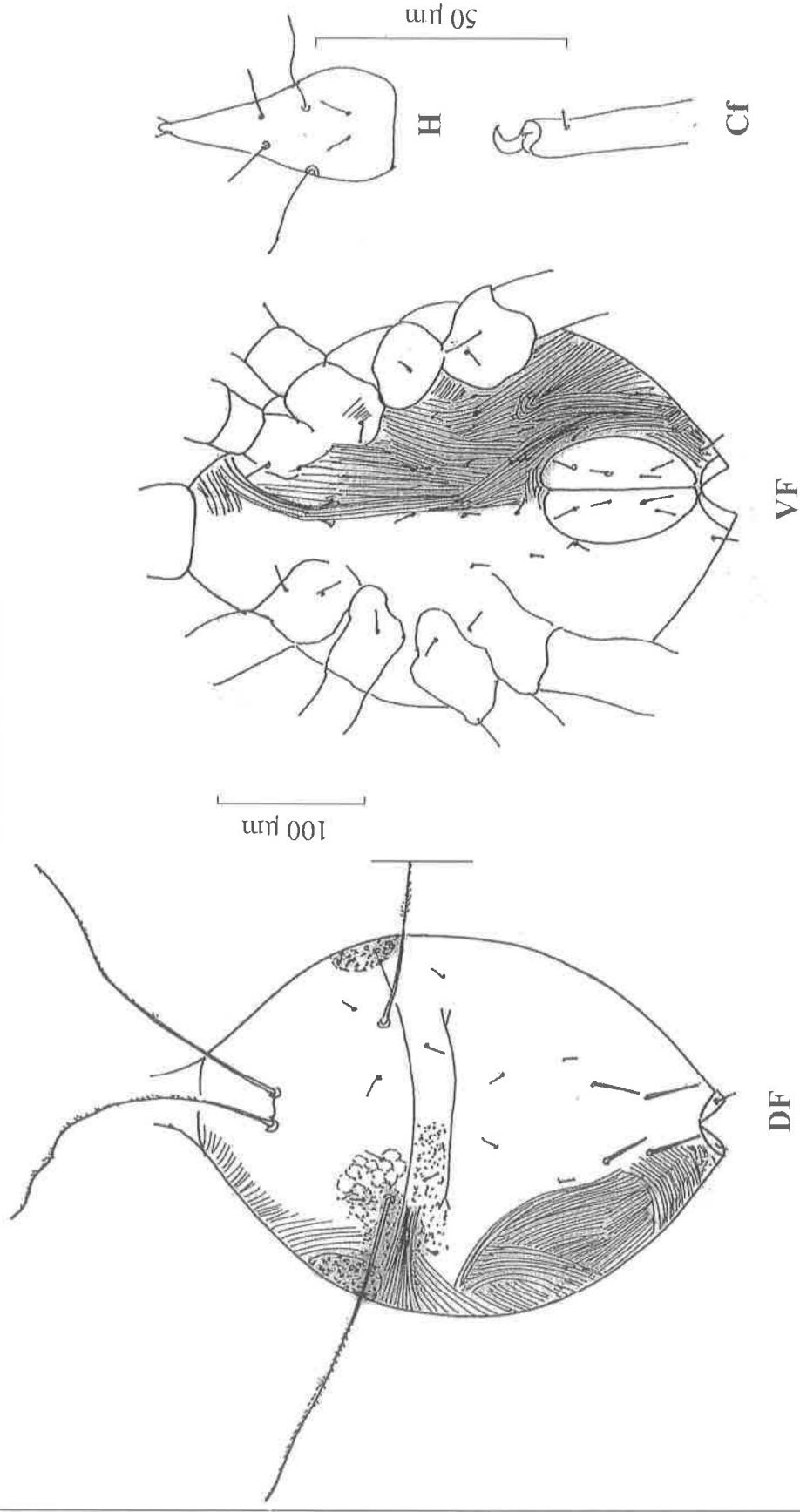


Pf

50 μ m

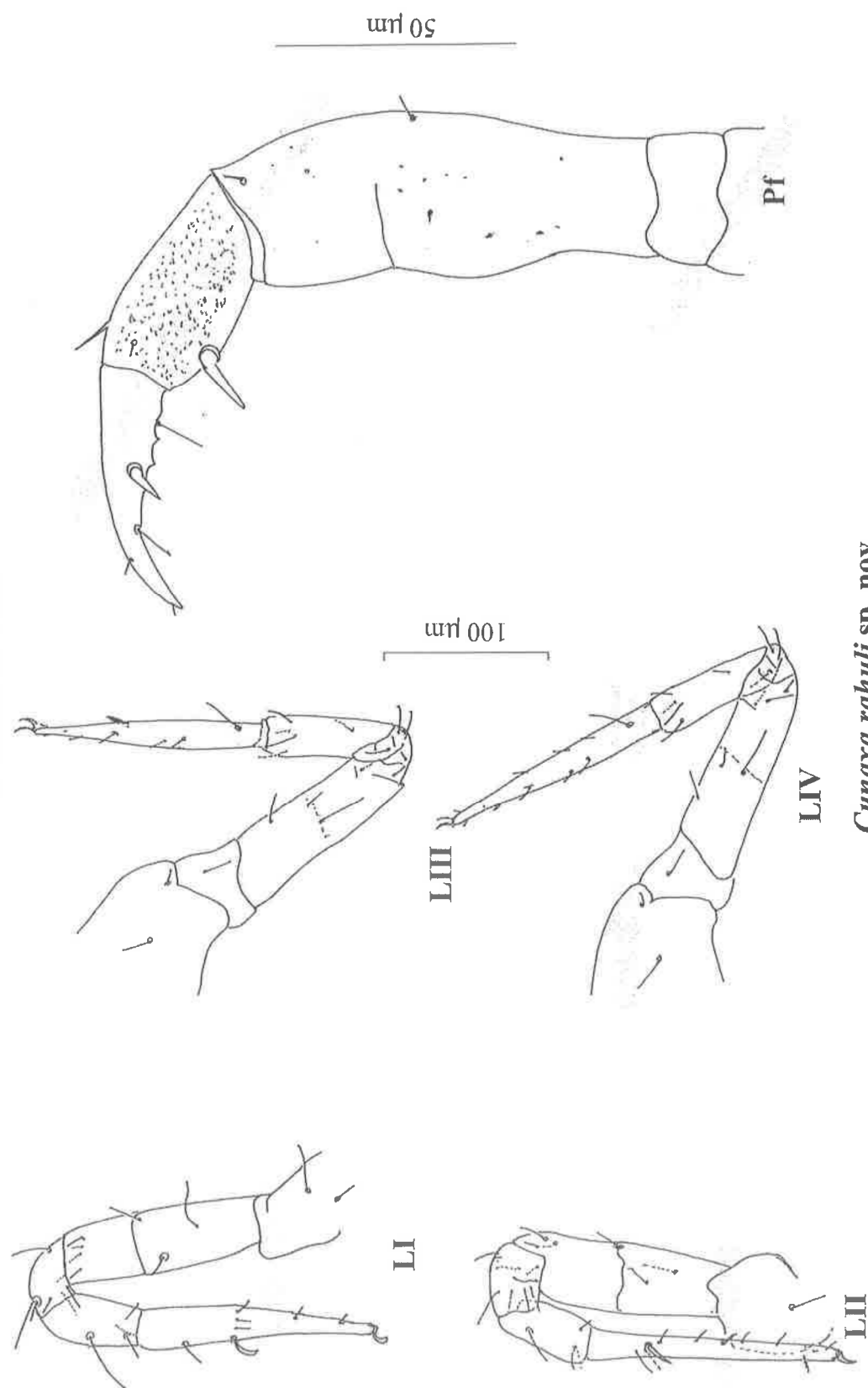
Cunaxa myristicae sp. nov.

PLATE 85A



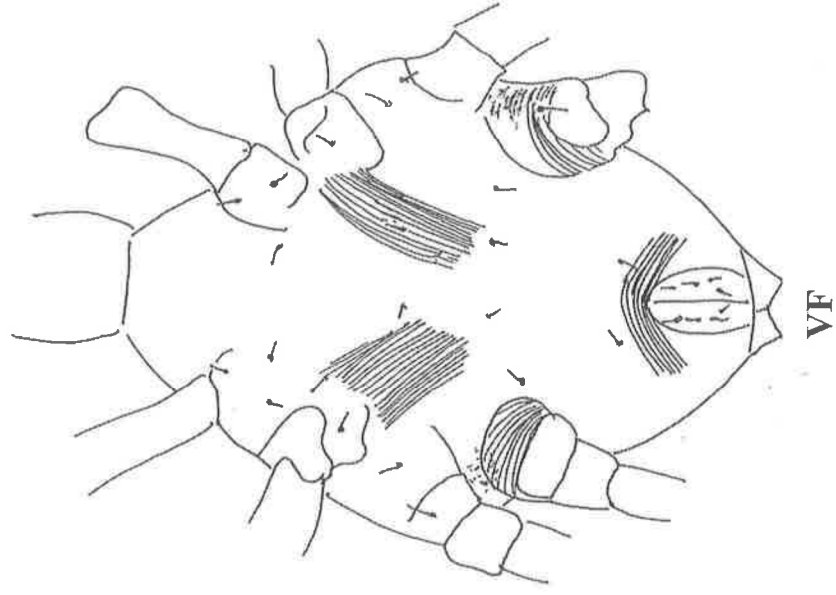
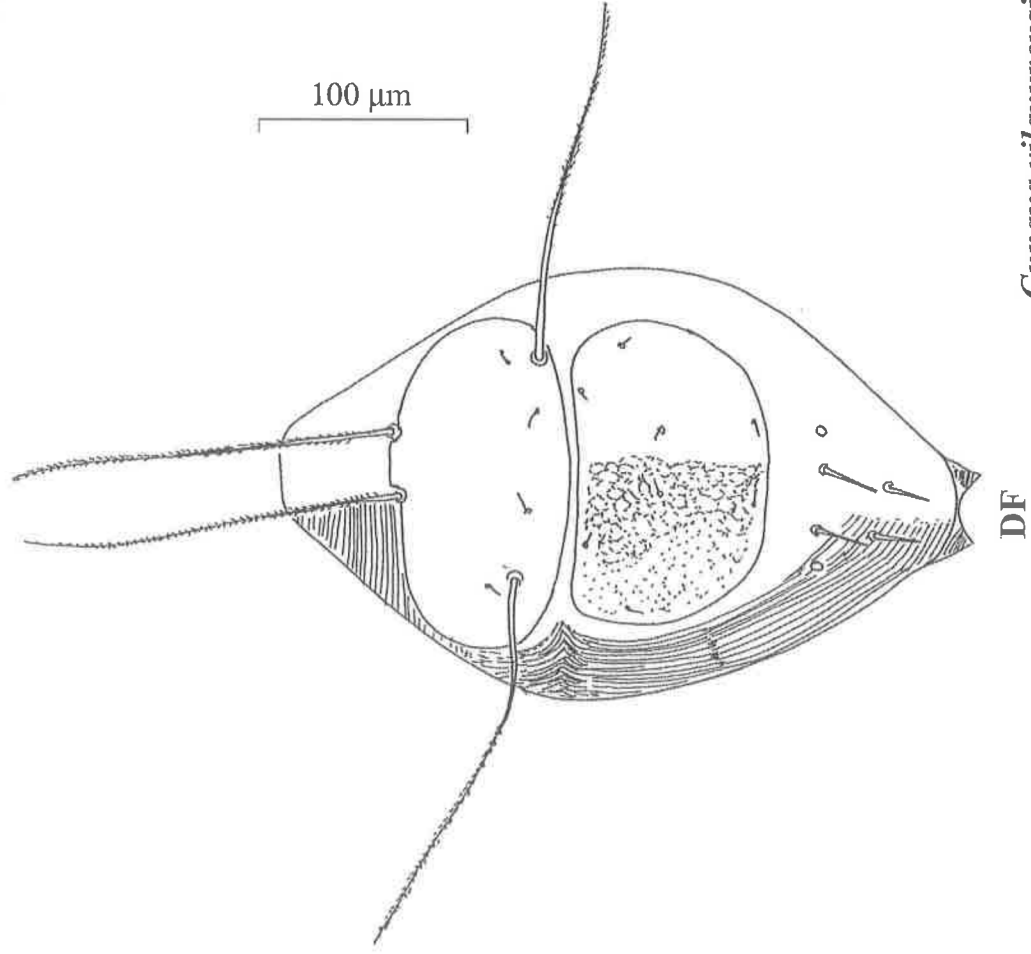
Cunaxa rahuli sp. nov.

PLATE 85B



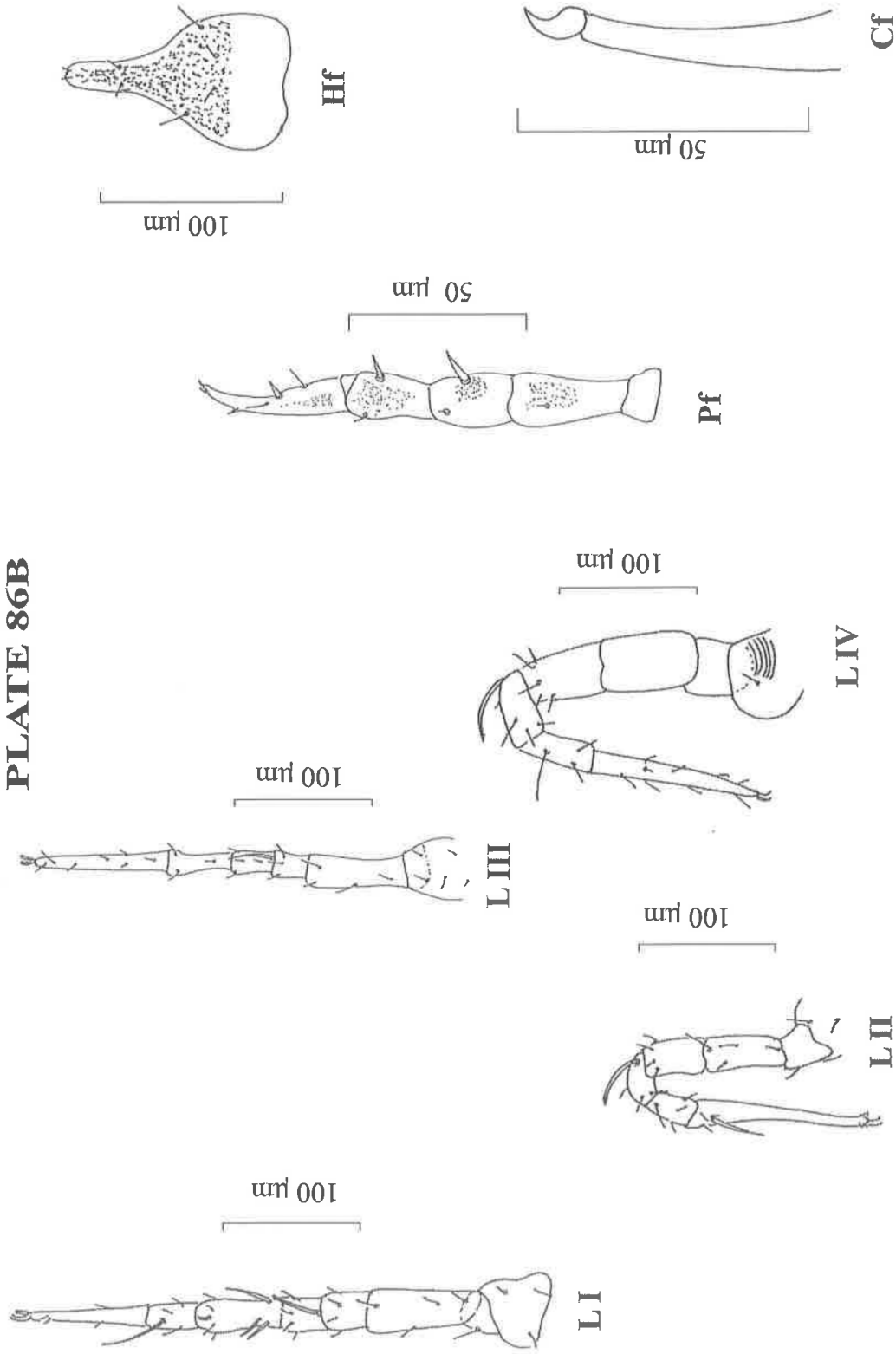
Cunaxa rahuli sp. nov.

PLATE 86A



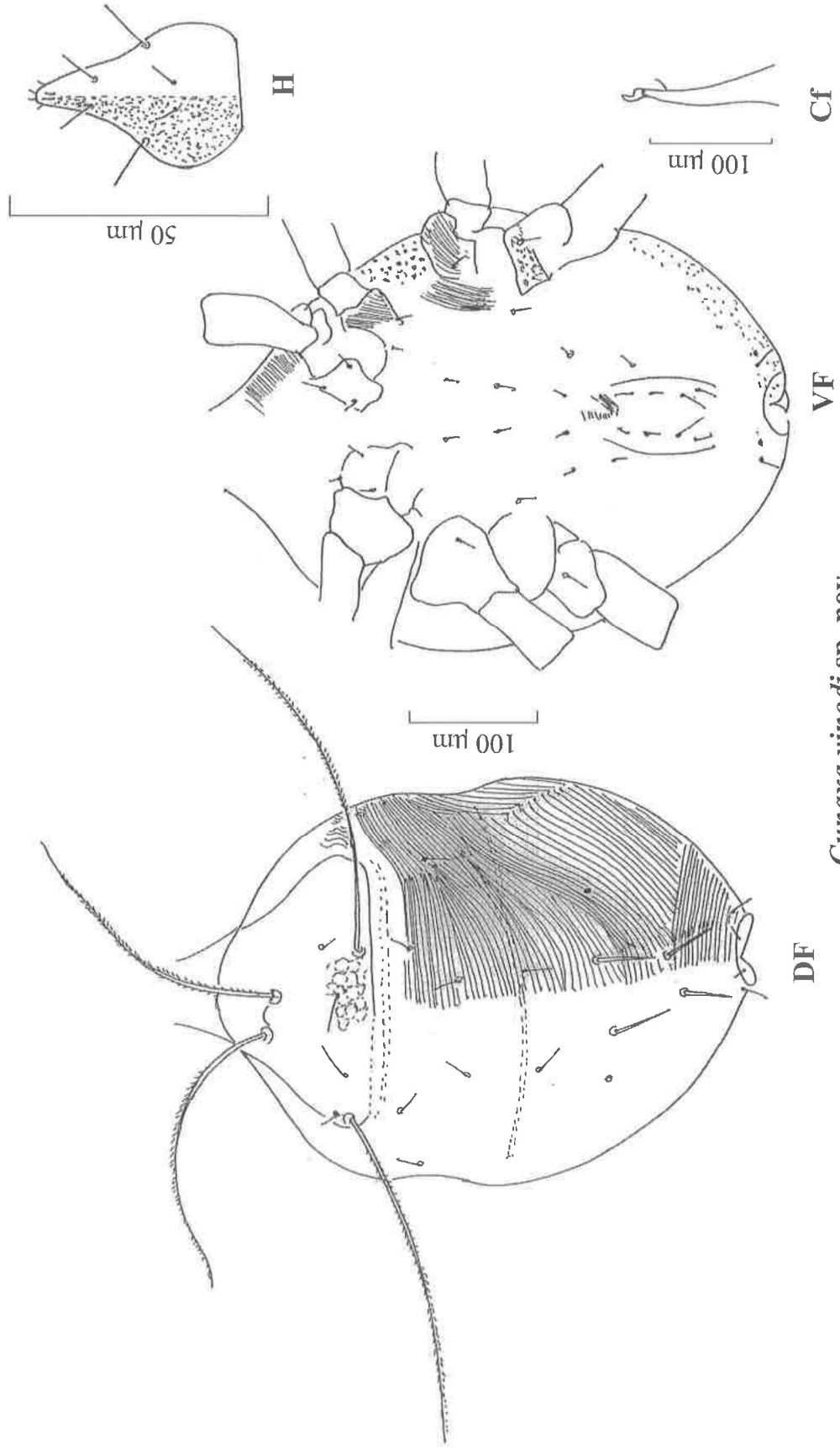
Cunaxa vilayurensis sp. nov.

PLATE 86B



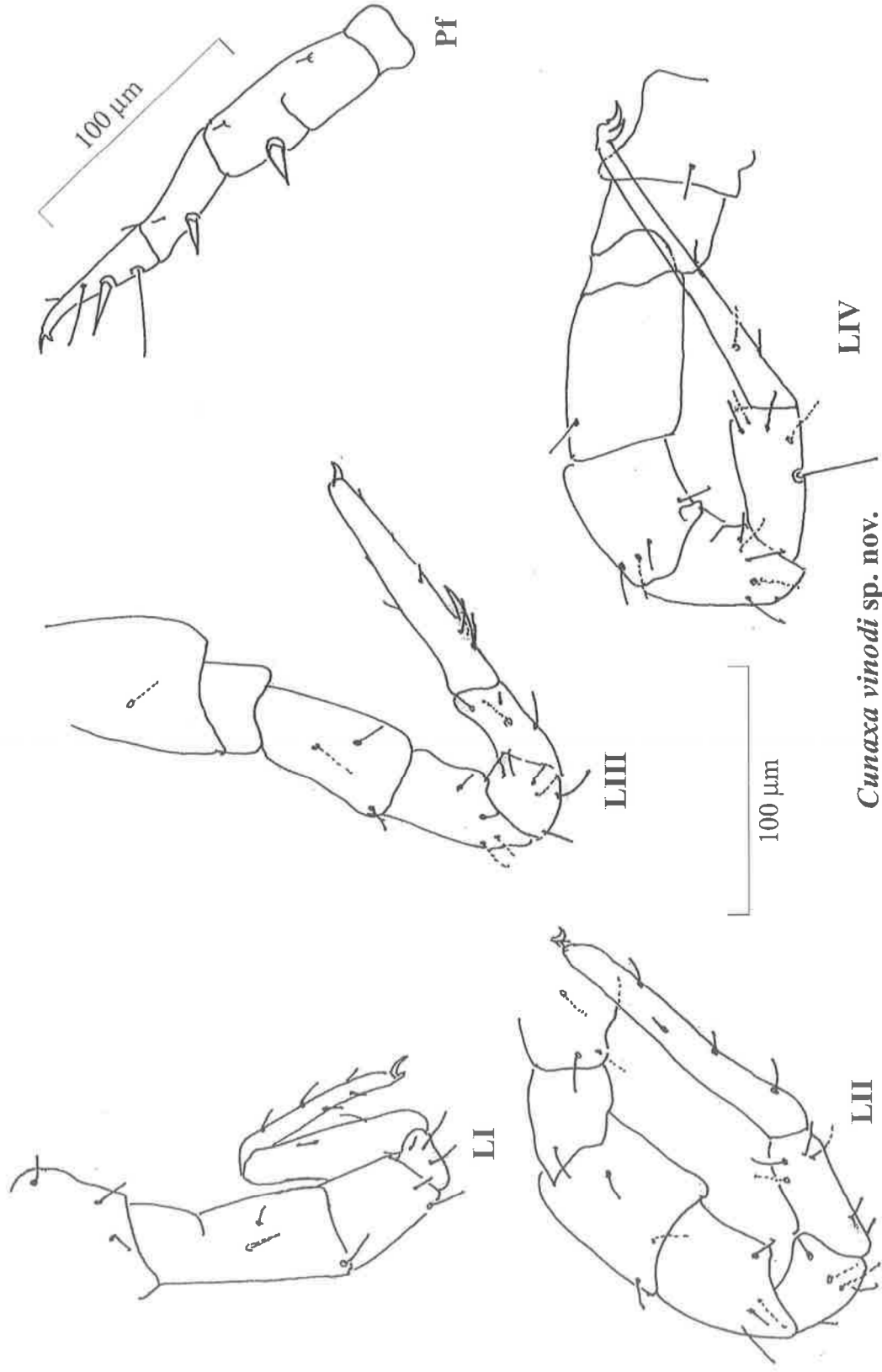
Cunaxa vilayurensis sp. nov.

PLATE 87A



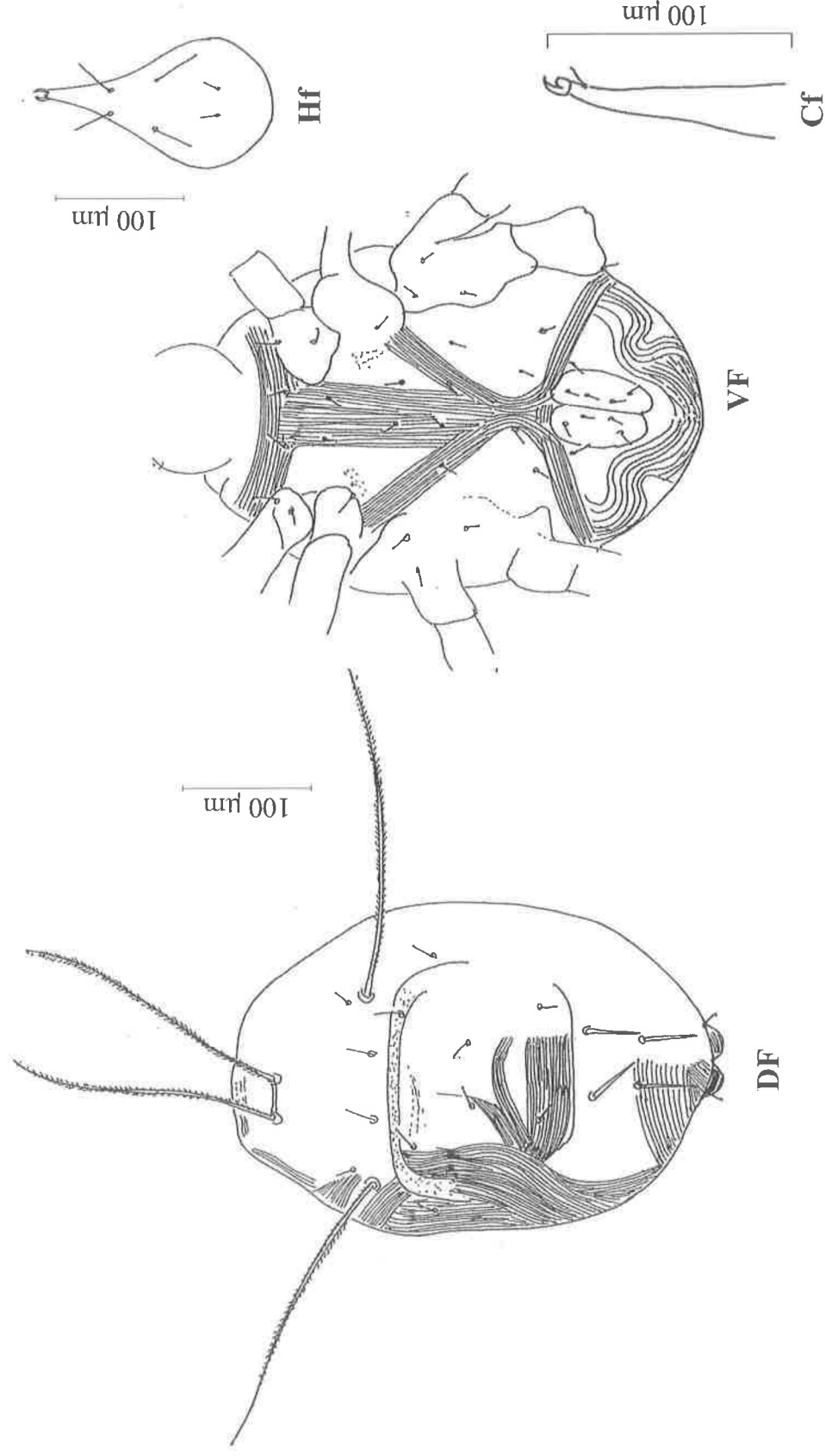
Cunaxa vinodi sp. nov.

PLATE 87B



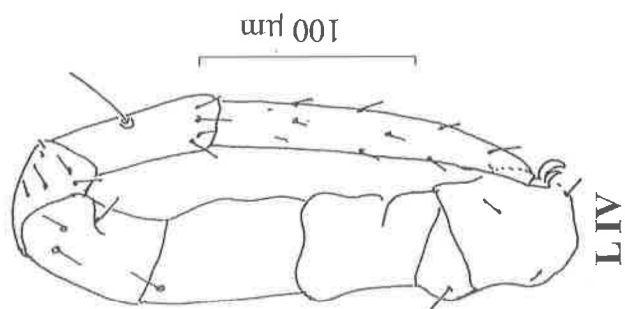
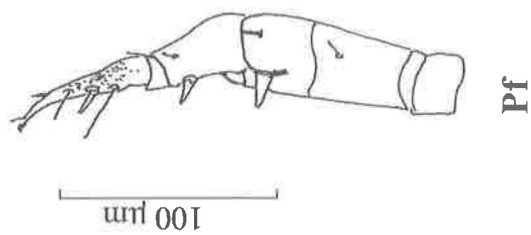
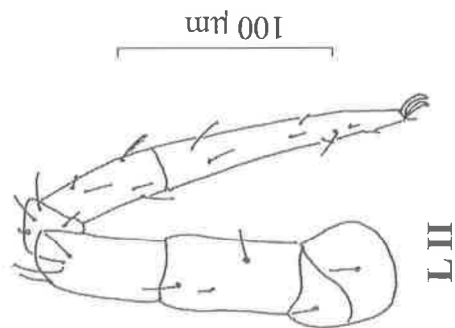
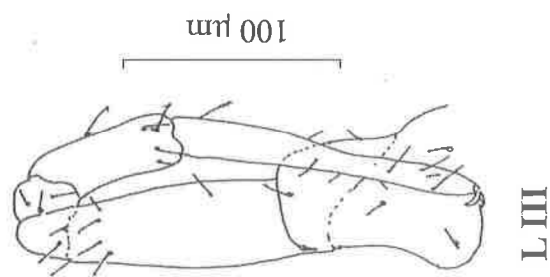
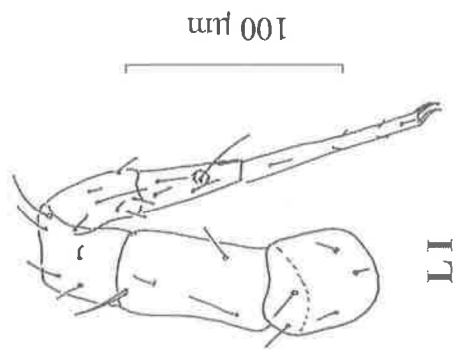
Cunaxa vinodi sp. nov.

PLATE 88A



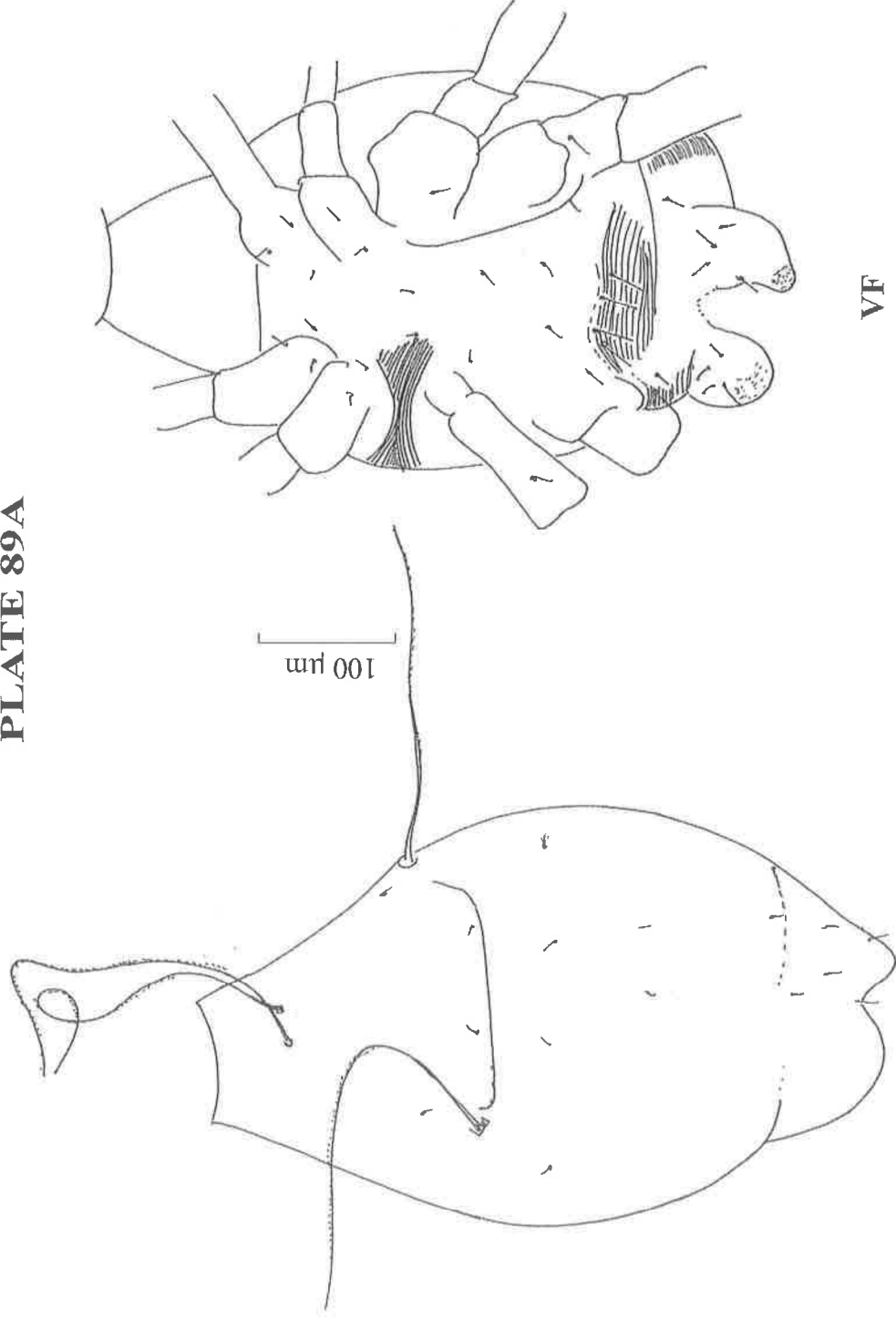
Cunaxa womersleyi Baker and Hoffmann, 1948

PLATE 88B



Cunaxa womersleyi Baker and Hoffmann, 1948

PLATE 89A

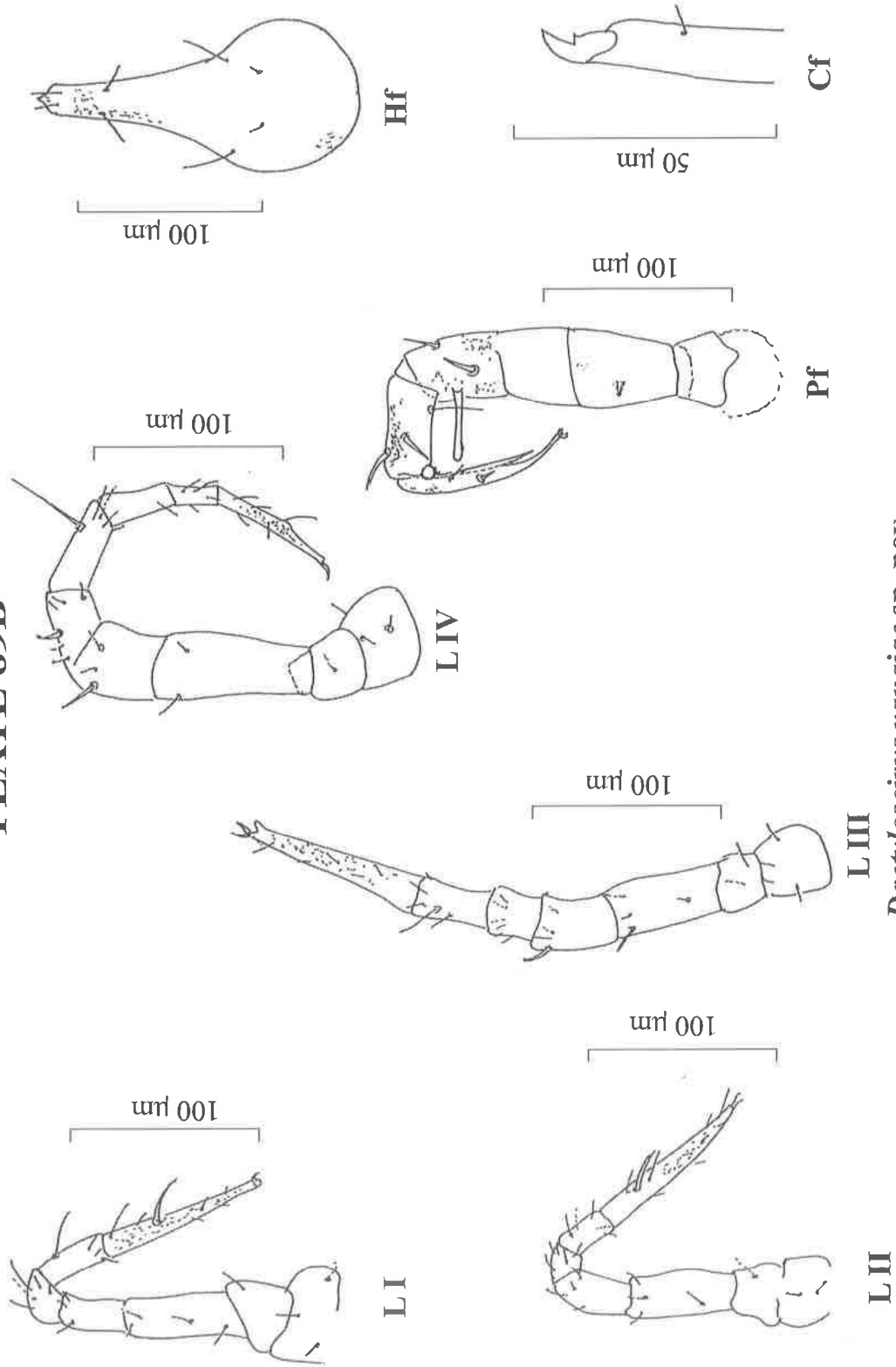


Dactyloscirus vanajae sp. nov.

DF

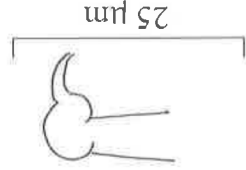
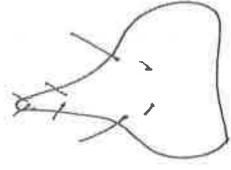
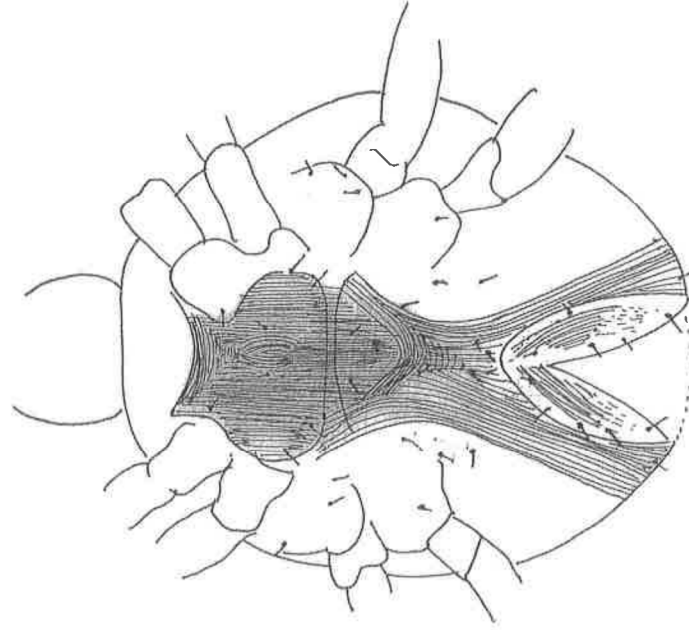
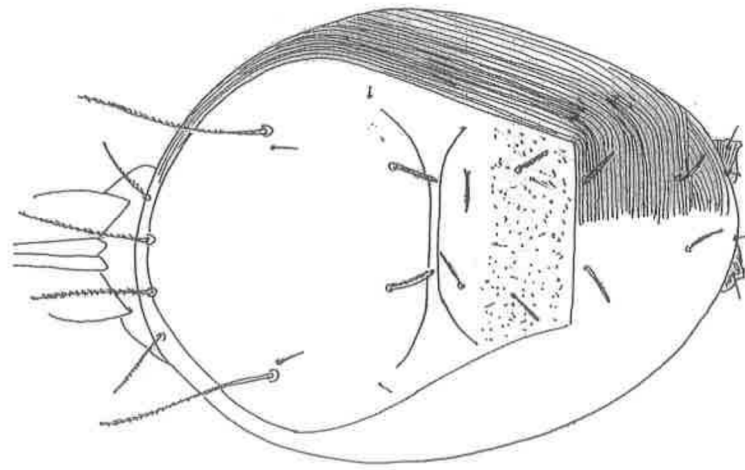
VF

PLATE 89B



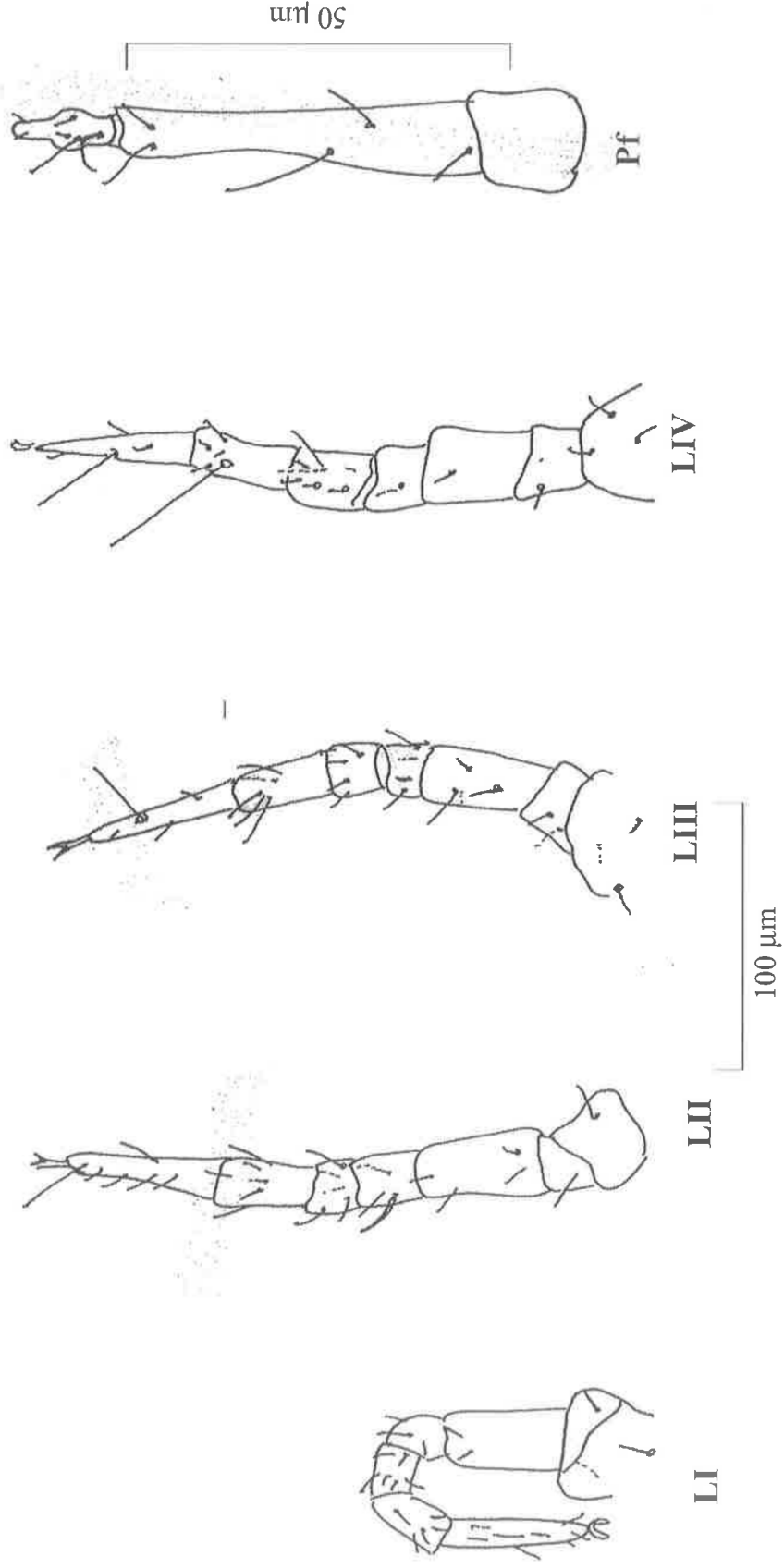
Dactyloscirus vanajae sp. nov.

PLATE 90A



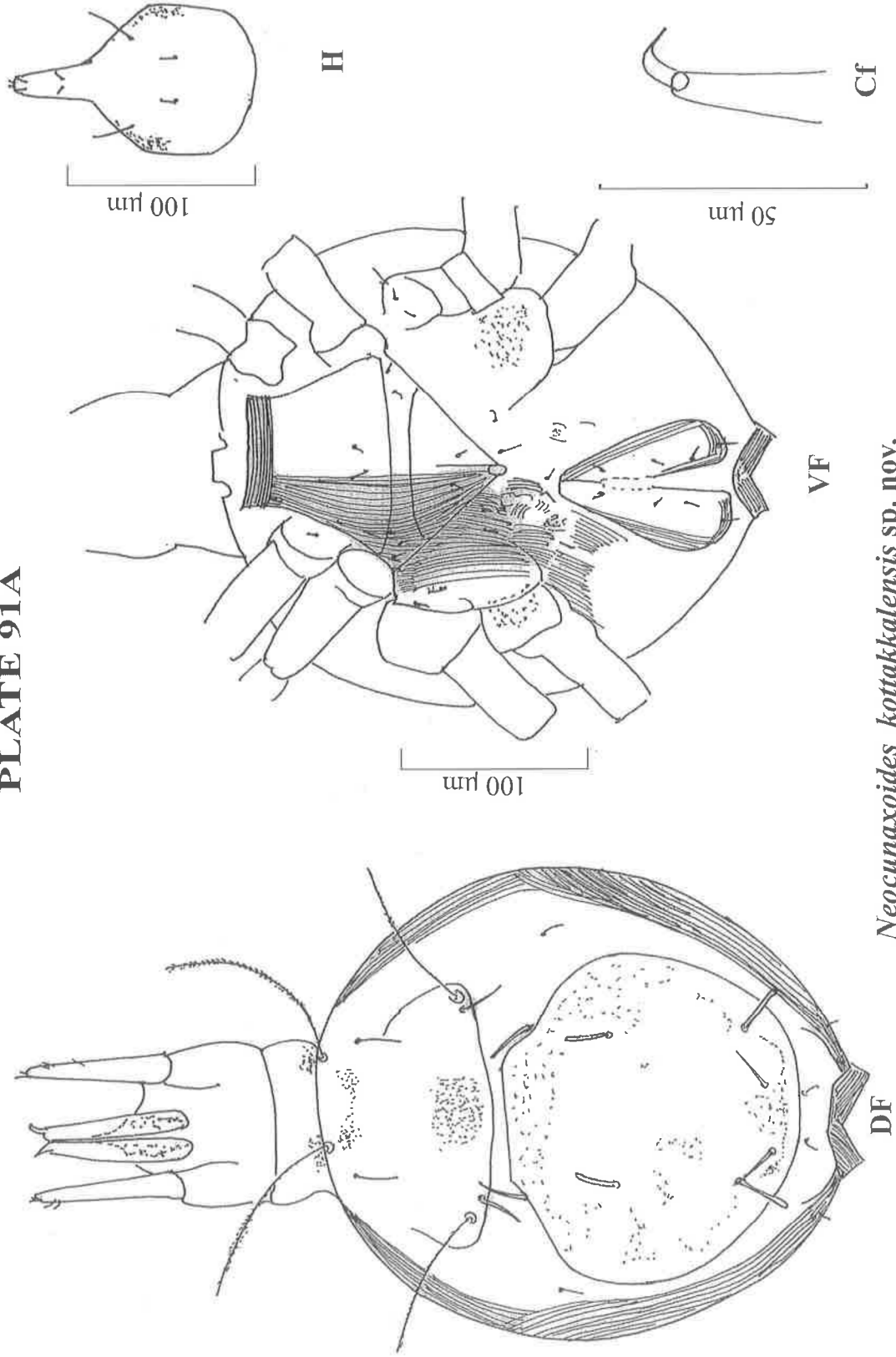
Neocunaxoides anithae sp. nov.

PLATE 90B



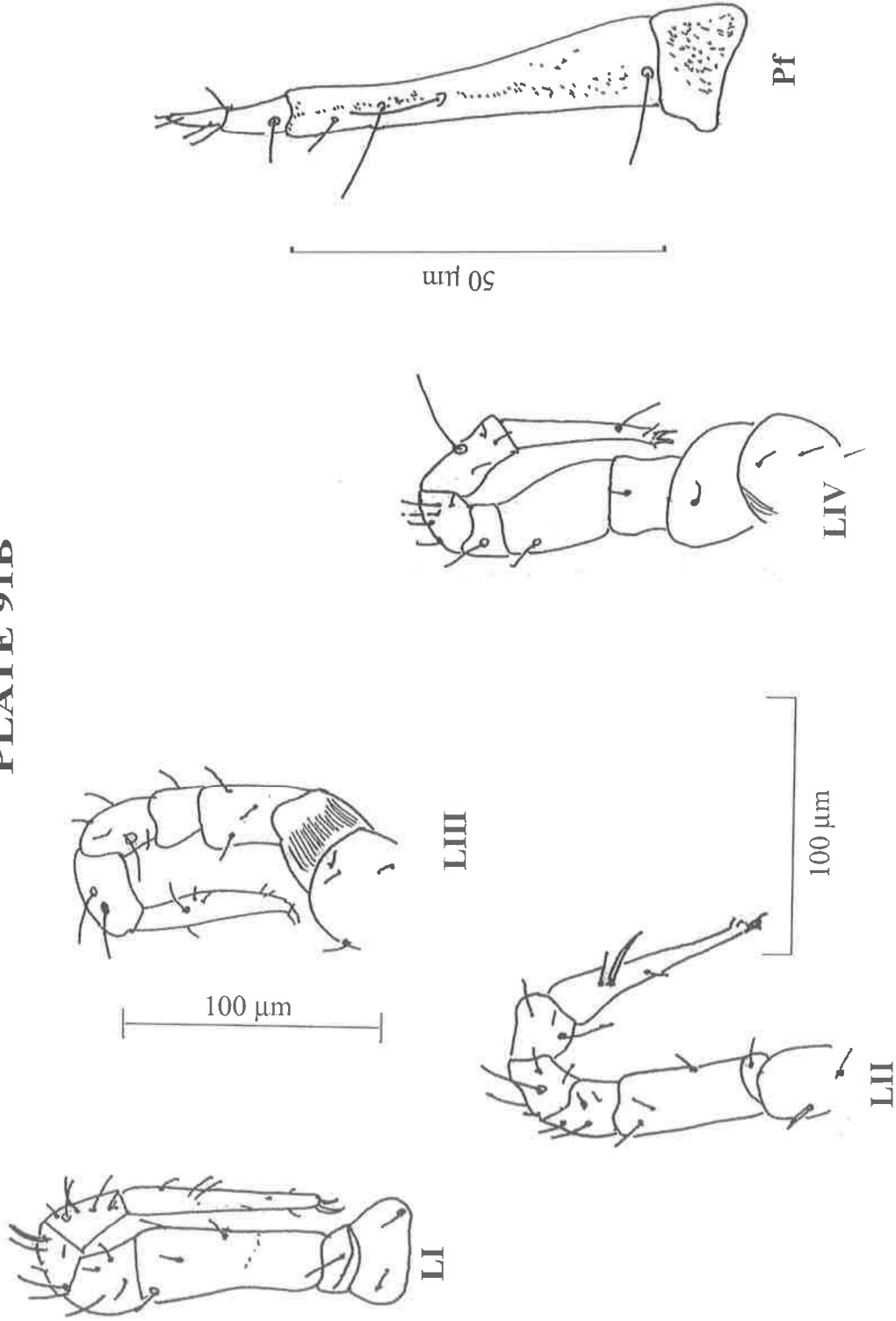
Neocunaxoides anithae sp. nov.

PLATE 91A



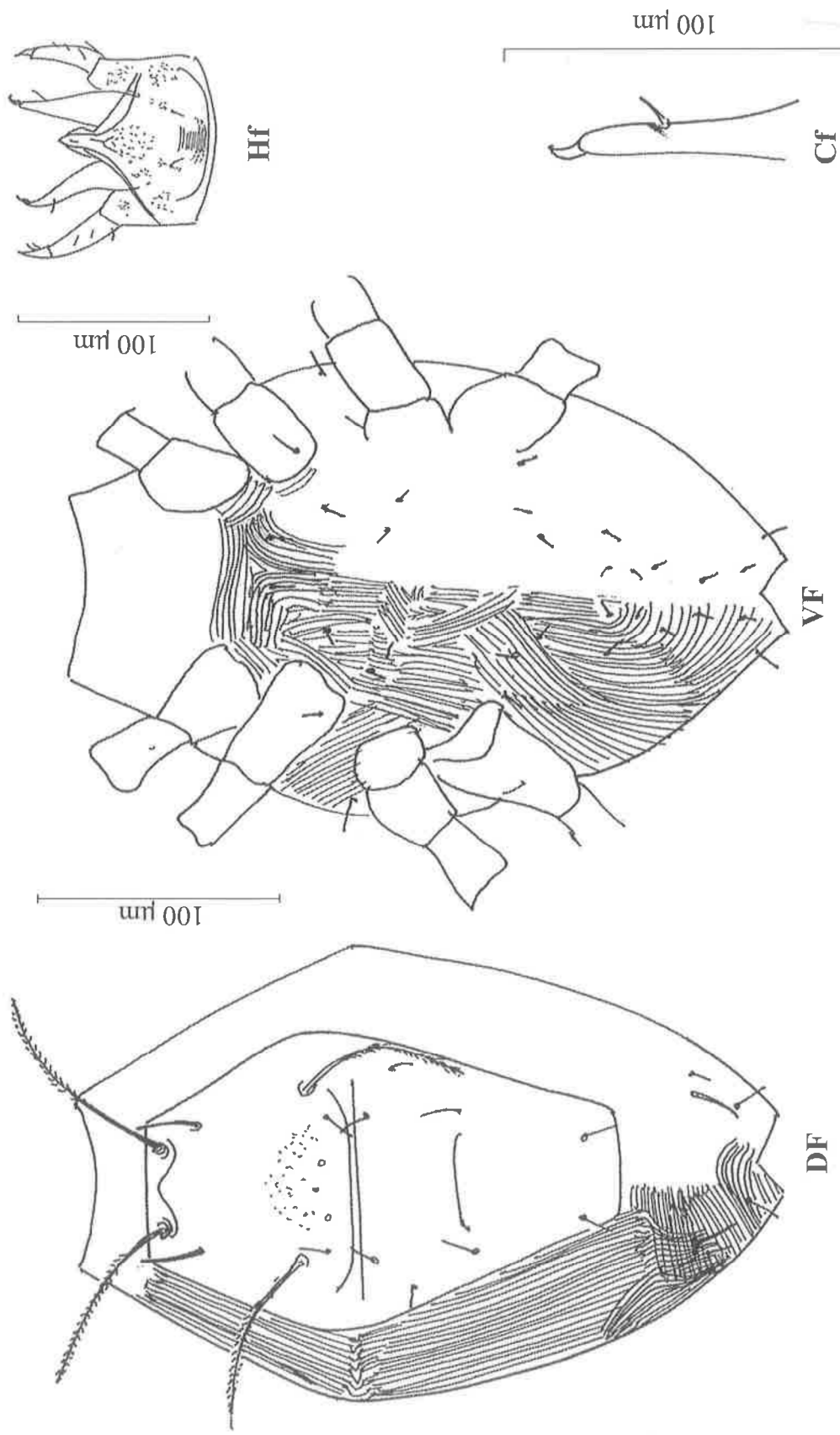
Neocunaxoides kottakkalensis sp. nov.

PLATE 91B



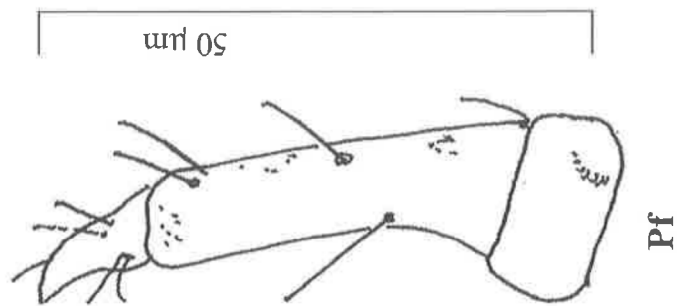
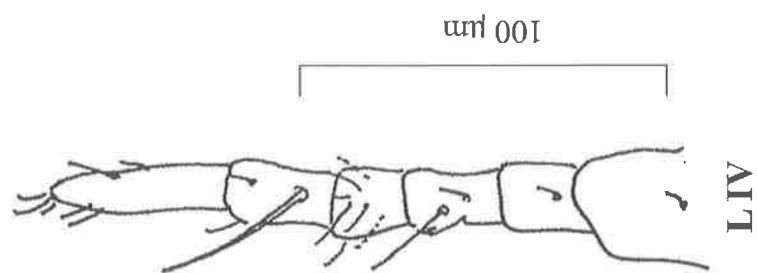
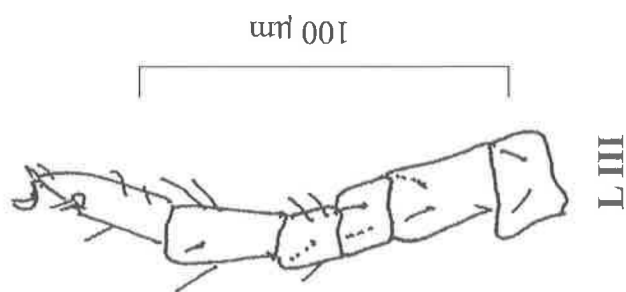
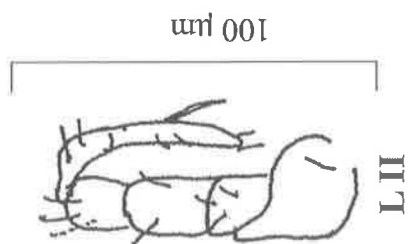
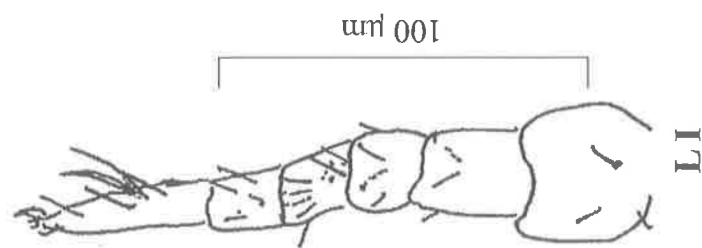
Neocunaxoides kottakkalensis sp. nov.

PLATE 92A



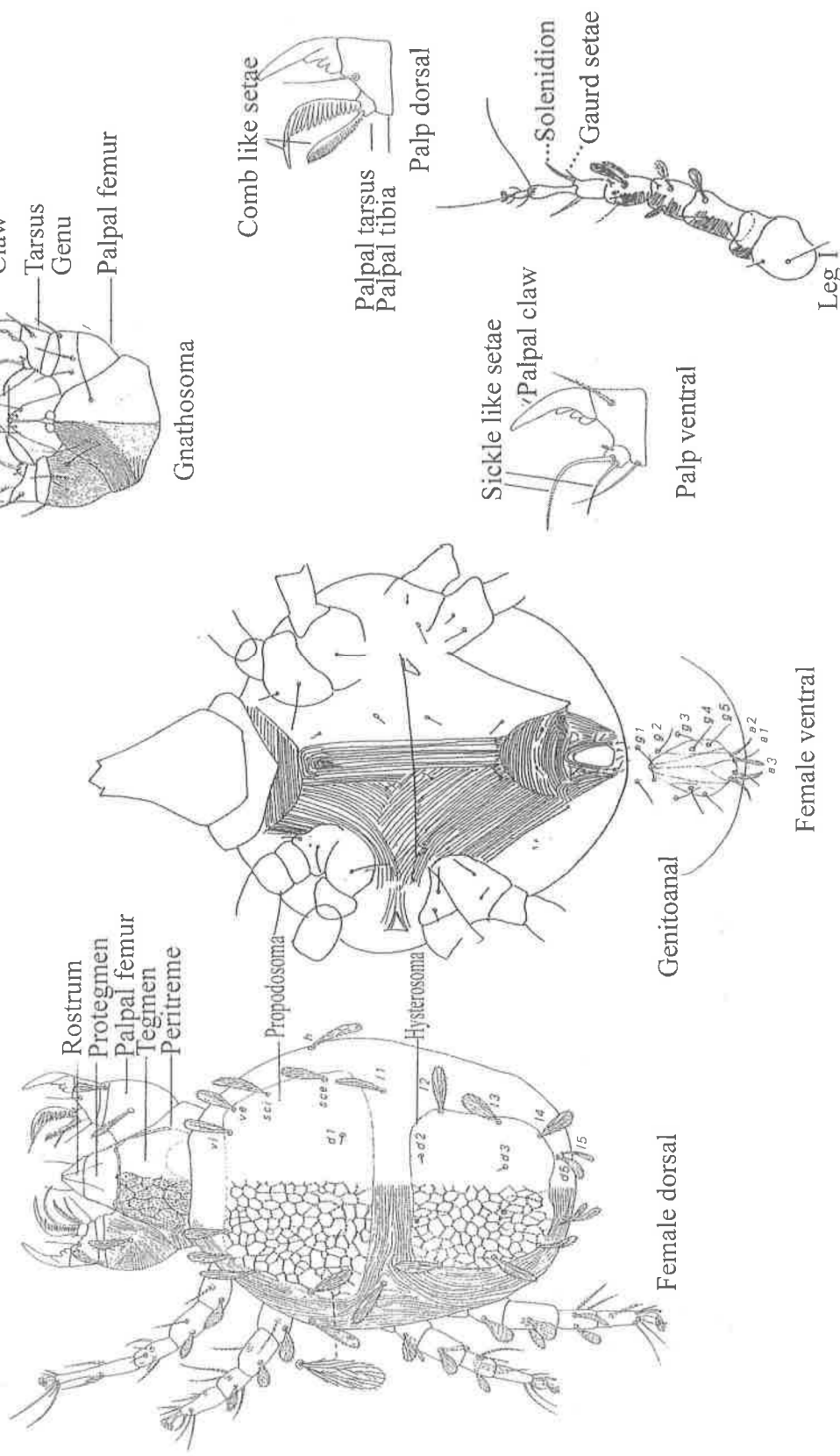
Neocunaxoides raghavani sp. nov.

PLATE 92B



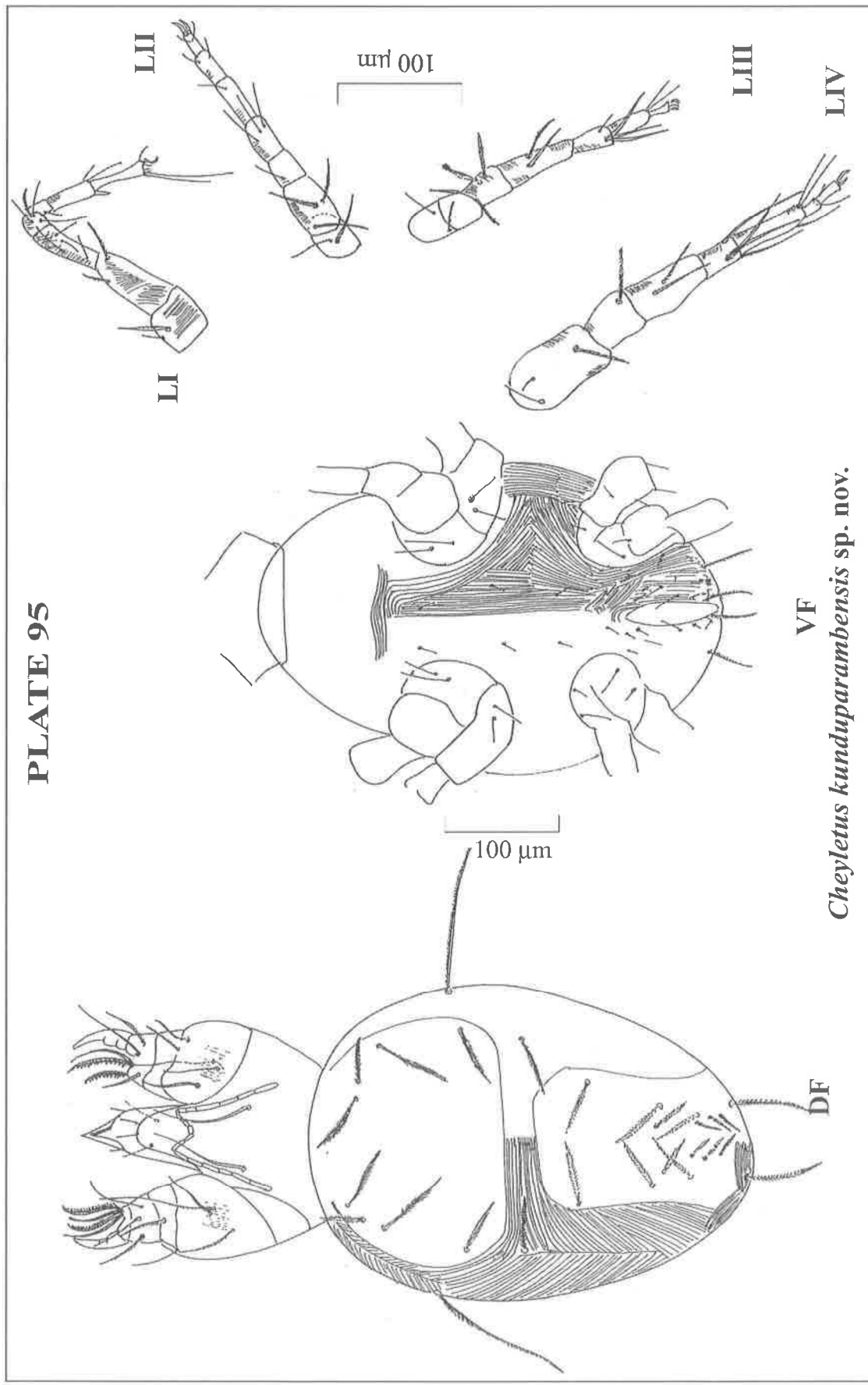
Neocunaxoides raghavani sp. nov.

PLATE 94



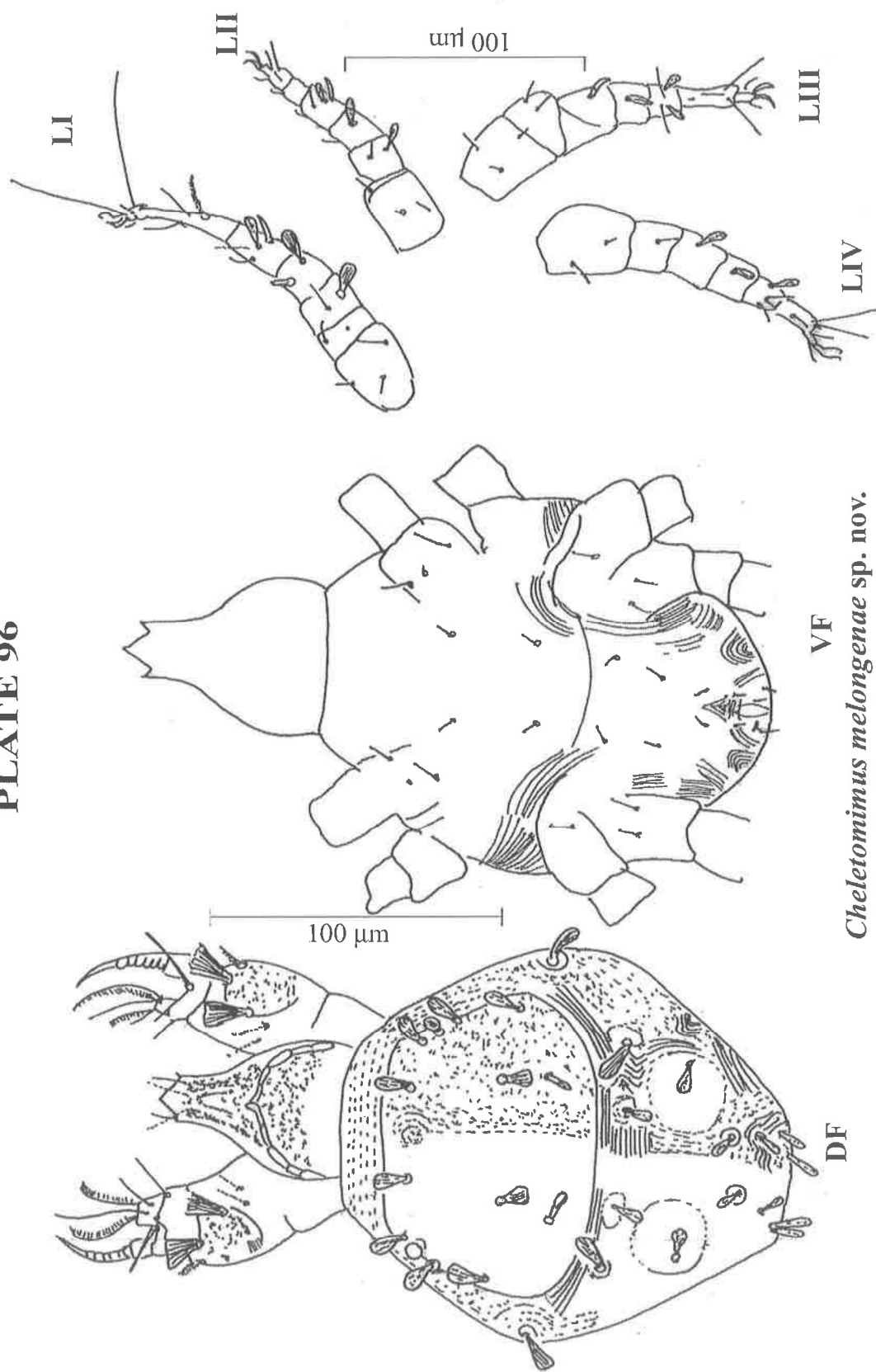
Morphological and Taxonomical characters of the family Chyletidae Leach, 1815

PLATE 95



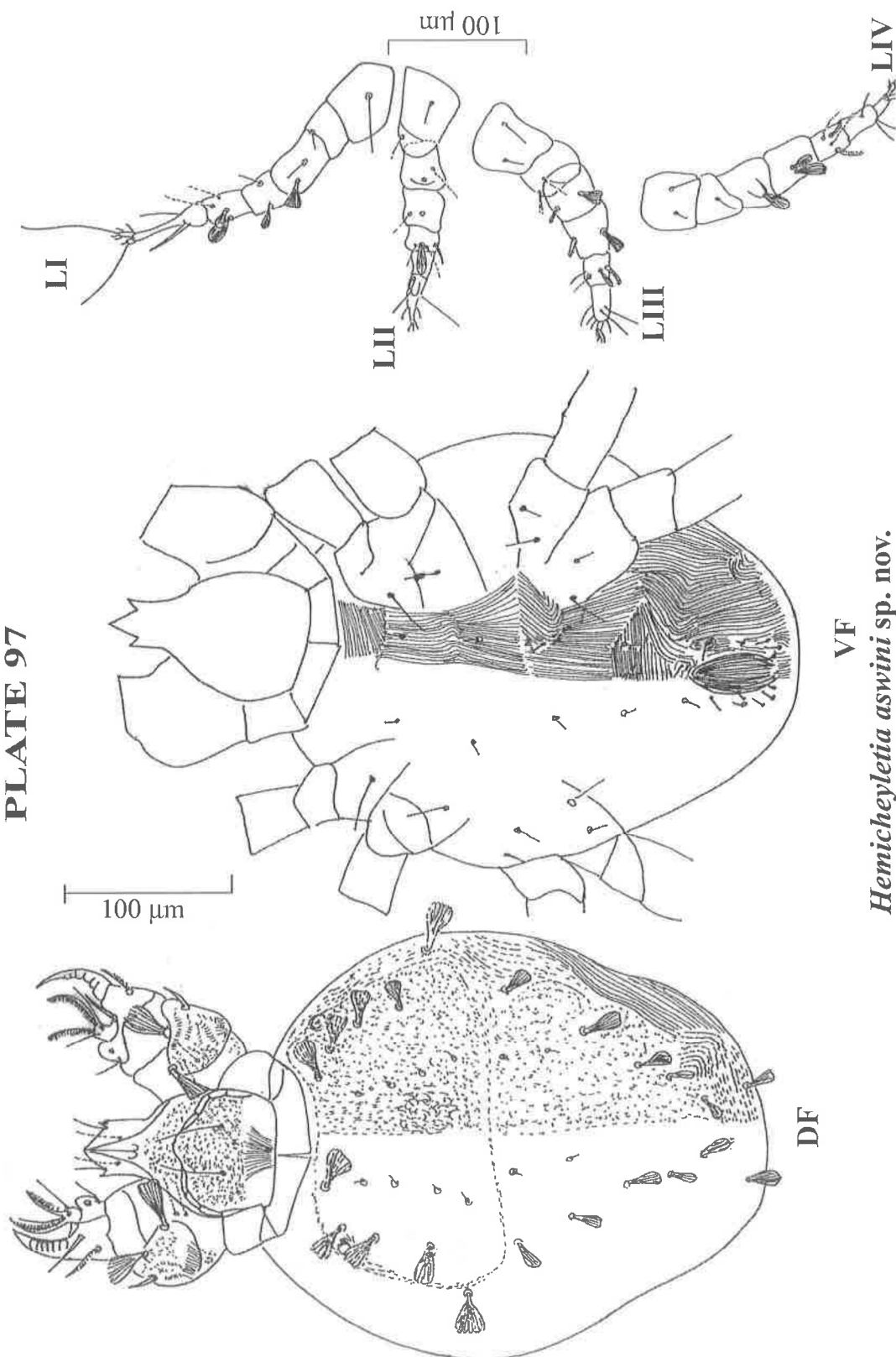
Cheyletus kunduparambensis sp. nov.

PLATE 96



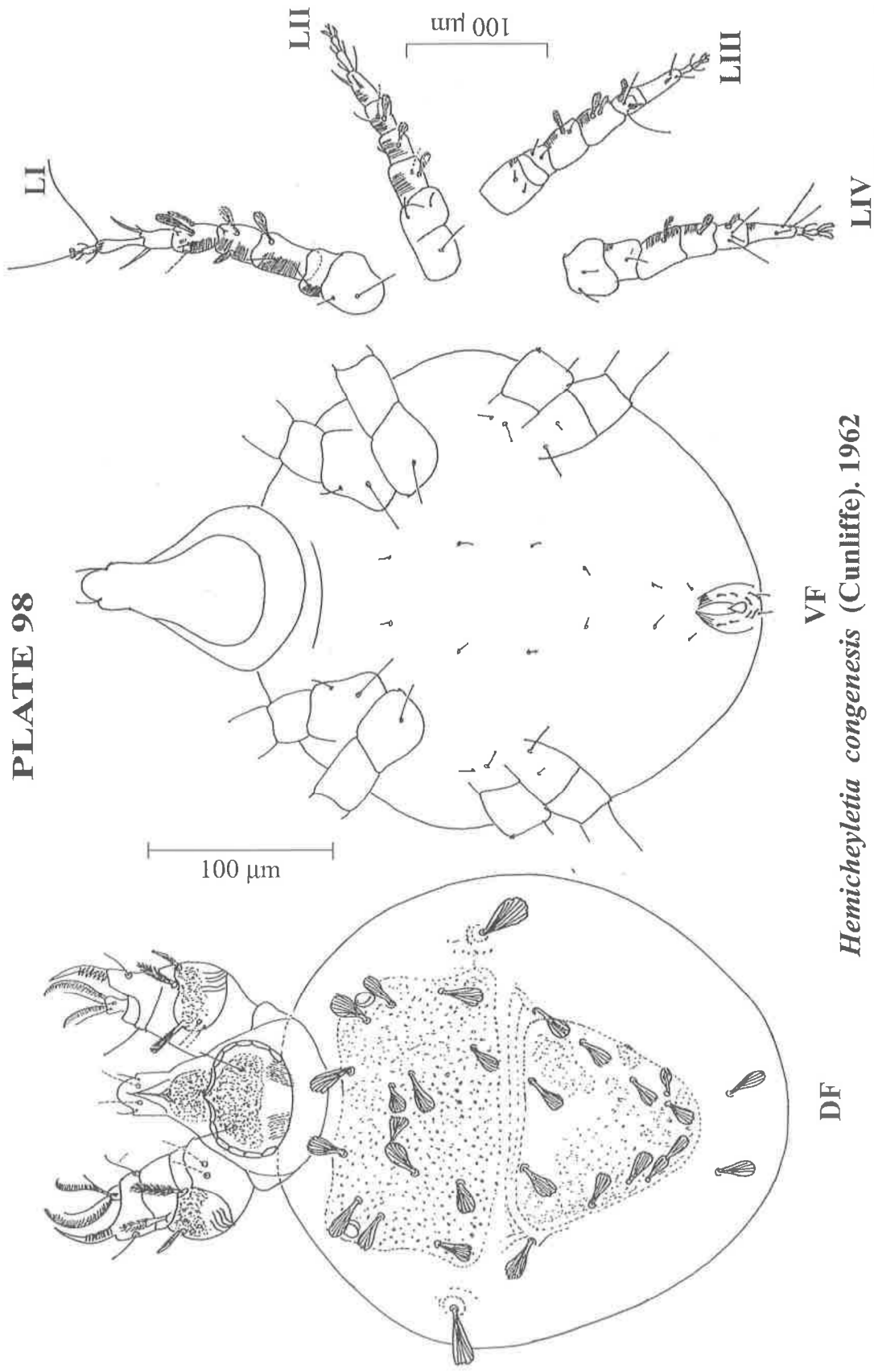
Cheletominus melongenae sp. nov.

PLATE 97



Hemicheyletia aswini sp. nov.

PLATE 98



Hemicheyletia congenesis (Cunliffe). 1962

PLATE 99

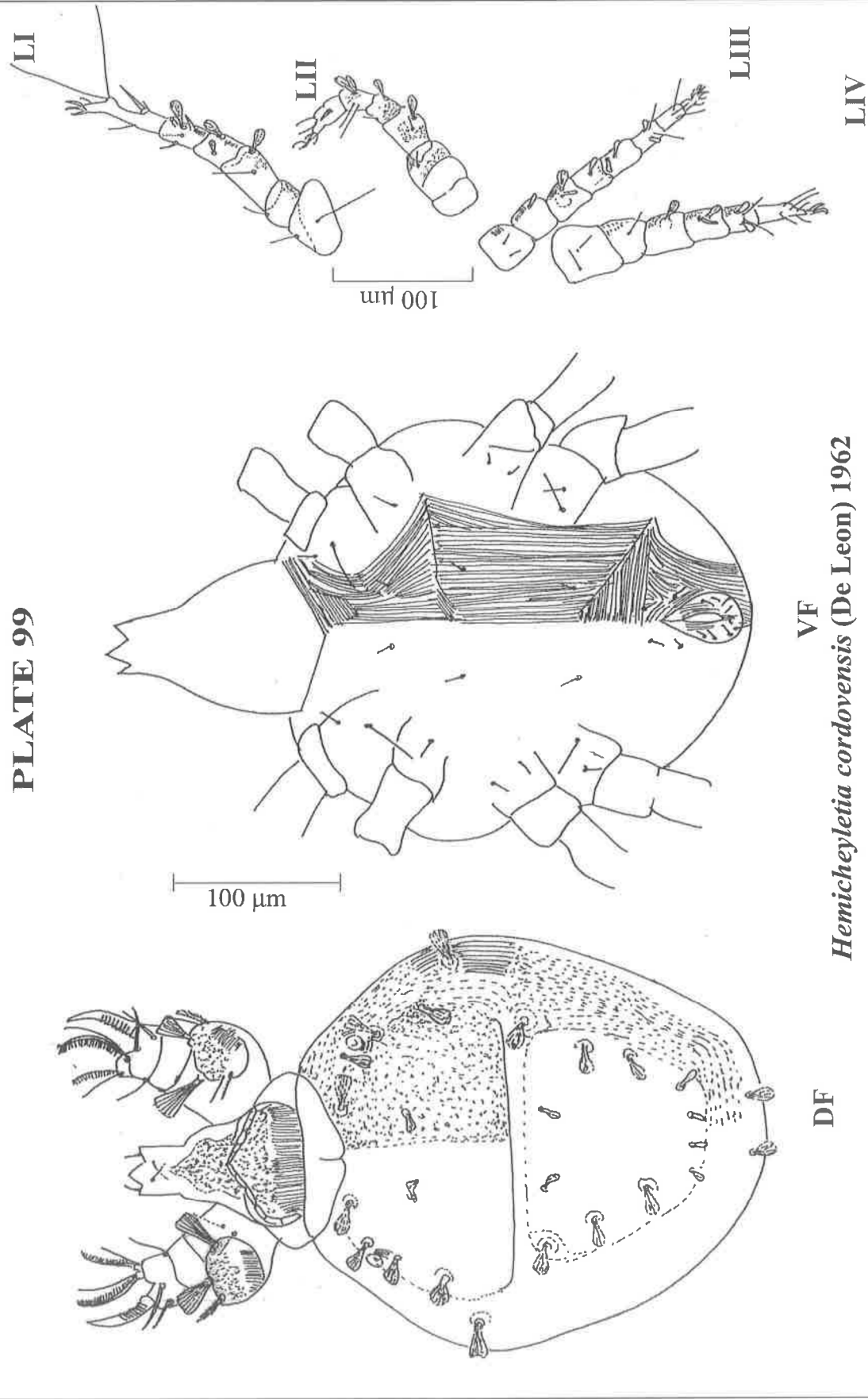
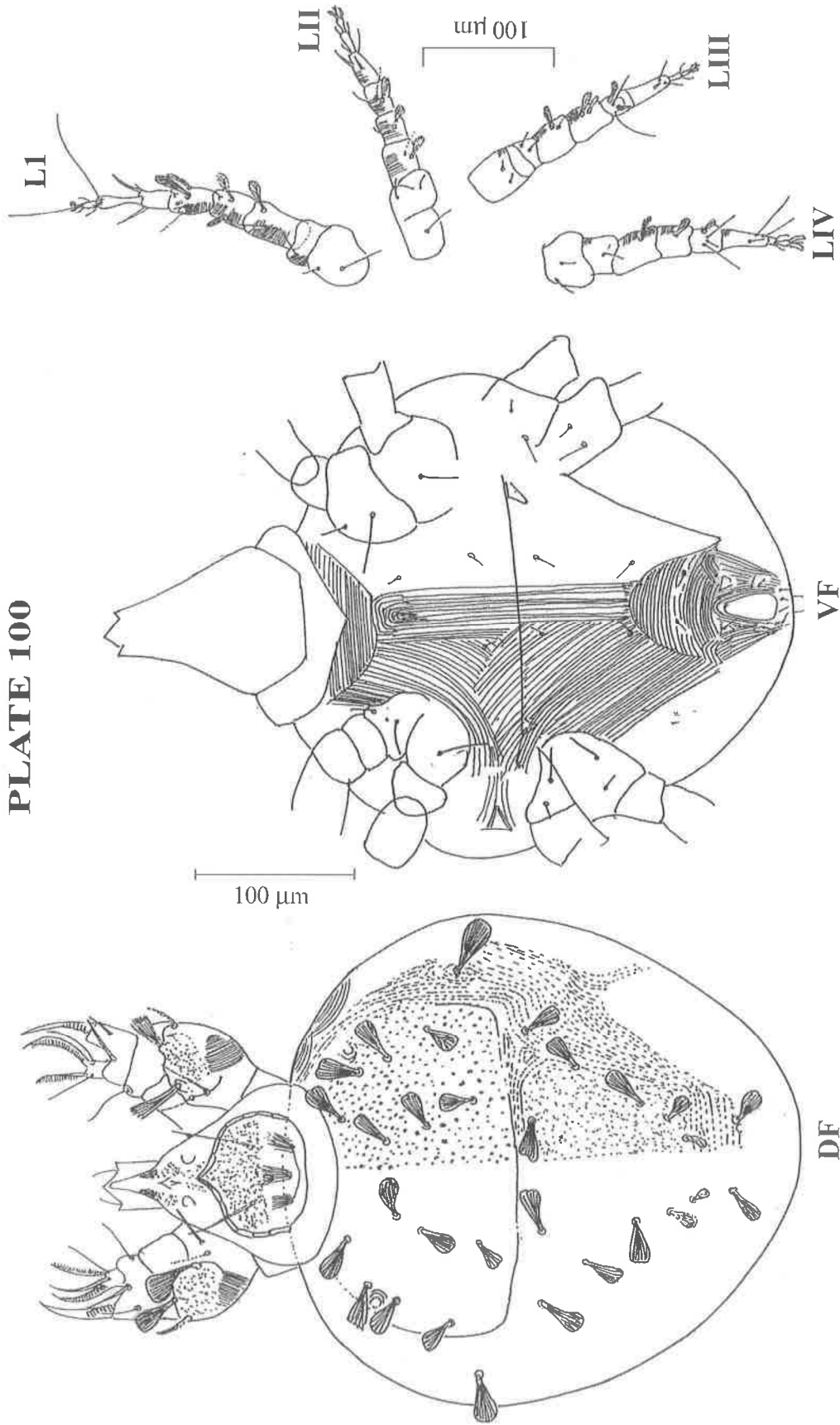
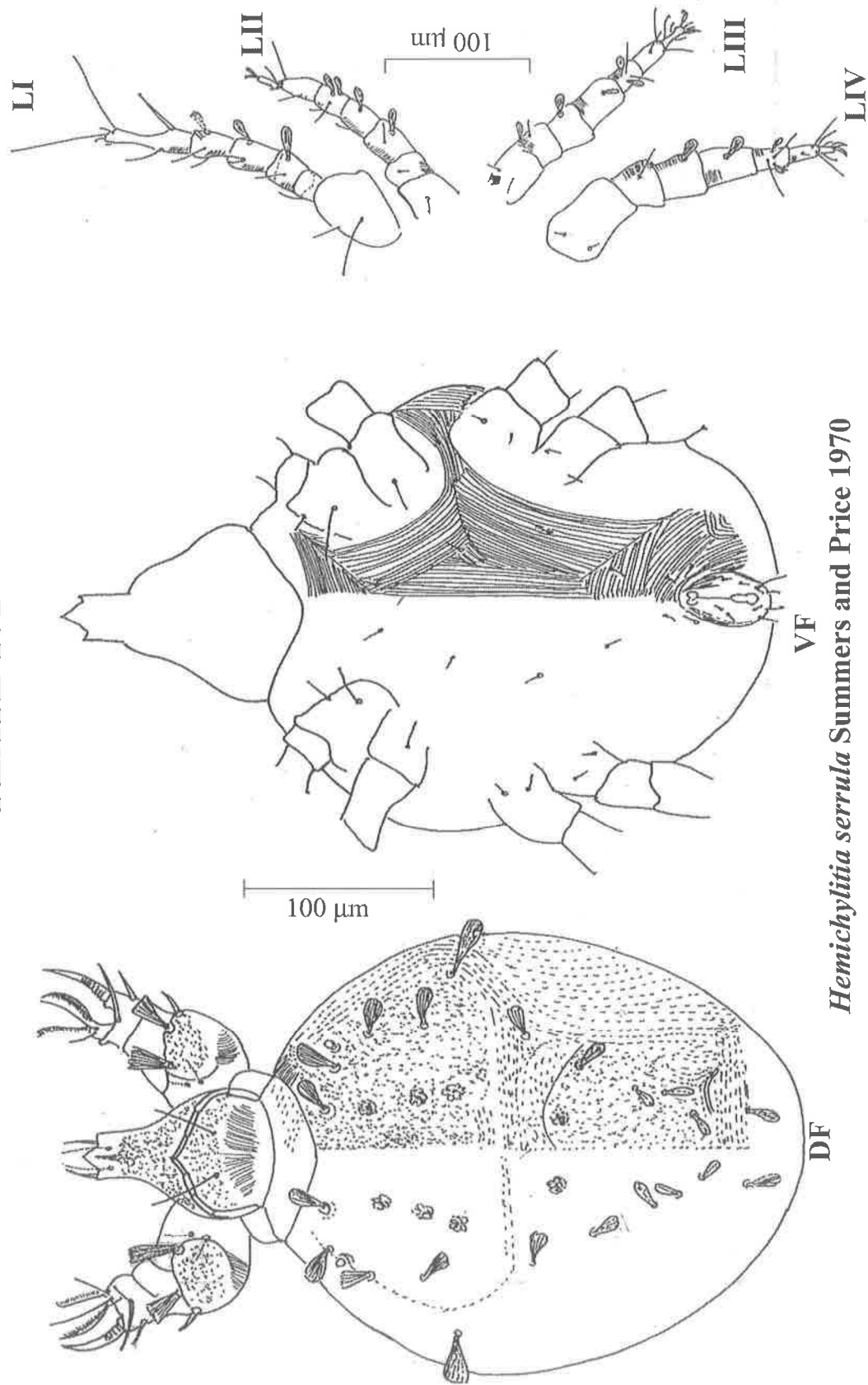


PLATE 100



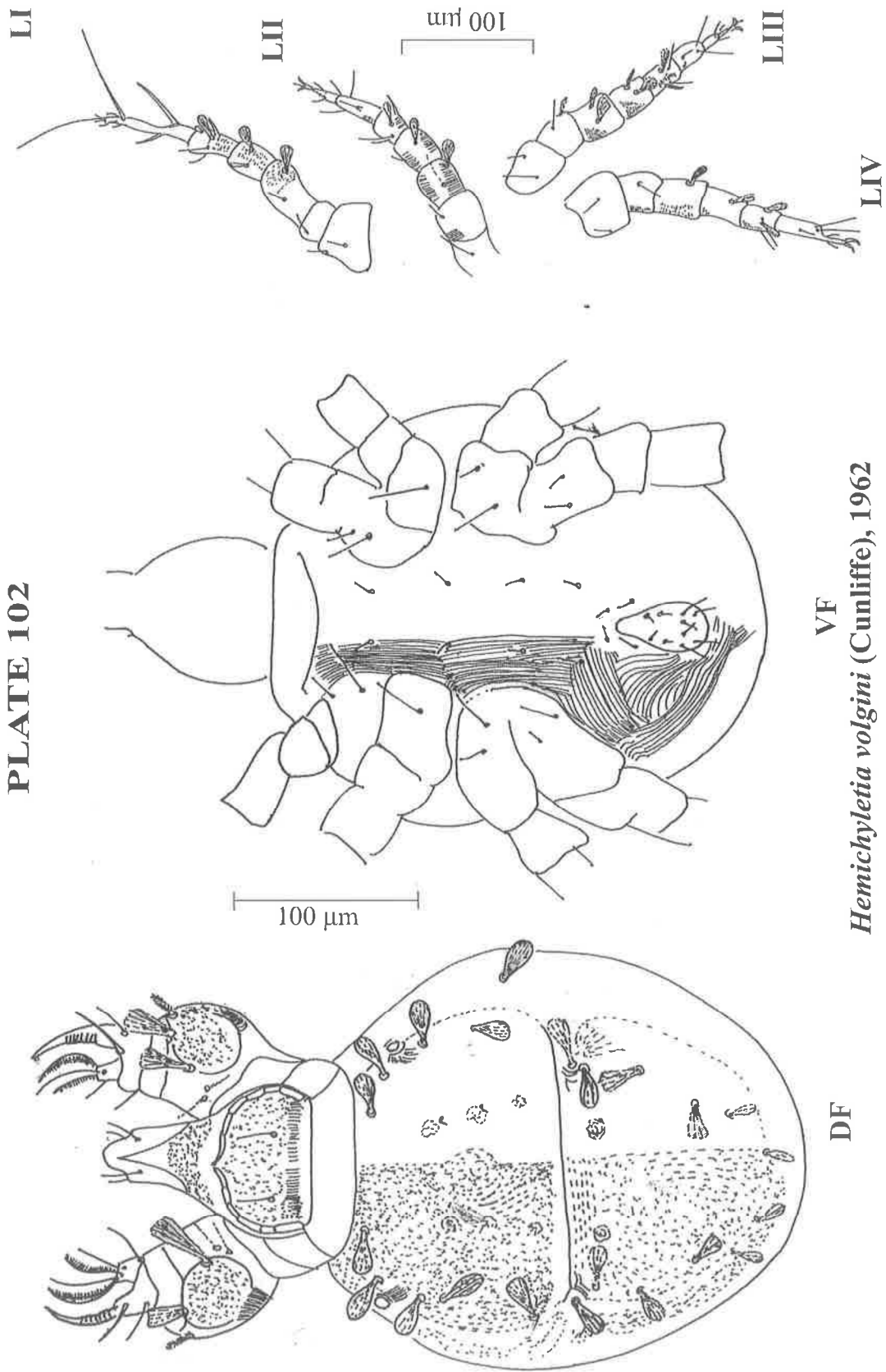
Hemecheyletia parvathiae sp. nov.

PLATE 101



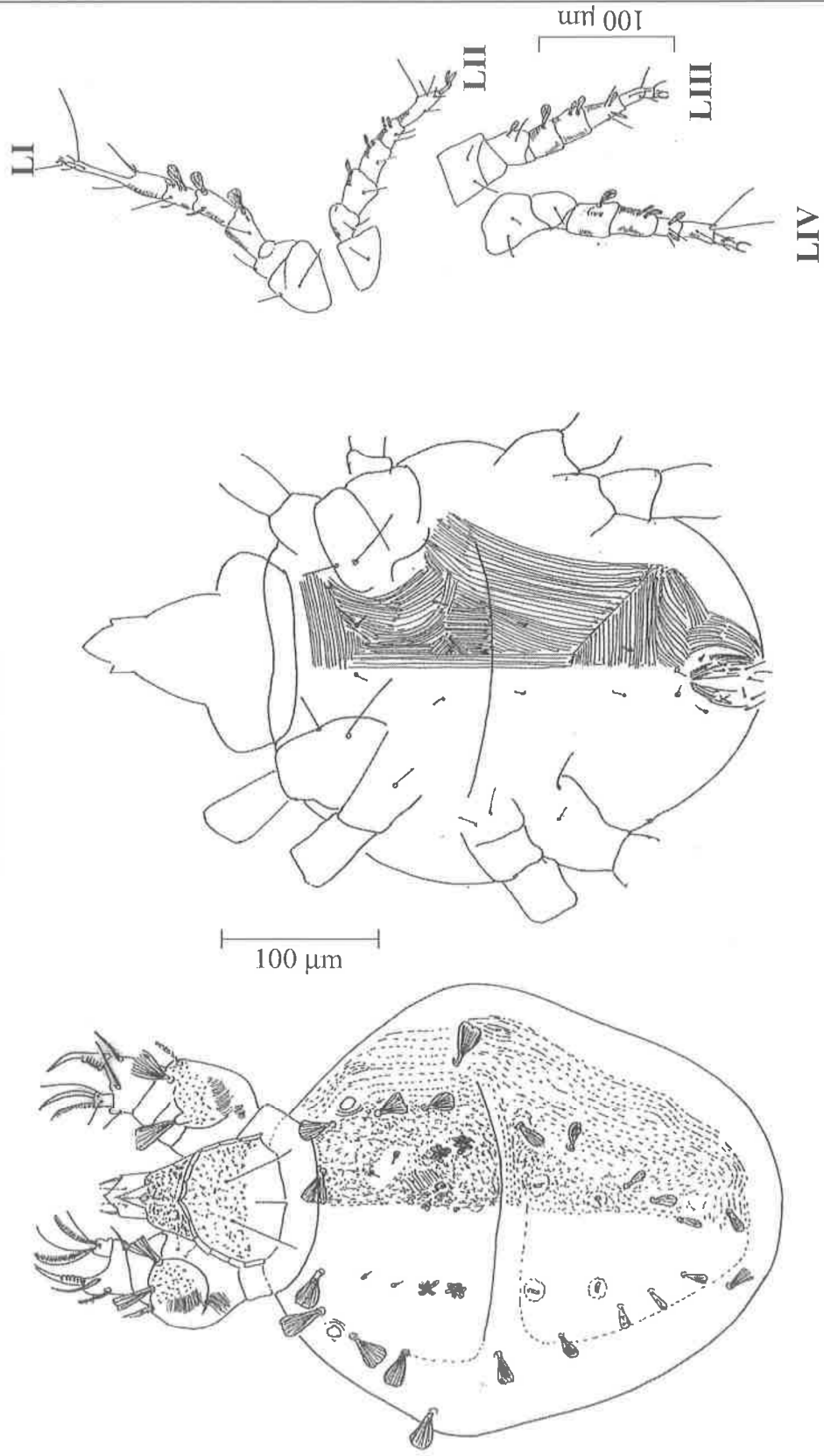
Hemichylitia serrula Summers and Price 1970

PLATE 102



Hemichyletia volgini (Cunliffe), 1962

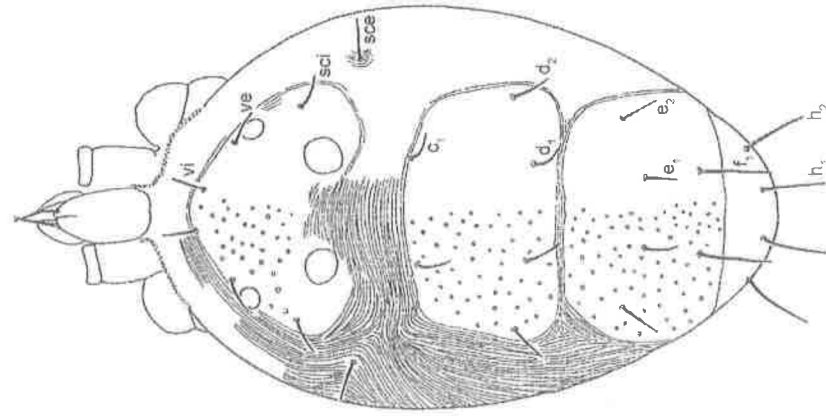
PLATE 103



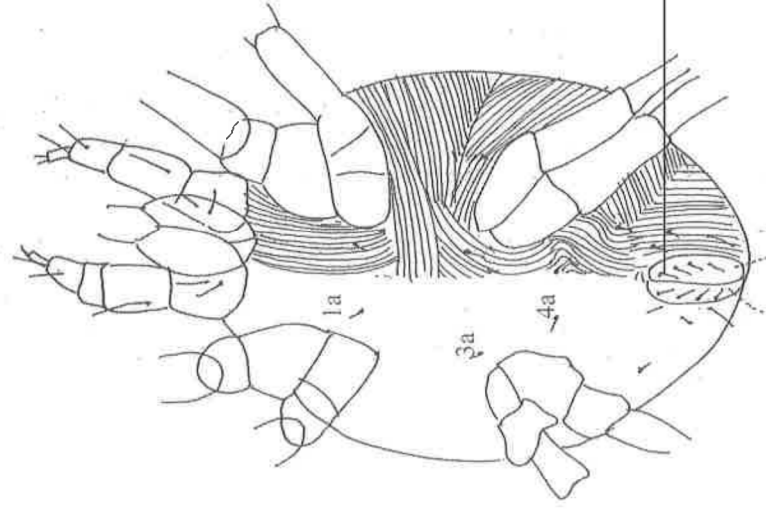
VF
Hemicheyletia wellsi (Baker), 1949

DF

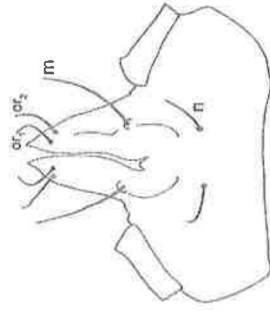
PLATE 105



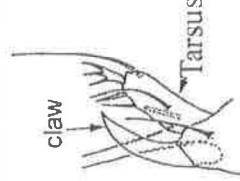
Female dorsal view



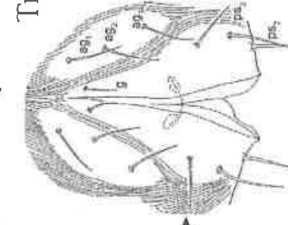
Female ventral view



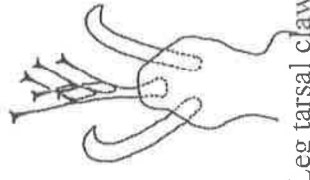
Gnathosoma dorsal view



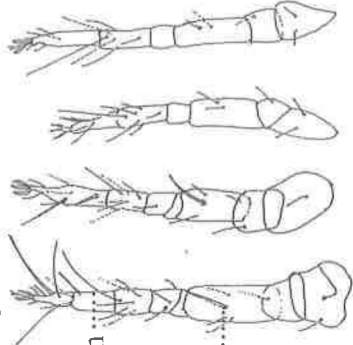
Palp tibial claw



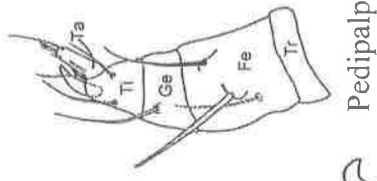
Genital setae



Leg tarsal claw



Leg I-IV

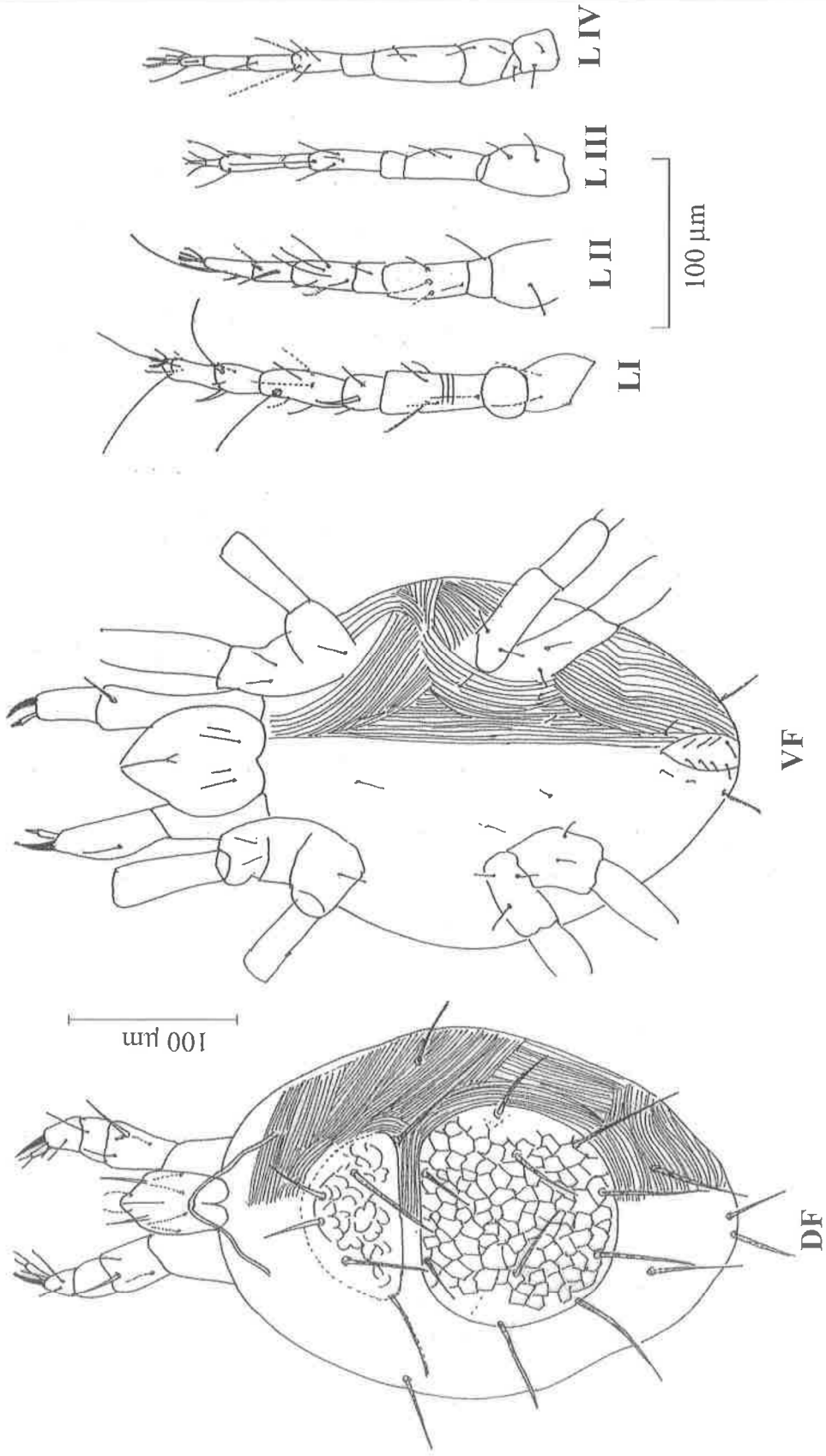


Pedipalp

Trichobothrium

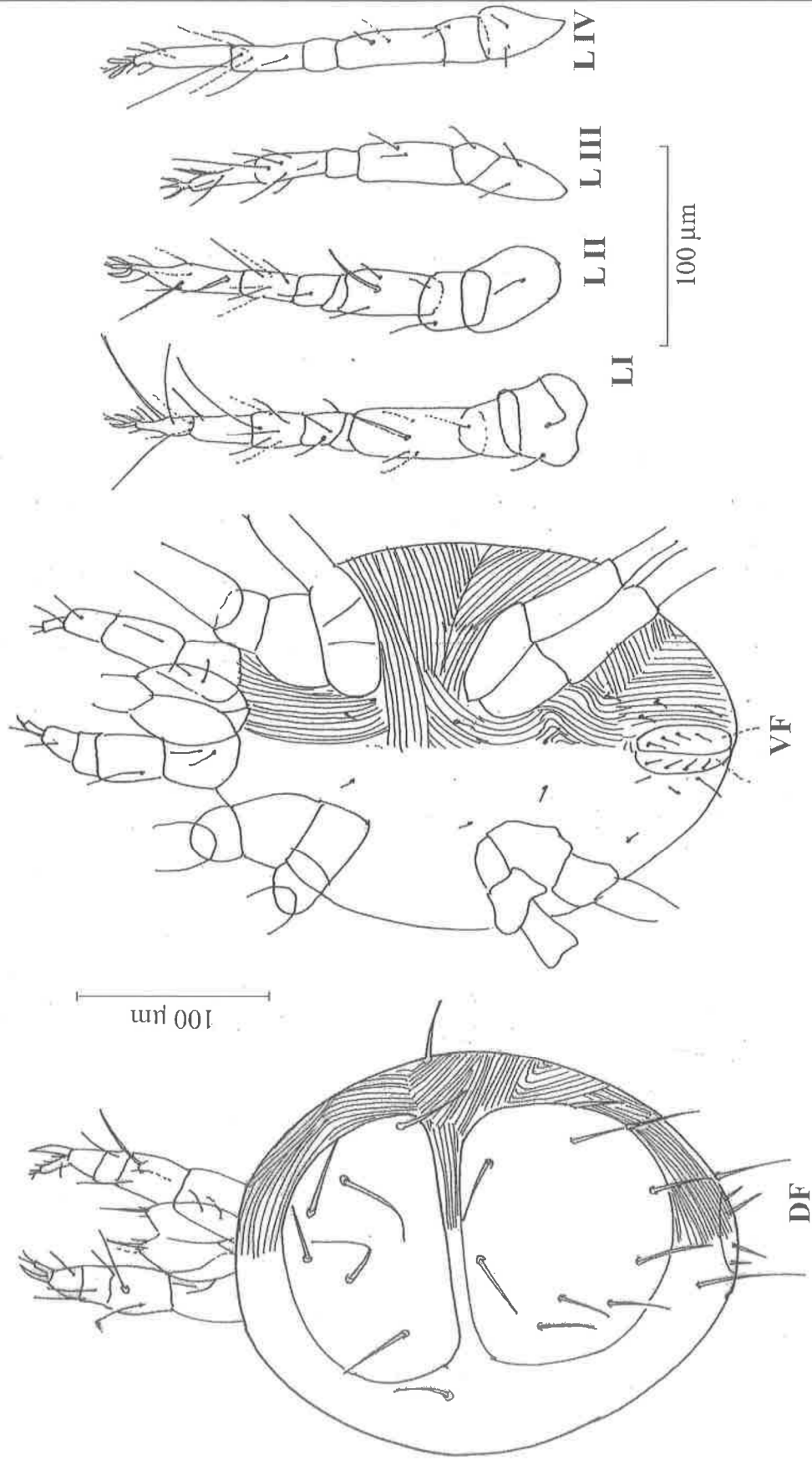
Solinidiom

PLATE 106



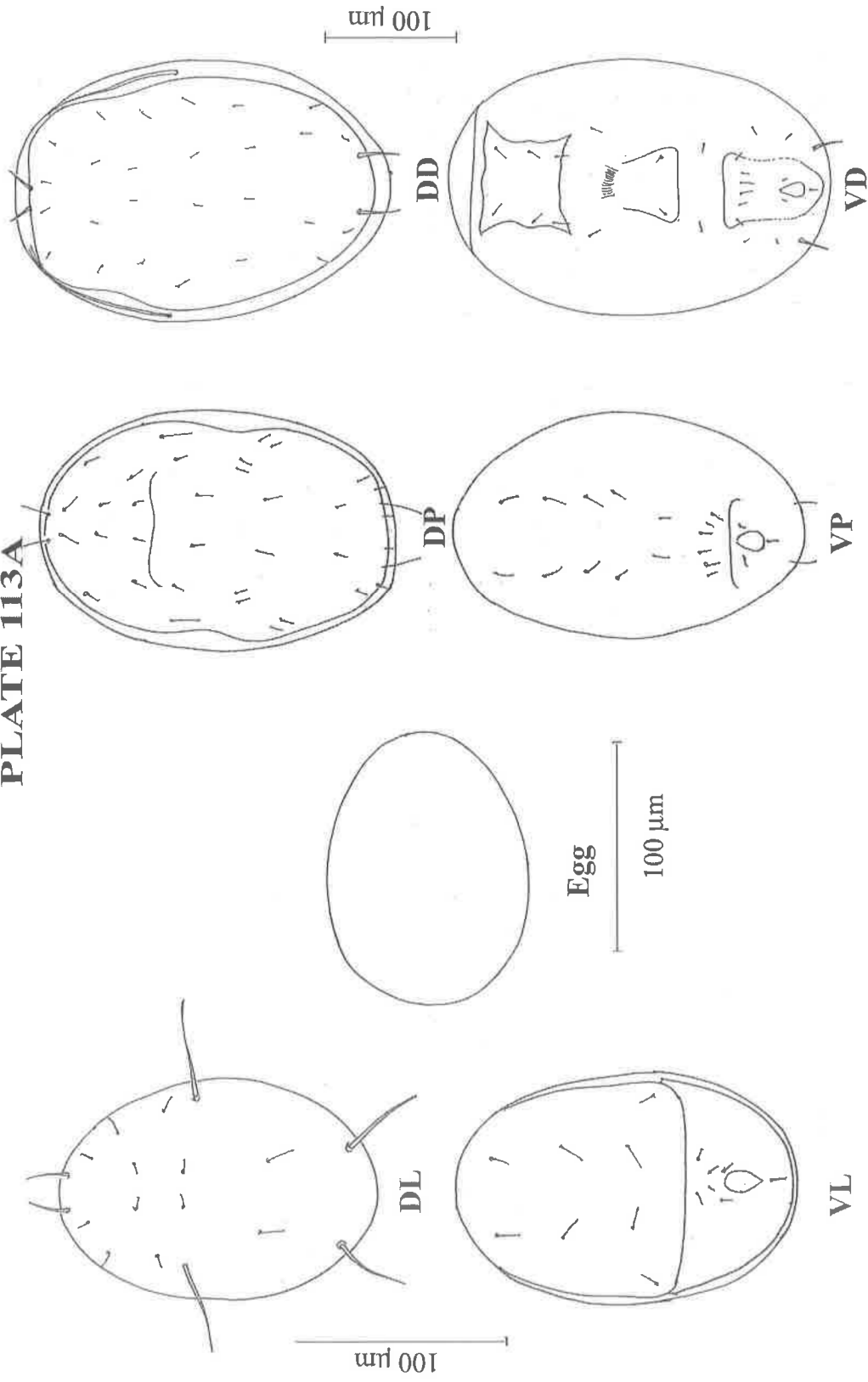
Agistemus fleschneri Summers, 1960

PLATE 107



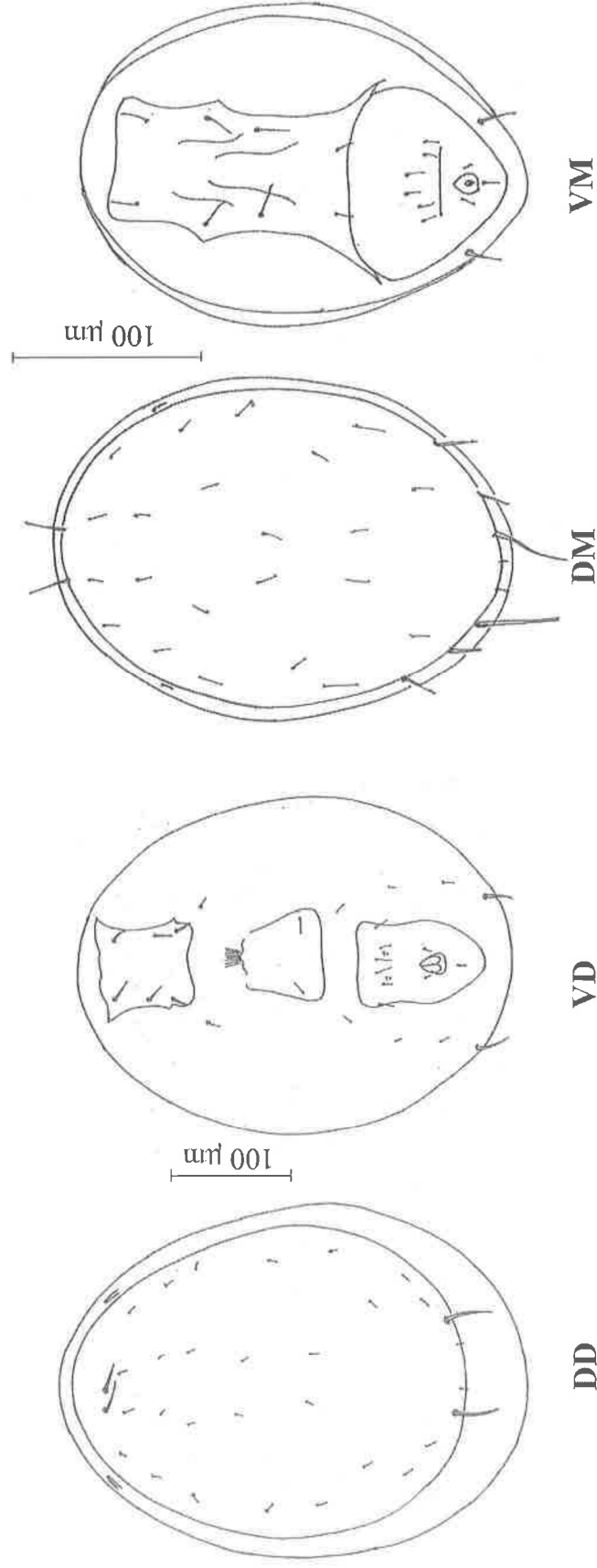
Agistemus terminalis (Quayle), 1912

PLATE 113A



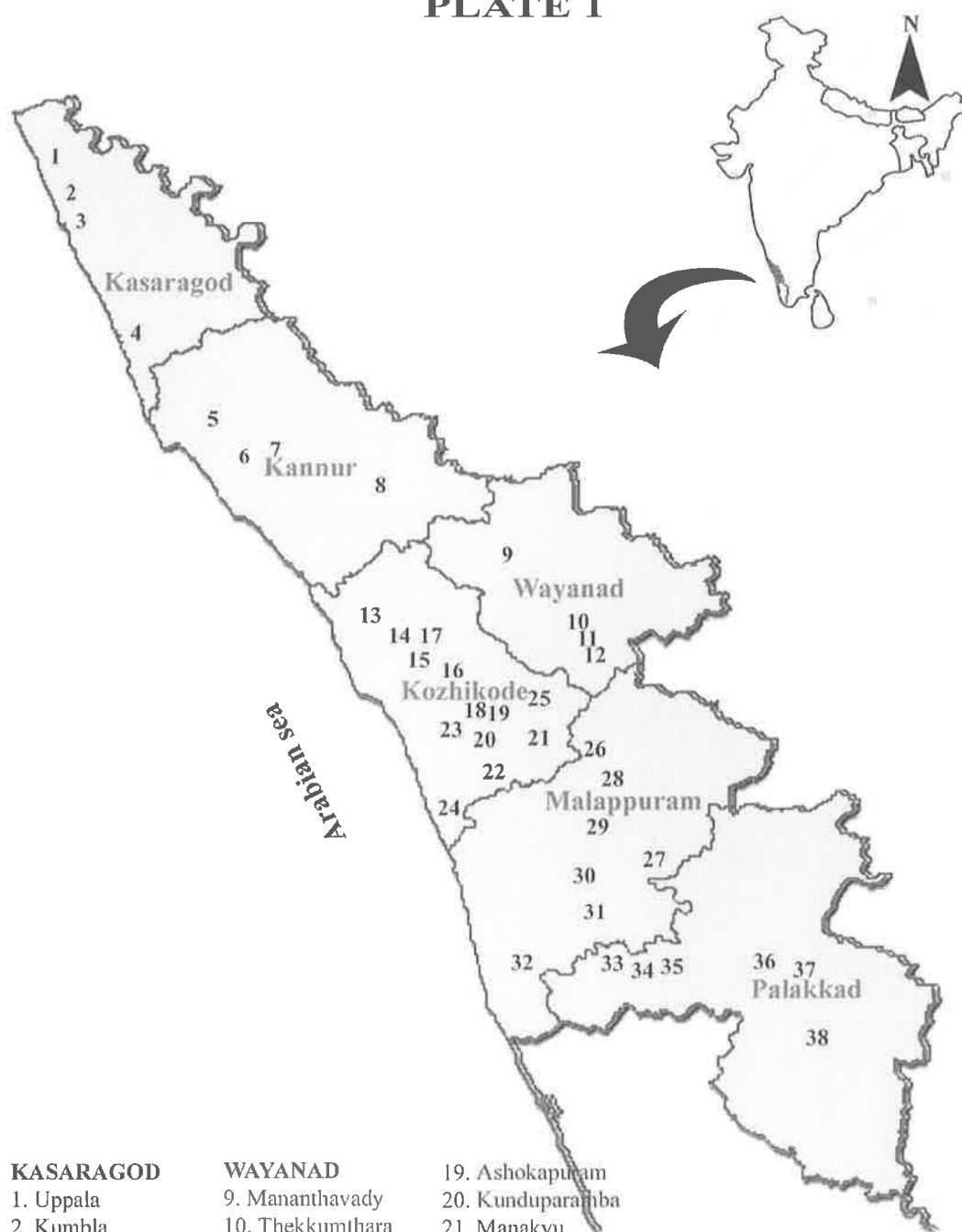
Developmental Stages of *Eusieus pariyarensis* sp. nov.

PLATE 113B



Developmental Stages of *Eusieus pariyarensis* sp. nov.

PLATE 1



KASARAGOD

1. Uppala
2. Kumbla
3. Nilleshwaram
4. Panathur

KANNUR

5. Payyannur
6. Pariyaram
7. Ayurveda college
Pariyaram
8. Valapattanam

WAYANAD

9. Mananthavady
10. Thekkumthara
11. Pulpally
12. Ambalavayal

KOZHIKODE

13. Vengeri
14. Kavumvattam
15. Kakkodi
16. Kurachundu
17. Balussery
18. Malabar
christian college

19. Ashokapuram

20. Kunduparamba
21. Manakvu
22. Pantheerankavu
23. Pazhur
24. Kadalundy
25. Kakkadampoyil

MALAPPURAM

26. Chelambra
27. Chenakkal
28. Botanical Garden
Calicut University
29. Parapangadi

30. Herbal garden, Kottakkal
31. Cherukara
32. Ponnani

PALAKKAD

33. Pattambi
34. Koppam
35. Vilayur
36. Cherpulassery
37. Ottappalam
44. Alathur.

WAYANAD	KASARAGOD (12.43°N-75.20°E)	KANNUR	(11.87°N-75.37°E)
	(11.68°N-76.13°E)	KOZHIKODE	(11.07°N-76.07°E)
		PALAKKAD	(10.78°N-76.65°E)

KERALA, INDIA

M. P. Rahul*, Mary Anithalatha Sadanandan and P. P. Santhosh
P.G. & Research Department of Zoology,
Malabar Christian College, Calicut, Kerala, 673 001, India
Affiliated to University of Calicut
Email: rahulmpmcc@gmail.com; manithals@yahoo.co.in

ABSTRACT: An adult female of a new Phytoseiid mite viz., *Amblyseius dioscoreae* is described and illustrated. It was collected from *Dioscorea alata* (L.) leaves infested with spider mite *Tetranychus macfarlanei*.

KEYWORDS: Acari, Predatory mite, Phytoseiidae, *Amblyseius*, New species, Kerala.



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A new species of predatory mite (Prostigmata: Cunaxidae: Cunaxa) from Kerala, India

M. P. Rahul, Mary Anithalatha Sadanandan and P. P. Santhosh

P. G. & Research Department of Zoology,

Malabar Christian College, Calicut, Kerala, 673001, INDIA

(Corresponding author: M. P. Rahul, rahulmpmcc@gmail.com)

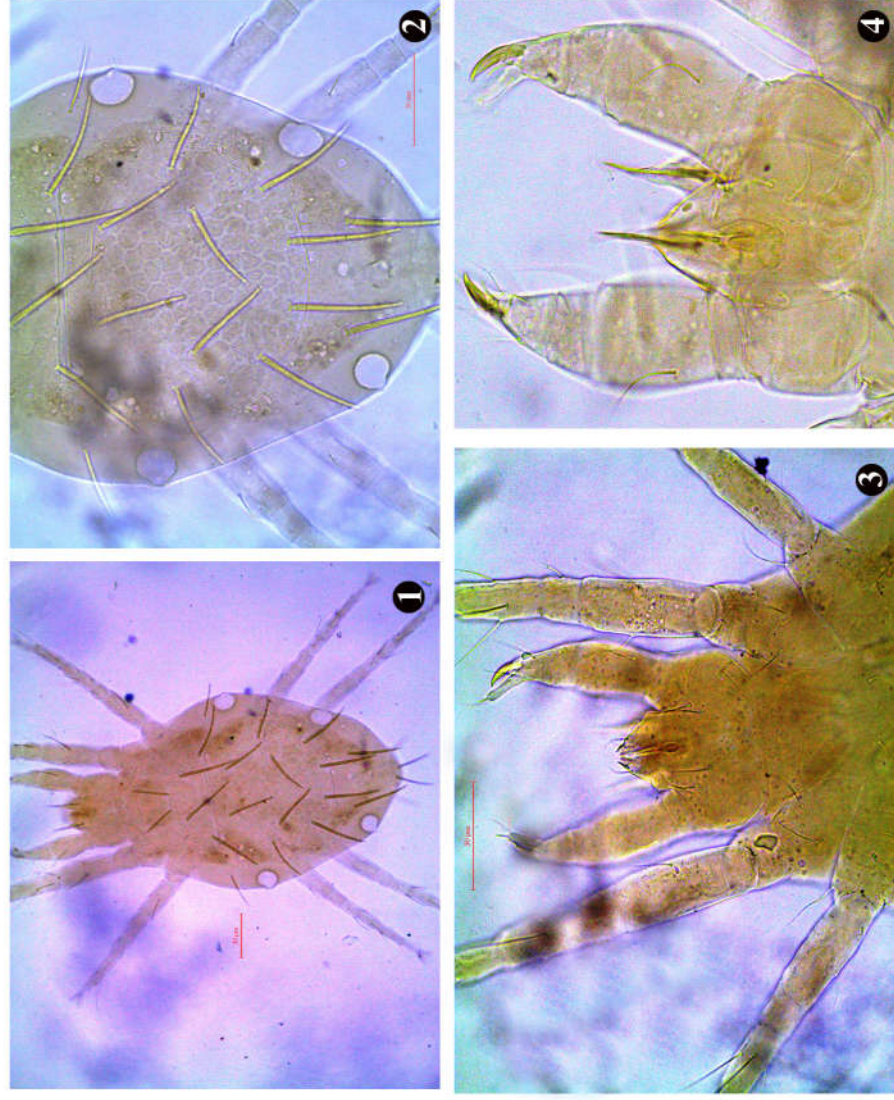
(Received 05 November, 2016, Accepted 21 December, 2016)

(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Mites belonging to the family Cunaxidae are potential predators of harmful mites and insects. During a survey on predatory mites associated with vegetable crops in North Kerala yielded a new species of cunaxid mite under the genus *Cunaxa* viz., *Cunaxa soansi* sp.nov is described and illustrated. It was collected from *Manihot esculenta* leaves infested with *Tetranychus neocaledonicus*.

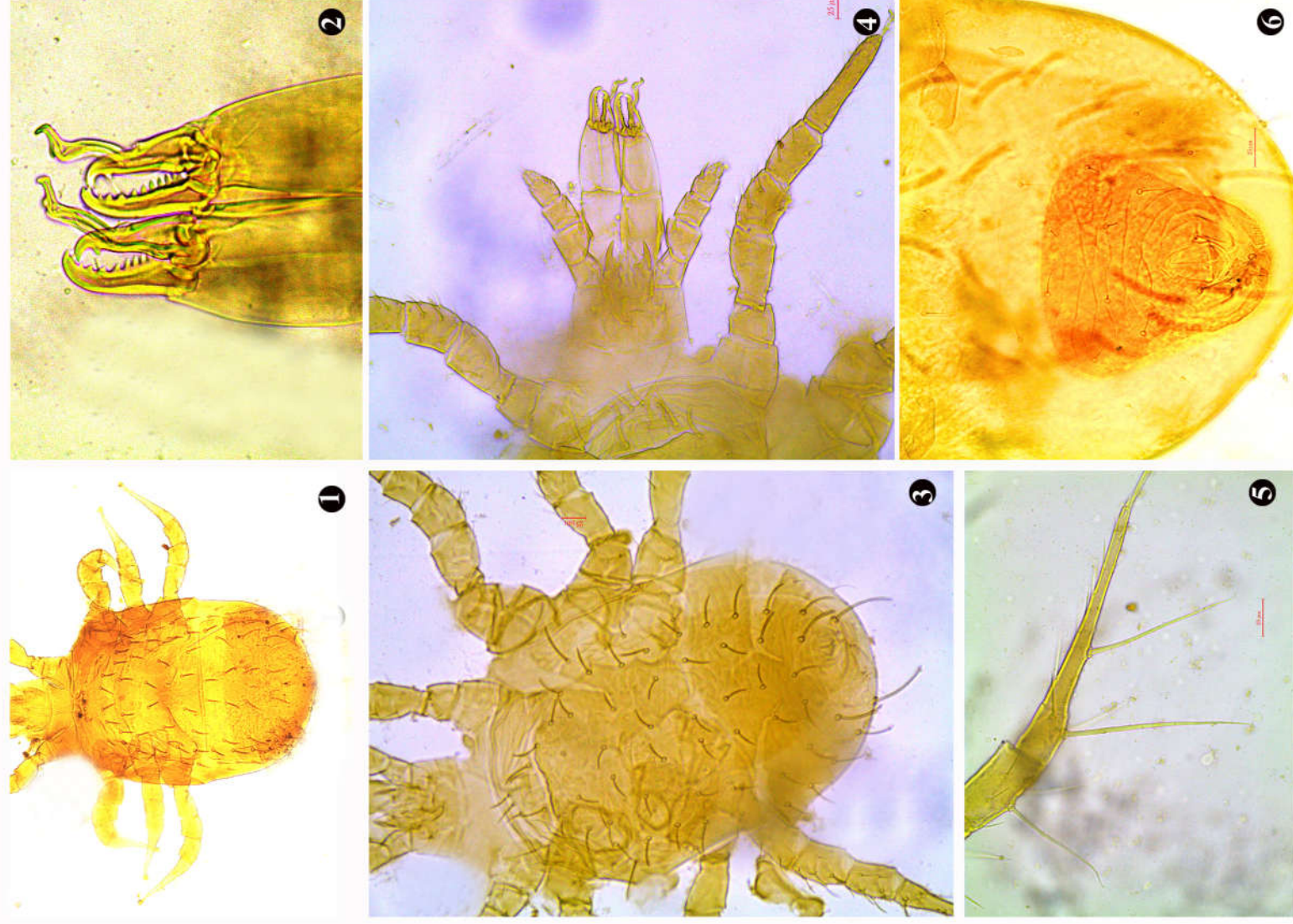
Keywords: Predatory mite, Prostigmata, Cunaxidae, *Cunaxa*, New species, Kerala.

PLATE 108



Figs. 1-4 Species of Stigmaeidae; 1. *Agistemus* dorsal view; 2. Dorsal setae
3. Gnathosoma; 4. Pedipalp.

PLATE 31



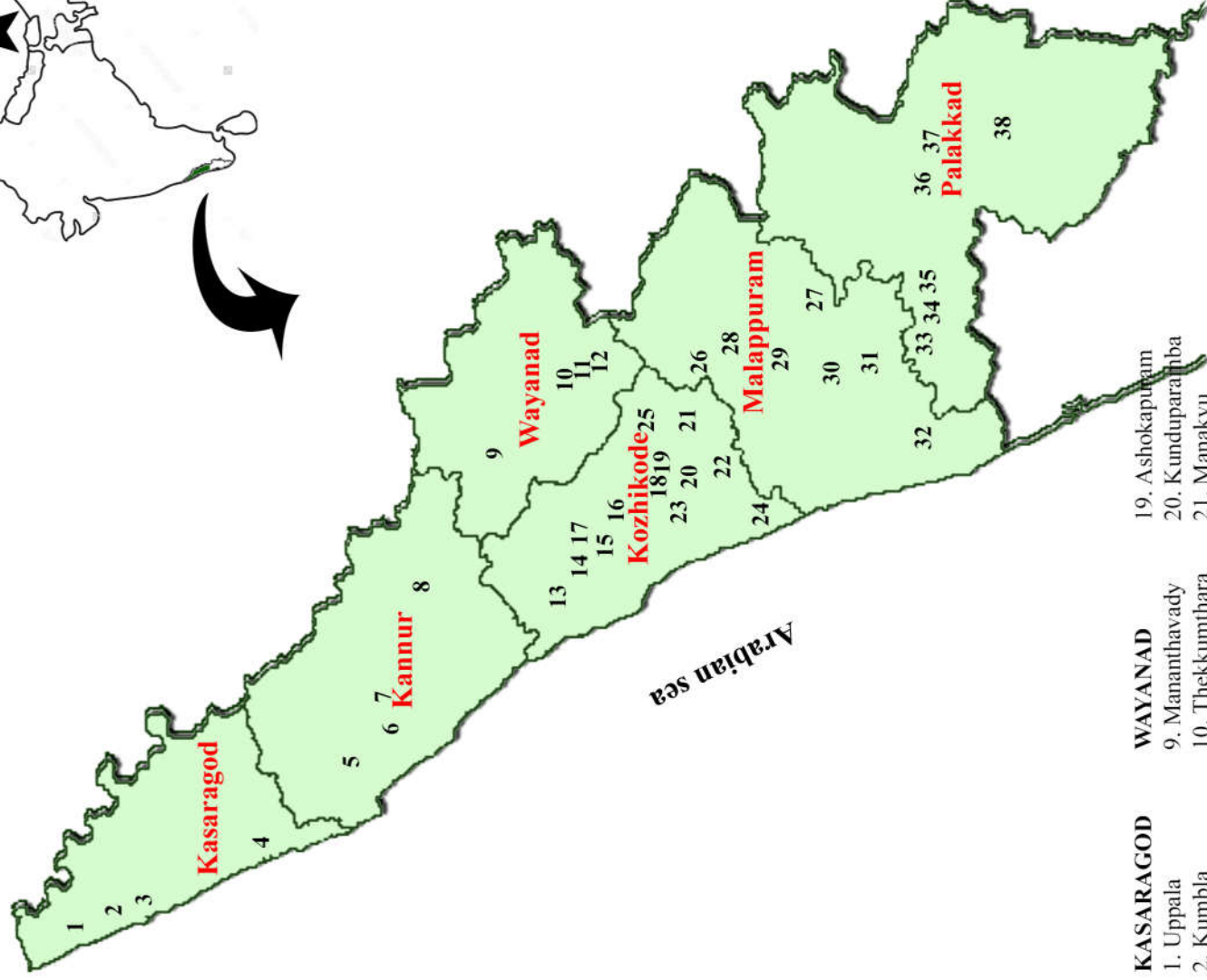
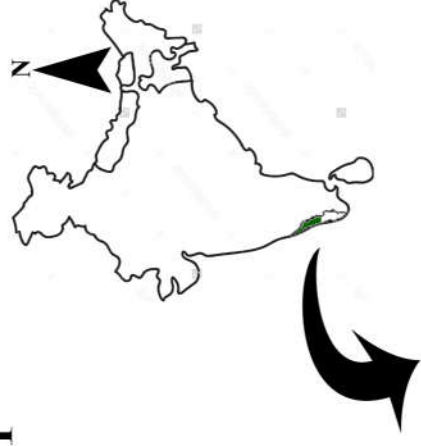
1. *Asca* dorsal view ; 2. *Asca* male chelicera with spermatophoral process;
 3. *Lasioseius* dorsal view 4. *Lasioseius* gnathosoma with male chelicera; 5. Leg with macro setae; 6. Ventrianal shield.

PLATE 4



Figs. 1-4. Collection sites at Malappuram District; **1,2** Botanical garden, Calicut University; **3.** Parappanangadi; **4.** Herbal garden, Aryavidyasala, Kottakkal; **Figs. 5-8.** Collection sites at Palakkad District; **5.** Ottappalam; **6.** Pattampi; **7.** Vilayur; **8.** Alathur.

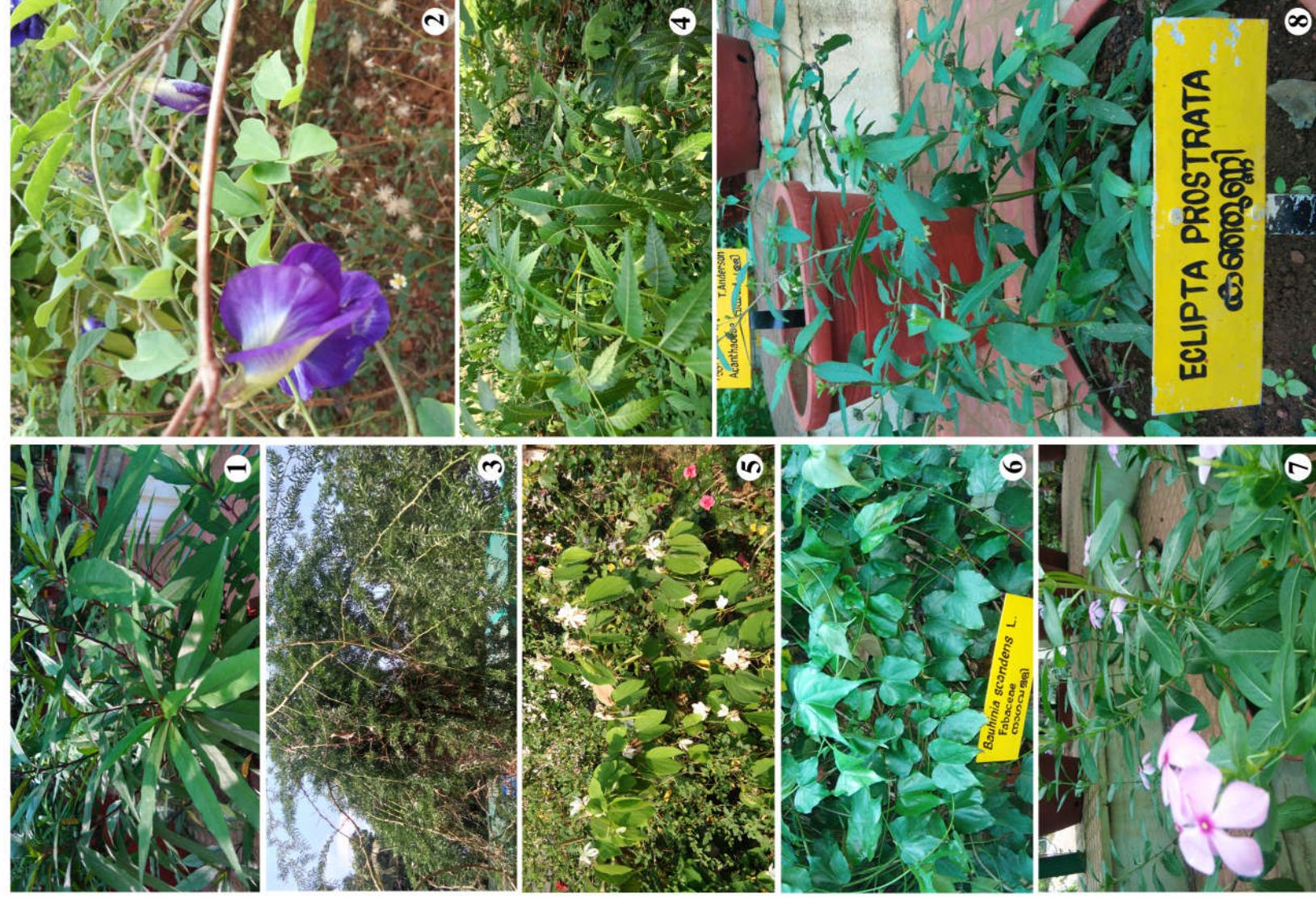
PLATE 1



KASARAGOD	WAYANAD	
1. Uppala	9. Mananthavady	19. Ashokapuram
2. Kumbala	10. Thekkumthara	20. Kunduparaphba
3. Nileschwaram	11. Pulpally	21. Manakvu
4. Panathur	12. Ambalavayal	22. Pantheerankavu
		23. Pazhur
KANNUR	KOZHIKODE	24. Kadalundy
5. Payyannur	13. Vengeri	25. Kakkadampoyil
6. Pariyaram	14. Kavumvattam	
7. Ayurveda college Pariyaram	15. Kakkodi	MALAPPURAM
8. Valapattanam	16. Kurachundu	26. Chelambra
	17. Balussery	27. Chenakkal
	18. Malabar christian college	28. Botanical Garden
		Calicut University
		29. Parapangadi
		30. Herbal garden, Kottakkal
		31. Cherukara
		32. Ponnani
		PALAKKAD
		33. Pattambi
		34. Koppam
		35. Vilayur
		36. Cherpulassery
		37. Ottappalam
		44. Alathur.

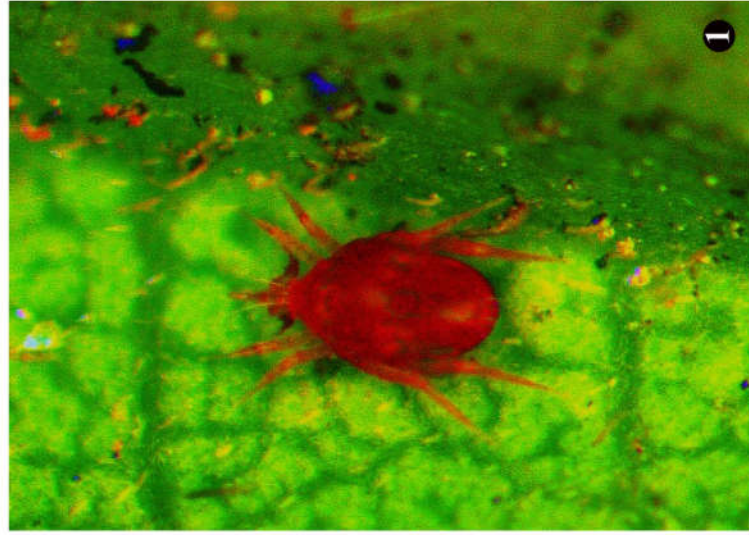
WAYANAD	KASARAGOD (12.43°N-75.20°E)	KANNUR	(11.87°N-75.37°E)
	(11.68°N-76.13°E)	KOZHIKODE	(11.07°N-76.07°E)
		PALAKKAD	(10.78°N-76.65°E)

PLATE 2



Figs. 1-4. Collection sites at Kasaragod District; **1.** Panathur; **2.** Neelaswaram; **3.** Uppala; **4.** Kumbala; **Figs. 5-8.** Collection sites at Kannur District; **5.** Payyannur; **6.** Pariyaram; **7.** Valapattanam; **8.** Herbal garden, Ayurveda College, Pariyaram

PLATE 93



1



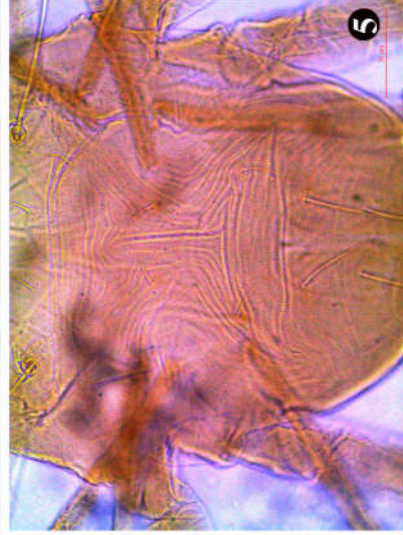
2



3



4



5



6

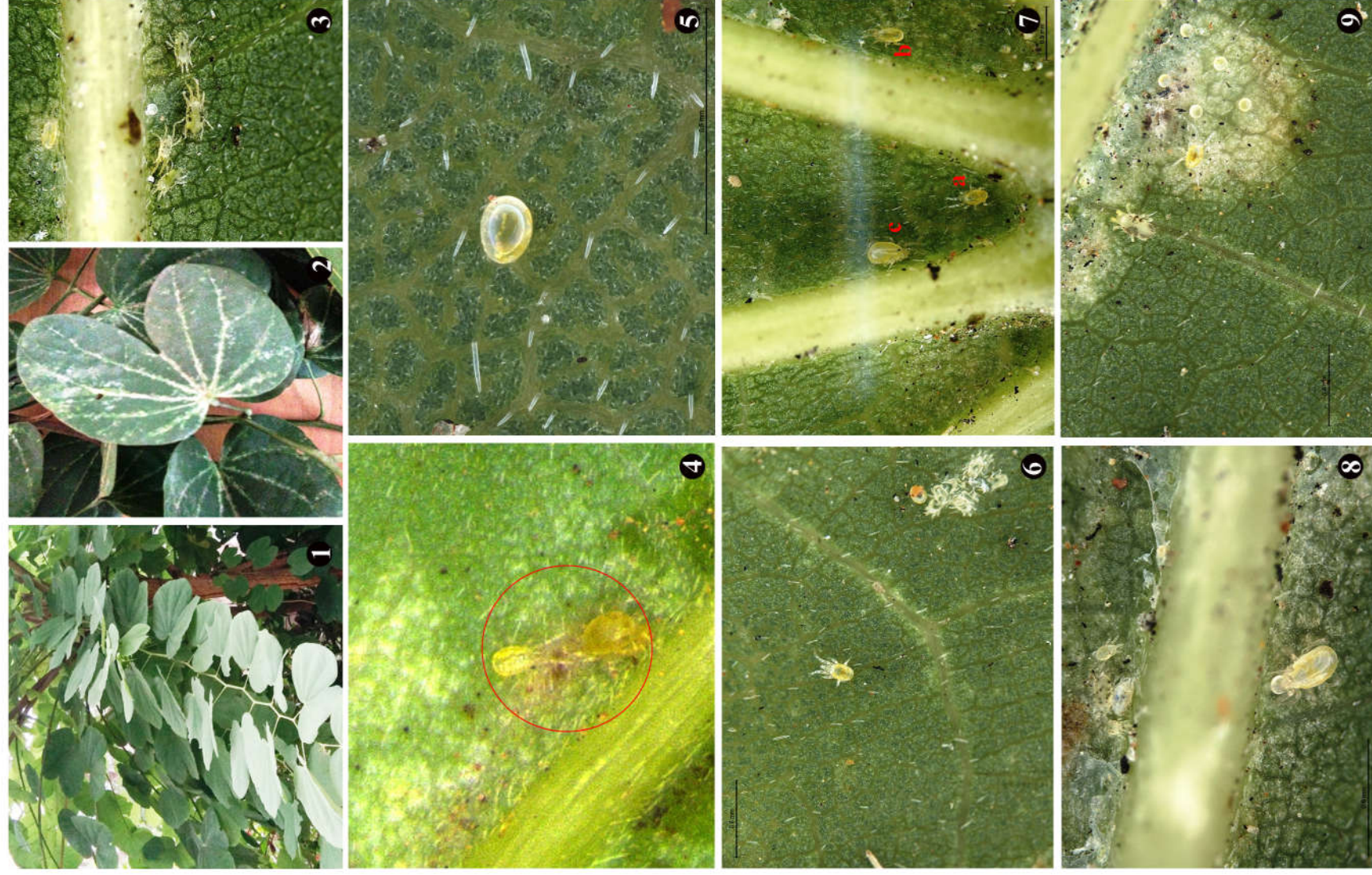
Figs. 1-6 Species of Cunaxidae; **1.** Cunaxid entire; **2.** Dorsal view **3.** Pedipalp; **4.** Gnathosoma; **5.** Ventral striation; **6.** Neocunaxoid dorsal view

PLATE 3



Figs. 1-4. Collection sites at Wayanad District; **1.** Mananthavady; **2.** Pulpally; **3.** Thekkumthara; **4.** Ambalavayal; **Figs. 5-8.** Collection sites at Kozhikode District; **5.** Herbel garden, Malabar Christian College; **6.** Kakkodi; **7.** Kavumvattam; **8.** Pantheerankavu.

PLATE 114



Figs. 1-9 Feeding and breeding biology; 1. Healthy plant of *Bauhinia acuminata*; **2.** Infestation of *T. neocalidonicus* **3.** Life stages *T. neocalidonicus*; **4.** Mating behaviour; **5.** Egg of *E. pariyavensis*; **6.** Larva; **7.** a. Protonymph, b. Deutonymph, c. Adult female; **8.** Adult female feeding on egg of *T. neocalidonicus*; **9.** Male feeding on eggs and nymphal stages of *T. neocalidonicus*.

**DISTRIBUTION OF PREDATORY MITES WITH RESPECT TO HOST PLANTS
IN VARIOUS LOCALITIES OF NORTH KERALA**

TABLE 2

Sl. No	Species	Host plant	Location	District
I	FAMILY: ASCIDAE Voigts and Oudemans, 1905			
1	<i>Asca devadasi</i> sp.nov.	<i>Cucurbita maxima</i> Duch.	Chelembra	Malappuram
2	<i>Asca garmani</i> Hulburt , 1963	<i>Justica gendarussa</i> Burm.f.	Pariyaram	Kannur
3	<i>Asca indirae</i> sp.nov.	<i>Clerodendrum paniculatum</i> L.	Chenakkal Calicut University	Malappuram
4	<i>Asca sashikalae</i> sp.nov.	<i>Ixora coccinea</i> L.	Kadalundi	Kozhikode
5	<i>Asca spicata</i> Hurlbutt, 1963	* <i>Bauhinia acuminata</i> L.	Kavumvattam	Kozhikode
II.	FAMILY: BLATTISOCIIDAE Garman, 1948			
6	<i>Lasioseius adhatodae</i> sp.nov.	<i>Justicia adhatoda</i> (L.)	Herbal garden, Malabar Christian College, Calicut	Kozhikode
7	<i>Lasioseius gangadharani</i> sp.nov.	<i>Psidium guajava</i> L.	Botanical garden, Calicut University	Malappuram
		<i>Magnolia chempaka</i> (L.)	Botanical garden, Calicut University	Malappuram
8	<i>Lasioseius gokuldasi</i> sp.nov.	<i>Murraya koenigii</i> (L.)	Kavumvattam	Kozhikode
9	<i>Lasioseius guptai</i> sp.nov.	<i>Coffea arabica</i> L.	Mananthavady	Wayanad
10	<i>Lasioseius kurachundensis</i> sp.nov	<i>Theobroma cacao</i> L.	Kurachundu	Kozhikode

Sl. No	Species	Host plant	Location	District
		<i>Solanum melongena</i> L.	Thekkumthara	Wayanad
11	<i>Lasioseius pavani</i> sp.nov.	<i>Murraya koenigii</i> (L.)	Kavumvattam	Kozhikode
12	<i>Lasioseius pazhurensis</i> sp.nov.	<i>Psidium guajava</i> L.	Pazhur	Kozhikode
13	<i>Lasioseius plumatus</i> Karg, 1980	* <i>Solanum anguivi</i> Lam.	Kavumvattam	Kozhikode
14	<i>Lasioseius soudhaminia</i> sp.nov.	<i>Helicterus isora</i> L.	Botanical garden, Calicut University	Malappuram
15	<i>Lasioseius wayanadensis</i> sp.nov.	<i>Salacia reticulata</i> Wight.	Thekkumthara	Wayanad
III	FAMILY: PHYTOSEIIDAE Berlese, 1952.			
16	<i>Amblyseius aerialis</i> (Muma), 1955	* <i>Justica adhatoda</i> (L.)	Kumbala	Kasaragod
		* <i>Benincasa hispida</i> (Thunb.)	Ottappalam	Palakkad
17	<i>Amblyseius channabasavannai</i> , Gupta and Daniel, 1978	* <i>Datura metel</i> L. * <i>Ipomoea sepiaria</i> Roxb. <i>Piper betle</i> L. <i>Saraca indica</i> L. <i>Solanum melongena</i> L. <i>Ocimum basilicum</i> L.	Uppala Cherukara Pulpally Balussery Koppam Payyanur	Kasaragod Malappuram Wayanad Kozhikode Palakkad Kannur
18	<i>Amblyseius cucurbitae</i> Rather, 1985	* <i>Abelmoschus moschatus</i> (L.) <i>Cucurbita maxima</i> Duch.	Botanical garden, Calicut University. Panathur	Malappuram Kasaragod
19	<i>Amblyseius devakiae</i> sp.nov.	<i>Ixora coccinea</i> L. <i>Abelmoschus moschatus</i> (L.)	Kadalundi	Kozhikode

Sl. No	Species	Host plant	Location	District
		<i>Baliospermum montanum</i> (willd.)	Arya Vaidya sala Herbal garden, Kottakkal	Malappuram
20	<i>Amblyseius kadalundiensis</i> sp.nov.	<i>Persea macrantha</i> (Nees.), <i>Abelmoschus moschatus</i> (L.) <i>Piper betle</i> L.	Kavumvattam Kadalundi Kadalundi	Kozhikode Kozhikode Kozhikode
21	<i>Amblyseius kavumvattamsis</i> sp.nov.	<i>Murraya koenigii</i> (L.)	Kavumvattam	Kozhikode
22	<i>Amblyseius largoensis</i> (Muma), 1955.	* <i>Aegle marmelos</i> (L.)	Mankavu	Kozhikode
23	<i>Amblyseius melongenae</i> sp.nov.	<i>Solanum melongena</i> L. <i>Elaeocarpus tuberculatus</i> Roxb	Mankavu Calicut University Campus	Kozhikode Malappuram
24	<i>Amblyseius neorykei</i> Gupta, 1977.	* <i>Murraya koenigii</i> (L.) * <i>Solanum virginianum</i> L	Neeleswaram Ambalavayal	Kazaragod Wayanad
25	<i>Amblyseius ramaniae</i> sp.nov	<i>Magnolia chempaka</i> (L.) <i>Piper betle</i> L.	Pazhur Calicut University	Kozhikode Malappuram
26	<i>Amblyseius thejassi</i> sp.nov.	<i>Datura metel</i> L. <i>Ipomoea maxima</i> (L.f.)	Calicut University Campus	Malappuram
27	<i>Amblyseius velayudhani</i> Santhosh and Mary Anitha, 2016	<i>Ocimum sanctum</i> L. <i>Cucurbita maxima</i> (Duch.)	Botanical Garden, Calicut University. Vengeri	Malappuram Kozhikode
28	<i>Amblyseius zoansi</i> sp.nov.	<i>Saraca indica</i> L.	Mankavu	Kozhikode
29	<i>Euseius alstoniae</i> Gupta, 1975	* <i>Jatropha curcas</i> L.	Calicut University	Malappuram

Sl. No	Species	Host plant	Location	District
		<i>*Bauhinia racemosa</i> L	Campus Pantherankavu	Kozhikode
30	<i>Euseius curcasae</i> sp.nov.	<i>Jatropha curcas</i> L. <i>Bauhinia acuminata</i> L.	Calicut University campus Chelembra	Malappuram Malappuram
31	<i>Euseius faisali</i> sp.nov.	<i>Carica papaya</i> L.	Herbal garden Govt.Ayurveda college, Pariyaram	Kannur
32	<i>Euseius finlandicus</i> (Oudemans), 1915	<i>*Bauhinia acuminata</i> L. <i>*Gmelina arborea</i> Roxb.	Kakkodi Parapanangadi	Kozhikode Malappuram
33	<i>Euseius macrospatulatus</i> Gupta ,1986	<i>Bauhinia acuminata</i> L. <i>Canavalia ensiformis</i> (L.)	Neeleshwaram Mananthavady	Kazaragod Wayanad
34	<i>Euseius moosai</i> sp.nov.	<i>Helicteres isora</i> (L.)	Kakkadampoyil	Kozhikode
35	<i>Euseius ovalis</i> (Evans), 1953	<i>*Averrhoa bilimbi</i> L. <i>*Achyranthus aspera</i> L.	Ponnani Alathur	Malappuram Palakkad
36	<i>Euseis pariyarensis</i> sp.nov	<i>Saraca indica</i> (Linn.)	Herbal garden Govt.Ayurveda college, Pariyaram	Kannur
37	<i>Euseius rhododendronis</i> Gupta, 1970	<i>*Jatropha curcas</i> L.	Calicut University Campus	Malappuram
38	<i>Neoseiulus longispinosus</i> (Evans), 1952	<i>*Bauhinia racemosa</i> Lam. <i>Sida rhombifolia</i> L.	Pantherankavu Pattambi	Kozhikode Palakkad

Sl. No	Species	Host plant	Location	District
		* <i>Justicia adhatoda</i> (L.) * <i>Gymnema sylvestre</i> R.Br.	Uppala Parapangadi	Kasaragod Malappuram
39	<i>Neoseiulus radhamaniae</i> sp. nov.	<i>Solaum melognena</i> L.	Mankavu	Kozhikode
40	<i>Paraphytoseius bhadrakaliensis</i> (Gupta), 1969	* <i>Plumbago indica</i> L. * <i>Psuedarthria viscida</i> (L.) * <i>Helicteres isora</i> L.	Valapattanam Pantherankavu Cherpulassery	Kannur Kozhikode Palakkad
41	<i>Paraphytoseius orientalis</i> Narayanan Kaur and Ghai, 1960	* <i>Solanum melongena</i> L. * <i>Bauhinia acuminata</i> L. * <i>Solanum virginianum</i> L.	Ashokapuram Kadalundi Calicut university campus	Kozhikode Kozhikode Malappuram
42	<i>Proprioseiopsis peltatus</i> Van der Merwe, 1968	* <i>Justica adhatoda</i> (L.)	Kavumvattam	Kozhikode
43	<i>Typhlodromips mathaii</i> sp.nov.	<i>Zingiber zerumbet</i> (L.)	Thekkumthara	Wayanad
44	<i>Typhlodromips syzygii</i> Gupta, 1975	* <i>Solanum virginianum</i> L. * <i>Averrhoa bilimbi</i> L. * <i>Ocimum sanctum</i> L.	Pattambi Herbal Garden Malabar Christian College, Calicut Thalassery	Palakkad Kozhikode Kannur
45	<i>Scapulaseius mohanasundarami</i> sp.nov.	<i>Solanum melongnena</i> (L.)	Thekkumthara	Wayanad
46	<i>Scapulaseius suknaensis</i> Gupta, 1970	* <i>Helicteres isora</i> L.	Kakkadampoyil	Kozhikode
47	<i>Gynaeseius mumai</i> sp.nov.	<i>Carica papaya</i> L.	Herbal garden,	Kannur

Sl. No	Species	Host plant	Location	District
			Govt. Ayurveda College, Pariyaram	
48	<i>Phytoseius asperae</i> sp. nov	<i>Achyranthes aspera</i> L.	Pariyaram	Kannur
49	<i>Phytoseius intermedius</i> Evans and Macfarlane, 1962	* <i>Solanum virginianum</i> L * <i>Averrhoa bilimbi</i> (L)	Malabar Christian College, Calicut Ashokapuram	Kozhikode Kozhikode
50	<i>Phytoseius macropilis</i> (Banks), 1909	* <i>Vitis vinifera</i> (L.)	Pariyaram	Kannur
51	<i>Phytoseius prakasani</i> sp. nov.	<i>Averrhoa bilimbi</i> L.	Herbal Garden Malabar Christian College, Calicut	Kozhikode
52	<i>Phytoseius rachelae</i> Swirski and Shechter, 1961	<i>Solanum virginianum</i> L.	Ashokapuram	Kozhikode
53	<i>Typhlodromus</i> (<i>Anthoseius</i>) <i>bambusicolus</i> Gupta, 1977	<i>Solanum virginianum</i> L.	Herbal Garden Malabar Christian College, Calicut	Kozhikode
IV	FAMILY: CHEYLETIDAE Leach, 1815			
54	<i>Cheyletus kunduparambensis</i> sp. nov.	<i>Syzygium samarangense</i> (Blume)	Kunduparamba	Kozhikode
55	<i>Cheletomimus melongenae</i> sp. nov.	<i>Solanum melongena</i> L.	Mankavu	Kozhikode
56	<i>Hemicheyletia aswini</i> sp. nov	<i>Solanum melongena</i> (L.)	Thekkumthara	Wayanad
57	<i>Hemicheyletia congensis</i> (Cunliffe), 1962	* <i>Solanum melongena</i> L.	Mankavu	Kozhikode
58	<i>Hemicheyletia cordovens</i> (De	* <i>Averrhoa bilimbi</i> L.	Herbal garden,	Kozhikode

Sl. No	Species	Host plant	Location	District
	Leon), 1962.		Malabar Christian College	
59	<i>Hemicheyletia parvathiae</i> sp.nov.	<i>Benincasa hispida</i> (Thunb)	Kadalundi	Kozhikode
60	<i>Hemicheyletia serrula</i> Summers and Price 1970	* <i>Wrightia tinctoria</i> (Roxb)	Calicut University, Botanical Garden	Malappuram
61	<i>Hemicheyletia volgini</i> (Cunliffe), 1962.	* <i>Solanum melongena</i> L.	Thekkumthara	Wayanad
62	<i>Hemicheyletia wellsi</i> (Baker),1949.	* <i>Solanum melongena</i> L.	Mankavu	Kozhikode
V	FAMILY: CUNAXIDAE Thor, 1902			
63	<i>Cunaxa jayasreeae</i> sp. nov.	<i>Psidium guajava</i> L.	Balusseri	Kozhikode
64	<i>Cunaxa justicae</i> sp. nov.	<i>Justica adhatoda</i> (L.)	Botanical Garden, University Calicut	Malappuram
65	<i>Cunaxa medicae</i> sp. nov.	<i>Citrus medica</i> L.	Kavumvattam	Kozhikode
66	<i>Cunaxa myristicae</i> sp. nov.	<i>Myristica fragrans</i> Houtt	Kadaludi	Kozhikode
67	<i>Cunaxa rahuli</i> sp. nov.	<i>Bauhinia acuminata</i> L.	Kadaludi	Kozhikode
68	<i>Cunaxa vilayurensis</i> sp. nov.	<i>Clitoria ternatea</i> (L.)	Vilayur	Palakkad
69	<i>Cunaxa vinodi</i> sp. nov.	<i>Abelmoschus moschatus</i> (L.)	Calicut University, Botanical Garden	Malappuram
70	<i>Cunaxa womersleyi</i> Baker and Hoffmann, 1948	* <i>Psidium guajava</i> L. * <i>Bauhinia acuminata</i> L.,	Pazhur Pantheerankavu	Kozhikode Kozhikode
71	<i>Dactyloscirus vanajae</i> sp. nov.	<i>Syzygium samarangense</i> (Blume)	Pazhur	Kozhikode

Sl. No	Species	Host plant	Location	District
72	<i>Neocunaxoides anithae</i> sp.nov.	<i>Ophiorrhiza mungos</i> L.	Arya vidhyasala Herbal Garden, Kottakal	Malappuram
73	<i>Neocunaxoides kottakkalensis</i> sp.nov.	<i>Hibiscus rosa-sinensis</i> L.	Arya Vaidya sala Herbal Garden, Kottakal	Malappuram
74	<i>Neocunaxoides raghavani</i> sp.nov.	<i>Citrus medica</i> L.	Kavumvattam	Kozhikode
VI	FAMILY: BDELLIDAE Duges, 1834			
75	<i>Bdella aniyammae</i> sp.nov.	<i>Helicterus isora</i> L.	Kakadampoyil	Kozhikode
76	<i>Bdella khasyana</i> Gupta ,1991	* <i>Argeria nervosa</i> (Burm.f.)	Botanical garden, Calicut University	Malappuram
77	<i>Bdella vincenti</i> sp.nov.	<i>Benincasa hispida</i> (Thunb)	Kadalundi	Kozhikode
78	<i>Bdellodes pazhurensis</i> sp.nov.	<i>Syzygium samarangense</i> (Blume.)	Pazhur	Kozhikode
79	<i>Cyta troglodyte</i> Hernandes, 2011	* <i>Curcuma longa</i> L.	Kurachundu	Kozhikode*
80	<i>Thoribdella citrifoliae</i> sp.nov.	<i>Morinda citrifolia</i> L.	Kurachundu	Kozhikode
VII	FAMILY:STIGMAEIDAE Oudemans, 1931			
81	<i>Agistemus fleschneri</i> Summers, 1960	* <i>Morus alba</i> L.	Pattambi	Palakkad
82	<i>Agistemus terminalis</i> (Quayle), 1912	* <i>Justicia adhatoda</i> (L.)	Kadalundi	Kozhikode

* New host plant