BIOSYSTEMATIC STUDIES ON THE SCOLOPENDRID CENTIPEDES (CHILOPODA: SCOLOPENDROMORPHA) OF KERALA WITH OBSERVATIONS ON THEIR ECOLOGY

Thesis submitted to the
UNIVERSITY OF CALICUT

In partial fulfillment of the requirements for the award of the degree of
DOCTOR OF PHILOSOPHY IN ZOOLOGY
(Faculty of Science)

By
DHANYA BALAN

Under the guidance of
Dr. P. M. Sureshan
Scientist - D & Officer - in - Charge

WESTERN GHAT REGIONAL CENTRE
ZOOLOGICAL SURVEY OF INDIA
KOZHIKODE, KERALA

May 2016

DECLARATION

I do hereby declare that the thesis entitled **Biosystematic studies on the Scolopendrid centipedes (Chilopoda: Scolopendromorpha) of Kerala with observations on their Ecology** submitted by me to the University of Calicut in partial fulfillment for the award of the **Degree of Doctor of Philosophy in Zoology** included the data generated by the original research by me under the supervision and guidance of **Dr. P. M. Sureshan, Scientist-D, Zoological Survey of India, Kozhikode**. The work has not been submitted to any University or Institution for the award of any Degree. I further declare that the findings of this research contribute in general to the advancement of knowledge in Science and in particular to Scolopendromorphic centipedes of Kerala State, India.

Kozhikode **Dhanya Balan**

Govt. of India
Ministry of Environment, Forests & Climate Change

Tele: ZOOLSUR-CALICUT
Phone/Fax:0495-2771929& 2771324
Officer-in-Charge: 0495-2771324
E-mail: zoolsurcalicut@dataone.in

ZOOLOGICAL SURVEY OF INDIA
Western Ghat Regional Centre
Kozhikode-673 006, Kerala

Certificate by the Guide

Certified that the thesis entitled **Biosystematic studies on the Scolopendrid centipedes (Chilopoda: Scolopendromorpha) of Kerala with observations on their Ecology** submitted by **Mrs. Dhanya Balan** to the **University of Calicut** in partial fulfilment for the award of the **Degree of Doctor of Philosophy in Zoology** is a bonafide record of research work done by her in **WGRC**, **Zoological Survey of India, Kozhikode** under my guidance and supervision. This has not been previously formed the basis for the award of any degree or diploma.

Mrs. Dhanya Balan has successfully qualified the Preliminary Qualifying Examination held on December, 2012 by the University of Calicut.

Dr. P. M. Sureshan
Scientist-D & Officer-in-Charge

Date:

Acknowledgement

I have been blessed with immense support from my teachers, friends, family and colleagues who have helped me at each and every stage of this great task. The process of doing this study and bringing it to a successful completion would not have been possible without the help, guidance and support of several people. I wish to place on record my sincere thanks and heartfelt gratitude to those wonderful people.

Dictionary is beyond words to express my heartfelt gratitude and thanks to my supervising teacher, Dr. P M Sureshan, Scientist D & Officer-in-Charge, WGRC, ZSI, Kozhikode, Kerala for his constant encouragement and help. This study would not have been possible without his generous guiding, practical suggestions, constructive criticism, strong emotional support and immense patience.

I am obliged to the Western Ghat Regional Centre, Zoological Survey of India, Ministry of Environment and Forestry and University of Calicut for providing me with the opportunity to work as a research scholar in their research centre. I wish to record my sincere thanks to Zoological Survey of India, Ministry of Environment and Forestry for the JRF & SRF fellowship. I wish to thank Department of Forestry, Kerala Govt. for the permission to collect samples and field study.

I wish to record my sincere thanks to Dr. John Lewis, Somerset, UK for the guidance in taxonomic study, supporting in identification of the specimens, inspiring suggestions and for making available literature for my perusal. I also place on record my gratitude to Dr. Greg Edgecombe, NHM, London, and Dr. Vinod Khanna for the supports in taxonomic studies. I wish to thank Dr. L.A. Periera &

Dr. A. Schlwyko or making available literature for my perusal. I am extremely happy to place on record my profound gratitude to Dr. Shaju Thomas for his excellent suggestions and constant encouragement. Besides, I am also grateful to Dr. S. Sankar, Dr. K P Dinesh and Dr. K. A Subramanian for their guidance in ecological studies. I also place on record my gratitude to Department of Soil Science, KFRI, Peechi, Thrissur for soil analysis studies. I am also indebted to Dr. Sasikala V and Dr. Sindhu and Mrs. Vidya G for their assistance in statistical analysis.

I wish to thank Dr. Praveen Karanth, CES, IISc, Bangalore, Dr. Jahnvi Joshi, NCBS, Bangalore and Dr. R M Sharma, ZSI, Pune for the permission to study the museum specimens at CES, IISc and WRC, ZSI, Pune.

I am indebted to Sri. C Radhakrishnan, Dr. Jaffer Palott, Dr. Rajmohana, Mrs. K G Emiliyamma, Mr. Rathnakaran. P, Mr. Bijoy C, Mrs. Aswathi. K, Mr. Abhilash Peter, Dr. D.C. Dhali, Dr. Sheeja, Mr. Nikhil, Mrs. Raseena, Mrs. Ameena and the entire ZSI staff and Research scholars for their inspiring suggestions, constant support and encouragement.

I also acknowledge and appreciate the services done by Mr.Manikantan, Mr. Madhavan and Mr.Dinesh for their immense support in field studies. I am also indebted to Mr. David Raju, Mr. Sandeep Das, Mr. Jnanakumar, Mr. Aswanth and Mr.Syamlal for the supports in field studies and the wonderful photographs from field. I am also indebted to Mr. Gafoor and the entire Staff of Malabar Wildlife Sanctuary for the supports during study.

I am indebted to GM (Kerala) , FCI, RO, Trivandrum for permitting to pursue my Studies. I have great pleasure in expressing on record my deep gratitude to Dr. C. T Sunilkumar, Area Manager, FCI, Kozhikode, Kerala for his support and encouragement for the submission of thesis. I am also thankful to the officials and my friends of at FCI, especially Mr. V. Balakrishnan, Mr. P. P Ramachandran, Mr. S Sasikumar, Mr. P S Jithin, Ms.Silpa, Mr. Hari Govind, Mrs. Greeshmam, Mr. Arun, Mr. Bijesh T P, Mrs. Sreeda and Mrs. Divya for their encouragement.

I wish to record my sincere thanks to all my friends and family members who have helped me to shape my thinking and enlightened the light of my research, especially of Dr. Sasikala V, Dr. O. K Murali Krishnan, Mrs. Rugmini Rajappan, Mr.Umesh P.K, Mrs. Aparna S and Mr. Harish K.C.

With love and gratitude I recall all the members of my family for their wholehearted inspiration, cooperation and prayers which I believe, have formed the basis of my research. I would like to thank my parents who gave me the best education possible and constantly encouraged and supported me in my endeavours. With immense love and gratitude, I express my thanks to my loving mother Mrs. Kumari Balan who is the greatest support and motivational force for my entire studies. I also wish to thank my husband Mr. Anuranj .C for his loving support, immense patience and encouragement. I also wish to record my heartfelt thanks to my brother Mr. Babu Balan and the staff of Kailaz Designs, Kozhikode for the wonderful assistance in lay-out and designing of the thesis.

Last but not the least; I thank God Almighty for getting me through all the hitches that came my way while doing this research work.

Dhanya Balan

Dedicated

To my Mother & Teachers

CONTENTS

5.6.5	Diagnosis of Genus *Cormocephalus* Newport	
5.6.6	Key to the species of *Cormocephalus* in Kerala	
	Cormocephalus indicus sp.nov.	
	Cormocephalus westwoodi westwoodi (Newport)	
	Cormocephalus dentipes Pocock	
	Cormocephalus (Dekanonyx) nigrificatus Verhoeff	
5.6.6	Diagnosis of Genus *Otostigmus* Porath	
5.6.7	Key to the species of *Otostigmus* in Kerala	
	Otostigmus politus politus Karsch	
	Otostigmus gravelyi (Jangi and Dass) Joshi and Edgecombe	
	Otostigmus orientalis Porath	
	Otostigmus ruficeps Pocock	
5.6.8	Diagnosis of Genus *Digitipes* Attems	
5.6.9	Key to the species of *Digitipes* in Kerala	
	Digitipes periyarensis Joshi and Edgecombe	
	Digitipes chhotanii Jangi and Dass	
	Digitipes pruthii Jangi and Dass	
	Digitipes barnabasi Jangi and Dass	
	Digitipes pseudobarnabasi sp.nov.	
	Digitipes jonesii (Verhoeff)	
	Digitipes coonoorensis Jangi and Dass	
5.6.10	Diagnosis of Genus *Ethmostigmus* Pocock	
5.6.11	Key to the species of *Ethmostigmus* in Kerala	
	Ethmostigmus coonooranus Chamberlin	
	Ethmostigmus rubripes platycephalus (Newport)	
5.6.11	Diagnosis of Genus *Rhysida* Wood	
5.6.12	Key to the species of *Rhysida* in Kerala	
	Rhysida aspinosus sp.nov.	
	Rhysida laetus sp.nov.	
	Rhysida immarginata immarginata (Porath)	
	Rhysida longipes longipes (Newport)	
	Rhysida longipes simplicior Chamberlin	
	Rhysida shenduruniensis sp.nov.	

LIST OF MAPS

LIST OF PLATES

b. Site 1: Urakkuzhy, Kakkayam, Malabar Wildlife Sanctuary (UK)

c. Site 2:Narayankulam, Kozhikode (NK)

d. Site 3: Kuttothparfambu, Kozhikode (KP)

▶ PLATE 9-12

Key characters of Scolopendromorpha

▶ PLATE 13: *Asanada sukhensis* Jangi and Dass

a.Ultimate leg after Jangi and Dass, 1984

b. Ultimate leg and posterior tergites

c. Ultimate leg prefemur d. *Asanada sukhensis* in life

e.Anterior tegites, cephalic plate and antennae

f. Middle tergites with sutures g.Ultimate leg femur and claw

▶ PLATE 14: *Asanada agharkari* (Gravelyi, 1912)

a. *A. agharkari* in life b. cephalic plate and antennae

c.forcipular coxosternum d. S21

e.T21 and ultimate leg prefemur(dorsal view) f.Ultimate leg claw

▶ PLATE 15: *Scolopendra morsitans* Linnaeus

a.*S. morsitans*(in life) b. Head capsule

c.Forcipular coxosternum d.Tergites showing paramedian sutures

e.T21 f.S21 and coxopleuron

g.Ultimate leg (dorsal view) h.Ultimate leg (ventral view)

i.*S. morsitans* with regenerated ultimate leg.

▶ PLATE 16: *Cormocephalus indicus* sp.nov. Holotype

a.Head capsule b. Forcipular coxosternum

c.T21 & Ultimate leg (dorsal)

d. S21 , coxopleuron and ultimate leg (ventral)

▶ PLATE 17: *Cormocephalus indicus* sp.nov. Paratype

a.T21 & Ultimate leg (dorsal view) b.Forcipular coxosternum

c.S21 , coxopleuron and ultimate leg (ventral view) d.Spiracle.

▶ PLATE 18: *Cormocephalus westwoodi westwoodi* (Newport)

a. antennae b.spiracle

c.S21 , coxopleuron and ultimate leg (ventral view)

d.forcipular coxosternum

▶ PLATE 19: *Cormocephalus dentipes* Pocock

a. anterior tergites, cephalic plate and antennae

b. forcipular coxosternum

c.S21 , coxopleuron and ultimate leg (ventral view)

▶ PLATE 20: *Cormocephalus nigrificatus* Verhoeff

a. antennae b.spiracle

c.S21 , coxopleuron and ultimate leg prefemur(ventral view)

d.forcipular coxosternum

▶ PLATE 21

Dentition in forcipular coxosternal tooth plate

and trochanteroprefemoral process

a.*Cormocephalus westwoodi westwoodi* b.*Cormocephalus indicus* sp.nov.

c. *Cormocephalus dentipes* d. *Cormocephalus nigrificatus*

▶ PLATE 22: *Otostigmus politus politus* Karsch

a.*O. politus politus* (in life) b. Cephalic plate and antennae

c. 2nd maxilliped d.T21 e .S21

f. S21 and coxopleuron g. Walking leg

h. Ultimate leg (ventrolateral view)

▶ PLATE 23 : *Otostigmus gravelyi* (Jangi and Dass)

a.Cephalic plate and anterior tergites b.Forcipular coxosternum

c.Middle tergites with keels e.T21

f.S21 and coxopleuron g.Ultimate leg (ventrolateral view)

▶ PLATE 24 : *Otostigmus orientalis* Porat

a.*O. orientalis* (in life) b.Cephalic plate and antennae

c.2nd maxilliped d.Forcipular coxosternum

e.S21 and coxopleuron f.Walking leg

▶ PLATE 25 : *Digitipes periyarensis* Joshi and Edgecombe

a.d. periyarensis (in life) b.Forcipular coxosternum

c.Cephalic plate and antennae d.Middle tergites

e.S21, coxopleuron and ultimate leg prefemur f.Ultimate leg

g.prefemur (dorsal view)

▶ PLATE 26 : *Digitipes chhotanii* Jangi and Dass

a.Cephalic plate, antennae and anterior tergites

b.Forcipular coxosternum

c.S21, coxopleuron and ultimate leg prefemur

d.T21 and Ultimate leg prefemur (dorsal view)

▶ PLATE 27 : *Digitipes barnabasi* Jangi and Dass

a.Cephalic plate, antennae and anterior tergites

b.*D. barnabasi* - in life c.Forcipular coxosternum

d.Middle tergites with sutures and keels e.T21

f.20th walking leg with pretarsal spur g.coxopleuron

▶ PLATE 28 : *Digitipes pseudobarnabasi* sp.nov

a.*D. pseudobarnabasi* - in life

b.Cephalic plate, antennae and anterior tergites

c.2nd maxilllipede with spur d.Middle tergites with sutures

e.T21 f.Coxopleuron g.Forcipular coxosternum

h.20th walking leg with pretarsal spur i.Walking leg 1

j.Walking leg 20 k.Ultimate leg

▶ PLATE 29 : *Digitipes jonesii* Jangi and Dass

a.Cephalic plate, antennae and anterior tergites

b.Forcipular coxosternum c.Middle tergites with sutures d.T21

e.S21 and Coxopleuron f.S21, Coxopleuron and ultimate leg prefemur

g.Ultimate leg prefemur with posterior process

▶ PLATE 30 : *Digitipes coonoorensis* Jangi and Dass

a,b. *D. coonorensis* (in life) c.Forcipular coxosternum

d.S21 and Coxopleuron e.Walking leg 20

f.S21 and coxopleuron g.Ultimate leg

▶ PLATE 31 : *Ethmostigmus rubripes platycephalus* Newport

a. *E. rubripes platycephalus* (in life)

b.Cephalic plate and basal antennal articles

c.Forcipular coxosternum d.Teeth on forcipular coxosternum

e.S21 f.coxopleuron

g.Ultimate leg prefemur

▶ PLATE 32 *Rhysida aspinosus* sp.nov.

a. Forcipular coxosternum

b.Cephalic plate and basal antennal articles

c.T21 d.Coxopleuron e.Walking leg 20 f, g.Ultimate leg

▶ PLATE 33: *Rhysida laetus* sp.nov.

a.Cephalic plate and basal antennal articles b.spiracle

c.T21 and Walking leg 20 d.S21 and Coxopleuron

e.forcipular coxopleuron f.Ultimate leg

▶ PLATE 34 :

Rhysida immarginata immarginata (Porat)

a.*R. immarginata immarginata* (in life) b.spiracle

c.Cephalic plate and basal antennal articles d.forcipular coxopleuron

e.coxopleuron f.Ultimate leg prefemur

Rhysida longipes longipes (Newport)

g.*R. longipes longipes* (in life) h. forcipular coxopleuron

i. coxopleuron j. Walking leg 20 f.Ultimate leg prefemur

▶ PLATE 35: *Rhysida longipes simplicior* Chamberlin

a.Cephalic plate and basal antennal articles b.forcipular coxopleuron

c.T21 d.coxopleuron

e. Walking leg 20 f.Ultimate leg prefemur

▶ PLATE 36: *Rhysida shenduruniensis* sp.nov.

a. Cephalic plate and basal antennal articles

b. *R. shenduruniensis* (in life) c.spiracle d.Forcipular coxosternum

e.middle tergites f.T21 g.S21 and Coxopleuron h.Walking leg 20

i.Walking leg tarsal spur and claw spur j.Ultimate leg prefemur

▶ PLATE 37:

Rhysida lithobiodes trispinosus Jangi and Dass

a. Cephalic plate and basal antennal articles

b.Forcipular coxosternum c.T21 d.S21 and Coxopleuron

e.Ultimate leg prefemur

Rhysida lithobiodes paucidens Pocock

f. Cephalic plate and basal antennal articles g.Forcipular coxosternum

h.T21 i.S21 and Coxopleuron j.Ultimate leg prefemur

▶ PLATE 38: *Cryptops (Cryptops) malabarensis* Dhanya *et al.*,

a. *Cryptops (Cryptops) malabarensis* (in life) b.antennal articles

c. Cephalic plate and basal antennal articles

d.Forcipular coxosternum e.Ultimate leg prefemur

f. Ultimate leg tibia, tarsus

▶ PLATE 39: *Cryptops (Trigonocryptops) sholavasi* sp.nov.

a. Forcipular coxosternum

b. Cephalic plate and basal antennal articles

c.Middle tergites d.T21

e.Walking leg 20 with segmentedtarsi

f.Distal tubercle on Ultimate leg tibia g. Ultimate leg

h.S21 i.saw teeth on tibia and tarsus 1

▶ PLATE 40: *Cryptops (Trigonocryptops) lewisi* sp.nov.

a.Cephalic plate and basal antennal articles b. Antennal articles

c. Forcipular coxosternum d.Middle tergites e.T21

f. Trigonal sutures on tergites g.S21 h.Coxopleuron

i.Distal tubercle on Ultimate leg tibia j.saw teeth on tibia and tarsus 1

▶ PLATE 41: *Paracryptops sureshani* sp.nov.

a.*P. sureshani* (in life) b. Cephalic plate and forcipules

c. Cephalic plate and basal antennal articles

d.Forcipular coxosternum e.Middle tergites f. Ultimate leg

g.T21 h.Coxopleuron i. Ultimate leg

▶ PLATE 42: *Paracryptops spinosus* Jangi and Dass

a. Cephalic plate and Forcipules

b. Cephalic plate and basal antennal articles

c.Forcipular coxosternum d.Middle tergites

e. S21 and Coxopleuron f.Walking leg 20

g. Ultimate leg h. Tubercle on ultimate leg prefemur and tibia

▶ PLATE 43: *Paracryptops sankari* sp.nov.

a.forcipules b. Cephalic plate and basal antennal articles

c.Forcipular coxosternum d.Middle tergites

e.Coxopleuron i. Ultimate leg j.Sawteeth

▶ PLATE 44

a. *Rhysida immarginata* in parental care

b. *Digitipes barnabasi* in parental care

c. stadium

d. moulted individual

e. *Cormocephalus* sps. in hibernation inside a coconut trunk

f. Ectoparasitism of Acari on *Digitipes coonoorensis*

LIST OF TABLES

LIST OF FIGURES

"If human beings were to disappear tomorrow, the world would go on with little change. But if invertebrates were to disappear, I doubt that the human species could last more than a few months."

E.O. Wilson

CHAPTER 1
INTRODUCTION

1.1. Significance of Invertebrate Taxonomy

Invertebrates dominate virtually every ecosystem in terms of species richness, biomass, and ecological function. Taken as a whole, the invertebrata constitute 80% of earth's species and over 95% of all animal species. The phylum Arthropoda alone, with roughly 1.1 million described species, represents over 82% of all animal diversity. Invertebrates are pervasive elements of every food chain, as herbivores, predators, parasites, and decomposers. While devising strategies for monitoring, managing, and conserving the millions of invertebrate species, the challenge faced today is the development of innovative approaches to overcome the scarcity of taxonomic and ecological understanding of many invertebrates. In addition to that, efforts to conserve invertebrates are severely hampered by a lack of public understanding of the values of invertebrate biodiversity (" Invertebrate conservation", n.d).

There are at least seven impediments which stand against the conservation of invertebrates. Three of the impediments are social dilemmas. Remaining four of the impediments are scientific shortfalls, related to areas of knowledge that are still far from sufficient and that sometimes reflect critical lack of data and understanding (Cardoso *et al*., 2011). The ultimate solution to overcome this situation is understanding the diversity of these "little things those running our world" through sound taxonomy.

1.2 Significance of the Group Arthropoda

Arthropods are sensitive to the disturbance of their environments. They are suitable biological indicators of ecosystem change and habitat modification due to their small body size and short generation time (Kremen *et al*., 1993), high sensitivity to temperature and moisture changes (Schowalter *et al*., 2003).

But the arthropods were largely ignored in the design of conservation management strategies. Their conservation in existing parks and reserves has been purely incidental (New, 1999). The primary limitations in using arthropods in conservation studies are mainly because of:

1. time constraints, 2.lack of knowledge of the taxonomy, biology and distribution, 3. non-standardized sampling protocols, and 4. inadequate number of taxonomists. Furthermore, arthropod surveys generate extremely large samples which demand a substantial effort to process in terms of time and expertise (New, 1999). Despite the above limitations of working with arthropods, they represent a group of organisms that are potentially useful when assessing the biodiversity of an area because of their – (i) generality of distribution, (ii) trophic versatility, (iii) rapid responses to disturbances, and (iv) ease of sampling (Holloway and Stork, 1991).

1.3 Role of Soil Macro Arthropods in Below- Ground Biodiversity

It is only in the past decade or two, soil biota and their roles in soil ecosystem services have emerged as important aspects of soil science research. Soil biota comprise a significant constituent of the soil ecosystem that perform a wide array of functions which are in turn essential for the sustainable performance of most all other ecosystems (Huising and Okoth, 2009).

Soil biota is a collective term for microorganisms and invertebrates that live in the soil, which includes bacteria, fungi, protozoa, insects, worms and other invertebrates. Their numbers, types and population are amazing and they are referred to as below-ground biodiversity (BGBD) or sometimes soil biodiversity. Soil biodiversity comprises of the organisms that spend all or part of their life cycles within the soil

or on its immediate surface (including surface litter and decaying logs) (Ruiz and Lavelle, 2008).

Soil organisms are the main mediators of soil functioning at different scales. These functions can be pictured as having a hierarchical relationship of eating and being eaten. These organisms are nick-named as "ecosystem engineers", since they control either directly or indirectly, the availability of resources to other species (Jones *et al.*, 1997).These organisms physically modify, maintain and create new habitats for other organisms. One effect of such organisms is creating higher habitat diversity, which may in turn increase species diversity (Lavelle and Spain, 2001). Scolopendromorpha are such a diverse group of invertebrate communities which play significant, but often poorly acknowledged or understood roles in the delivery of soil ecosystem services. It belongs to the category of soil macro fauna i.e., *" an invertebrate group found within terrestrial soil samples which has more than 90 percent of its specimens (individuals) in such samples visible to the naked eye" (*IBOY, 2000).As predators, they regulate herbivores, other ecosystem engineers, litter transformers, decomposers and micro regulators (Moreira *et al*., 2008).

1.4 Centipedes

The centipedes have often been grouped as class Chilopoda under Super class Myriapoda along with the millipedes (Class Diplopoda) and other two classes of soil-dwelling arthropods: the Symphyla and the minute Pauropoda. The class Chilopoda comprises the orders Geophilomorpha, elongated, worm-like soil-dwelling centipedes with 31 to about 181 pairs of legs (Plate 1.a); the Scolopendromorpha containing the large tropical and subtropical species with 21 or 23 pairs of legs (Plate 1.b); the Lithobiomorpha, short-bodied centipedes with 15 pairs of legs (Plate 1.d); and the Scutigeromorpha which are mainly tropical and subtropical forms with 15 pairs of very elongated legs (Plate 1.c). A fifth type Craterostigmomorpha, with problematical affinities and includes exclusively the Australasian species *Craterstigmus tasmanianus* described by Pocock in 1902 from Tasmania which shows similarities to both Lithobiomorpha and Scolopendromorpha. Besides Tasmania it occurs only in New Zealand (Lewis, 2006b).

Centipedes are common and relatively familiar animals which are found in soil and litter or under stones or bark. They are soft-bodied and dorsoventrally flattened having from 15 to 181 pairs of legs, one pair to each trunk segment. Species from temperate regions are usually of moderate size, varying from 1 to 10 cm in length and of drab brownish or yellowish coloration. Many tropical species of the order Scolopendromorpha are large; some reach a length of 26 cm, and are brightly coloured: red, black, green or violet (Lewis, 2006b).

Like other arthropods, the centipedes are bilaterally symmetrical, metamerically segmented animals with a double ventral nerve cord, typically with a ganglion in each segment and concentrations of nervous tissue above and below the gut at the anterior end of the body. A circulatory system is present carrying blood forwards in a dorsal vessel and backwards in a ventral vessel. The body is covered by a non-living layer, the cuticle, secreted by the epidermis. The cuticle is in the form of relatively rigid sclerites separated by flexible arthrodial membranes; it is shed periodically to allow growth, a phenomenon known as moulting or ecdysis. The anterior part of the body is differentiated to form a head which bears a pair of antennae, a pair of jaws (mandibles) and two pairs of jointed legs modified to form mouthparts (the first and second maxillae). The legs of the first trunk segment are modified to form the characteristic poison claws which are used to seize prey (Lewis, 2006b).

1.5 Bionomics and Behavior

1.5.1 *Habitat and Adaptation*

Centipedes are generally photonegative in nature. They are susceptible to desiccation and normally found only in places where moisture is sure to be available. But the presence of water in their environment can be as dangerous to them as its absence. Excess water can create them problems of endosmotic water uptake, oxygen cut-off, and immobilization by surface tension. Centipedes have overcome this difficulty largely by evolving appropriate locomotory habits and the associated body design, which enables them not only to escape quickly enough from unreceptive physical and biotic surroundings, but also to hunt their prey with remarkable pace and precision (Manton, 1952, 1958).

The Scolopendromorpha, Lithobiomorpha and Scutigeromorpha are all fleet footed surface roamers, with their speeds progressively increasing in that sequence as do the lengths of their legs. Although the Scolopendromorpha and Lithobiomorpha take to surface retreats it available generally below ground debris and in crevices (Jangi, 1976).

1.5.2 *Food and Feeding Habits*

Centipedes are carnivorous and have been known to exploit a rich variety of prey; the burrowers among them subsist mainly on earthworms, termites, and subterranean insect larvae, such as white grubs; the surface roamers use adult insects, especially the soft-skinned ones, in addition to woodlice, spiders, slugs, and occasionally smaller vertebrates, such as frogs, toads, lizards, snakes, birds and mice. However, they hardly ever feed on an animal that is already dead. Centipedes are innately predators and active hunters and must capture their prey alive. It seems unlikely that they would habitually seek anything but small-sized creatures that can be easily subdued. If the prey is too small, such as a termite, it is captured directly by the feeding appendages, introduced into the mouth and immediately swallowed, but if it is large enough and vigorous in defending itself, the venom apparatus has be brought into action in order to cripple and kill it. If no food is available, centipedes can cannibalize. The feeding behavior of newly moulted centipedes is different. With their cuticle soft and pliable, they are unable to hunt and they depends on the readily available exuviate of their own (Jangi, 1976).

1.5.3 *Reproductive Behavior*

Centipedes are bisexual, but copulation in the strict sense of the term does not seem to occur in these animals. The male deposits its spermatophore, which later finds attachment to the female genital orifice. Since the seminal receptacles, of adult females are always found to contain spermatozoa (except in the parthenogenetic species such as *Geophilus proximus* reported by Sograff in1882), and the isolated females have repeatedly produced offspring in captivity, it would appear that once the centipede is inseminated, it carries an excessive supply of the sperm, which may probably be enough for its lifetime (Jangi, 1957). The Chilopoda are oviparous, and although the anamorphic among them, excepting *Craterostigmus*, deposit their

eggs on the ground and do not practice brooding, the epimorphic display remarkable parental care in as much as they persistently guard their eggs and young ones. The mother scolopendrid lays a cluster of eggs held together in a sticky secretion within the brood space closed by the body, which is curled up in a spiral, thereby preventing them from coming in contact with the ground. To begin with, it is a tight spiral, but with the progression of development and consequent increase in the brood mass it loosens more and more until the parent centipede must lie on its back, clutching the young with its legs and keeping them off the ground. The brooding period may last about a month, during which the centipede does not normally feed and depends entirely on its rich reserve of fat. If the brooding mothers are disturbed beyond a certain point, they react sharply by devouring or abandoning the brood but are less likely to do so after the latter has attained a fairly advanced stage of development (Jangi, 1976).

1.6 Collection and Culture

Centipedes are available in large numbers during the rainy season and can be beset caught with a large pair of specimen forceps. The proficiency in collecting these awesomely subtle and evasive creatures comes only with experience. Their legs, particularly the last pair, are liable to detach if the animals are not handled carefully, particularly at the time of taking them in the field, and in view of the importance of these organs in taxonomic determination, every care ought to be taken to procure intact specimens, no sooner is a centipede captured than it is dropped in a glass container, such as a specimen jar or a wide-mouthed bottle containing damp earth, which is then covered and secured with a perforated screw cap. Confined singly in this manner and placed in enamel or glass dishes with water to provide a humid microclimate around them and also to keep the predator ants at bay centipedes can be kept alive for many months on a diet of cockroaches, termites, insect larvae, and earth worms, yet successful centipede farming is disappointingly not yet possible, if it even will be. Centipedes do not readily breed in captivity, nor do they grow fast, and they take years to mature (Jangi, 1976).

1.7 Venom and its role

Our knowledge on the chemistry of centipede venom is scarce. Although it is claimed

to be a clear, colorless-to-yellowish fluid, no one has really even been able to obtain the venom in its pure-form (Jangi, 1976).

1.8 Order: Scolopendromorpha

There are usually 21 leg-bearing segments in the Scolopendromorpha but in the scolopendrid genus *Scolopendropsis* and the cryptopid subfamily Scolopocryptopinae, there are 23. The more or less rounded head capsule bears antennae composed of 17 or more antennomeres and either four ocelli on each side or none. Tomosvary organs (hygroreceptor sensory organs at the side of the head) are lacking in them. The mid-piece of the labrum is small, projecting posteriorly as a single tooth; the side pieces are well developed and fringed with setae. The mandibles are well developed, the trunk of each bearing a cruciform suture. The apical ridge bears a dentate lamella with five tricuspid teeth on one mandible, four on the other. The dorsal angle bears a tuft of fine setae; the ventral angle bears several pectinate lamellae. The coxosternite of the first maxillae is divided medially, lacks lateral palps but posess coxal projections. The distal segment of the telopodite is terminated by a pad bearing very fine hairs (Lewis, 2006b).

The forcipular tergite is fused with the first trunk segment. In many Scolopendridae the anterior border of the coxosternite bears a pair of tooth plates and a single pleurite is present on each side. The tibia and tarsus are shorter and form incomplete rings. The femuroid may bear a lateral tooth. As in the Geophilomorpha a pair of posterior extensions from the coxosternite sinks into the first trunk segment (Manton, 1964). The trunk tergites show varying degree of heteronomy, segments 2, 4, 6,9,11,13,15,17 and 19 being slightly shorter than the remainder. This is noticeable in the anterior segments, barely perceptible in the posterior ones. Spiracles are present on segments 3, 5, 8,10,12,14,16,18,20 and sometimes on segment 7. In species with 23 pairs of legs spiracles are present on segment 22 also. In *Plutonium,* spiracles *are* present on segments 2 to 20. Separate pretergites are wanting but transverse sutures at the front of each tergite delimit an area that probably corresponds to the pretergite. Longitudinal paramedian sutures are usually present. In some *Cryptops* species there is a cruciform suture on the first tergite. In scolopendrids the more posterior tergites have a ridge along each lateral margin and are then said to be marginate.

Presternites are present and similar to those of geophilomorphs. The metasternites are sometimes prolonged above the subsequent metasternite as an endosternite, as in *Cryptops* (Lewis, 2006b).

The pleurites are reduced in scolopendromorphs; the stigmatopleurites are only just large enough to contain the spiracles. The coxa is incomplete dorsally and the legs are of five or six segments and show a gradual increase in length from the anterior region of the trunk backwards. The last leg-bearing segment has a tergite which is narrower than the preceding ones as is the Sternite. The pleuirtes are fused with the inflated coxa of the terminal legs which frequently bear numerous pores and in many scolopendrids there is a posteriorly projecting coxopleural process armed with spines. The telopodite of the last pair of legs (ultimate legs) consists of five segments, the trochanter being absent. These legs are usually thicker than the normal walking legs. In scolopendrids they frequently bear spines on the prefemur but in Cryptopids the prefemur is without spines. Instead there is a row of saw-like teeth on the ventral margin of the tibia and tarsus which meet when the legs are flexed and may be used as prehensile organs. In *Newportia* there are 23 pairs of legs and the femur of the last pair usually carries from one to three teeth: the second tarsus is divided into a large number of secondary segments (Lewis, 2006b).

The terminal segments are strongly retracted beneath the twenty-first tergite and are scarcely sclerotised. Seen from below they hardly project beyond the sternite of the ultimate leg-bearing segment. Bucherl (1942) described the terminal segments of several species and particularly in males the fourteenth and fifteenth pairs of legs are particularly thickened. In males either or both of these pairs of legs may show secondary sexual structures. Each segment of each leg may bear distal spines which may be as many as six, three dorsal and three ventral. The arrangement of these spines is of considerable taxonomic importance (Lewis, 2006b).

1.9 Objectives of the present study

- To make a systematic revision of the Scolopendromorphic centipedes (Chilopoda: Scolopendromorpha) of Kerala which includes the habitats of Southern Western Ghat by undertaking extensive field surveys and collection

of specimens from different soil ecosystems.

- To describe new taxa and redescribe known taxa of scolopendrid centipedes of Kerala based on the material to be collected through field surveys and collections in museum depositories.
- To prepare identification keys to genera and species of Scolopendromorpha occurring in Kerala for stabilizing the systematic status of species.
- To provide basic knowledge about the ecology of Scolopendrid centipedes of Kerala and the distributional patterns of them in relation to the various ecological and Physiogeographic parameters.

1.10 Scope of the present study

- Systematic studies on the centipedes (Scolopendromorpha) have so far mainly been restricted to the North and North-Eastern states of India and selected parts of Deccan plateau. Since practically no work has been done on the centipedes of Western Ghats, a biodiversity rich hotspot of the country, it is imperative to undertake a detailed systematic study on the centipede fauna occurring in Kerala including the habitats of Southern Western Ghat in order to fill the gaps in the systematic knowledge about the group.
- The ecological role played by Scolopendromorpha in the terrestrial ecosystem is a totally unrevealed area of research, hence a preliminary approach is proposed.
- Detailed observations on the patterns of distribution of centipedes in relation to various ecological and physiogeographic parameters will be useful to understand their ecological role in ecosystem.

1.11 Organization of the Thesis

This thesis is organized into 6 chapters. In Chapter 1, general introduction, objectives and scope of the study is included. In Chapter 2, detailed review of previous studies of Scolopendromorpha included. Chapter 3 provides a detailed description of the field methods used to collect Scolopendromorpha samples, the collection techniques and preservation methods. Chapter 4, describe the study area –Kerala State, India with concise notes on its location area and boundaries, physical attributes, vegetation, forest types and faunal diversity. Besides, the three different ecosystems studied for

ecological data were also discussed. Chapter 5 provides a comprehensive inventory of the Scolopendromorpha from different districts of Kerala state with the detailed taxonomic descriptions and keys to genera and species for this region. Chapter 6 deals with the third objective, analyzing the diversity and richness of Scolopendromorpha in three different ecosystems using biodiversity indices and the impact of different soil parameters on the diversity pattern. Chapter 7 summarises the key findings of the study.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Chronicles of the world wide studies on Scolopendromorpha

The generic name Genus *Scolopendra* was first proposed and described by Linnaeus (1758) – father of modern taxonomy. He published it in the 10th volume of the much celebrated Systema Natura. In the original work he placed it under "Insecta-Aptera". In the same communication he described, *Scoplopendra morsitans* and *Scolopendra gigantea*.

Leach (1815) described the genus *Cryptops*. which was generally regarded as very difficult taxonomically. The term Chilopoda was introduced by Laterille (1817).

Newport (1844a) described genus *Cormocephalus* from New Zealand designating *C. rubriceps* as type species. In the same year Newport (1844b) described *Scolopendra hardwickei* from India. He was the first worker to recognize that the forcipules of centipedes contain a poison gland. Newport (1845) described *Heterostoma spinosa* from Sri Lanka which was subsequently designated as *Ethmostigmus platycephalus spinosus* by Attems (1930) and *Rhysida lithobiodes lithobiodes* having doubtful type locality from China. In the same communication he described *Branchiostoma longipes* which was subsequently designated as *Rhysida longipes* (Attems, 1930)

Scolopendra heros was described by Girard (1853). Genus *Rhysida* was described by Wood (1862) and two genera viz *Branchiostoma* (Wood, 1862) and *Ptychotrema* (Peters, 1855) were synonomised under this genus. Porat (1876) described *Cormocephalus mirabilis* from an unknown locality which was later synonomised as *Scolopendra mirabilis* and *Otostigmus spinosus* from Borneo. Meinert (1886) described genus *Asanada* designating *Asanada brevicornis* from Kooloo, Himachal Pradesh, India as type species. In the same paper he described *Scolopendra indica* from the same locality. *S.mirabilis* was described by Porat (1876) from Sudan. In the same communication he described genus *Otostigmus*. The type species was *O.orientalis* from Bombay, India which was later designated by Attems (1930).

Karsch (1881) described *Otostigmus politus politus* from Tienstein, China. Kohlrauch (1881) documented the family Cryptopidae. Plateau (1886) showed that centipedes not only seek dark humid resting place but also regions where most of the body is in contact with a firm object (thigmotactic behavior). Haase (1887) described *Otostigmus ceylonicus* and *O. insularis* from Sri Lanka, *Otostigmus geophilinus* from Timor, Indonesia and *O. metallicus* from Sangir Island. The alimentary canal of genus *Cryptops* has been described by Balbiani (1890). Pocock (1891a) described *Cryptops doriae* from Myanmar.

Genus *Paracryptops* and Genus *Arthrorhabdus* was formulated by Pocock (1891a). The type specimen for the genus *Arthrorhabdus* was *A. formosus* from South Africa. Pocock (1892) described *Otostigmus oweni* from Mergui Archipelago, Owens Island, Myanmar. Later, Genus *Ethmostigmus* was formulated by Pocock (1898). Another species, *Asanada socotrana* was described by Pocock (1899) from Socotra. Kraepelin (1903) described four new genera viz- *Hemicormocephalus, Colobopleurus, Hemiscolopendra and Psilopscolopendra.* In that same paper he erected Subfamily Otostigminae and described *Otostigmus oatesi* from British Burma (Tavoy), *Rhysida afra cuprea* from Bhutan and *R.stuhlmanni* from German-East Africa (Bogamoyo, Rio Quaqua). Verhoeff (1906) classified family Cryptopidae into subfamily Cryptopinae and Scolocryptopinae.

Scolopendra gardullana was described by Attems (1909) from Gardulla in southern

Ethopia. Gravely (1912a) described *Rhysida ceylonicus* from Peradeniya, Ceylon and *Pseudocryptops agharkari* from Koyna Valley, Satara, India *P.agharkari singhbhumensis* from Singhum, Chota Nagpur, India and *Otostigmus burn-murdochi* from Upper Rohtang, Himachal Pradesh. *Scolopendra mazbii* was described from Rotang by Gravely in the same communication. Chamberlin (1913) described *Otostigmus amballae* from Ambala, Haryana, India. Silvestri (1924) described *Cryptops kempi* from Siju Caves, Assam.

Attems (1930) in his monograph on world "Scolopendromorpha" listed, described and illustrated more than 400 species. He also included keys to families, subfamilies, tribes, genera and species in the same communication. He described *Otostigmus sumatranus kraepelini* from Chitral, Pakistan. He synonymised *Hemiscolopendra* with *Cormocephalus* and relegated other three genera *Colobopleurus, Hemiscolopendra and Psilopscolopendra* which was erected by Kraepelin in 1903 into nominate subgenera of *Cormocephalus.* Besides he described the genus *Digitipes*, designating *D.verdascens* as type species from Congo.

Auerbach (1951) stated that different species of centipedes show food specificity. Crabill (1955) requested the plenary powers of ICZN to designate a type species for the genus *Scolopendra* and designate *S.morsitans* as the type species for the genus. Cloudsley-Thompson (1958) noted the observation of *Scolopendra* which killed and ate small geckos of genus *Pachydactylus.*

There was a paucity of adequate monographs of Scolopendromorpha but some of the areas of the world were well categorised, such as France (Brolemann, 1930), South Africa (Lawrence, 1955) and Madagascar (Lawrence, 1960).

Manton (1964) suggested that the maxilla II and forcipular glands are structures for grooming behavior. Lewis (1973) discussed the taxonomy, distribution and ecology of genus *Asanada* from Nigeria. Three forms of the species were recognized and their relationship with other African population was discussed. An account on the biology of *A. sokotrana* was also discussed in detail. Observing the ecology and behavior, he pointed out that during the rainy season species were characteristically

found near deserted mounds of *Trinervetermes* spp., but disappear in dry season. Egg laying and brooding take place at the end of dry season and young ones appear during the onset of rains. He also noted the interesting observation that males live for only one year but some females live longer than this.

Lawrence (1975) published a paper on the chilopods of South West Africa. Manton (1977), in her book The Arthoropoda regrouped the Arthropoda group into three heads viz., Chelicerata, Crustaceae and Uniramia.

Lewis (1978) discussed the variations in tropical centipedes. Later, Lewis (1981) discussed the taxonomic problems caused by regeneration in scolopendromorph centipedes, like the antennal articles, ultimate leg prefemur spinulation and tarsal spur on walking legs.

Koch (1983) published a paper on genus *Ethmostigmus* of Australia including distribution map ,redescription of *Ethmostigmus rubripes* (Brandt) and 5 new species viz., *E.curtipes, E.muiri, E.nudior, E.pachysoma and E.parkeri* from Australia.

Lawrence (1984) published a guide on Centipedes and Millipedes of South Africa. In this guide he discussed the characteristics, structure and habitats of Centipedes and Millipedes in general.

Lewis (1986) pointed that *Trachycormocephalus* was a junior synonym of *Scolopendra.* Lewis (1992) published a paper on Scolopendrids from Nepal and Kashmir. The paper included the description of three new species- *Otostigmus martensi* sp.nov. and *Ethmostigmus trigonopodus pygomenasoides* from Nepal and *O. kashmiranus* from Pahalgam, Kashmir. Besides it included new reports of *Cormocephalus pygmaeus, Rhysida afra, Otostigmus scaber, Otostigmus amballae* and *Otostigmus glaber.*

Later, Lewis (1996) studied the type specimens of eight species of Genus *Otostigmus* decribed by Pocock from collection of the Natural History Museum, London. He redescribed *O.(O.) splendens, O.(O.) morsitans, O.(O.) nudus, O.(O.) ruficeps.*

O.(O.) oweni and *O.(O.) taeniatus*. Through his work *(O.) splendens* and *O.(O.) morsitans* were synonomised as *O.orientalis* Porat and *O.(O.) ruficeps* became a junior synonym of *O.multidens* Haase.

Lewis (1999) published a paper on genus *Cryptop*s from Nepal. Including the redescription of type materials of *C.australis* Newport and *C. doriae* Pocock. And the description of a new species *C.nepalensis*.

Pereira (2000) detailed the preparation of centipedes for microscopic examination. He discussed the recommended procedures for dissection and mounting of specimens. Lewis (2001) described *Otostigmus beroni* from Nepal basing the collection of National Museum of Natural History in Sofia. He gave details of two specimens of *Scolopendra afer* Meinert, 1886 and discussed that these specimens are more related to *Trachycormocephalus afer* Attems, 1930 and runs down to *S. gardullana* and seems to be conspecific. Later, Lewis (2002a) reported *S. gardullana* as a junior synonym of *S. afer*. Lewis (2002b) redescribed 11 type specimens of *Otostigmus* described by Chamberlin from the Museum of Comparative Zoology, Haward. In that communication, only three species, *O.amballae* from India*, O. proponens* from Solomon Island *and O.pamuanus* from Philippinus were regarded as valid species. *O. simplex*, which type locality is doubtfully Indian region was transfered to *R.longipes, O. barbouri* from New Guinea to *O (O.) astenus, O. malayanus* from Malaya to *O. insularis, O. completes* from Solomon Island to *O. (O.) politus, O. philippinus to O.(O.). tuberculatus pauperatus, O.bakeri* from Philippines to *O.(O). loriae.* and *O. moluccanus* as nomen dubium. Lewis (2003) discussed the identity of various taxa that have been assigned to *Otostigmus politus* Karsch, 1881.

Schileyko and Stagl (2004) critically reevaluated the collections of centipedes in the Natural History Museum in Vienna. The major evaluation was based on the samples examined by the famous worker on Myriapods, Attems during his systematic and taxonomic studies from 1894- 1952. The restudy of Scolopendromorphs included genus *Arthrorhabdus* (1 species), *Asanada* (2 species), *Cormocephalus* (21 species), *Ethmostigmus* (3 species), *Newportia* (5 species), *Rhoda* (1 species) and *Tidops* (1 species).

Chagas and Shelley (2004) rediscovered and redescribed *Paracryptops inexpectus* Chamberlin, 1914 from Roseau, Dominica, in the Lesser Antillis. Lewis (2004a) published a paper on the type specimens of *Otostigmus armatus, Otostigmus multidens and O.scaber* described by Attems in 1953 from Indo-China. Lewis (2004b) reassessed the type material of African species – *O.reichardti* Kraepelin and *O. tanjanjikus* Verhoeff. He synonomised *D. katangensis* with *O.reichardti* and suggested to cite *O.reichardti as D. reichardti.*

A new species of the genus *Cryptops (Trigonocryptops)* from Western Australia was published as *C. (T.) roplainsengsis* by Edgecombe (2005). Lewis (2006) created a third new monogenetic family Mimopidae, characterized by the possession of single ocellus on each side of the head, fascicular plates lacking teeth, 21 pair of walking legs and the ultimate legs with numerous small spines. It was included under Genus *Mimops* Kraeplin, 1903 which was earlier categorized in subfamily Cryptopinae by Attems (1930).

A Global database of Chilopoda was compiled by Minelli *et al*., (2006) (http://chilobase.bio.unipd.it).

Lewis and Cole (2007) published a note on *Rhysida longipes* from Chagos Island, Indian Ocean. It was the first centipede species reported from the Chagos Archipelago. Edgecombe (2007) discussed the progress and problems in Centipede taxonomy. Chao and Chang (2008) reviewed the Scolopendromorpha in Taiwan and designated the neotype for two centipedes, *Scolocryptops curtus* (Takakuwa, 1939) and *Cryptops nigropictus* Takakuwa, 1936. This paper also included the synonomisation of *Otostigmus multispinosus* Takakuwa, 1937 to *O.aculeatus* Haase, 1887; *O. striatus* Takakuwa, 1940 to *O.scaber* Porat, 1876 and *Rhysida vanagiharai* Takakuwa, 1935 to *Rhydida longipes longipes* (Newport, 1845). And key to Taiwanese species of genera *Scolocryptops* and *Cryptops* were provided.

Ernst, Rosenberg and Hiken (2009) described firstly the structure and distribution of hat like sensillae in centipede species *Cryptops hortensis* (Donovan, 1810). Lewis (2009) published a review of some characters used in taxonomy of genus *Cryptops.*

He pointed out the reliability of characters like shape of poison gland calyx and the arrangement of setae on the anterior margin of coxosternum. And the variability in characters like shape of Sternite 21.

Lewis (2010a) published a key and annoted list of *Scolopendra* species from the Old world along with the reappraisal of genus *Arthrorhabdus.* In this paper, key to 42 species and 7 subspecies of *Scolopendra* were included. *Artrorhabdus somalus* Manfredi, 1933 was transfered to *Scolopendra* and became *S.somala* (Manfredi, 1933). *Arthrorhabdus jonesii* Verhoeff, 1938 is removed from the list because of its uncertain status.

Lewis (2010b) revised the *rugulosus* group-the largest group of subgenus *Otostigmus* of genus *Otostigmus.* In this paper he categorised the subgenus into nine groups based on Attems (1930). Lewis (2010c) opined that there was no evidence to support the suggestion of Bücherl (1971) that the ultimate legs of genus *Cryptops* were utilized for capturing the prey, he also pointed out that they are defensive.

Lewis (2011a) reviewed the species in the genus *Cryptops* from Old World related to *C.hortensis* (Donovan, 1810). In this paper he categorized the species into those with and without transverse suture on Tergite 1. The latter group was also further divided into species with the ultimate leg prefemur without a saw tooth or teeth (the *hortensis* group) and those with one or more teeth (the *doriae* group).

Lewis (2011b) redescribed the species *Cryptops nanus* Attems, 1938 from Hawaii which is earlier synonomised as *C.nanus* by Shelley (2000). Lewis (2012) published a review of six species of Scolopendromorph from Seychells.

Dugon and Arthur (2012) opined that several species of scolopendrids had been observed seizing prey with the ultimate legs and then flicking the anterior half of the body to inject the prey with venom. They also observed that in experiments with *Scolopendra subspinipes mutilans* Koch, 1878 (now *S.subspinipes* Leach, 1815) prey was only attacked with the forcipules.

Kronmuller and Lewis (2012) elevated *S.dehaani, S.dawydoffi* and *S.japonica* to the rank of separate species.

Lewis (2014) discussed about Paedomorphosis in the scolopendrid centipede genus *Asanada* which creates different characters in embryonic stage and adult *Asanada* and explains the reason for incongruence between morphological and molecular data sets. He pointed out that a number of characters are only seen in embryonic or early adolescent stadia.

Shelley *et al*., (2014) reported *Scolopendra morsitans* from Honolulu, Oahu, Hawaiian Islands. This document was the first record of this anthropochoric centipede from both the archipelago and state. Two other species of Scolopendra, *S. polymorpha* Wood, 1861, "*S. subspinipes* Leach, 1815, complex," also reported on the same communication as introduced species.

Kronmuller and Lewis (2015) on an investigation on the function of ultimate legs in Scolopendromorpha, reported that the use of the ultimate legs is primarily for defence, however, in the case of a prey when it make contact with the centipede, the defensive response and defensive biting will lead to feeding of the prey whereas in the case of a predator, the centipede will try to escape after one or more warning bites.

Siriwut *et al*., (2015a) described *Digitipes kalewaensis* from Myanmar which was the first record of the African-Indian genus *Digitipes* from South East Asia. In that study, molecular analysis of the species revealed that the species resolved as a sister group to a clade composed of most Indian species. In the same year, Siriwut *et al*., (2015b) studied the molecular phylogenetics , geometric morphometrics and external morphology of genus *Scolopendra* in Southeast Asia. Their study revealed that the most densely sampled species in their *study S.dehaani* Bandt has three subclades with allopatric distribution in mainland Southeast Asia. They studied 5 colour morphs of the species and found that colour morphs 2, 3, 4 were found in all the populations where 1 and 5 is restricted to regional populations. They opined that environmental factors can be a reason for these variations. Besides, their study also revealed that

S.morsitans and S.japonica exhibited specific colourmorphs in different populations.

2.2 Historical review on the studies of Scolopendromorpha in India

The Indian centipedes have been studied for over a century and a half past. The Indian species of centipedes have been studied since the period of Linnaeus (1758) who described e *Scolpendra morsitans* from India followed by Fabricus (1781). The studies on Indian centipedes in early 19th centuary begans with Leach (1815). Another known reference on Indian Centipedes was Newport's (1844a)- Monograph of Class Myriapoda, Order Chilopoda, followed by Haase (1886,1887), Pocock (1890,1891a,1891b,1892), Kraepelin (1903) and Gravely (1910, 1912a, 1912b). Newport (1844b) after examining specimens studied by Linnaeus concluded that he may included several species of similar size under *S.morsitans*. The genus *Asanada* was described with *Asanada brevicornis* Meinert (1886) as the type species from Kooloo, Himachal Pradesh, India. Porat (1876) described *Otostigmus orientalis* from Bombay, India and *O.rugulosus* from Madras, Tamil Nadu.

Pocock (1890) described *Otostigmus morsitans, Otostigmus nudus, O.splendens and O.ruficeps* from Madras, India. Pocock (1891a), based on a single specimen from Bengal, described *Cormocephalus dentipes*, which has since been placed under the nominate subgenus *Cormocephalus* and became *Cormocephalus (Cormocephalus) dentipes*. Later, Pocock (1892) described *Cormocephalus pygmaeus* from Madras, Tamil Nadu, India. Pocock (1897*)* described *Rhysida paucidens* which was later erected as *R.lithobiodes paucidens* (Attems, 1930) from Pondichery, India.

Kraepelin (1903) described *Rhysida crassipina* from Matheran, Alibargh, Maharashtra, India and *R.stuhlmanni*. Krapelin (1908), in his redescription of *S.morsitans*, pointed out that Linnaeus studied the material having homogenized characters regarding tarasl spur on 20th leg, except a single specimen.

Attems (1909) described *Trachycormocephalus occidentals* from Dinapur, Bihar, India. *Scolopendra dehaani, Scolopendra* subspinipes was reported by Gravely (1910) from Punkhabari, Darjeeling, Calcutta and Cochin respectively. In the same communication he reported *O.politus.politus* from Himalayan Region. Gravely

(1912a) described *Pseudocryptops agharkari*, Satara, India from Koyna Valley, *P.agharkari singhbhumensis* from Singhum, Chota Nagpur, India and *Otostigmus burn-murdochi* from Upper Rohtang, Himachal Pradesh. Later, Gravely (1912b) described *Scolopendra mazbii* from Upper Rohtang, Himachal Pradesh.

Chamberlin (1913) described *Otostigmus simplex* from Madras, Tamil Nadu. And he described *Otostigmus amballae* from Ambala, Haryana, India. In the next year, Chamberlin (1914) described *Trachycormocephalus indiae* which was later synonomised as *Scolopendra indiae.* Cornwall (1916) discussed that the Indian species of *Rhysida* sp. and *Otostigmus* sp. have small poison claws and can penetrate only delicate skin Chamberlin (1920b) described *Ethmostigmus coonooranus* from Coonoor, Tamilnadu, India. and *Otostigmus proponens* from Manipur, India. In that same paper he described *Rhysida simplicior* also from same locality which was later designated as *R.longipes simplicior* by Attems in 1930. Silvestri (1924) in his paper on the collections of centipedes in Indian Museum, described a new species *Cryptops kempi* and *Paracryptos indicus* from Siju Caves, Assam.

Attems (1928) described *Cormocephalus macrosestrus* from Madder Thorey, Kolkatta. Attems (1930) published a monograph on the Scolopendromorpha of the world. After the publication of the Attems' monograph in the year 1930, the number of known species has increased from 436 to over 600 globally. From India alone the numbers of species have multiplied four times, from 27 to 101. He described *Trachycormocephalus indiae* from Jeypore and *Trachycormocephalus occidentalis* from Dinapore, Bihar. Subsequently, Verhoeff (1937) recorded a new subgenus and species *Cormocephalus (Dekanonyx) nigrificatus* from India.

Jangi and Dass were the pioneers in Indian Myriapodology and in their various communications they discussed in detail about the biology as well as the taxonomy of Scolopendrmopha. Jangi (1955a) published a paper on Scolopendromorphs of Nagpur including the description of three new species *Cormocephalus pilosus, Rhysida nuda subnuda* and *Cryptops (Trigonocryptops) orientalis*. Jangi (1955b) discussed the possible taxonomic status of two variant forms 'A' and 'B from Nagpur, India; of *S.morsitans*. In his view, Linnaeus in Systema Natura published in 1758

included *S.morsitans* but with a meager description of characters. And according to Jangi, Attems (1930) opinion on the synonimisation of several species under *S.morsitans* might be due to the fact that most of the synonomised species have poor descriptions. He also suggested that the ultimate leg character (a secondary sexual character) which was considered important by Attems is of supraspecific level, and may present in more than one species of same genus.

Jangi (1960) explained the antennal musculature of *S.amazonica*. In a discussion about the musculature of ultimate legs, Jangi noted that Scolopendra didn't utilize the ultimate legs as locomotory organs. Jangi (1961) studied the extrinsic and intrinsic musculature of the antennae and musculature of ultimate legs of *Scolopendra morsitans*.

Jangi (1964) also mentioned that there was an increased rate of discharge from the crural nerve when the ultimate legs of *Scolocryptops sexspinosus* were raised. Jangi studied the foregut of *Scolopendra morsitans* and explained that foregut extends as far as the thirteenth walking legs. Jangi and Dass (1975) discussed the interesting and unique sexual dimorphism in *C.dentipes* (Pocock). According to his study, an adult male can be readily distinguishable from its female counterpart by "rougher maxillipedes" and more number (10 against 6 in female) showing lateral emargination and tubercle invested anal (ultimate) legs. Jangi (1976) in handbook of Natural Toxins edited by Anthgony T.TU, discussed in detail about venom apparatus ie., the maxillipedes, its ultrastructure, physiology, envenomation, pathology, pharmacodynamics and therapeutic / preventive measures. Jangi and Dass (1977) discussed the chemoreceptive function of poison fangs of *S.morsitans*. It was the first communication regarding the sensory role of poison fang, depicting the gustatory role besides that of killing the prey.

An observation on the food and feeding habits of *Scolopendra valida* Lucas was reported by Khanna (1977a). In that communication the preliminary observations on the food and feeding habitats of the species were carried out in four different conditions of soil and food. He reported that it is rather difficult to acclimatize *S.valida* under laboratory conditions. *S.valida* preferred flaccid body. And the

species don't feed on cockroaches. The highly cannibalistic species use reserve food in adverse conditions, survived even seven days without food. Besides this, the examination of dead samples was also found to be infested with acarine mites, probably *Caloglyphus* sp. Khanna (1977b) described *Trachycormocephalus hayati* and *Trachycormocephalus jodhpurensis* from Rajasthan.

Jangi and Dass (1978a), published a redescription of the Indian centipede *Pseudocryptos agharkari* Gravely (Chilopoda: Scolopendromorpha: Scolopendridae). A new species *Paracryptops spinosus* was published by Jangi and Dass (1978b). A redescription of Indian centipede *Scolopendra mazbii* Gravely (Chilopoda Scolopendromorpha: Scolopendridae) was also published by Jangi& Dass (1979). Jangi and Dass (1980b) described *Trachycormocephalus nudus* from Delhi University, India. Ahmed (1980) reported *Scolopendra subspinipes, S.hardwickii* and *S.dehaani* from Andaman and Nicobar Islands.

Ahamed (1983) published a brief account of centipedes (Scolopendromorpha) from Madhya Pradesh. In that communication a total of 9 species under 4 genera had been recorded, 8 of which were reported for the first time from this area. Scolopendrid centipedes of western Himalaya with an annotated list of Indian species (Chilopoda: Scolopendromorpha: Scolopendridae) was published by Khanna and Kumar (1984). It dealt with the Scolopendrid centipede of Western Himalaya, Uttar Pradesh. In that discussion, nine species had been recorded from this region i.e., *Cormocephalaus (cormocephalus) dentipes* Pocock *, C. (C) pygmaeus* Pocock*, Otostigmus amballae* Chamberlin*, O.(O) politus* Karsch*, and Rhysida afra cuprea* (Peters) were recorded for the first time from Uttar Pradesh and Western Himalaya. *Rhysida carinulata* (Haase) and *R. stuhlmanni* were recorded for the first time from India*. Rhysida monalli* was described as new to science. Additional distributional records of *Scolopendra morsitans* were given. Besides a key to the known Indian centipede genera of the family Scolopendridae was also provided as well as a key to the known Indian species of the genus *Rhysida* (Wood) included.

Khanna and Tripathi (1984), published another work discussing the observation on the seasonal incidence within the centipede genus *Cormocephalus* Verhoeff

(Chilopoda: Scolopendromorpha). The interesting ecological aspect of this study was that all the specimens of both the species viz. *C. dentipes* Pocock *and C. pygmaeus* Pocock had been found to be collected during the peak winter months of the year (October to February) beginning as early as late September to the end of February or early March, from the western Himalaya (U.P), terai and plains. Khanna and Tripathi (1985) described a new species - *Rhysida longicarinulata* from Paonta, Sirmaur, Himachal Pradesh and reported *R.ceylonica* Gravely for the first time from India. Khanna and Tripathy (1986), described a new species of the centipede genus *Otostigmus* Porat - *Otostigmus pooname* from Himachal Pradesh (Scolopendridae: Otostigmini). This paper dealt with the Indian species of the centipede genus *Otostigmus* Porat, collected from H.P India and *Otostigmus geophilinus* Haase *and Otostigmus ceylonicus* Haase had been recorded for the first time from India.

Khanna and Tripathi (1987) described *Trachycormocephalus paranudus*, a new scolopendrid centipede from Hissar district (Haryana), India. Observations on the colour variation in the centipede *Scolopendra morsitans* Linnaeus (Myriapoda: Chilopoda) from Maharashtra, India was conducted by Yadav (1993a). He observed different colour patterns of faint blue, dark bluish, dark green and greenish grey in tergite colour of *S.morsitans*. Yadav (1993b) published a work on the collection of centipedes (Myriapoda: Chilopoda) from Pune including the record of *Scolopendra morsitans* Linn.

Khanna (1994a), published the Chilopod fauna of North East states, India (Chilopoda: Scolopendromorpha). In another communication on same year (1994b) he described three new species *Rhysida corbetti, Rhydida stuhlmanni himalayanus* from Kaladungi-Mangoli Road, Nainital, Utharanchal and *Rhysida liothobiodes kumaonensis* from Corbett National Park, Utharanchal, India. He(1994c) described the species *Rhysida lithobiodes shivalikensis* from Motichur, Sivalik Hills, Dehraduhn, Utharanchal.

Rathinasabapathy and Daniel (1997) reported tiger centipede *Scolopendra hardwickei* Newport from Coimbatore Zoological park site, Anaikatty, Tamilnadu, Western Ghats. Khanna and Yadav (1997) studied Indian species of genus *Scolopendra* Linn.

(Chilipoda: Scolopendridae) with description of a new species namely *Scolopendra jangii* from Pune, Maharashtra.

Khanna (2001), published a check list of the Indian species of the centipedes (Chilopoda: Scolopendromorpha) including 101 species of Scolopendrid centipede from India. In that communication the author consolidated the zoogeographical distribution of the Indian species of Scolopendromorpha as documented from early 19th century till the year 2001, which includes 95 species of the subfamily Scolopendrinae belonging to 8 genera viz. *Scolopendra, Cormocephalus, Arthrorhabdus (*Tribe Scolopendrini); *Asanada* (Tribe Asanadini); *Otostigmus, Rhysida, Ethmostigmus, Digitipes* (Tribe Otostigmini) and 6 species of the subfamily Cryptopinae belonging to genera *Cryptops, Paracryptops* and *Otocryptops*. The majority of the species documented in this work are mainly Indian, the predominant percentages of which are endemic to Deccan Plateau. Western Ghats and Eastern Himalaya, the two known "hot spots" harbor greater species diversity.

Yadav (2001) recorded 16 species of Scolopendrid centipedes from Nilgiri Biosphere Reserve in which *Otostigmus* was the most abundant group. Khanna (2003) published the review on the diversity of Scolopendrid centipedes (Chilopoda: Scolopendromorpha) in Himalayan ecosystem and adjacent areas. In that paper the pattern of the distribution of 75 species from Himalaya were accounted.

Khanna (2004) published the Myriapod diversity in Arunachal Pradesh with a check list of 12 species of Scolopendrid centipedes. Khanna (2005) also published the trends in the distribution of Scolopendromorpha from India. He discussed that out of known 102 species, about 76.5% of the species reported from India have Oriental Origin. Out of which 65 species have their type locality in India only. The type locality of 13 species are unknown, 2 species are of Australian Region, one Nearctic and two in Ethopian region. In India 35 species are known from Indo Gangetic plains, 43 from Western Himalayas, 15 from Central Himalayas, 26 from Eastern Himalayas, 11 species belong to Arid and Coastal region of India.

Khanna (2006) published the checklist of Scolopendromorphic centipedes from Central

India. It was a compilation report for Achankar-Amarkantak BiosphereReserve and adjoining areas of Chhattisgarh and Pachmarhi BiosphereReserve, Madhyapradesh. He reported 11 species in that study, including first report of *C.pygmaeus* from Central India. Khanna (2007) reported *C.doriae* Pocock as the first report from Uttaranchal, the specimen was collected from Doon Shiwaliks.

Yadav (2005,2006a, 2006b) inventorised the Scolopendromorpha of Melghat Tiger reserve, Tadoba Andhari Tiger Reserve and Sanjay Gandhi National Park, and reported 15 species, 12 species, 8 species respectively from the specified protected areas. Yadav (2006a) discussed that from the state of Maharashtra 35 species were altogether accounted.

Sureshan *et al*., (2006b) reported nine species of scolopendrid centipedes belonging to 5 genera and 2 subfamilies from the state of Orissa. Two species viz. *Asanada indica* Jangi & Dass and Rhysida *longipes longipes* (Newport) are reported as the first report from the state. Sureshan and Yadav (2008a) reported 5 species of centipedes from Lonar WildLife Sanctuary, Maharashtra.

From the Goa state 8 species of centipedes under 4 genera were reported by Sureshan and Yadav (2008b), in that communication they pointed out that *D.coonoorensis* is the most commonly occurring species in the state of Goa.

Khanna, in his national register (2008) check-listed 90 species of Scolopendrid centipedes from India, belonging to two families. Khanna (2010) compiled the fauna of Ranthambhore National park, Rajasthan in which, *C.westwoodi dispar* Porat, *O.burn-murdochi* Gravelyi and *Cryptops* spp were added as new record from the state of Rajasthan.

Regarding the molecular phylogeny of Scolopendrids in India, Joshi and Karanth (2011) studied about the Cretaceous-Tertiary diversity among select Scolopendrid centipedes of South India. The resulted phylogenetic tree supported the monophyly of family Scolopendridae which was in turn split into two clades of tribes Otostigmini and Scolopendrini-Asanadini. The study also supported that earliest diversification

within different genera of Scolopendromorpha were between 86 and 73 mya, indicating the Gondwanan origin. In particular atleast four genera-*Scolopendra, Cormocephalus, Rhysida* and *Digitipes* might have undergone diversification in late cretaceous period on the drifting Peninsular India.

Later, Joshi and Karanth (2012) conducted a coalescent analysis based on mitochondrial dataset which results in 9 putative species. In the same communication through an integrated approach of nuclear, morphology and climatic dataset they get a supporting data for 8 putative species, among which 5 were new to science.

Joshi and Edgecombe (2013) published the review of Scolopendrid centipede belonging to genus *Digitipes* Attems from India reconciling the molecular and morphological estimates of species diversity. In that paper two new species- *D.jangii* a Joshi and Edgecombe and *D. periyarensis* Joshi and Edgecombe were described, which were raised as putative in their earlier study and *Arthrohabdus jonesii* Verhoeff was synonomised under *D. jonesii* consequently deleting the genus *Arthrohabdus* from Indian checklist.

2.3 Historical review on the taxonomic studies on Scolopendromorpha in Kerala

The taxonomic study of Scolopendromorpha from Kerala region can be traced back to the description of *C.(Dekanonyx) nigrificatus* by Verhoeff (1937). The type locality of the species was Nedumangadu, 2 miles east of Trivandrum, Kerala. In the same year he also described *Arthrorhabdus jonesii* from Ponmudi Hills, Trivandrum which was later synonimised as *D.jonesii* by Joshi and Edgecombe in 2013.

Jangi and Dass (1984) described *D.gravelyi* from the collection by Gravely made during 1914 from Parambikulam, Cochin, Kerala. From the same collection they described *D.indicus* from Tramway, Palaghat, Kerala. Both these species were published in their monograph of Scolopendrids of Deccan Region.

The first taxonomic attempt to inventorise Kerala Fauna of Scolopendromorpha was the communication of distributional records by Sureshan *et.al.*, (2003) In that study basing the collection from Western Ghats Research Centre, Zoological

Survey of India, Calicut. 8 species; *Cormocephalus dentipes, Otostigmus splendens, Ethmostigmus coonooranus, Digitipes coonorensis, Digitipes barnabasi, Rhysida lithobiodes paucidens, Rhysida lithobiodes trispinosus, Rhysida longipes longipes* were reported for the first time from Kerala. A total of 23 species were reported. Sureshan *et al.,* (2006a) updated the checklist of Scolopendrid centipedes from Kerala state (including part of the Western Ghats) and prepared an illustrated key for the identification of 15 species .

Dhanya *et al.,* (2012) described a new species of centipede of genus *Cryptops* Leach (Scolopendromorpha: Cryptopidae) - *Cryptops (c) malabarensis* from Malabar Wildlife Sanctuary, Kerala with a key to the species of *Cryptops* in India. It was the first attempt to study the Family Cryptopidae of Kerala state. In that study, family Cryptopide (Scolopendromorpha) and genus *Cryptops* was reported for the first time from the Southern Western Ghat area including Kerala state.

Dhanya *et al.,* (2013) communicated a study on the biodiversity in outside protected areas, with a special focus on the Scolopendromorphic centipedes of Puliyampoyil hill, Calicut, Kerala- A foothill of the southern Western Ghats. It was the first attempt to study the ecological aspects of centipedes in Kerala region. The authors discussed the diversity and richness of Scolopendromorphs and observed 11 species under 6 genera in 2 families, which accounted for 47.82% of total species reported from Kerala.

2.4 Historical review on the Systematics of Scolopendromorpha

The systematic study of Scolopendromorpha can be traced back to the period of Linnaeus (1758) who first reported the genus *Scolopendra*. Leach (1815) recommended the family Scolopendridae included genera *Lithobius* (Lithobiomorpha), *Scolopendra* and *Cryptops*. Newport (1845) opined that the family Scolopendridae consisted of 8 genera of three subfamilies: Scolopendrinae (genera *Scolopendra*, *Scolopocryptops*, *Cryptops* and*Theatops*), Heterostominae (genera *Branchiostoma*, *Heterostoma* and *Scolopendrosis*) and Cormocephalinae (genera *Cormocephalus* and *Rhombocephalus*). His study was based on the structures and the number of external respiratory organs. Haase's (1887) in his communication named

"Indo-Australische Chilopoden", divided the family Scolopendridae 3 subfamilies according to the number of body segments and pairs of spiracles. Pocock (1897) opined that the family should be erected to the order Scolopendromorpha.

The classification proposed by Attems (1930) was the most widely accepted. In that classification, presence of ocelli was used for dividing the order Scolopendromorpha into 2 families: Scolopendridae (ocelli present) and Cryptopidae (ocelli absent). The family Scolopendridae consists of two subfamilies viz., subfamily Scolopendrinae (the atrium of spiracle is divided into a vestibule and inner cavity by a diaphragm consisting of three valves) and subfamily Otostigminae (an open spiracle without atrium). The family Cryptopidae included three subfamilies: Scolopocryptopinae (with 23 pairs of legs), Cryptopinae (with 21 pairs of legs, without tooth plate, ultimate legs normal) and Theatopsinae (with 21 pairs of legs, with long tooth plate, ultimate legs long and thin). Later, Crabill (1953) renamed genus *Scolopocryptops* as *Dinocryptops*, and the genus *Otocryptops* as *Scolopocryptops*.

Schileyko (1992) considered that the much older Haase's system (1880) is more appropriate as reflecting the phylogeny than the Attems (1930) classification. According to him taxonomic system of Scolopendromorpha should be based on the number of body segments and pairs of spiracles, that is, order Scolopendromorpha was consisted 34 genera of eight subfamilies of three families: family Plutoniidae (with 21 body segments and 19 pairs of spiracles), family Scolopendridae (with 21 body segments and 9 or 10 pairs of spiracles), and family Scolopocryptopidae (with 23 body segments, and 10 or 11 pairs of spiracles) (Schileyko 1992, 1996, Schileyko and Pavlinov 1997).

Schileyko (1996) suggested that the family Cryptopidae of Attems' system is probably an unnatural composite taxon. He also informed that Genus *Plutonium*, belonging to the family Cryptopidae in Attems' system, deserves not only a family of its own, but even a superfamily status. Later, Schileyko and Pavlinov (1997), discussed that the family Scolopendridae consisted of subfamilies Cryptopinae and Theatopsinae (formerly these two subfamilies belong to family Cryptopidae in Attems' system), Scolopendrinae, Otostigminae, Sterropristinae; the family Scolopocryptopidae

consisted of subfamily Scolopocryptopinae and Newportiinae. Again, Shelley (1997) placed *Plutonium* and *Theatops* in the subfamily Plutoniuminae, concerning the presence of 19 pairs of spiracles in *Plutonium* as only a generic character. Thus, he adopted the same classification system of Attems (1930).

The recently adopted classification was the system by Bonato *et al.,* (2011). In that classification they subdivided Order Scolopendromorpha into five families viz., Family Cryptopidae Kohlrausch, 1881; Family Mimopidae Lewis, 2006a; Family Plutoniumidae Bollman, 1893; Family Scolopendridae Leach, 1814 and Family Scolopocryptopidae Pocock, 1896.

CHAPTER 3
MATERIALS AND METHODS

3.1 Sampling methods for Selection of localities for Taxonomic studies

Stratified random sampling methods were used for the selection of sites from each district in Kerala state, India. Different strata of places were selected according to the diversity in habitat, ecosystem and geographic features. For a preliminary selection the entire study region was divided into three i.e, Southern Kerala, Central Kerala and Northern Kerala and each broad region was subdivided based on districts and each place in each districts were stratified on the basis of above criteria from which random sampling sites were selected.

Unidentified Samples from the faunal depository of Western Ghat Regional Centre, Zoological Survey of India (WGRC, ZSI) were also categorized based on their area of collection and included in the study.

3.2 Selected sites for the inventory in Kerala

Based on the sampling method and field surveys were conducted in three major regions (South, Central and North Kerala). A detailed list of collection places are represented in Appendix 1. The plotting of distribution map for the studied species has entirely been done with the help of DIVA-GIS 7.5, application of GOOGLE EARTH and Geographic Positioning System (G.P.S) The data referenced with G.P.S.

of the samples collected during the present study in Kerala were also analyzed and the species distribution maps plotted were created using DIVA-GIS 7.5 (Map 2-10).

3.3 Sampling methods for the Selection of places for Ecological Studies

The effect of diversified ecosystem features on biodiversity has been a topic of great interest for many earlier and contemporary biogeographers. Concerning centipedes, few studies have been carried out in detail focusing on the relationship between species diversity and ecological parameters. Thus, here I intended to investigate effect of seasonal fluctuation and ecosystems characteristics on the diversity of Scolopendromorpha. All the above methods mentioned for taxonomic studies were carried out during the morning hours (7am - 11am) as night sampling was not possible in the study areas. And the study period was April 2011 to November 2012. For ecological studies, samples were collected on a monthly basis from the three selected sampling sites. Sampling was done on a monthly basis during the second week of each month.

Soil Temperature, Soil pH, Soil Electrical Conductivity (EC), Organic Carbon (OC), Available P, K, Ca and Mg were analyzed during seasons to study the influence of such parameters in diversity of Scolopendromorpha.

For calculating the diversity indices EstimateS Version 8.2.0 software was utilized (Colwell, 2009). For statistical analysis of the data MS-Excel 2007, PAST 1.89 software package (Hammer *et al.,* 2001) and SPSS were utilized.

3.4 Collection Methods

Niches: Collecting Scolopendrids and locating their possible hide-outs/ niches requires a lot of skill coupled with experience. They are found singly under stones, logs, leaf litters, cow dung, flowerpots, bark of trees, sheath of banana stems, in side termite mounds, etc. The most suitable habitat is an area with optimum moisture and temperatures conditions near a forest patch, around ponds, lakes or rivers or on the hill slopes (Khanna, 1993). Centipedes are nocturnal and the most appropriate time for their collection is either early in the morning or in the evening hours. However, in hilly areas it can be collected throughout the day especially on the hill slopes, which

receive filtered sunlight through tall trees, and the floor is covered with leaf litters and the soil is of gravel nature.

Sampling techniques: Sampling was carried along the 14 districts in Kerala for 5 years (2011-2015). As Scolopendromorphic centipedes exploit a wide variety of niches (Plate: 2), sampling was done in order to collect representative samples from all niches within each intensive sampling plot. Sampling required a combination of methods, so different collection techniques adopted *viz*., from vegetation sampling, litter sampling and ground hand collection (Plate: 2). The principal purpose of this sampling design was to produce a relatively complete species list and associated abundance data for a representative sample of each site in the region, and of the region as a whole. These methods were employed for 1 hour in the same sampling plot.

Sampling from vegetation involved searching leaves, branches, tree trunks, and spaces in between, from knee height up to maximum overhead arm's reach.

Ground collection involved searching on hands and knees, exploring the leaf litter, logs, rocks, and plants below low knee level.

Litter sampling was done by manually sorting samples from leaf litter collected in a tray. Specimens were identified up to family, genus and species level when possible.

3.5 Narcotization and Killing

Preservation technique was adopted from Khanna (2005). While collecting centipedes, extreme care is required to be taken to hold the animal gently through its trunk but firmly, with the help of a pair long forceps to avoid damage to the body. If not properly handled, it's walking legs, ultimate legs or antennae may be damaged or broken; thereby rendering them unfit for taxonomic studies. Narcotization was given by inhaling anesthetic agents like chloroform in an anesthetic jar or cotton plugs dipped in Ethyl acetate was utilized. The narcotized specimens were kept in diluted formalin for killing. Before examination they were washed well with distilled water.

3.6 Fixation and Clearing

Specimens collected from the field were fixed in 70% ethanol or 2% formaldehyde. Scolopendromorphs especially the slender Cryptopids were examined in Petri dishes containing ethylene glycol monophenol ether before microscopic examinations. Perforation of the pleura by this chemical agent facilitates clearing of specimens. But for large sized specimens, this may take several days (Pereira, 2000).

3.7 Storing and Preservation

Narcotized samples were preserved in 70% alcohol or in solution of 2% formaldehyde. The size of the container was big enough so that the captured animals could move freely within the killing reagent before it died, and it should not get curled up or coiled. The curled up or coiled animals may get damaged during examination. The specimens preserved in 2% formaldehyde solution were washed with running water immediately after they were brought back to the laboratory from the fields. Since the specimens preserved in formaldehyde for a long time turn hard and become brittle also at some stage, which makes their taxonomic examination difficult. The washed samples were transferred to separate collection tubes containing 70% alcohol, along with collection data labels for permanent preservation.

3.8 Labelling and Registering

Temporary labels with a register number for unidentified specimens were provided in the field at the time of collection. Permanent labels containing,1) Register Number 2) Scientific Name (family/genus/species upto which level possible) 3) Locality 4) Date of Collection (month in Roman Letter) 5)Name of the collector 6) Lot Number given(for unidentified specimens in the field) 7) Name of person who identified/determined the sample and 8) Number of examples (Plate: 3).

Registration of specimens was done after the identification. Both the temporary and permanent labels were written with Rotring 0.2/0.5 microtip pen.

3.9 Identification

For Scolopendridae, Taxonomic keys by Jangi and Dass (1984), Khanna and Kumar (1984), Lewis (2010a), the illustrated key by Sureshan *et al*.,(2006a), Joshi

and Edgecombe (2013) were utilized. For Cryptopidae, Attems (1930), Dhanya *et al*.,(2012) were used for identification of species.

3.10 Photography

Digital imaging was carried out using a Leica M205A stereomicroscope and a Leica DFC-500 digital camera. Scanning electron micrographs were captured with Jeol JCM-5000 Neoscope bench-top SEM.

3.11 Depository

The type specimens and other registered specimens were deposited at Zoological Survey of India, Western Ghat Regional Centre, Kozhikode (ZSIK) (Plate.4).

3.12 Terminology

An alphabetical index of all recommended terms were provided (Annexure -2, Plate: 4-7) based on the general terminology adopted from Bonato *et al*., (2010).

CHAPTER 4
STUDY AREA

4.1 Introduction

In the present study Kerala State, India was selected as the study area for the taxonomic survey and for the ecological studies three different study areas ie., site 1-Forest Ecosystem : Kakkayam at Malabar Wildlife Sanctuary, Kozhikode Dist, Kerala; site 2-Unprotected and isolated hilly area: Narayamkulam, Kozhikode Dist, Kerala and Site 3-Houseland Ecosystem: Kuttothparambu, Kozhikode Dist, Kerala were selected. The details of the study areas are as follows.

4.2 Kerala- study area for taxonomic survey (Map:1)

The state of Kerala positioned in between 8° 17' 30" and 12° 47' 40' north latitudes and 74° 52' and 77° 22' 47" east longitudes on the southernmost tip of Peninsular India. It stretches along the coast of the Arabian Sea and is separated from the rest of the subcontinent by the steep Western Ghats.

Physiographically Kerala can be categorised to three

1. **High ranges** (elevation over 600 mts): the 'high range" is a narrow area on the eastern part comprises mountains and deep valleys noted by the presence of rich forest of Southern Western Ghats.
2. **Mid lands** (elevation 300-600 mts): It's the central region. In this area hills

are not very steep but the valleys are wide.

3. **Plains** (elevation between 30-300 mts): Majorly including valleys and coastal plains.

4. **Low lands** (elevation below 30 mts): Extensive paddy fields, thick groves of coconut trees and backwaters linked with canals and rivers, are the features of this region.

Majority of the areas in Kerala falls in the Midland category with an elevation of 300 meters. At the eastern border of the state lies the Western Ghats. The highest peak in Western Ghats, the Anamudi (2817 mts) is situated at Eravikulam National Park. About 14 peaks in Kerala have an altitude of over 2000 mts. Palakkad gap with a width of 30 kms is an important pass across Western Ghats, which spreads to a length of 80 kms; Aryankavu pass in Kollam district, is another important pass across the Western Ghats; Kumili-Kambam pass, Udampanchola-Tamil Nadu pass, Munnar-Bodinayakanoor pass are some of the other important passes across the state as well as western ghat mountains.

4.2.1. *Rivers:*

There are 44 rivers in the state, of which 41 originate from the Westerns Ghats and flow towards west drain into the Lakshadweep Sea (GoK, 2007). Three tributaries of the river Cauvery, namely Kabani, Bhavani, Pambar originate in Western Ghats and flow east into the neighbouring states and join river Cauvery, which drains into the Bay of Bengal. These rivers and streams flowing down from the Western Ghats either empty themselves into the backwaters in the coastal area or directly into the Arabian Sea.

4.2.2. *Climate:*

Kerala experiences a tropical climate. The proximity to sea and the heterogeneity in the physical features of the state have a profound influence on the climate of the region. The inter linkages between topography, climate and vegetation make it complex and constantly changing (Nair, 1991).The climate of Kerala is heavily influenced by the seasonal monsoon rains, the southwest summer monsoon and northeast winter monsoon. The overeall result of these rains is the wet and maritime tropi-

cal climate. Four different climatic seasons exist; winter season (Jan-Feb), summer (March-May), south west monsoon season (June-Sept), north east monsoon (Oct-Dec). Precipitation is below 50 mm in winter. On an average 300.400 mm of rain is received in north Kerala and 50-200 mm in south Kerala. The maximum temperature in coastal areas is around 38°C, while minimum temperature comes to around 22°C; in interior areas, summer temperature sometimes raises to 41°C. Kerala receives a fairly good annual rainfall varying from 1250 to 5000 mm. The average annual rainfall of Kerala is 3107 mm. (national average is 1197mm).

4.2.3. *Soil:*

The major group of soil in Kerala is laterite and its variations. In the highland region, the major soil type is forest loam, the midlands have typical lateritic soils and the coastal area has sandy and sandy loam soils. Soils in the state are well drained in more than 94 % of the area and imperfectly drained in 6% of area. The soil mantle is very deep in 65% of area and deep in 25% of area (GoK, 2007).

4.2.4. *Flora and fauna:*

The Western Ghats region, wherein the state is situated, is one of the 35 biodiversity hotspots in the whole world. Kerala is rich with high floral and faunal diversity. It has over 25% of India's 15,000 plant species. The state's forest wealth includes tropical wet evergreen, semi-evergreen and tropical moist deciduous forests. The state contains more than 4,500 species of flowering plants of which above 1,500 taxa are endemic in the region. There is also equally rich faunal wealth in the state. The diversity of lower plants and animal groups, and the marine flora and fauna in particular even though not fully known, is remarkably rich in the state. An earlier rough estimate had shown that there are about 10,035 plant species indigenous to the state. It also posess highly diverse animal fauna. Out of the 430 species of mammals reported from India, 102 species are represented in Kerala including 12 taxa endemic to the Western Ghats. Nearly 25% of the Indian avifauna is recorded from the state. Of which nearly 150 species have been located in the coastal area. About 448 species of reptiles are reported from India of which 187 species are recorded from Kerala. ("Biodiversity", n.d)

4.3. Sites selected for studying Scolopendromorphic centipede diversity in Kerala.

In order to get a good sampling, the collection sites were planned to cover northern, central and southern regions of Kerala, as well as low lands and high lands covering all the districts of the state.

4.4 Study areas for Ecological study (PLATE 8: Fig.a-d)

Following areas were surveyed for studying the diversity, richness, abundance, soil properties and seasonal fluctuation in the diversity of Scolopendromorpha.

SITE 1: Forest Ecosystem at Urakkuzhy, Kakayam, Malabar Wildlife Sanctuary, Kozhikode Dist.

The Malabar Wild Life Sanctuary falls between11 ^{0} 75', and 11^{0} 76' North latitude and between 76 ^{0}m 20' and 75^{0} 38' East longitude. The sanctuary which is declared in 2009 is located in the Koyilandy taluk of Kozhikode Revenue District. The Malabar Wildlife Sanctuary forms a part of Western Ghats. It also included under Nilgiri Biosphere Reserve and forms a part of Wayanad Elephant Reserve. This is also the place of origin of Kuttiady river and has three reservoirs in the catchment area.

The selected study area in forest ecosystem was a plot of 100 x 100m area, at Urakkuzhy Region(Fig .b), Kakkayam Reserve Forest, Malabar Wild Life Sanctuary (11˚ 32′ 40.59″N &75°55′ 33.40E, Elevation 720.3m), Kozhikode, Kerala. After a pilot study, five quadrates (10m x10m each) were laid for the random sampling. Monthly observations were made during March 2011 to November 2012.The time spent in each quadrate was 40 minutes.

SITE 2: Non –protected and isolated hilly area at Narayamkulam, Kozhikode Dist.

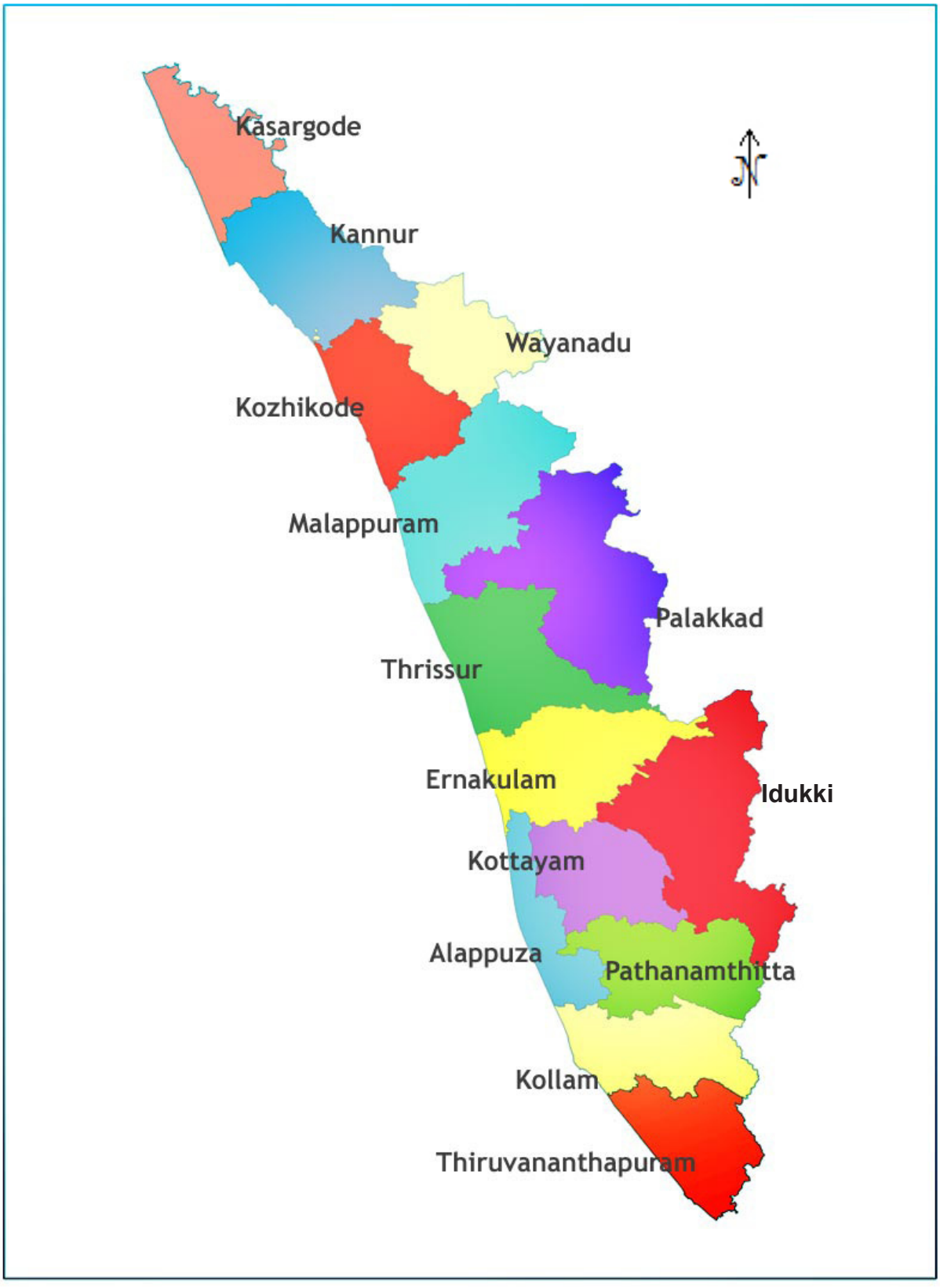
Site 2 was in a non –protected and isolated hilly area at Puliyampoyil (N 11° 30' 26.98"; E 75° 48'24.11"Elevation 134m asl) in Kottur Grama Panchayath, located about 38km east of Kozhikode city and a foothill of Southern Western Ghats (Fig.c). After a pilot study, five quadrats (10m x10m each) were laid for the random

sampling. Monthly observations were made during March 2011 to November 2012. The time spent in each quadrat was 40 minutes.

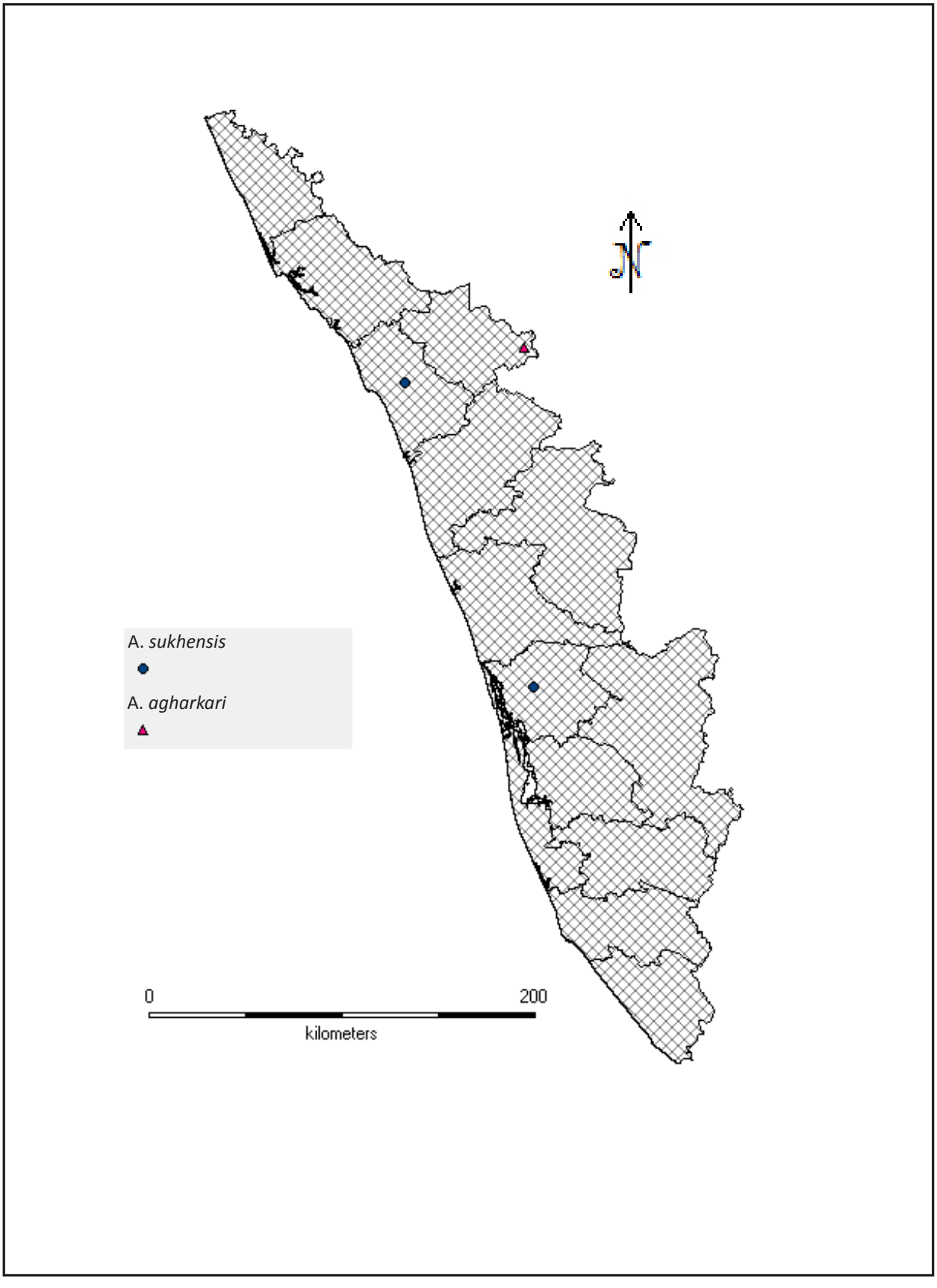
SITE 3: Houseland Ecosystem at Kuttothparambu, Kozhikode Dist

Site 3 was in a residential area at Kuttothparambu (N 11° 17' 599"; E 75° 46'690" Elevation 36.4m asl) in Vengeri Village, Kozhikode Cooperation area located about 5km east of Kozhikode city and from seacoast (Fig.d). After a pilot study, five quadrats (10m x10m each) were laid for the random sampling. Monthly observations were made during March 2011 to November 2012.The time spent in each quadrat was 40 minutes. The area comprises of laterite soil with a wetland area nearby.

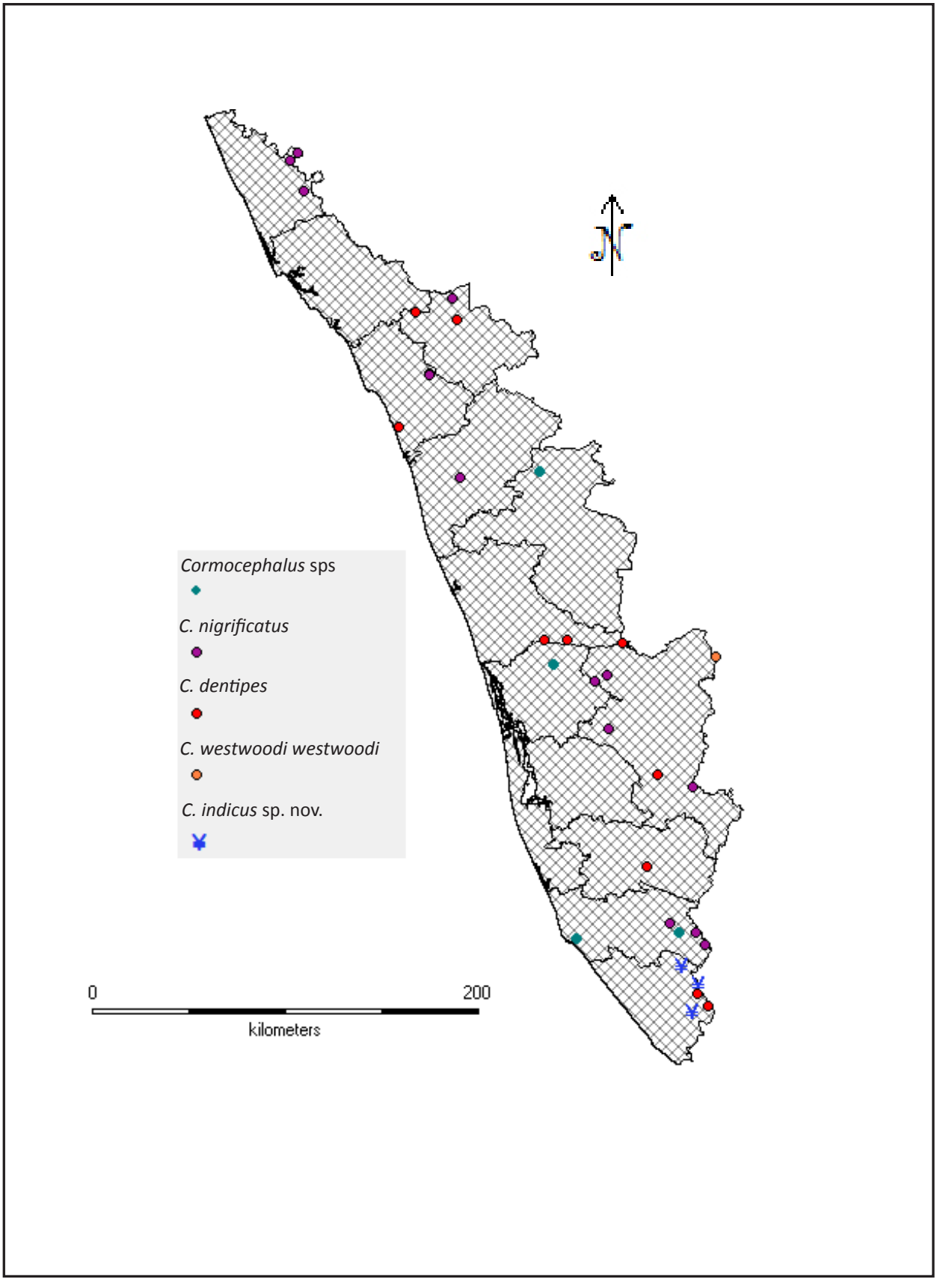
Map 1: Study Area- Kerala



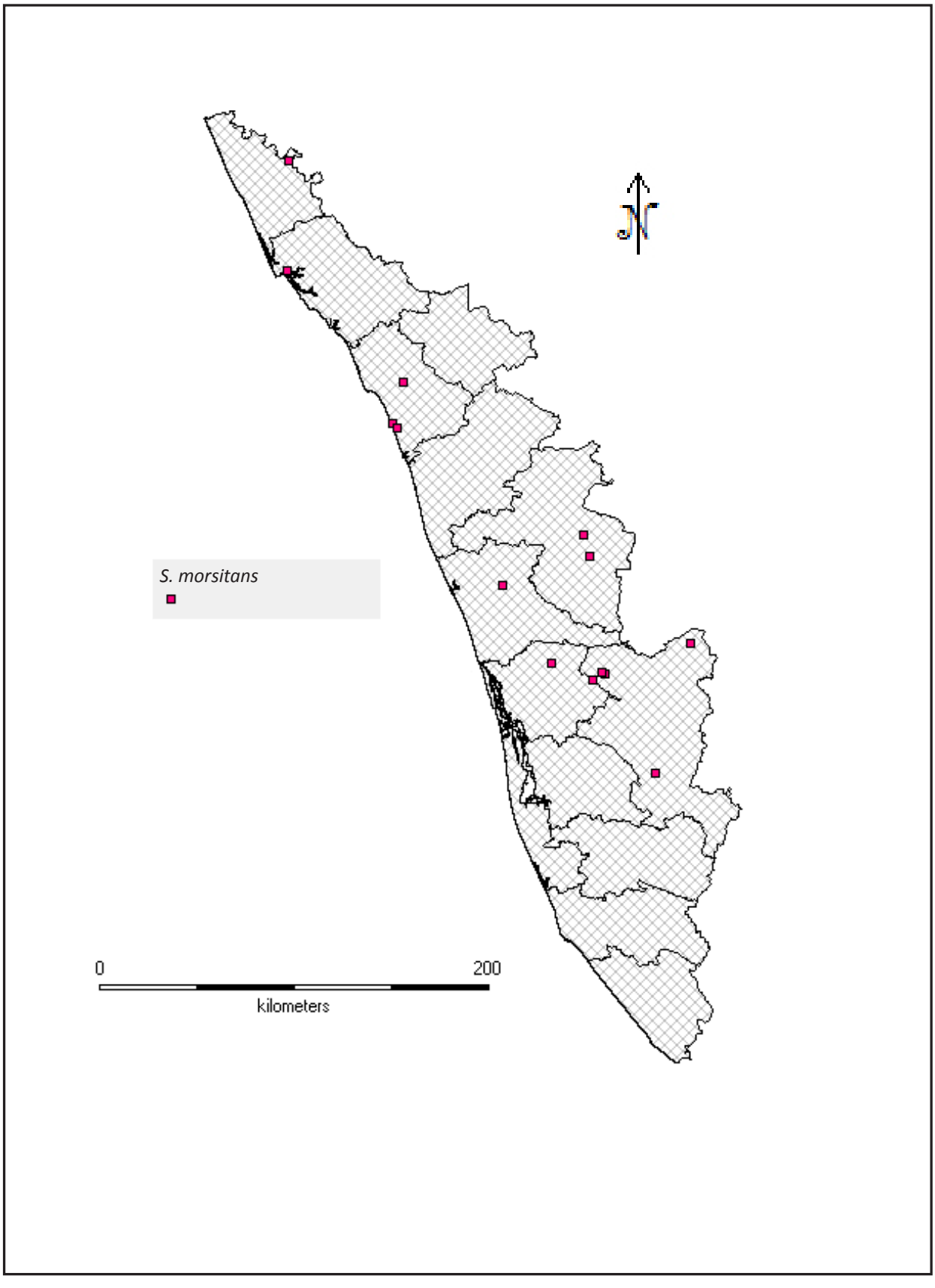
Map 2 :
Distribution of species of Genus *Asanada* Meinert in Kerala



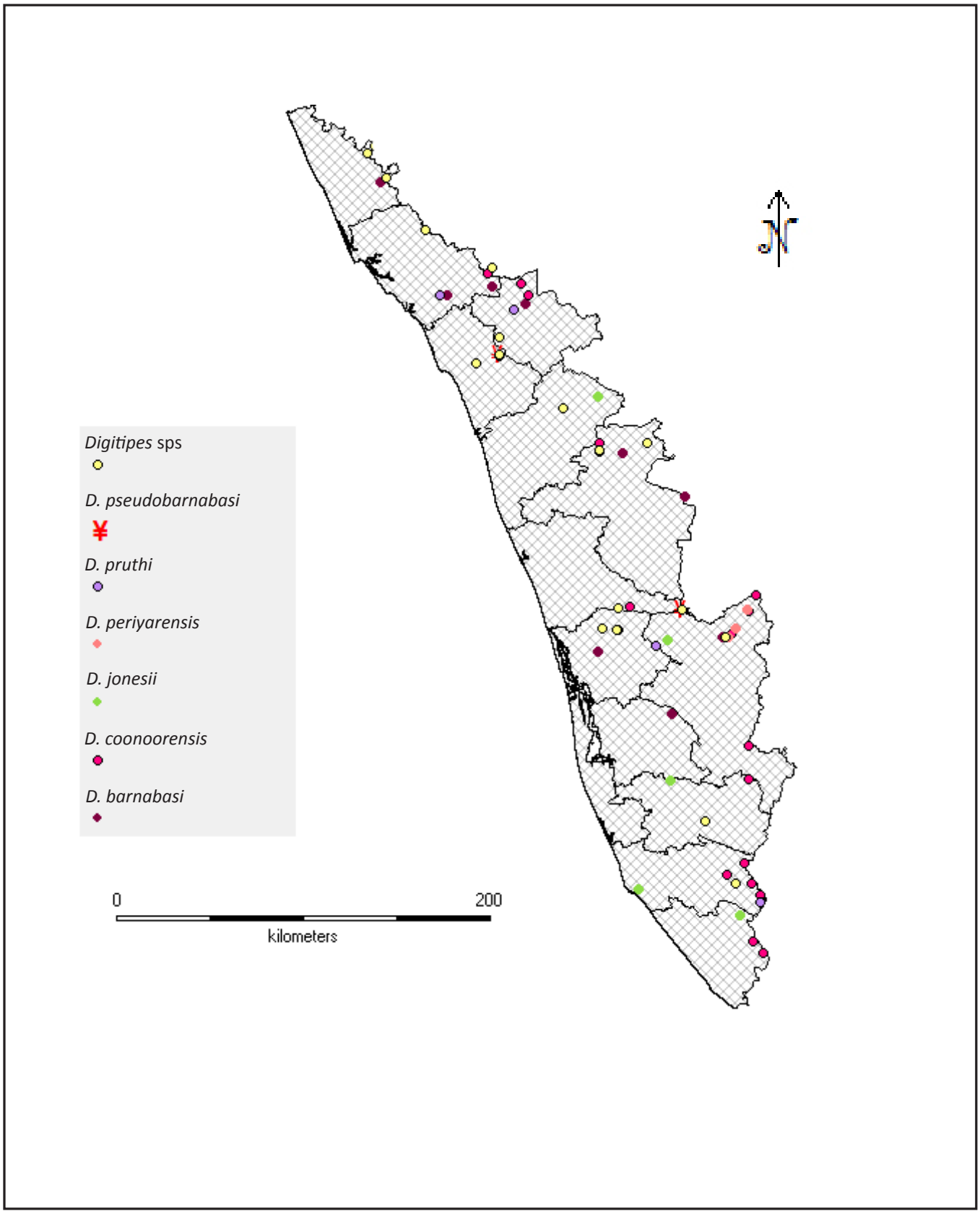
Map 3 :
Distribution of species of Genus *Cormocephalus* Newport in Kerala



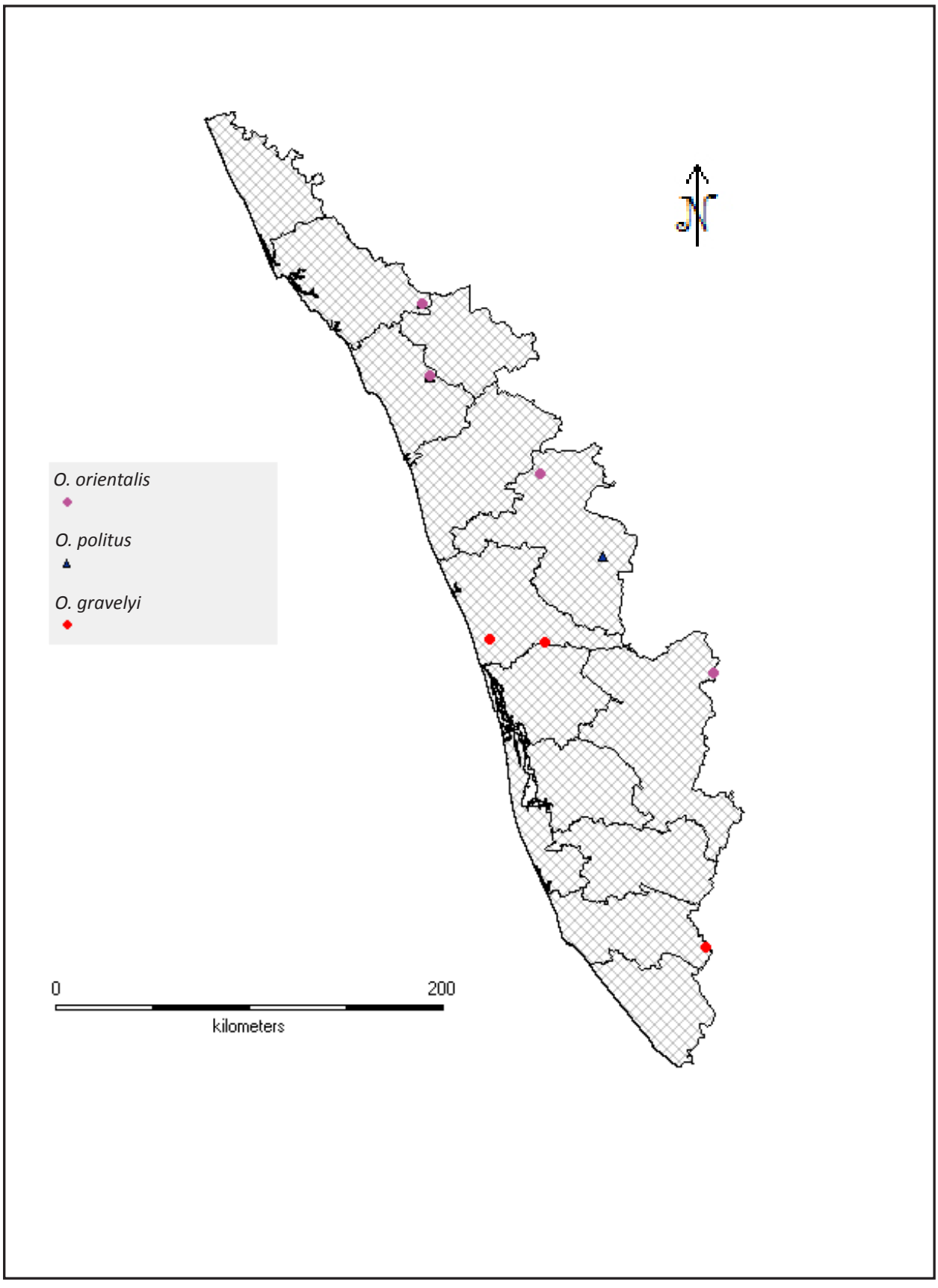
Map 4 :
Distribution of species of Genus *Scolopendra* Linnaeus in Kerala



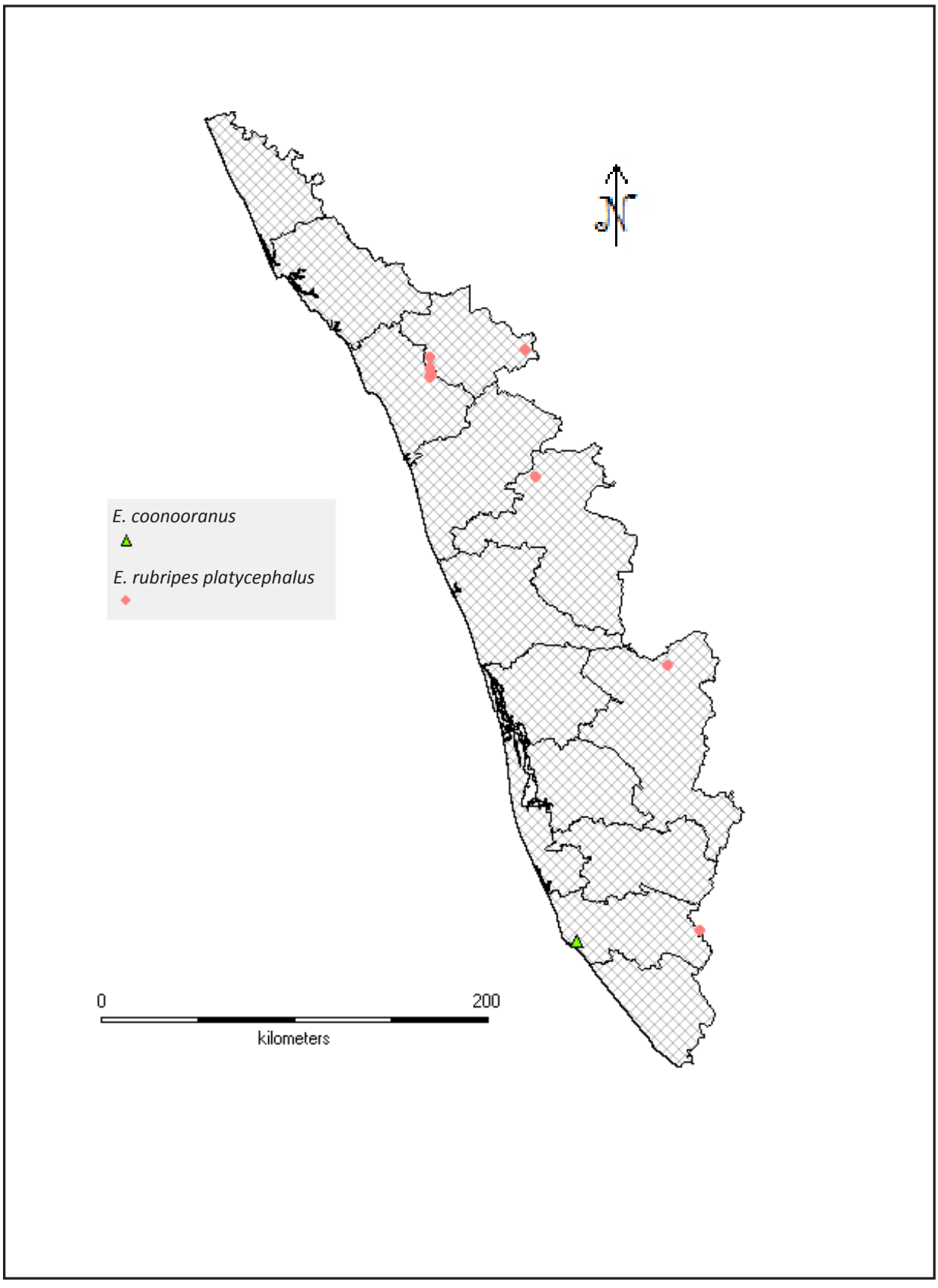
Map 5 :
Distribution of species of Genus *Digitipes* Attems in Kerala



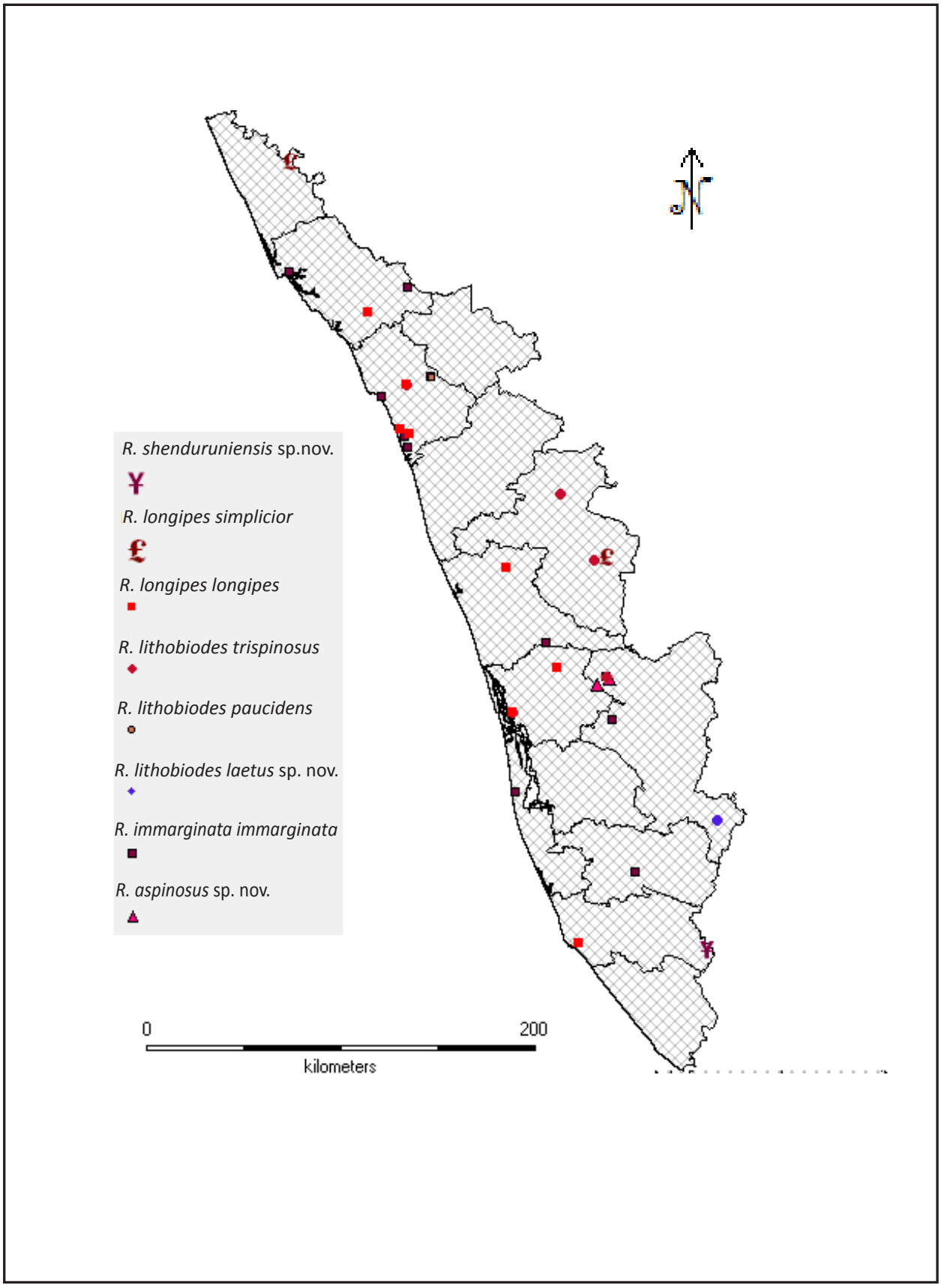
Map 6 :
Distribution of species of Genus *Otostigmus* Porat in Kerala



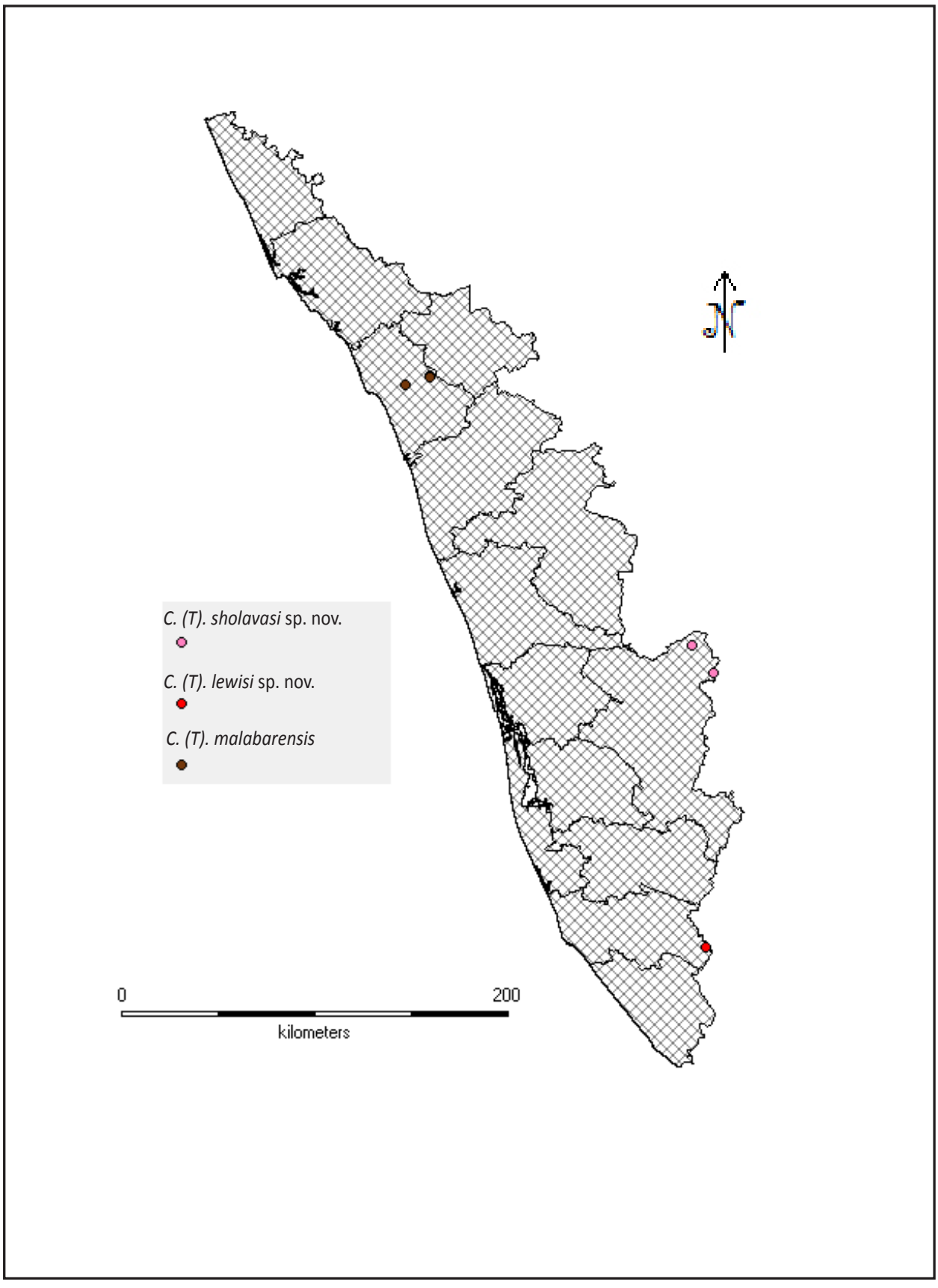
Map 7:
Distribution of species of Genus *Ethmostigmus* Pocock in Kerala



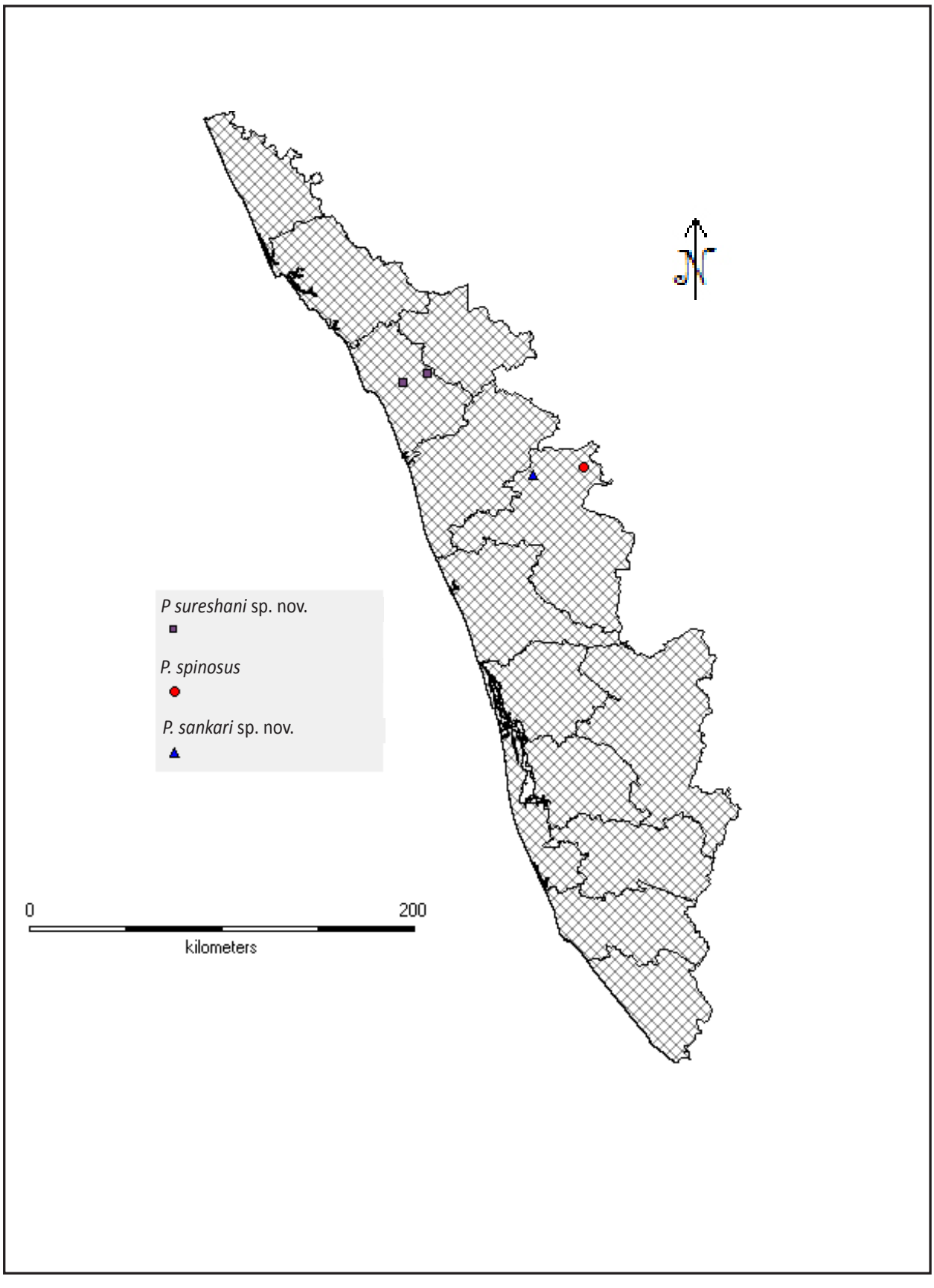
Map 8 :
Distribution of species of Genus *Rhysida* Wood in Kerala



Map 9 :
Distribution of species of Genus *Cryptops* Leach in Kerala



Map 10 :
Distribution of species of Genus *Paracryptops* Pocock in Kerala



CHAPTER 5
TAXONOMIC ACCOUNT

5.1 Order: Scolopendromorpha

Scolopendrides Leach, 1815: 382.
Scolopendromorpha Verhoeff, 1907: 242.
Scolopendromorpha, Attems, 1930: 79.
Scolopendromorpha, Bonato *et al.,* 2011: 392

5.2 Diagnosis:

Body flattened, moderately elongate. Colour varied, sometimes vivid and in banded patterns. Adult body length varies from 9 mm to 30cm. Antenna mostly attenuated gradually, with 14-34 (usually 17-21) articles. Eye a cluster of four ocelli, single ocellus or absent. Labrum with a single medial tooth. Epipharynx with a row of bullet-shaped sensilla at border between labral and clypeal parts. Mandible with four or five strong teeth; the four laminae composing the mandible intersecting at a cruciform suture. Distal article of the first maxillary telopodite with the inner side fringed by setae with slender stalks and short branches along a distal, curled part. Distal article of the second maxillary telopodite bearing a dense fringe of simple bristles (dorsal brush) along its dorsal side. Anterior margin of the forcipular coxosternite often with a pair of toothplates, but sometimes without projections. Forcipules often with a sclerotized process on the mesal side of the basal article, the

other articles without such projections. A single tergite covering forcipular and first leg-bearing segment. Number of pairs of legs 21 or 23 in all but one known species (with 39 or 43).

Most trunk tergites with paramedian sutures. Trunk heterotergy slight or distinct in at least anterior segments. Spiracles confined to segments with long tergites. Spiracular pouches with muscles attaching to their dorsal and ventral sides. Ultimate leg-bearing segment with coxopleura enlarged; coxal organs opening through scattered pores (except Tribe Asanadini). Ultimate legs different from the walking wlegs, varied in shape and size. Terminal part of the trunk retracted above the sternite of the ultimate leg-bearing segment.

Distribution:

Almost worldwide; maximum species richness in tropical and subtropical regions.

Diversity:

Approx. 700 species in five families worldwide, 34 extant genera and four extinct genera worldwide.

5.3 Key to the Genera of Order Scolopendromorpha in Kerala (Plate: 9-12)

1. Four ocelli on each side of the head, below antennae **(Fig.a)**.....
…….....Family **Scolopendridae 2**

- No ocelli, blind centipedes, smaller in size (**Fig.b)** .....
……..…….....Family **Cryptopidae 8**

2. Spiracles triangular, with spiracular cavity divided into an inner and outer chamber by a tripartitevalve **(Fig.c)**…….....
…….....Subfamily **Scolopendrinae 3**

- Spiracles oval or round, with spiracular cavity undivided**(Fig.d)**…….....
…….....Subfamily **Otostigminae**: Tribe **Otostigmini 5**

3. Coxopleura with coxopleural pores. Ultimate leg prefemur with dorsomedial process and rows of spines on ventral and medial sides**(Fig.e)**.....
…….....Tribe **Scolopendrini 4**

- Coxopleura lacking process and pores. Ultimate leg prefemur without

dorsomedial process and rows of spines on ventral and medial sides **(Fig.f)**.....
……..…….....Tribe **Asanadini**
…….....***Asanada* Meinert**

4. All legs mostly without tarsal spur. Cephalic plate covered posteriorly by T1 **(Fig.g)**……..…...***Cormocephalus* Newport**

- Legs with tarsal spur. Cephalic plate usually overlapping T1 **(Fig.h)**.....
…….....***Scolopendra* Linnaeus**

5. Nine pair of spiracles, are each on leg bearing segments 3,5,8,10,12,14,16,18 and 20 **(Fig.i)**…….....**6**

- Ten pair of spiracle,s one on each leg bearing segments 3, 5,7,8,10,12,14,16,18 and 20 **(Fig.j**)..……**7**

6. Femur of ultimate leg in male with a posteriomedial process **(Fig.k)**.....
…….....***Digitipes* Attems**

- Femur of ultimate leg in male without a posteriomedial process **(Fig.l)**.....
……...***Otostigmus* Porat**

7. Prefemur of maxillipede without a medial dental process**(Fig.m)**.....
……..……..***Ethmostigmus* Pocock**

- Prefemur of maxillipede with a medial dental process **(Fig.n)**.....
.....***Rhysida* Wood**

8. Forcipular coxosternal margin mostly with a sclerotized marginal rim, and without lobes, tarsangulum moderately developed **(Fig.o)**.....
……..….....***Cryptops* Leach**

- Forcipular coxosternal margin mostly with blunt, round or slightly flattened hyaline lobes, tarsangulum very short **(Fig.p)**…….....
.....***Paracryptops* Pocock**

5.4 Family: Scolopendridae

Subfamily Scolopendrinae + Scolopendropsinae Bollman, 1814: 165.
Scolopendridae Leach, 1914: 101.

Diagnosis:

Basal few antennal articles sparsely setose, with abrupt transition to more distal articles that have short, dense setae. Eyes usually present as a rhomboid cluster of

four ocelli. Labral bristle field completely covering distal sclerotisation of epipharynx (except *Notiasemus*); elongate, two smooth depressions surrounding each sensillum on clypeal part or epipharynx. Number of leg-bearing segments invariantly 21 apart from *Scolopendropsis*. Trunk sternites usually with two paramedian sutures, without transverse groove. Locomotory legs with sparse setae, and with two tarsal articles.

Disribution:

Almost worldwide, mainly in tropical regions. More than 400 species in 21 genera worldwide.

Subfamily: SCOLOPENDRINAE Leach, 1814

Diagnosis:

Spiracles with atrium covered by a three-valved flap, usually triangular with at least the anterior angle pointed, often compressed dorsoventrally. Paramedian sutures on trunk sternites complete.

Disribution:

Temperate and tropical parts throughout the world. More than 220 species in 12 genera worldwide.

Tribe: SCOLOPENDRINI Leach, 1814.

Diagnosis:

Antennae relatively long, extending behind T2. Anterior part of tergites not delimited by a strong transverse furrow. A variable number of marginate tergites in addition to ultimate tergite. Ultimate leg prefemur with dorsomedial process and rows of spines on ventral and medial sides.

Disribution:

Mostly tropical and subtropical regions throughout the world. More than 210 species in 10 genera.

Tribe: ASANADINI Verhoeff, 1907.

Diagnosis:

Antennae relatively short, not extending behind tergite 1, tapering distally. Claws of second maxillae without accessory spines. Anterior part of tergites distinctly delimited from the remaining tergite by a strong transverse furrow. Tergites lacking margination apart from T21. Coxopleura lacking process and pores. Ultimate legs forcipulate, with longitudinal groove along dorsal side of femur (and variably on prefemora and tibia).

Disribution:

Tropical and subtropical regions of Africa, Asia and Oceania. Approx. 14 species in two genera worldwide.

Subfamily: OTOSTIGMINAE Kraepelin, 1903

Diagnosis:

Spiracles round or ovate, their long axis generally oriented vertically; floor of spiracular atrium usually raised into humps.

Disribution:

Tropical and subtropical regions throughout the world. Approx. 200 species in nine genera worldwide.

Tribe: OTOSTIGMINI Kraepelin, 1903.

Diagnosis:

Border between labral and clypeal part of epipharynx strongly curved forwardly. Forcipular coxosternite with toothplates. Leg tibiae and tarsi with spurs, the latter sometimes paired.

Disribution:

Most tropical and subtropical regions throughout the world. Approx. 200 species in six genera worldwide.

5.5 FAMILY CRYPTOPIDAE Kohlrausch, 1881

Diagnosis:

Eyes absent. Claw of second maxillae hook-like, accompanied by a ventral flange, exceptionally simple. Forcipular coxosternite without tooth-plates, with either scattered setae along the margin, a sclerotized band or non-denticulated, hyaline lobes. Forcipules without tubercles or projections. 21 leg-bearing segments. Trunk tergites with lateral crescentic sulci; pretergites relatively strongly developed. Sternites usually with transverse line of skeletal thickening, without paramedian grooves, with endosternites usually well developed in the anterior part of trunk. Most legs with a single tarsal article (except for *Trigonocryptops*). Coxopleura without processes. Ultimate legs a clasping structure, with strongly bent terminal articles; tibia and tarsus 1 usually with a row of saw teeth.

Disribution:

Almost worldwide, both in temperate and tropical regions. More than 170 species in two genera worldwide.

5.6 FAMILY SCOLOPENDRIDAE

Tribe: ASANADINI Verhoeff, 1907.

Genus *Asanada* Meinert, 1886

Asanada Meinert 1886, by monotypy: 189.

Pseudocryptops Pocock, 1891a : 225. Synonymised with *Asanada* by Lewis, 1968: 191.

Type species: *Asanada brevicornis* Meinert, 1886

5.6.1 Diagnosis: Body length 25-38mm. Antennae reaching T1, markedly tapering distally, flattened. Dorsal brush on tarsus of second maxillae relatively small. Lateral margins of T1 and T2 convex outwards. S21 variably overhanging coxopleura.

Distribution: Tropical and subtropical regions of Africa, Asia and Pacific islands. 13 species worldwide.

5.6.2 Key to the species of *Asanada* in Kerala (Modified from Jangi and Dass, 1984)

1. Longitudinal median groove present on ultimate leg femur only……
   ……..….....2
   -Longitudinal median groove present on ultimate leg prefemur and femur.....
   ……..….....3
2. Longitudinal median groove present throughout on ultimate leg femur……..
   …….....***A.sokotrana* Pocock**
   -Longitudinal median groove confined to posterior half of ultimate leg femur (Plate 13: a,b) …….……..…….....***A.sukhensis* Jangi and Dass**
3. Longitudinal median groove present on posterior half of ultimate leg prefemur and femur. Serrated claw with about 30 teet…….....….
   .....***A.indica* Jangi and Dass**
   -Longitudinal median groove present on middle of ultimate leg prefemur and posterior of femur. Serrated claw with 12 or more blunt teeth (Plate 14: e)
   …… ***A.agharkari* (Gravely)**

***Asanada indica* Jangi and Dass, 1984**

Asanada indica Jangi and Dass, 1984: 38.

Asanada indica. Khanna, 2008: 39.

Type Locality: India: Maharashtra, Urlikanchan, Pune**.**

Diagnosis: Antennae with 17 articles. Complete paramedian sutures on T6-T20 and S2-S20. Ultimate legs short and thick with prefemur and femur with a dorsal median groove each in posterior half corresponding to anterior concavities on femur and tibia respectively. Serrated claw with about 20 teeth.

Description*:* Length 22 mm approximately.

Head Capsule: Antennae short, tapering, composed of 17 articles, basal 6 glabrous, rest densely pilose. Cephalic plate anteriorly with a short median groove.

Forcipular coxosternum: with 3+3 dentition.

Tergites: with paramedian sutures from T6-T20. T21 without sutures and with an angular posterior margin.

***Sternite*s**: S2-S20 with complete paramedian sutures from S1-S20, 21 without sutures, nearly twice as broad as long; arched posterior margin with a slight median notch at posterior margin.

Ultimate leg: Ultimate leg femur stout and thick with dorsal median groove in posterior end corresponding to the anterior concavities of femur and tibia respectively. Serrated claw with 20 teeth and without claw spurs.

Distribution: India: Kerala, Madhya Pradesh, Maharshtra, Orissa, Delhi, Haryana, Rajasthan. Himachal Pradesh, Uttar Pradesh and Utharanchal.

Material examined: This is an endemic species to India. Khanna (2001) and Sureshan *et al*., (2006) reported the species from Kerala. No locality details were available from their study. No material was collected during the present study. The diagnostic characters were presented based on the museum collections from WRC, ZSI, Pune.

1 ex. Maijlegaon, Sindfana River, Maharashtra, India. Jangi and Dass. (MYR1/358).

***Asanada sokotrana* Pocock, 1899**

Asanada sokotrana Pocock, 1899: 9.

Asanada sokotrana, Attems, 1930: 124-125.

Asanada sokotrana, Jangi and Dass, 1984: 38.

Asanada sokotrana, Khanna, 2001*:* 205.

Asanada sokotrana, Sureshan *et al.,* 2006a *:* 2286.

Type locality: Yemen: Socotra.

Diagnosis: Antennae damaged. T21 angular in posterior end. S21 with a curved end. Longitudinal median groove present throughout on anal leg femur.

Distribution: India: Kerala, Maharshtra, Tamil Nadu; Sokotra, Sudan, South Africa, Zimbabwe, Transvaal, French Guinea (Ethiopian)

Material examined: No material was collected during the present study diagnostic characters were presented based on Khanna (2001) and Sureshan *et al*., (2006a). Jangi and Dass (1984) gave details of locality as Parambikulam, Palakkad, Kerala.

***Asanada sukhensis* Jangi and Dass, 1984**

(Plate: 13)

Asanada sukhensis Jangi and Dass, 1984: 38.

Asanada sukhensis, Khanna, 2001: 205.

Asanada sukhensis, Sureshan *et al*., 2006a: 2286.

Asanada sukhensis, Khanna, 2008: 39.

Type locality: India: Madhya Pradesh.

Diagnosis: Short and thick ultimate legs with dorsal median groove present on femur only in distal half. Serrated claw with 30 or more teeth.

Description*:* Length 18-21mm.

Colour: Grape brownish in life (Fig. d), but the colour faded after preservation in alcohol. Under observation in alcohol the colour (may be the pigments) oozed out from the freshly preserved specimens, not changing the colour of the preservative.

Head Capsule: Antennae short, tapering, composed of 17 articles, basal 6 glabrous, rest densely setose (Fig. e). Cephalic plate with a short median groove.

***Forcipular coxosternum*:** with 3+3 dentition.

Tergites: with paramedian sutures from T2-T20 (Fig. f). T21 without sutures.

Sternites: S2-S20 with complete paramedian sutures from S1-S20, 21 without sutures, nearly 2.25 times as broad as long; arched posterior margin.

***Ultimate leg*:** Ultimate leg femur stout and thick with dorsal median groove confined to the distal half (Fig. a, b, c & g). Serrated claw with 30 or more teeth.

Distribution: India: Kerala, Madhya Pradesh, Maharshtra, Orissa.

Material examined: 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll. Umesh.P.K. 01.vi.2012. (ZSI/WGRC/I-R/INV-2248). 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll. Umesh.P.K. 02.xii.2011. (ZSI/WGRC/I-R/INV-2142).

Habitat*:*

This species observed very rarely**.** Specimens found in the habitats of loose soil

and leaf litter from the undisturbed agroforest ecosystem. The specimens from Kozhikode, Kerala were collected from a coconut plantation beneath the loose top soil.

Remarks:

Asanada sukhensis is an enedemic species to India. Sureshan *et al*., (2006a) included *Asanada sukhensis* in Scolpendrids checklist of Kerala based on the reports by Khanna (2001) but no locality details were available in these records. So present study is the first report based on locality details of from Kerala.

***Asanada agharkari* (Gravely, 1912)**

(Plate. 14)

Pseudocryptops agharkari Gravely, 1912a : 416.

Asanada agharkari (Gravely)**,** Synonymised by Jangi and Dass, 1978a : 423.

Type locality: India: Satara: Koyna valley Western Ghat

Diagnosis: Ultimate leg femur with median groove in posterior two thirds. Serrated claw with 12 or more blunt teeth.

Description: Body length 30-32mm.

***Colour*:** Before preservation (Fig. a) up to T4 pale red, rest red with faint reddish antennae and legs. Ultimate legs red. Colour (after preservation) yellowish brown and the red pigments having been leached out to the alcohol. Antennae composed of 17 articles; tapering distally, the basal three articles glabrous, a few tiny setae on articles 4 to 6, 7 onwards with dense patch of hairs.

***Head capsule*:** Head capsule curved in anterior end and with almost straight lateral edges (Fig.b). Cephalic plate with a short, anterior median groove and not covered posteriorly by T1.

Forcipular coxosternum: Forcipular coxosternum with distinct long median groove. Each coxosternal tooth plate with 3 teeth; the middle one prominent and inner and outer ones small (Fig. c).

***Tergites*:** A short anterior oblique suture on T1. Paramedian sutures incomplete anteriorly on T2-T5, and complete from tergite T6-T20. T21 with very short

longitudinal median sulcus and with a weakly curved posterior margin. T21 length 3.48x width.

Sternites: Sternites with anteriorly forked paramedian sutures complete from S4-S20. S 21 without sutures and with straight lateral edges ending in curved posterior margin (Fig. d).

Walking legs: 1-20 with a pair of pretarsal spurs.

Ultimate leg: Prefemur of ultimate leg 0.91x femur (Fig e). Serrated claw with 12 or more blunt teeth (Fig. f).

Distribution: India: Satara: Koyna valley Western Ghat, Kerala (New record to Kerala).

Material examined: 2 exs. Tholpetty, Muthanga Wildlife Sanctuary, Wayanad District, Kerala, India. Coll. P M Sureshan. 17.x.2011. (ZSI/WGRC/I-R/INV-2260).

Habitat:

The present specimens were collected from 'a termite infested tree trunk' about 1.219 meters above the ground, in the post-monsoon period. Lewis (1973) recorded *Asanada sokotrana* Pocock from deserted mounds of termite species *Trinervermes* from Nigeria during rains. Maschwitz *et.al.,* (1979) also pointed out the occurrence of *Asanada* sp. "in wood infested by nasutitermitines". These findings indicate the probable association of *Asanada* species with termitaria as a source of food or suitable ecological niche.

Remarks:

The Tribe *Asanadini* Verhoeff of Scolopendromorpha (Chilopoda) stands for two genera *Asanada* Meinert, 1886 and *Asandopsis* Wurmli, 1972. Among other scolopendromorph centipedes the tribe is notable by the absence of process and pores in coxopleuron and forcipulate ultimate legs with characteristic dorsal longitudinal grooves on femur (and variably in prefmur and tibia). The other distinguishing characters include smaller size, relatively short antennae tapering distally and not extending behind tergite 1, claws of second maxillae without accessory spines, anterior part of tergites distinctly delimited from the remaining tergite by a strong transverse

furrow, tergites lacking margination apart from tergite-1.This group of centipedes is distributed in tropical and subtropical regions of Africa, Asia and Oceania. There are about 14 described species worldwide in the tribe, one species under the genus, *Asandopsis* Wurmli and 13 species under the genus *Asanada* Meinert (Bonato *et al*., 2011).

The genus *Asanada* was described with *Asanada brevicornis* Meinert, 1886 as the type species from Kooloo, Himachal Pradesh, India. Pocock (1891a) erected genus *Pseudocryptops in* Scolopendromoprha with *P.walkeri* Pocock as the type species from Perim Island in Red Sea, off the coast of Abyssinia and Gravely (1912) added another species *Pseudocryptops agharkari* from Koyna Valley of Western Ghats, Satara Dist, Bombay Presidency, India (now at Maharashtra state, India) to the genus. He also described a sub species *Pseudocryptops agharkari singhbhumensis* from Chaakardharpur, Singbhum Dist, Chota Nagpur. Later Lewis (1973) based on the study of the type specimens of *P.walkeri* housed in British Museum (National Museum), synonymised *Pseudocryptops* under *Asanada* and opined that *P.agharkari* Gravely, 1912 may also come under *Asanada*. Jangi and Dass (1978a) studied the type material of *P.agharkari,* and confimed the synonymy of the species under *Asanada* and also redescribed the species based on the lectotype selected from the collections of Gravely, deposited in the faunal holding of Zoological Survey of India, Kolkata. The genus *Asanada* is represented by 6 species from India, of which 3 are endemic to the country. Later works on *Asanada* from India are of Khanna (2010, 2006, 2005, 2004) from North and North-eastern states, Sureshan and Yadav (2008b) from Maharashtra and Sureshan *et al*., (2006a) from Kerala.

Tribe: Scolopendrini

Scolopendrini Attems. 1926, 4**:**373.

5.6.3. Genus *Scolopendra* Linnaeus, 1758

Scolopendra Linnaeus, 1758: 637.

Trachycormocephalus Kraepelin. Lewis, 1986:1083-1088.

Type Species: *Scolopendra morsitans* Linnaeus

Diagnosis: Body length 23-275 mm. Cephalic plate usually overlapping T1. Coxosternal tooth-plates short to moderately long. Walking Legs with tarsal spurs. Pretarsal claws of the ultimate legs usually with accessory spurs.

Distribution: India: Throughout. In all tropical and temperate zones of the world. Worldwide 90 species.

5.6.4. Key to the species of *Scolpendra* from Kerala

1. Alternate brown or dark green and brownish orange or yellow tergites, resulting intransversely banded appearance on tergites……..…..... .....***S. hardwickei*** **Newport**
   - No such banding colour pattern on tergites..... .....……..…….....…..……2
2. Ultimate leg prefemur with 1 to 4 dorsolateral spine in one row 2 to 7 ventromedial spine and 2 or 3 ventro lateral spines arranged in three rows (Plate: 15.g)……..... …….....…….***S. morsitans*** **Linnaeus**
   - Ultimate leg prefemur with 1 dorso medial spines, 2 on the tip of posterior-medial process.……..……..... .....***S. subspinipes dehaani*** **Brandt**

Scolopendra hardwickei **Newport, 1844**

Scolopendra hardwickei Newport, 1844b: 96.

Scolopendra subspinipes var. *hardwickei*, Kraepelin*,* 1903**:** 262.

Scolopendra hardwickei, Khanna. 2001: 201.

Scolopendra hardwickei, Sureshan *et al*.,2006a : 2286.

Type locality: India

Diagnosis: Bodylength 15- 16cm. Leg bearing segments 2, 4, 9, 11, 13, 15, 17 dark brown alternating with yellow to yellowish orange tergites, a typical colour pattern paculiar to this species. Antennal articles 17-22, basal 7 glabrous dorsaly. Complete paramedian sutures T3-T20, T21 without sutures. Lateral margination T3-T21. From S2-S20 complte paramedian sutures. S21 with middle suture, and tapering in end.

Forcipular coxosternum with 4+ 6 dentition. Coxopleura with numerous small pores and single spine at apex. Ultimate legs with 1 dorsolateral and 1 corner spine.

Distribution: India: Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Kerala, West Bengal and Andaman & Nicobar Islands; Sri Lanka, Sumatra (Indo-Malayan).

Remarks:

Sureshan *et al*., (2006a) mentioned the occurrence of this species in Kerala but no locality details are available. No material was collected during the present study; diagnostic characters were presented based on the museum collections from WRC, ZSI, Pune.

1 ex. Forest rest house, Phansad Wildlife Sanctuary, Maharashtra, India. Coll. P. S Bhatnagar, 14. i.2011. 1 ex. on the way to Majgaon village. Phansad Wildlife Sanctuary, Maharashtra, India. 11. i. 2011. Coll. P. S Bhatnagar.

***Scolopendra morsitans* Linnaeus, 1758**

(Plate: 15)

Scolopendra morsitans Linnaeus, 1758: 638.

Scolopendra morsitans, Kraepelin, 1903: 250.

Trachycormocephalus jodhpurensis, Khanna, 1977b: 151-156.

Type Locality: India

Diagnosis: Large and robust species, 20th pair of walking leg with tarsal spur, ultimate leg prefemur with three longitudinal rows of three spines each on ventral side.

Description: Body length 53-101mm.

***Colour*:** Colour before preservation (Fig. a). The species observed in different colour patterns ranging from brownish yellow to dark orange, in cephalic plate, T1 and ultimate legs. Antennae generally yellowish brown with black coloured distal articles. Sternites pale yellow to greenish yellow. Generally tergites appear in contrast colours of yellow/ orange and black/brown, giving a typical band pattern. Colour (after preservation) yellowish brown to pale yellow.

***Head capsule*:** Antennae composed of 19-21 articles; tapering distally, the basal

three to four articles glabrous. Head capsule curved in anterior end and with almost straight lateral edges (Fig. b). Cephalic plate smooth with minute setae marginally and without any sutures.

Forcipular coxosternum: Each coxosternal tooth plate with 3+3 to 5+4 teeth; the inner and outer ones separated each other. Post dental spur present. Median prefemoral process dentate with 2 or 3 teeth (Fig.c).

Tergites: T1 smooth without any sutures. Paramedian sutures complete on T2-T20 (Fig. d). Lateral margination of tergites from T3 or T8 to T21. T21 with straight lateral margin and angular posterior end (Fig. e); very prominent longitudinal median sulcus which may sometimes extended to posterior margin of T20.

***Sternites*:** Smooth; paramedian sutures complete on S1 to S20. S21 gradully narrowing in posterior end with convex posterior margin; without sutures (Fig. d).

***Walking legs*:** 1-20 with a tarsal spur and 2 claw spur. Tarsal spur on 20 which distinguishes it from *S.amazonica* in earlier designations.

***Coxopleural process*:** with small but distinct pores and poreless strip at apex. It posess two to four apical spines (Fig. f).

***Ultimate leg*:** Prefemur with 1 to 4 dorsolateral spine in one row (Fig.g), 2 to 7 ventromedial spine and 2 or 3 ventro lateral spines arranged in three rows. A prominent posteriomedian process with one to three corner spines presents (Fig.h). Specimen (ZSI/WGRC/I-R/INV-2195) observed with a regenerated leg. (Fig.i)

Distribution: India: Assam, Arunachal Pradesh, Andhra Pradesh, Andaman & Nicobar Islands, Bihar, Bengal, Delhi, Gujarat, Himachal Pradesh, Haryana, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Sikkim, Uttar Pradesh and Uttranchal. In all tropical and temperate zones of the world.

Material Examined: 2 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll. Umesh.P.K. 19.i.2011. (ZSI/WGRC/I-R/INV-4029). 1 ex. Krishna Menon Museum, East Hill, Kozhikode District, Kerala, India. Coll. Dhanya Balan.30.v.2011. (ZSI/WGRC/I-R/INV-4024). 3 ex Churulippetty, Chinnar Wildlife Sanctuary, Idukki District, Kerala, India. Coll. K G Emilyamma. 30.v.2011. 2 ex. Kallipara, Thattekad,

Ernakulam District, Kerala, India. Coll. P.M Sureshan. 22.iv.2015 (ZSI/WGRC/I-R/INV-4478). 1 ex. Choolannoor Wildlife Sanctuary, Palakkad District, Kerala, India. Coll. Bijoy. C. 01.ii.2011. (ZSI/WGRC/I-R/INV-4020). 1 ex. Pudunagaram, Palakkad District, Kerala, India. Coll. Bijoy. C. 29.i.2012. (ZSI/WGRC/I-R/INV-2195). 1 ex. Pudunagaram, Palakkad District, Kerala, India. Coll. Bijoy. C. 18.iii.2012. (ZSI/WGRC/I-R/INV-2213). 1 ex. Kodanadu, Mallam RF, Ernakulam District, Kerala, India. Coll. P. M Sureshan. 14/iii/2014. (ZSI/WGRC/I-R/INV-3525). 1 ex. Madaippra, Kannur District, Kerala, India. Coll. Jaffer Palott. 23/x/2013. (ZSI/WGRC/I-R/INV-4021). 1 ex. Madaippra, Kannur District, Kerala, India. Coll. Jaffer Palott. 10.vii.2011. (ZSI/WGRC/I-R/INV-4026). 1 ex. Mandekol, Kasargod District, Kerala, India. Coll. Rajmohana. 03.i.2013. (ZSI/WGRC/I-R/INV-2509). 1 ex. Forest IB, Marayoor, Idukki District, Kerala, India. Coll. P M Sureshan. 07.x.2013. (ZSI/WGRC/I-R/INV-3533). 2 ex. Kallippara, Thattekad, Kerala, India. Coll. P M Sureshan. 22.iv.2013. (ZSI/WGRC/I-R/INV-4478).

Habitat:

Most of the specimens were collected under stones, decaying wood, coconut husk and tree trunk. Collection localities included deciduous forests, laterite soil of plains and hilly areas.

Remarks:

This species was considered earlier as a sympatric species with its sibling *Scolopendra amazonica* (Bucherl, 1946) without hybridization. Later *Scolopendra amazonica* was synonomised with this species (Jangi and Dass, 1984, Minelli *et al*., 2006).

***Scolopendra subspinipes dehaani* Brandt, 1840**

Scolopendra subspinipes dehaani Brandt, 1840: 152.

Scolopendra subspinipes dehaani, Attems. 1930: 51.

Scolopendra subspinipes dehaani, Khanna. 2001: 200.

Scolopendra subspinipes dehaani, Sureshan *et al.,* 2006a: 2286.

Type locality: Indonesia: Java

Diagnosis: Antnnae with 18 antennomeres, 6 basal glabrous and rest pilose; cephalic

plate puncatae and more or less roundish. T1, T2 and T21 without sutures, T6-19 with complete paramedian sutures. Coxopleural process with two apical spines. Walking legs 1-20 with one tarsal spur. Walking leg 21 without tarsal spur.

Description: Body length 119mm (largest among *subspinipes* group).

Head capsule: Antnnae with 18 antennomeres, 6 basal glabrous and rest pilose; cephalic plate puncatae and more or less roundish.

Tergites: T1, T2 and T21 without sutures, T6-19 with complete paramedian sutures. T21 without sutures. Lateral margination from T7 onwards but rather indistinctly.

Sternites: S2-S20 with a paramedian longitudinal sutures.

Forcipular coxosternum: Each coxosternal tooth plate with 4+5 teeth; outer ones distinctly spacred and the inner ones partially united. Post dental spur present. Median prefemoral process dentate.

Coxopleuron: Coxoplural pores minute and dense. Coxopleural process conical, moderately long, with two apical spines.

Walking legs: Walking legs 1-20 with one tarsal spur.

Ultimate leg: Ultimate leg without tarsal spur. Prefemur with 1 dorso medial spines, 2 on the tip of posterior-medial process.

Distribution: India: Assam, Madhya Pradesh, Uttar Pradesh, Utharanchal, West Bengal, Maharashtra, Karnataka, Tamil nadu, Kerala and Andaman & Nicobar Islands; Sumatra, Java, Malaysia, Myanmar, Thailand, China (Indo-Malayan, Indo-Chinese).

Remarks:

Khanna (2001) and Sureshan *et al*., (2006a) mentioned the occurrence of this species in Kerala but no locality details are available. No material was collected during the present study, diagnostic characters were presented based on Sureshan *et al*.,(2006a).

5.6.5. Genus *Cormocephalus* Newport, 1844

Cormocephalus Newport, 1844a:275

Cormocephalus + Cupipes + Psiloscolopendra+ Hemicormocephalus + Hemiscolopendra + Colobopleurus, Kraepelin, 1903: 174- 217.

Type Species*: Cormocephalus rubriceps* (Newport).

Type Locality: New Zealand.

Diagnosis: Body length 21-160 mm. Antenna usually with 17 (rarely 16 or 18-21) articles. Cephalic plate covered posteriorly by T1, the former with basal plates at posterolateral corners and usually a pair of longitudinal sutures along posterior half. Legs without tarsal spurs. Almost a hundred species globally.

Distribution: India, Bangladesh; Sri Lanka, Philippines (Oriental), Africa, Madagascar, Tasmania (Ethiopian); New Guinea, Australia (Australian Region); Central America, South America, West Indies (Neotropical) and Caroline Islands, Solomon Islands, Loyality Islands, Lord Homes Islands, Galapagos Islands (All Tropical and Subtropical lands)

5.6.6. Key to the species of *Cormocephalus* from Kerala

1. T21 with a longitudinal median sulcus.....
   ……..…….....2
   - T21 without a longitudinal median sulcus.....
   …….....……..3
2. Longitudinal median sulcus on T21 confined to posterior half. Lateral margination only in T21. All walking legs with pretarsal spurs (Plate: 16.c)……
   ….....***C. indicus* sp.nov**.
   - Longitudinal median sulcus on T21 almost complete. Lateral margination T13 onwards. All walking legs may or may not with pretarsal spur (Plate: 18.c)
   …….....***C. westwoodi westwoodi* (Newport)**
3. Cephalic plate with a prominent posterior paramedian suture. Trochanteroprefemoral process with teeth (Plate:19. b,c)…….....
   ….....……***C. dentipes* Pocock**
   - Cephalic plate with a small posterior paramedian suture. Trochanteroprefemoral process without teeth (Plate:20.d)…….....….
   ….....***C.* (*Dekanonyx*) *nigrificatus* Verhoeff**

***Cormocephalus indicus* sp.nov.**

(Plate: 16, 17)

Diagnosis*:* Antennae with 17 articles. Tergite paramedian suture from T1-T20. T21 with a posterior median depression. Lateral margination in T21 only. Triangular spiracle with irregular folding in spiracular opening.

Description of Holotype: Body length 71 mm.

Colour: Cephalic plate and tergites yellowish brown with antennae slightly blue. Colour after preservation in 70% alcohol: Cephalic plate and tergites dull brown with dark blue antennae.

Head Capsule: Antennae with 17 articles, 7 glabrous dorsally; rest with dense hairs both dorsally and ventrally. Cephalic plate smooth with posterior paramedian suture (Fig. a). Cephalic plate length 0.93× its width.

Tergites: smooth lacking keels and with complete paramedian suture from T1- T20. Indistinct anterior lateral suture from T1-T7. T21 with moderately convex lateral margin that converge posteriorly; angular posterior margin and a clear posterior median depression (Fig. c). Lateral margination present only in T21. T21 as long as wide.

Sternites: with complete paramedian suture from S1-S20. S21 with straight lateral margin that tapers posteriorly and curved posterior margin. S21 elongated; length 1.35× its width.

Forcipular coxosternum: with three teeth on one side; 2 almost fused medial teeth and one isolated larger lateral teeth. Most of the teeth not well separated; 1 dental spur. Trochanteroprefemoral process with two not distinctly defined teeth along inner margin (Fig. b & Plate: 21).

Coxopleuron: with highly dense pores; wide porous area longer than S-21. Coxopleural process small with 2 apical spines, one slightly recurved and one lateral spine (Fig .c).

Ultimate legs: with 3 dorsolateral, 10 ventomedian in 2 rows, 6 ventolateral spines in 2 rows and two spined prefemoral process. Length of tarsus 1 is 1.21× than tarsus 2. Tarsal spur absent on legs 1-20. Two pretarsal spur on legs 1-20 (Fig. d)

Additional information from Paratypes*:* Body length varies between 32-61

mm. Specimen from Neyaar, Trivandrum, Kerala (ZSI/WGRC/IR/INV-2384) has forcipular coxosternum with 3 median teeth instead of 2 in others (Plate: 17: Fig. b). When compared to the Holotype, the ultimate leg spinulation varies being 10 ventromedial instead of 9 (ZSI/WGRC/IR/INV-2385) and 5 dorsolateral, 7 ventomedian in 2 row, 7 ventolateral spines in two rows (ZSI/WGRC/IR/INV-2384).

Etymology*:* The name of the species derived from the country "India", where the specimens collected.

Material examined:

Holotype: 1 ex. Pandipath, Thiruvananthapuram District, Kerala, India; Coll. K G Emiliyamma and Party. 15.x.2012 (ZSI/WGRC/IR/INV/2386).

Paratypes: 1 ex. Ponmudi Hills, Thiruvananthapuram District, Kerala, India; Coll. K G Emiliyamma and Party, 1.x.10.2012 (ZSI/WGRC/IR/INV-2385); 1ex. Neyar Island, Thiruvananthapuram District, Kerala, India; Coll. K.G Emiliyamma and Party, 11 .x.2012 (ZSI/WGRC/IR/INV-2384).

Habitat:

The present collection mostly represents sampling from typical shola forest patches of Agasthyamala Hill Ranges of Southern Western Ghats. Specimens were collected from leaf litter and under stone.

Remarks:

In the key to Scolopendrids of Deccan by Jangi and Dass (1984), the new species partially runs to *C.inermipes* described from Sri Lanka in 1891, due to the possession of "longitudinal median sulcus confined at posterior half" of T21. But it differs from *C.inermipes* in having claw spur (i.e., pretarsal spurs) on walking legs 1-20 (absent in *C.inermipes*). Jangi and Dass (1984) included *C.inermipes* it in their key without any details on description and specimens examined. *C.inermipes* is having distribution only in Sri Lanka (Minelli *et al*., 2006) and the species is included under *westwoodi* species group by Schileyko and Stagl (2004) due to the possession of "terminal prefemur (ultimate leg prefemur) with 2(3) rows of spines ventolaterally; tergum XXI (T21) with median sulcus; wide coxopleural porous area considerably

longer than sternum XXI (S21)". Due to the possession of above set of characters *C.indicus* sp.nov. can also be included in *westwoodi* group.

Though grouped together, the new species differs from *C.westwoodi westwood*i in the possession of posterior depression posteriorly on T21 which is rather a complete suture in *C. westwoodi*. The new species also differs from *C.westwoodi westwood*i in the number of tergites marginated (T13-T21) in latter and in the new species only on T21 and number of teeth in forcipular coxosternum (4 in latter and in the new species 3). The new species also possess a characteristic irregular folding in spiracular opening (Plate 17, Fig. d). *C.indicus* also shows similarity with the other Indian species viz., *C.dentipes, C.nudipes* Jangi and Dass, 1984 and *C.pygmaeus Pocock* 1892*,* in having 6 glabrous antennal articles and in the number of spines in coxopleuron. But it differs from all these species in having margination only on T21 which is T14/T16-21 (in *C. dentipes*), T13-T21 (in *C.nudipes*) and T17-T21(in C. *pygmaeus*). Though it resembles *C.nigrificatus* in having only T21 marginated and in the the number of coxopleural process apical and lateral spines, but differs from the latter in the presence of posterior depression in T21.

***Cormocephalus westwoodi westwoodi* (Newport, 1844)**

(Plate: 18)

Scolopendra westwoodi Newport, 1844b: 100.

Cormocephalus dispar Porat, 1871: 1155.

Cormocephalus dispar, Attems. 1928: 99.

Cormocephalus westwoodi Kraepelin, 1903: 200.

Cormocephalus westwoodi dispar Lawrence, 1955: 159.

Cormocephalus (C.) westwoodi westwoodi Attems, 1930:78.

Cormocephalus westwoodi westwoodi (Newport, 1844),

Schileyko & Stagl. 2004: 81

Type locality*:* Australia.

Diagnosis*:* Shape of spiracle triangular with a special protruding folding in spiracular opening. Antennae with 19 articles, dorsally 6.5 glabrous. Tergite paramedian suture from T2-T20. T21 with almost complete sulcus.

Description: Body length: 52- 58 mm.

***Colour*:** Cephalic plate and tergites dark blue. Colour after preservation in 70% alcohol: Cephalic plate and tergites greyish black and legs blue.

Spiracle: Shape of spiracle triangular; a special protruding fold projecting towards chamber on the base of triangular shaped spiracular opening (Fig. b).

Head capsule: Antennal articles 19; dorsally and ventrally 6.5 glabrous. Cephalic plate smooth and with posterior paramedian sutures (Fig. a). Cephalic plate length: width ratio is almost 1.

Tergites: moderately punctate. Complate paramedian sutures from T2-T20. T21 with convex posterior margin and almost complete sulcus. T21 length 0.9× than its width. Lateral sutures present on T3- T20. Lateral margination T13 onwards.

Sternites: with distinct paramedian sutures from S1 to S20. S21 tapering posteriorly and with almost straight posterior margin with a short median sulcus. S21 length 1.33× than width.

Forcipular coxosternum: Forcipular coxosternal tooth not separated clearly, 4 partially fused teeth in one side; outer one is separated from the rest. Trochanteroprefemoral process dentate but teeth not well separated (Fig. d and Plate: 21). Second maxillary claw with a prominent spur.

Coxopleuron: Coxopleural process short with two apical spines, one recurved and a very small side spine (Fig. c).

Walking legs: Walking legs 1-20 with 2 pretarsal spur. No tarsal spurs.

Ultimate legs: prefemur with 2 dorsolateral spine, 6 ventromedial spine arranged in 2 rows, and 3 ventro lateral spines. A prominent posteriomedian process with 2 corner spines presents. Tarsus 1 1.6× longer than tarsus 2. No tarsal spurs.

Distribution: India: Gujarath, Maharashtra, Goa, Rajasthan, Goa, Kerala (New record to Kerala); S.Africa, Madagascar, Zimbawe, Srilanka.

Material examined: 1 ex. Puralimala, Thiruvananthapuram District, Kerala, India; Coll. K. G Emiliyamma & Party; 11.x.2012. (ZSI/WGRC/IR/INV-2383); 1 ex. Churulippetty, Chinnar Wildlife Sanctuary, Idukki District, Kerala, India, Coll. P. M Sureshan, 4.iv. 2012. (ZSI/WGRC/IR/INV/2230).

Habitat:

Specimen collected from dry deciduous and moist deciduous forests. Habitat includes stone and soil litter.

Remarks*:*

C. westwoodi westwoodi, a polytypic old world species, is reported for the first time here from the South Indian forests. Both the localities of collection represent typical forested area, in which Puralimala is down-hill of Agasthyamala Hills and Chinnar which represents the typical rain-shadow forests of Western Ghats. Present collection represents robust specimens collected from dense forest tracts. Attems (1930) discussed about the subspecies and variations of *C. westwoodi* as 1) *C. westwoodi westwoodi* 2) *C. westwoodi westwoodi* var. *westwoodi 3) C. westwoodi westwoodi* var *huttoni* Pocock, 1893) *C. westwoodi dispar* Porat, 1871. While discussing the "high variability among widely distributed C. *westwoodi"* Schlieyko and Stagl (2004), mentioned that "there are no clear distinctions between subspecies and varieties" and "except for *C.huttoni* all the conditions of their diagnostic characters fit within the known range of intraspecific variability of *C.westwoodi*". The examples of present study shares similarity in most of the characters they discussed but differ notably in number of antennal articles (19 against 17 in present examples).

***Cormocephalus dentipes* Pocock, 1891**

(Plate: 19)

Cormocephalus dentipes Pocock 1891a*,* 7: 66.

Cormocephalus pseudonudipes, 1984, Jangi and Dass*,*43(2): 37.

Cormocephalus dentipes Pocock 1891*, syn . by* Khanna: 1994: 310.

Cormocephalus dentipes, Lewis, 2001:58.

Cormocephalus dentipes, Yadav, 2009: 224.

Type Locality: India: Bengal.

Diagnosis*:* Spiracles oval or triangular. Antennae with 17 articles; 6-7 basal glabrous. Tergite paramedian suture from T1-T20. No sutures on T21. Forcipular coxosternum with 4-5 teeth, outer 1-2 separated from the inner ones.

Description*:* Body length: 39 – 65 mm.

Colour**:** In life: Cephalic plate and tergites yellowish brown. Colour after fixing in formalin & preservation in 70% ethyl alcohol: Cephalic plate and tergites yellowish brown with basal antennal articles dull violet. Colour after preservation in 70% alcohol: Cephalic plate and tergites greyish black with legs blue/violet.

Spiracle: Shape of spiracle oval or triangular.

Head capsule: Antennal articles 17(16 in specimen reg. no ZSI/WGRC/IR/INV-2187), dorsally 6-7 glabrous and with hairs (4.5 in specimen reg. no ZSI/WGRC/IR/INV-2098 and ZSI/WGRC/IR/INV-2382).

Cephalic plate: moderately punctate and with posterior paramedian sutures (Fig. a).

Tergites: Tergites moderately punctate with complete paramedian sutures from T1-T20 (Fig. a); and with lateral keel from T1-T20. No sutures on T21. Lateral margination begins from T13 or T16 and ends in T21. Specimen reg. no ZSI/WGRC/IR/INV/2382 has margination on T21 only. Transverse wrinkles observed anteriorly on T1-T5, both anteriorly and posteriorly on T6-T8 and posteriorly on T9-T19.

Sternites: clearly punctate and with clear paramedian sutures from S1 to S20.

Forcipular coxosternum: Each forcipular coxosternal toothplate with 4-5 teeth, the lateral teeth is separated from the rest. Trochanteroprefemoral process dentate with 2-3 teeth in inner side (Fig. b & Plate: 21).

Coxopleuron: Coxopleural process with small pores and poreless strip at apex and with two apical spines and a very small lateral spine (Fig. c).

Walking legs: Legs 1-20 with 2 pretarsal spur. No tarsal spurs observed.

Ultimate leg: prefemur with 3 dorsolateral spine , 6 to 12 ventromedial spine arranged in 2 or 3 rows, and 4-6 ventro lateral spines. There is a prominent non-spine strip on prefemur; the prefemoral process with 1 or 2 spines. Legs 1-20 with 2 pretarsal spur. No tarsal spurs observed.

Distribution: India : Madhya Pradesh, Orissa, Kerala, West Bengal, Uttar Pradesh, Bihar, Delhi, Himachal Pradesh, Meghalaya, Maharashtra Mizoram, Uttaranchal, Andaman & Nicobar Islands; Nepal (Indo- China).

Material examined: 1 ex. East Hill, Kozhikode District, Kerala, India; Coll. Madhavan; 18.ii.2011. (ZSI/WGRC/IR/INV-2097); 1 ex. Urakkuzhy, Malabar

Wildlife Sanctuary, Kerala, India. Coll. Umesh. 21.v.2011. (ZSI/WGRC/IR/INV-2098); 1 ex. Thumboormuzhy farm, Thrissur District, Kerala, India; Coll. Harish K.C. 25.v. 2010. (ZSI/WGRC/IR/INV-2382); 1 ex. Peppara, Thiruvananthapuram District, Kerala, India; Coll. K.G Emiliyamma & Party.13.x.2012. ZSI/WGRC/IR/INV-2371); 1 ex. Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India; Coll. Dhanya Balan. (ZSI/WGRC/IR/INV-2356): 1 ex. Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India; Coll. Dhanya Balan. 07.v.2012. (ZSI/WGRC/IR/INV-2357):1 ex. Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India; Coll. Dhanya Balan. 1.iii.2012. (ZSI/WGRC/IR/INV/2183); 1 ex. Thannikuzhy, Malappuram District, Kerala, India; Coll. Rajmohana & Party; 04.ii.2012. (ZSI/WGRC/IR/INV-2187); 1 ex. Kartikulam, Wayanad District, Kerala, India; Coll. Subina; 10.xi.2013. (ZSI/WGRC/IR/INV-3546). 5 ex. Kattikulam coffee plantation, Wayanad District, Kerala, India; Coll. Subina; 7.x.2013. (ZSI/WGRC/IR/INV-3542). 1 ex. Kattikulam coffee plantation, Wayanad District, Kerala, India. Coll. Subina. 28.x.2013. (ZSI/WGRC/IR/INV-3546); 2 ex. Kattikulam coffee plantation, Wayanad District, Kerala, India; Coll. Subina; 10.vii.2013. (ZSI/WGRC/IR/INV-3563); 3ex. Palakappara, Konni, Pathanamthitta District, Kerala, India; Coll. P.M Sureshan; 21.i.2014. (ZSI/WGRC/IR/INV-3536); 1 ex. Malakkappara, Vazhachal, Thrissur District, Kerala, India; Coll. P M Sureshan; 27.xi.2013. (ZSI/WGRC/IR/INV-3538); 1 ex. Malakkappara, Vazhachal, Thrissur District, Kerala, India; Coll. P M Sureshan; 10.vii.2013. (ZSI/WGRC/IR/INV/3542); 1 ex. Orukomban, Vazhachal, Thrissur District, Kerala, India. Coll. P M Sureshan; 26.ii.2013. (ZSI/WGRC/IR/INV-2518); 1 ex. Palakappara, Konni, Pathanamthitta District, Kerala, India; Coll. P M Sureshan; 21.i.2014. (ZSI/WGRC/IR/INV-3536); 1 ex. Periya Peak, Wayanad District, Kerala, India; Coll. . P M Sureshan; 15.viii.1994. (ZSI/WGRC/IR/INV-2433); 1 ex. Thirunelli, Wayanad District, Kerala, India; Coll.Suvina. 30.x.2013. (ZSI/WGRC/IR/INV-3547); 1 ex. Thirunelli, Wayanad District, Kerala, India; Coll. Suvina. 23.x.2013. (ZSI/WGRC/IR/INV-3562).

Habitat:

C. dentipes is a commonly occurring species found in different ecosystems like forests, agricultural lands and residential areas. It was collected from both plains and high elevations. During the sampling in Winter Seasons in Western Ghat Forests,

the specimens appeared to be in hibernation without much activity. Specimens were bserved under stone, decaying wood, leaf litter and soil, most preferably areas around trees.

Remarks:

In the key by Jangi and Dass (1984) *C. dentipes* runs to *C. pseudonudipes* which is synonymised by Khanna (2005) as *C. dentipes*. Jangi and Dass separated these two species using an interesting character, the presence of tuberculation in ultimate legs. In the description of type material of *C.dentipes* from Bengal, Jangi and Dass (1980) mentioned that the character combination of tuberculation in ultimate leg prefemur, femur, tibia and lateral margination from T13 can be used for separating the adult male from female and juveniles. But Khanna (1994e) opined that only 20% of population shows such secondary characters. The specimens examined here also not possess any such tuberculation in ultimate legs and show a range in margination of tergites. Attems (1930) in his key published in the monograph of world scolopendromorpha use "femur and tibia ventrally coarsely granular in ultimate legs and 4-5 antennal articles glabrous" to separate *C. dentipes* from *C. pygmaeus* Pocock. The same was quoted by Lewis (2001a) in discussing the reassignment of *C. pygmaeus* from Nepal under *C. dentipes* and he concluded that the number of glabrous articles and tuberculation could not be considered as a reliable character to separate *C. dentipes*. So, we assume that the "tuberculation" which is also present in another species *C.denticaudus* Jangi and Dass, 1984 may be a character possessed only by a small population of male individuals mostly reported from North and North-East Indian States. Besides, *C. dentipes* is also characterised by the presence of either oval or triangular spiracles, which is triangular in all other Indian species.

***Cormocephalus* (*Dekanonyx*) *nigrificatus* Verhoeff, 1937**

(Plate: 20)

Cormocephalus (Dekanonyx) nigrificatus Verhoeff, 1937: 81.

Cormocephalus (Dekanonyx) nigrificatus, Khanna. 2008: 38.

Type locality*:* India: Nedumangad, Trivandrum Dist, Kerala.

Diagnosis: Spiracle triangular. Antennae with 17-18 articles, dorsally 5-6 glabrous

but with minute hairs from the second article onwards. Tergite paramedian suture from T1-T20. Margination only in T21. No suture in T21.

Description: Body length: 37- 68 mm.

***Colour*:** In life: Cephalic plate and tergites greyish black. Colour after preservation in 70% ethyl alcohol: Cephalic plate and tergites greyish black and blue legs.

Spiracle: Shape of spiracle triangular (Fig. b).

Head capsule: Antennal articles 17-18, dorsally 5-6 glabrous; extended up to T2/T3.

Cephalic plate: Cephalic plate moderately punctate and with posterior paramedian sutures (Fig. a).

Tergites: Tergites moderately punctate; complete paramedian sutures from T1-T20. T21 angular and without any sutures. Lateral margination present in T21 only.

Sternites: Sternite with distinct paramedian sutures from S1 to S20. S21 without any sutures and with straight posterior end (Fig. c).

Forcipular coxosternum: Each forcipular coxosternal tooth plate with 3 main teeth, teeth are very small and not well separated. Trochanteroprefemoral process not dentate (Fig. d & Plate: 21).

Coxopleuron: Coxopleuron densely porous; coxopleural process elongated with two prominent apical spines, one recurved and one lateral (Fig. c).

***Ultimate leg*:** Ultimate leg prefemur with 2 dorsolateral spines, 6 ventromedial spines arranged in 2 rows, and 3 ventro lateral spines. A prominent posteriomedian procees with 2 corner spines present (Fig. c).

***Walking legs*:** Legs 1-20 with 2 pretarsal spurs. No tarsal spurs.

Distribution: India: Kerala, Goa.

Material examined*:* 1 ex. Karadippara, Shenduruny Wildlife Sanctuary, Kollam District, Kerala, India. Coll. K. G Emiliyamma & Party; 16.x.2012. (ZSI/WGRC/IR/INV-2376); 1 ex. Karadippara, Shenduruny Wildlife Sanctuary, Kollam District, Kerala, India. Coll. K. G Emiliyamma & Party; 16.x.2012. (ZSI/WGRC/IR/INV-2436); 1 ex. Rosemala, Kollam District, Kerala, India. Coll. K. G Emiliyamma & Party; 16.x.2012. (ZSI/WGRC/IR/INV-2387); 1 ex. Urakkuzhy, Malabar Wildlife Sanctuary, Kerala, India; Coll. Umesh P.K. 5.vii.2012. (ZSI/WGRC/IR/INV-2358);

1 ex. Urakkuzhy, Malabar Wildlife Sanctuary, Kerala, India; Coll. Dhanya Balan. 8.i.2011. (ZSI/WGRC/IR/INV-2112);1 ex. Ambalappara, Malabar Wildlife Sanctuary, Kerala, India; Coll. Dhanya Balan. 29.v.2013. (ZSI/WGRC/IR/INV-2358);1 ex. Thannikuzhy, Olakkara Reserve Forest, Malappuram District, Kerala, India; Coll. Rajmohana & Party; 4.i.2012. (ZSI/WGRC/IR/INV-2188); 1 ex. Meenmutty, Idukky District, Kerala, India; Coll. P. M Sureshan and Party; 15.i.1996. (ZSI/WGRC/IR/INV-2277); 1 ex. Mullakudi, Idukky District, Kerala, India; Coll. Rajmohana and Party; 4.v.2013. (ZSI/WGRC/IR/INV/3510). 1 ex. Manalar, Idukky District, Kerala, India; Coll. Rajmohana and Party; 4.vii.2013. (ZSI/WGRC/IR/INV/3512).1 ex. Pachamala, Thekkady, Idukky District, Kerala, India; Coll. Rajmohana and Party; 1.iii.2013. (ZSI/WGRC/IR/INV-3530); 1 ex. Pachamala, Thekkady, Idukky District, Kerala, India; Coll. Rajmohana and Party; 4.iv.2013. (ZSI/WGRC/IR/INV-3513); 2 ex. Kolombo, Thattekad, Ernakulam District, Kerala, India; Coll. Jaffer Palott; 25.ii.2014. (ZSI/WGRC/IR/INV-4488); 1 ex. Urulanthanni, Thattekad, Ernakulam District, Kerala, India; Coll. P. M Sureshan; 25.xi.2014. (ZSI/WGRC/IR/INV-4488);1 ex. Bellipady, Kasargod, Kerala, India; Coll. Rajmohana and Party; 1.iii.2013. (ZSI/WGRC/IR/INV-3529); 1 ex. Manekol, Kasargod, Kerala, India; Coll. Rajmohana and Party; 1.iii.2013. (ZSI/WGRC/IR/INV-2511); 1 ex. Maruthome, Kasargod, Kerala, India; Coll. Rajmohana and Party; 1.iii.2013. (ZSI/WGRC/IR/INV/3526); 1 ex. Bellipady, Kasargod, Kerala, India; Coll. Rajmohana and Party; 1.iii.2013. (ZSI/WGRC/IR/INV-3530); 1 ex. Deer Park, Shenduruny Wildlife Sanctuary, Kollam District, Kerala, India; Coll. K. G Emiliyamma & Party; 14.vi.2012. (ZSI/WGRC/IR/INV-2439). 1 ex. Deer Park, Shenduruny Wildlife Sanctuary, Kollam District, Kerala, India; Coll. Dhanya Balan; 18.x.2012. (ZSI/WGRC/IR/INV-2374). 1 ex. Thirunelli,Wayanad District, Kerala, India; Coll. Rajmohana and Party. 1.iii.2013. (ZSI/WGRC/IR/INV-2511). 1 ex. Thirunelli,Wayanad District, Kerala, India; Coll. Suvina. 25.ix. 2013 (ZSI/WGRC/IR/INV-3543). 6 ex. Thirunelli,Wayanad District, Kerala, India; Coll.Suvina. 25.ix. 2013 (ZSI/WGRC/IR/INV-3566).

Habitat:

Cormocephalus (*Dekanonyx*) *nigrificatus* is a commonly occurring species found in different ecosystems like forests, agricultural lands and residential areas. It was collected from both plains and high elevations. Specimens were observed under

stone, leaf litter and soil, most preferably areas around trees.

Remarks:

Cormocephalus (*Dekanonyx*) *nigrificatus* is unique because it is endemic to India and reported only from Southern India; Kerala (Sureshan *et al*., 2006) and Goa (Sureshan and Yadav, 2008b) so far. It is characterized by the absence of trochanteroprefemoral process dentition. The specimens (ZSI/WGRC/IR/INV-2376 and ZSI/WGRC/IR/INV-2439) were collected from the protected areas of Kollam District, Kerala near to the type locality Nedumangad, Trivandrum District. The original type locality (Nedumangad) is presently a township, and habitat might have changed during the past years which might led to extension of distribution of the species into similar habitats of nearby forests. Specimens of the present study were collected mainly from decayed wood and leaf litter from forest areas of Western Ghats.

SUBFAMILY: OTOSTIGMINAE

Otostigminae Kraepelin, 1903: 29, 64.

Otostigminae, Attems, 1930:127.

5.6.6. Genus *Otostigmus* Porat, 1876

Otostigmus Porat, 1876: 18

Branchiotrema, Kohlrausch, 1878.22.

Otostigmus, Haase, 1886, 5: 69

Type Species: *Otostigmus orientalis* Porat

Type Locality: India (Bombay)

Diagnosis: Body length 20-150 mm. Leg-bearing segment 7 lacking spiracles.

Distribution: Most parts of tropical and subtropical regions. About 120 species world wide, in three subgenera.

5.6.7. Key to the species of *Otostigmus* from Kerala

1. Coxopleural process with 2 apical and no lateral spines (Plate 22. f)……...
……..*O. politus politus* **Karsch**

-Coxopleural process with 2 or more apical and lateral spine…….....
…….....***2***

2. Antennae composed of 2 glabrous basic articles (Plate 23. b).……..…...
…….....***O. gravelyi* (Jangi and Dass)**

-Antennae composed of 2 to 3 glabrous basic articles…….....…….3

3. Coxopleural process with 2 apical spines and one lateral spines (Plate 24. e).....
……..…….....***O.orientalis* Porat**

- Coxopleural process with 2 apical spines, rarely dorsal spine and lacking lateral spines …….....…….***O.ruficeps* Pocock**

***Otostigmus politus politus* Karsch, 1881**

(Plate: 22)

Otostigma politum Karsch. 1881**:** 219.

Otostigmus (O.) politus politus, Attems, 1930: 149.

Otostigmus politus politus, Lewis. 2003: 193-206.

*Otostigmus politus politus***,** Sureshan and Yadav. 2008a:157

Type Locality: China

Diagnosis: Antennae composed of 17 articles, basic 3 glabrous. Coxopleural process with 2 apical spines. Lateral spines may or may not present.

Description: Body length 35-52mm.

***Colour**:* The species is very distinct by the yellow coloured T1 apperaing as a clear ”band”between the brownish cephalic plate and tergites (Fig.a). Antennae generally blue. Sternites pale yellow to greenish yellow. Legs blue, sometimes banded appearance with alternate blue and pale yellow.

***Head capsule*:** Antennae composed of 17 articles; tapering distally, the basal 2.5 or 3 articles glabrous. Cephalic plate moderately punctate with a small median sulcus (Fig. b). First maxillipede with spur (Fig. c).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; the outer two and separated from the inner; one dental spur. Median prefemoral process dentate with 3 or 4 teeth.

Tergites: T1 and T2 smooth and shiny without any sutures. T3-T4 with anteriorly

confined small sutures. T6-T20 with complete paramedian sutures. T21 with an angular posterior end (Fig. d). Lateral margination from T13-T21.

***Sternites*:** S1 to S20 moderately punctate; anterior paramedian sutures on S2 to S5. S21 gradully narrowing in posterior end and without sutures (Fig. e).

Coxopleuron: Coxopleural process short with moderately sized pores; lacks poreless strip at apex. It posess two apical spines and one diminutive lateral spine, which are absent in some specimens (Fig. f).

***Walking legs*:** 1-5 with 2 tarsal spur and 2 claw spur, rest with 1 tarsal spur and 1 claw spur (Fig. g).

***Ultimate leg*:** Prefemur with 1 or 2 dorsolateral spines, 4 ventromedial spines and 2 ventro lateral spines (Fig. h).

Material Examined: 01 ex. Kakkayam, Kozhikode, Kerala, India. Coll. K. P Dinesh. 01/xi/2011. (ZSI/WGRC/I-R/INV-2343). 01 ex. Kottiyur Wildlife Sanctuary, Kannur, Kerala, India. Coll.P.M Sureahan. 14/x/2011. (ZSI/WGRC/I-R/INV-2139). 01 ex. Kakkayam, Kozhikode, Kerala, India. Coll.Dhanya Balan. 03/i/2012. (ZSI/WGRC/I-R/INV-2182). 01 ex. Kakkayam, Kozhikode, Kerala, India. Coll.Dhanya Balan. 21/iv/2012. (ZSI/WGRC/I-R/INV-2091). 02 ex. Kakkayam, Kozhikode, Kerala, India. Coll.Dhanya Balan. 08/ii/2013. (ZSI/WGRC/I-R/INV-3956). 01 ex. Kakkayam, Kozhikode, Kerala, India. Coll.P. M Sureshan. 01/xii/2014. (ZSI/WGRC/I-R/INV-4475).

Distribution: India: Assam, Delhi, Himachal Pradesh, Kerala, Maharashtra, Meghalaya, Orissa, Sikkim, Uttaranchal and West Bengal; *:* China, Korea, Vietnam (Indo-Chinese).

Habitat:

The species generally collected beneath stones, decaying wood, leaf litter

Remarks:

This species is a very common forest dweller. The syntype description of *O.politus politus* (Lewis, 2003) was referred for comparing the specimens. Interestingly the specimens studied in the present study shares similarities in number of antennal

articles, forcipular dentition, spinualation in coxopleural process with the Chinese specimens decribed in that communication.

***Otostigmus gravelyi* (Jangi and Dass, 1984)**

(Plate: 23)

Digitipes gravelyi Jangi and Dass, 1984: 41

Digitipes gravely, Sureshan *et al*. 2006: 2287.

Otostigmus gravelyi (Jangi and Dass, 1984), Joshi and Edgecombe, 2013:121

Type Locality: India

Diagnosis: Antennae composed of 2 glabrous basic articles. Coxopleural process with 2 lateral spines, 4 apical spines. Prominent keels from T1-T20.

Description: Body length 73-97mm.

Colour: In life: The species was observed in the colour patterns of bluish black in tergites, orange in Cephalic plate, T-3-T21 and coxopleural process, T1-T3 brownish. Antennae generally reddish. Sternites pale yellow to greenish yellow.

***Head capsule*:** Antennae composed of 21articles; tapering distally, the basal two articles glabrous (Fig. a, b). Cephalic plate moderately punctate.

Forcipular coxosternum: Each coxosternal tooth plate with 5/4 to 6 teeth; the outer two fused and separated from the inner. Median prefemoral process dentate with 3 or 4 teeth (Fig.b).

Tergites: T1 and T2 smooth without any sutures. T3-T4 with three median sutures. T5-T21 with keels (Fig. c). T21 with a very prominent median sulcus. Lateral margination from T5 or T6-T21.

***Sternites*:** S1 to S20 moderately punctate; anterior paramedian sutures complete on S6 to S20. S21 gradually narrowing in posterior end with concave posterior margin (Fig. d).

***Walking legs*:** 1-20 with a tarsal spur and 2 claw spurs.

***Coxopleuron*:** Coxopleural process with prominent pores and poreless strip at apex and with four apical spines, two lateral spines (Fig. e).

***Ultimate leg*:** Prefemur with 2 dorsolateral spines, 4 ventromedial spines and 3 ventro lateral spines (Fig. f).

Distribution: India: Kerala.

Material Examined: 1 ex. Thoppimudu, Thattekad Bird Sanctuary, Ernakulam, Kerala, India. Coll. P M Sureshan. 22/iv/2015. (ZSI/WGRC/I-R/INV-4029); 1 ex. Thattekad Bird Sanctuary, Ernakulam, Kerala, India. Coll. P M Sureshan. 22/iv/2015. (ZSI/WGRC/I-R/INV-4029); 1 ex. KFRI Campus, Peechi, Thrissur, Kerala, India. Coll. Dhanya Balan. 06/ii/2010. (ZSI/WGRC/I-R/INV-3950); 1 ex. Palaruvi, Kollam, Kerala. India. Coll. P M Sureshan. 10/viii/1997. (Reg No: 10465); 1 ex. Vallamvetti Kollam, Kerala. India. Coll. P M Sureshan. 18/viii/1997. (Reg No: 10645); 1 ex. Parakadavu,
Kollam, Kerala. India. Coll. P M Sureshan. 08/viii/1997. (Reg No: 10463).

Habitat:
The specimens were generally collected under stones and decaying wood.

Remarks:
This species is endemic to Kerala. It was described on the basis of the holotype alone, a female collected from Parambikulam, Kerala, in 1914. Specimens from the Kollam District in Kerala were subsequently assigned to it by Sureshan *et al.,* (2006). It was the first report from Kerala. According to Joshi *et al*., (2013), the male has not been described for "*D. gravely"* so its membership in the genus was not solidly established. They discussed that the number of articles, 19–21 in *D.gravelyi* is very specific when studying the specimens identified by Sureshan *et al*., (2006a) and typical because all other Indian species have a conserved number of 17 articles. Besides the presence of five teeth on each forcipular tooth plate in this species is in contrast to the highly conserved pattern of only four teeth in the other Indian and African species. Above all, *Digitipes* species reported from India or Africa have no dorsal spines along with the two apical spines on the coxopleural process and no Indian species posess a single lateral spine. But *D. gravelyi* has two strong lateral spines. Pointing out the similarities of all these characters to genus *Otostigmus,* they reassigned the species to *Otostigmus* as the new combination *Otostigmus* (*Otostigmus*) *gravelyi* (Jangi and Dass, 1984).

***Otostigmus orientalis* Porat, 1876**

(Plate: 24)

Otostigmus orientalis Porat, 1876: 19.

Otostigmus (O.) orientalis, Attems, 1930: 139.

Type Locality: India: Bombay (Maharashtra).

Diagnosis: Antennae composed of 17 articles, 2.5 or 3 basic glabrous. Coxopleural process with 1 lateral and 2 apical spines. Prominent keels from T11-T20.

Description: Body length 67-82mm.

Colour: The species was observed in the colour patterns of greyish black in tergites and cephalic plate (Fig. a). Walking leg 20 and ultimate leg grape colour. Sternites pale yellow.

***Head capsule*:** Antennae composed of 17 articles; tapering distally, the basal 2.5 or 3 articles glabrous (Fig.b). Cephalic plate moderately punctate and with an anterior notch. First maxillipede with a clear spur (Fig.c).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; Median prefemoral process dentate (Fig.d).

Tergites: T1 and T5 smooth without any sutures. T6-T20 with complete paramedian sutures. T11-T20 with keels. Lateral margination from T10-T21. T21 without any sutures.

***Sternites*:** S1 to S20 moderately punctate; anterior paramedian sutures complete on S2 to S20. S21 bisinuated with tapering end and without any sutures (Fig. e).

***Coxopleuron*:** Coxopleural process with moderately sized pores and poreless strip at apex is having two apical spines and one lateral spine (Fig. e).

***Walking legs*:** 1-2 with 1 femoral, 2 tibial, 2 tarsal spur and 2 claw spur. 3-6 with 2 tarsal spur and 2 claw spur.7-19 with 1 tarsal spur and 2 claw spur. 20 with 1 tarsal spur and 1 claw spur (Fig.f).

***Ultimate leg*:** Prefemur with 1 dorsolateral spine, 3 ventromedial spine and 2 ventro lateral spines.

Distribution: India: Maharashtra, Kerala (New record to Kerala).

Material Examined: 01 ex. Kottiyur Wildlife Sanctuary, Kannur, Kerala, India. Coll. Dhanya Balan. 14/x/2011. (ZSI/WGRC/I-R/INV-2140). 01 ex. Thuruthimala, Kozhikode, Kerala, India. Coll. Umesh P K. 14/x/2011. (ZSI/WGRC/I-R/INV-2289). 01 ex. Urakkuzhy, Malabar Wildlife Sanctuary, Kozhikode, Kerala, India. Coll. Dhanya Balan. 27/vii/2012. (ZSI/WGRC/I-R/INV-2287).

Habitat:

The species generally found beneath stones, leaf litter and decaying logs.

Remarks:

It's an endemic species to India. And this is the first report outside from the type locality in Maharashtra state. Lewis (1996) redesribed the typematerial of *O.(O). splendens* and pointed out that it can be a junior synonym to *O.orientalis.* So, the specimens identified as *O.splendens* by Sureshan *et al., (*2006) were reassigned here as *O.orientalis,* and the former record deleted from the Kerala Checklist.

***Otostigmus ruficeps* Pocock, 1890**

Otostigmus ruficeps Pocock, 1890: 247

Otostigmus ruficeps, Lewis, 1996: 828.

Otostigmus ruficeps, Joshi and Egdecomb, 2013:121.

Type locality: India: Madras.

Diagnosis: Antennae with 21 elongate articles, basal 2-2.5 glabrous dorsally. Forcipular teeth with 4+4 dentition. Longitudinal median depression on posterior half of T21. Two apical spines in coxopleural process, dorsal spine rarely present, lateral spines mostly lacking. Ultimate leg prefemur with 2 ventromedial and 2-3 ventrolateral spines.

Description: Body length 36 mm.

Colour: Cephalic plate and T1 brown or orange brown**.** T2/T3- T21 mostly bluish, with brown pigments.

***Head capsule*:** Antennae composed of 21 articles; the basal 2 or 2.5 articles glabrous.

dorsally. Cephalic plate moderately punctate with longitudinal median furrow.

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 main teeth; the inner two separated from the outer; inner ones grouped together. Median prefemoral process dentate with 3 or 4 teeth. Second maxillary claw with slender accessory spur.

Tergites: T5-T7 with complete sutures. No keels or ridges on tergites. Lateral margination from T6-T8.

***Sternites*:** Sternites with anteriorly confined paramedian sutures.

Coxopleuron: Coxopleural process moderately long. It posess 2 or 3 apical spines and one diminutive lateral spine, which are absent in some specimens.

***Walking legs*:** Walking legs 1-17 to 1-19 with 2 tarsal spur and 2 claw spur, rest with 1 tarsal spur, 1-6 to 1-7/8 with a tibial spur. Walking leg 1 with 1 femoral spur invariably.

***Ultimate leg*:** Prefemur with no dorsolateral spines, 2 ventromedial spines and 2 or 3 ventro lateral spines (Fig. g).

Distribution: India: Kerala, Karnataka.

Material examined: No material was collected during the present study diagnostic characters and description were presented based on Joshi and Egdecomb (2013).

5.6.8. Genus *Digitipes* Attems, 1930

Digitipes Attems. 1930. 54 (2): 167-168

Type species: *Digitipes verdascens* Attems, 1930

Diagnosis: Body length 32-65 mm. Leg-bearing segment 7 lacking spiracles. Claws of second maxillae lacking accessory spines. Male femora of ultimate legs with a Distal short subcylindrical process.

Distribution: Ethiopian (Congo only) and Oriental (India only)

5.6.9. Key to the species of *Digitipes* in Kerala
(Modified from Joshi & Edgecombe, 2013)

1. All walking legs lacking tarsal spurs.....***D. periyarensis* Joshi & Edgecombe**

- At least one tarsal spur on walking legs 1–19 2
2. Longitudinal median furrow on cephalic plate bifurcate posteriorly 3
- Longitudinal median furrow on cephalic plate not bifurcate posteriorly 4
3. 2.5 glabrous antennal articles; walking leg 20 posess tarsal spur (Plate 26: c)…... .....***D. chhotanii* Jangi & Dass**
- 3 glabrous antennal articles; walking leg 20 lacking tarsal spur..... .....***D. pruthii* Jangi & Dass**
4. Two glabrous antennal articles; pore field extending close to dorsal margin of coxopleuron 5
- Three or four glabrous antennal articles; pore field distant from dorsal margin of coxopleuron 6
5. Antenna with 17/18 antennal articles; T21 without any sutures (Plate 27: a. e)..... .....***D.barnabasi* Jangi and Dass**
- Antenna with 18/22 antennal articles; T21 with a clear median depression (Plate 28: a. e).....***D. pseudobarnabasi* sp.nov.**
6. Leg 20 with tarsal spur .....***D. jonesii* (Verhoeff)**
- Leg 20 lacking tarsal spur (Plate 30: e) .....***D. coonoorensis* Jangi & Dass**

***Digitipes periyarensis* Joshi and Edgecombe, 2013**

(Plate: 25)

Digitipes periyarensis Joshi and Edgecombe, 2013: 116.

Type Locality: India: Periyar, Kerala

Diagnosis: Antennae composed of 17 antennal articles, three basal antennal segments glabrous dorsally, complete paramedian sutures almost complete in sternites; no tarsal, tibial and femoral spurs in walking legs. Coxopleural process short, lacking spines. Prefemur of ultimate leg stout and with dorsal longitudinal grooves.

Description: Body length 42 mm to 58mm.

***Colour*:** Glassy pale greenish brown with black colouration along margins in all tergites (Fig. a). Posterior tergites with irregular black colouration throughout. Walking legs glassy pale yellow & ultimate leg brown with black markings in thickened dorso-lateral area. In 90% alcohol: Dull greenish tergites, antennae,

walking legs and ultimate leg bluish.

***Spiracles*:** oval, positioned in 3, 5, 8, 10, 12, 14, 16, 18, 20.

***Head capsule*:** Antennae relatively short, 17 articles, extending up to T2. Basal 3 articles glabrous dorsally and 2 ventrally, rest with setae. Forcipular coxosternum with 4+4 dentition (Fig. b), outermost 2 of them separated from rest. Second maxillipede without spurs. Cephalic plate elongated, moderately punctate and without sutures (Fig. c).

***Tergites*:** T1 moderately punctate and without sutures. T2-20 with complete paramedian suture. Lateral margination T9 onwards (Fig. d); incompletely from T2-T8. T21 without any sutures. Its width almost twice as that of length; with straight lateral ends and posterior convex end.

Sternites: S1-S21 with complete paramedian sutures. S21 with a small paramedian suture, tapering posteriorly with a concave end (Fig. e).

***Coxopleural process*:** Short coxopleuron with number of pores 51. Pores with varying sizes and wide gap separating each pores, 2 apical spines, small finger like poreless area (Fig. e).

***Walking legs*:** First Walking leg with 1 small tarsal spur and claw spur. Walking legs 1- 20 without tarsal spur and 1 claw spur only.

***Ultimate leg*:** thickened and short, almost sickle shaped. Dorsally prefemur and femur flattened with lateral thickening and a groove in prefemur (Fig. f). Prefemur with two ventro median + 3 ventro median+ 2 ventro lateral spines. Claw with two claw spurs.

Distribution: India: Kerala.

Material examined:

01 ex. Amar shola, Vaguvarai, Idukki District, Kerala, India. Coll.K G Emiliyamma. 22/ix/2014. (ZSI/WGRC/I-R/INV-3937). 01 ex. Amar shola, Vaguvarai, Idukki District, Kerala, India. Coll.K G Emiliyamma. 24/ix/2014. (ZSI/WGRC/I-R/INV-4015); 05 ex. Erachippara shola, Idukki District, Kerala, India. Coll.K G Emiliyamma. 23/ix/2014. (ZSI/WGRC/I-R/INV-3934). 01 ex Idalimotta, Mannavan shola, Idukki District, Kerala, India. Coll.P M Sureshan. 25/v/2014. (ZSI/WGRC/ I-R/INV-4040). 01 ex. Methap, Mannavan shola, Idukki District, Kerala, India. Coll. P M Sureshan.

24/v/2014. (ZSI/WGRC/ I-R/INV-4041). 01 ex. Mannavan shola, Idukki District, Kerala, India. Coll.Dhanya Balan. 4/vi/2012. (ZSI/WGRC/ I-R/INV-2342).

Habitat: The species was found inside small tree trunks, it probably chooses wooden tunnels as its habitat (Fig. a). The entire collection localities in the present study were typical shola forests.

Remarks: *D.periyarensis* is very paculiar among the other Indian *Digitipes*, exclusively identified by the total absence of tarsal spurs, the long paramedian sutures on the sternites, and by the robust ultimate legs with dorsal grove on prefemur, femur and tibia of the ultimate legs.

***Digitipes chhotanii* Jangi and Dass, 1984**

(Plate: 26)

Digitipes chhotanii, Jangi and Dass, 1984: 41.

Digitipes chhotanii, Khanna, 2001: 210.

Digitipes chhotanii, Sureshan *et al*., 2006a: 2287.

Type Locality: India: Suranganer Reserve Forest, Tamilnadu

Diagnosis:

Antennae composed of 17 antennal articles, 2.5 basal antennal segments glabrous. Lateral margination from T7. Coxopleural process short, tipped with very small 2 spines.

Description: Body length 45mm to 53mm.

***Head capsule*:** Antennae composed of 17 articles, the basal 2.5 articles more or less glabrous, rest densely pilose. Cephalic plate punctate, posess bifurcated median furrow, but it absent in some specimens.

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; the outer two fused and separated from the inner. Median prefemoral process dentate with 3 or 4 teeth (Fig. b).

Tergites: Tergites punctate. T7-T20 with paramedian sutures. T21 without any sulcus, with angular posterior margin. Lateral margination from T7.

***Sternite*s:** punctate, anterior paramedian sutures complete on S2 to S20. S21 with longitudinal median groove (Fig. d).

Coxopleuron: Coxopleural process with moderate pores and poreless strip at apex. It posess two diminutive apical spines and no lateral spine.

***Walking legs*:** 1-20 with two claw spur**.** Femoral, tibial and tarsal spur absent on 1**.** 20 with a single tarsal spur.

***Ultimate leg*:** Prefemur with 2 ventromedial spines and 3 ventrolateral spines.

Distribution: India: Kerala, Maharashtra and Tamilnadu.

Material examined: No material was collected during present study. Diagnosis based on already identified/reported specimens by Sureshan *et al*., (2006).
2 ex. Thakarappady, Kozhikode District, Kerala, India. Coll. K. N Nair & Party. 15/x/1991. (ZSI/WGRC/I-R/113). 1 ex. Amakulam, Kollam District, Kerala, India. Coll. P. M Sureshan. 02/ii/1995. (ZSI/WGRC/I-R/7453). 1 ex. Kottiyoor, Kannur District, Kerala, India. Coll. P. M Sureshan. 16/viii/1997. (ZSI/WGRC/I-R/10464). 1 ex. Amakulam, Kollam District, Kerala, India. Coll. P. M Sureshan. 16/viii/1997. (ZSI/WGRC/I-R/10464).

Habitat: The species was collected from forest areas.

Remarks: Jangi and Dass (1984) gave the presense of posteriorly bifurcated anterior median furrow on the cephalic plate as an important character for type material. But it lacks or indistinct in some of the specimens studied.

***Digitipes pruthii* Jangi and Dass, 1984**

Digitipes pruthii Jangi and Dass. 1984: 41.
Digitipes pruthii. Joshi and Edgecombe. 2013: 118.
Type Locality: India: Nagalaur, Shevaroy Hills, Salem (Tamil Nadu).

Diagnosis: Antennae composed of 17 antennal articles, three basal antennal segments glabrous. Lateral margination from T2-T21. Coxopleural process tipped with very small 2 spines.

Description: Body length 51mm to 62mm.

***Color*:** Cephalic plate, tergites dark to pale green. Articles reddish, walking legs blue.

***Head capsule*:** Antennae composed of 17 articles; tapering distally, extending up to T4, the basal three articles glabrous. Cephalic plate moderately punctate, notched anteriorly, posess bifurcated median furrow.

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; the outer two fused and separated from the inner. Median prefemoral process dentate with 3 or 4 teeth.

Tergites: T1 and T2 smooth without any sutures. T3-T20 with paramedian sutures. T21 without any sulcus. Lateral margination from T2-T21.

***Sternite*s:** smooth; anterior paramedian sutures complete on S6 to S20. S21 posterior end slightly concave.

Coxopleuron: Coxopleural process with prominent pores and poreless strip at apex. It posess two diminutive apical spines and no lateral spine.

***Walking legs*:** 1-20 with two claw spur**.** 1-4 with two tarsal spur and 2 claw spur.

***Ultimate leg*:** Prefemur with 2 rows of 2 ventromedial spines.

Distribution: India: Tamil Nadu, Kerala.

Material examined:

1 ex. Kodanad Elephant Kral, Ernakulam District, Kerala, India. Coll.Harish K C. 23/x/2010. (ZSI/WGRC/I-R/INV-2212). 1 ex. Narayamkulam, Kozhikode District ,Kerala, India. Coll.Umesh P K. 19/iii/2011. (ZSI/WGRC/I-R/INV-4039). 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll.Dhanya Balan. 19/iii/2013. (ZSI/WGRC/I-R/INV-2193). 1 ex. Pandimotta, Shenduruni Wildlife Sanctuary, Kollam District, Kerala, India. Coll.Umesh P K. 03/x/2012. (ZSI/WGRC/I-R/INV-2212). 1 ex. Kallippara, Thattekad, Ernakulam District, Kerala, India. Coll. P.M Sureshan 22/iv/2015. (ZSI/WGRC/I-R/INV-4481)

Habitat: The species was majorly collected from loose soil.

Remarks: Joshi and Edgecombe (2013) provisionally accept the identity of *D.pruthii*. Even though one of the specific character i.e., 'presence of short median groove bifurcating posteriorly on cephalic plate', lacks the specimens studied in present study shares all the other vital characters with the original description of type specimens by Jangi and Dass (1984).

***Digitipes barnabasi* Jangi and Dass, 1984**

(Plate: 27)

Digitipes barnabasi Jangi and Dass, 1984: 44.

Digitipes barnabasi, Sureshan *et al.,* 2006a: 2287.

Digitipes barnabasi, Joshi and Edgecombe, 2013: 102.

Type Locality: India: Ahmednagar (Maharashtra)

Diagnosis: Antennae composed of 17-18 antennal articles, two basal antennal segments glabrous, flat median ridge from T3 or T5-T20. Continuous longitudinal tuberculate keels from T6 or T9. Coxopleural process short, tipped with 2 small spines and one lateral spine, porous area extending closely to the dorsal margin.

Description: Body length 51mm to 65mm.

***Color*:** Cephalic plate and T1 dark to reddish brown. Rest tergites chestnut brown. Walking legs pale brown with a bluish tinge (Fig. b).

***Head capsule*:** Antennae composed of 17 articles; tapering distally extending up to T5-T6, the basal two (2.25 in some specimens) articles glabrous. Cephalic plate moderately punctate notched anteriorly and with an anterior longitudinal median furrow (Fig. a).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; the inner two sometimes fused and separated from the outer. Prominent dental setae present. Median prefemoral process dentate with 3 or 4 teeth (Fig. c). Second maxillary claw bears a slender accessory spur.

Tergites: T1 and T4 smooth without any sutures. T5-T20 punctate; with complete paramedian sutures. T21 without any sulcus. Lateral margination from T5-T21, a few individuals with strong ridges from T5 onwards. Continuous longitudinal

tuberculate keels from T6 or T9 (Fig. d).

***Sternites*:** Punctate; anterior paramedian sutures complete on S2 to S20. S21 posterior end slightly concave and lateral margins almost straight (Fig. e).

Coxopleuron: Coxopleural process with prominent pores, porous area nearly reaching dorsal margin of coxopleuron and poreless strip at apex. It posess two diminutive apical spines and one lateral spine (Fig. g).

***Walking legs*:** 1 with 1 tibial and femoral spur**.**1-4 and 14-15 with two tarsal spur**.** 14-15 to 20 with one tarsal spur. A pair of claw spurs in all walking legs (Fig. g).

***Ultimate leg*:** Prefemur with 2 ventro medial spines, 2 or 3 ventro lateral and 0 or 1 dorso medial spines (Fig. h).

Distribution: India: Maharashtra, Kerala.

Material examined:

01 ex. Rajamalai, Eravikulam NP, Idukki District, Kerala, India. Coll.P M Sureshan . 4/ix/2012. (ZSI/WGRC/I-R/INV-2223). 01 ex. Kappalamud, Kottayam District, Kerala, India. Coll. Dhanya Balan. 10/vii/2011. (ZSI/WGRC/I-R/INV-2212). 01 ex. Kolombo, Thattekad, Ernakulam District, India. Coll. Jaffer Palott. 27/xi/2014. (ZSI/WGRC/I-R/INV-4485). 02 ex. Thoppimud, Thattekd District, Kerala, India. Coll.P M Sureshan. 26/xi/2014. (ZSI/WGRC/I-R/INV-4490). 01 ex. Chittariparamb, Kannur District, Kerala, India. Coll. Dhanya balan. 24/x/2011. (ZSI/WGRC/I-R/INV-2379). 03 ex. Forest IB Marayur, Idukki District, Kerala, India. Coll. P M Sureshan. 9/vii/2013. (ZSI/WGRC/I-R/INV-3537). 01 ex. Forest IB Mukkali, Palakkad District, Kerala, India. Coll. Dhanya Balan. 22/iii/2012. (ZSI/WGRC/I-R/INV-2210). 01 ex. Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll. Dhanya Balan. 07/v/2012. (ZSI/WGRC/I-R/INV-2359). 01 ex. Kannavam RF, Kannur District, Kerala, India. Coll. Dhanya Balan. 23/ii/2011. (ZSI/WGRC/I-R/INV-2379). 01 ex. Karadippara, Athirapilly, Thrissur District, Kerala, India. Coll. P M Sureshan. 28/ii/2013. 01 ex. (ZSI/WGRC/I-R/INV-2516). 01 ex. Kartikulam coffee plantation, Wayanad District, Kerala, India. Coll. Suvina. 09/ix/2013. (ZSI/WGRC/I-R/INV-3565). 02 ex. Kodanad, Mallam RF, Ernakulam District, India. Coll. P M Sureshan. 14/iii/2014. (ZSI/WGRC/I-R/INV-3524). 01 ex. Maruthome, Kasargod District, Kerala, India. Coll. Rajmohana. 1/x/2013. (ZSI/WGRC/I-R/INV-3528). 01

ex. Nadukani, Nilambur, Malappuram District, Kerala, India. Coll. Rajmohana. 29/xii/2011. (ZSI/WGRC/I-R/INV-2516). 01 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll. Umesh. 20/ix/2012. (ZSI/WGRC/ I-R/INV-2052). 01 ex. Narayamkulam, Kozhikode District, Kerala,India. Coll. Dhanya. 21/ii/2011. (ZSI/WGRC/ I-R/INV-3952). 01 ex. Palamuk, Wayanad District, Kerala, India. Coll. Suvina. 31/x/2013. (ZSI/WGRC/I-R/INV-3550). 02 ex. Palamuk, Wayanad District, Kerala, India. Coll. Suvina. 31/x/2013. (ZSI/WGRC/I-R/INV-3560). 01 ex. Palamuk site 2, Wayanad District, Kerala, India. Coll. Suvina. 31/x/2013. (ZSI/WGRC/I-R/INV-4013). 01 ex. Pandimotta, Shenduruni Wildlife Sanctuary, Kollam District, Kerala, India. Coll. P M Sureshan. 17/x/2012. (ZSI/WGRC/I-R/INV-2380). 01 ex. Panthamthodu, Silent Valley NP, Palakakd District, Kerala, India. Coll. Umesh. 22/ii/2013. (ZSI/WGRC/ I-R/INV-2211). 01 ex. Parippthodu, Kottiyur RF, Kannur District, Kerala, India. Coll. P M Sureshan. 13/x/2011. (ZSI/WGRC/ I-R/INV-2144). 01 ex. Peppara, Trivandrum District, Kerala, India. Coll. Dhanya. 13/x/2012. (ZSI/WGRC/I-R/INV-2372). 01 ex. Thekkady, Anjuruli, Idukki District, Kerala, India. Coll. P M Sureshan. 04/ix/2013. (ZSI/WGRC/I-R/INV-3508). 01 ex. Thirunelli, Wayanad District, Kerala, India. Coll. Suvina. 25/ix/2013. (ZSI/WGRC/I-R/INV-3544). 01 ex. Thirunelli, Wayanad District, Kerala, India. Coll. Suvina. 25/ix/2013. (ZSI/WGRC/I-R/INV-3552). 01 ex. Thirunelli, Wayanad District, Kerala, India. Coll. Suvina. 10/ii/2013. (ZSI/WGRC/I-R/INV-3564). 01 ex. Thirunelli, Wayanad District, Kerala, India. Coll. Suvina. 25/ix/2013. (ZSI/WGRC/I-R/INV-4017). 01 ex. Thirunelli, Wayanad District, Kerala, India. Coll. Suvina. 25/ix/2013. (ZSI/WGRC/I-R/INV-3548). 01 ex. Urakkuzhi, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll.Dinesh K P. 2/i/2011. (ZSI/WGRC/ I-R/INV-1911). 01 ex. Urakkuzhi site 1, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll.Umesh. 25/ii/2011. (ZSI/WGRC/ I-R/INV-2194). 01 ex. Urakkuzhi site 1, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll.Dhanya. 27/viii/2012. (ZSI/WGRC/ I-R/INV-2284). 01 ex. Urakkuzhi site 1, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll.Dhanya. 1/iii/2012. (ZSI/WGRC/I-R/INV-2184). 01 ex. Urakkuzhi site 1, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll.Umesh. 19/iii/2012. (ZSI/WGRC/ I-R/INV-2259). 01 ex. Urulanthanni, Thattekad, Ernakulam District, Kerala, India. Coll.P M Sureshan. 22/v/2015. (ZSI/WGRC/ I-R/INV-4476). 01 ex. Narayamkulam, Kozhikode

District, Kerala, India. Coll.Umesh. 21/ii/2011. (ZSI/WGRC/ I-R/INV-3952). 01 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll.Umesh. 20/ix/2011. (ZSI/ WGRC/ I-R/INV-2352). 01 ex. Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll.Dhanya. 16/xi/2011. (ZSI/WGRC/ I-R/INV-2375). 01 ex. Koottikal, Ernakulam District, Kerala, India. Coll.P M Sureshan. 22/v/2015. (ZSI/WGRC/ I-R/INV-4484).

Habitat: Generally collected from loose soil, decaying wood, tree trunk, leaf litter and beneath stone.

Remarks: It's a most common forest species collected throughout the forest tracks, and from agro forest area. Joshi and Edgecombe (2013) reported it as one of the most widely distributed species of *Digitipes* across Western Ghats. The distribution map of *D. barnabasi* (Map. 5) based on collection localities of the present study supported the same.

***Digitipes pseudobarnabasi* sp.nov.**

(Plate: 28)

Diagnosis: Antennae with 18-22 articles. Tergite paramedian suture from T16-T20. T21 with a posterior median depression. Lateral margination in T7 onwards. Coxopleuron with 1 apical spine.

Description of Holotype*:* Body length 61 mm.

***Colour*:** Cephalic plate and T1 and T2 yellowish brown, others shining black. Walking legs blue (Fig. a).

***Head capsule*:** Antennae with 21 articles on left side and 18 (damaged) on right, 2.5 glabrous dorsally and ventrally; rest with dense hairs both dorsally and ventrally. Cephalic plate smooth (Fig. b).

***Tergites*:** Tergites carinated and with small anterior and posterior suture on T5 & T6; complete paramedian suture from T6- T20 (Fig. d). T21 with moderately convex lateral margin that converge posteriorly; angular posterior margin and a clear posterior median depression (Fig. e). Lateral margination present from T7. T21 as long as wide.

***Sternites*:** Sternites punctate. S21 tapers posteriorly and with curved posterior margin (Fig. f).

***Forcipular coxosternum*:** with four teeth in one side; two almost fused medial teeth and two larger lateral teeth; one prominent dental spur. Trochanteroprefemoral process with four small teeth along inner margin (Fig. g).

Coxopleuron: Coxopleuron with highly dense pores, porous area nearly reaching dorsal margin of coxopleuron; poreless strip at apex. Coxopleural process moderately long with 2 apical spines (Fig. h).

***Walking legs*:** 1-4 with 1 tibial, 1 tarsal and 2 claw spur. Rest with 2 tarsal and 1 claw spur (Fig. i, j).

Ultimate legs: with 2 ventro median, 2 ventro lateral spines (Fig. k).

Additional information from Paratypes: Coxopleural process moderately long with 2 apical spines and one very small lateral spine.

Etymology*:* The name of the species derives from species *"D.barnabasi"* having more affinity with the new species.

Material examined:

Holotype: Urakkuzhy site 1, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India; Coll. Dhanya Balan. .21/v/2011. (ZSI/WGRC/IR/INV-1911).

Paratypes: 1 ex. Kakkayam damsite, Urakkuzhy, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India; Coll. Dhanya Balan. .03/i/2012. (ZSI/WGRC/IR/INV-2184). 1 ex. Malakkappara, Vazhachal, Thrissur District, Kerala, India; Coll. P. M Sureshan. 27/ii/2013. (ZSI/WGRC/IR/INV-4474).

Habitat:

The species is generally found under stone or from leaf litter. The type locality was moist-deciduous forest.

Remarks:

Digitipes pseudobarnabasi sp.nov. shares common characters with *D.barnabasi,* in the number of teeth in the forcipular coxosternum (4+4), number of teeth in

prefemoral process, number of spines in ultimate leg prefeur and coxoplural porous area nearly reaching dorsal margin of coxopleuron. But it conspicuously different from *D.barnabasi* in characters like number of antennal articles (18-22), presence of median depression in T21 and presence of paramedian sutures from T16-T20.

***Digitipes jonesii* (Verhoeff, 1938)**

(Plate: 29)

*Arthrorhabdus (Trachycormocephalus) jonesii***,** Verhoeff. 1938: 384.

Digitipes indicus, Jangi and Dass, 1984**:** 46-47.

Digitipes indicus, Sureshan *et al*., 2006a: 2287.

Digitipes jonesii, Joshi and Edgecombe. 2013: 108.

Type Locality: India: Ponmudi, Trivandrum, Kerala

Diagnosis: Antennae composed of 17-18 antennal articles, three basal antennal segments glabrous dorsally, complete paramedian sutures from T6-T8, ridges absent. Coxopleural process with one lateral spine. Walking leg 20 with a tarsal spur.

Description: Body length 51mm to 58mm.

***Color*:** Cephalic plate blue to olive green, Tergites dark brown or bluish with dark patches. Articles light blue in basic and purplish distally.

***Head capsule*:** Antennae composed of 17 articles; tapering distally extending up to T5-T6, the basal three articles glabrous dorsally. Cephalic plate punctate; notched anteriorly and with a longitudinal median furrow (Fig. a).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; the inner two separated from the outermost ones; outer two smaller than inner. Prominent dental setae present. Median prefemoral process dentate with two or three teeth (Fig. b). Second maxillary claw bears a slender accessory spur.

Tergites: T1 –T6 punctate without any sutures. T6 and T7-T20 punctate; with complete paramedian sutures (Fig.c). T21 without any sulcus; convex lateral margin converging posteriorly (Fig. d). Lateral margination from T7-T21.

***Sternites*:** punctate; anterior paramedian sutures complete on S8 to S20. S21 posterior end slightly concave and lateral margins almost straight (Fig. e).

***Coxopleural process*:** short, with dense pores; porous area away from the dorsal

margin. with two apical spines and one lateral spine which lacks in some specimen (Fig. f).

***Walking legs*:** 1 with 1 tibial and femoral spur.1-4 to 14-15 with two tarsal spur. 14-15 to 20 with one tarsal spur.

***Ultimate leg*:** Prefemur with 2 or 3 ventro medial spines, 2 or 3 ventro lateral and 0 or 1 dorsomedial. Femur posess elongated finger like posteriomedial process in male specimen (Fig. g- Reg No: ZSI/WGRC/I-R/INV- 2189)

Distribution: India: Kerala.

Material examined:

1 ex. Urulanthanni, Thattekad, Ernakulam 01 ex. Koottikal, Ernakulam District, Kerala, India. Coll.P M Sureshan. 22/v/2015. (ZSI/WGRC/ I-R/INV-4484). 1 ex. Kolumba, Thattekad, Ernakulam District, Kerala, India. Coll. K Rajmohana. 04/iii/2013. (ZSI/WGRC/I-R/INV-3532). 1 ex. Pamba, Mellathodu, Pathanamthitta District, Kerala, India. Coll.P M Sureshan. 21/ii/1997. (ZSI/WGRC/I-R/INV-3951). 1 ex. Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll. Dhanya Balan. 27/vii/2012 (ZSI/WGRC/I-R/INV-2286). 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll. P. K Umesh. 06/i/2012 (ZSI/WGRC/I-R/INV-2377). 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll. Dhanya Balan. 31/v/2011 (ZSI/WGRC/I-R/INV-2378). 1 ex. Nilamboor, New Amarambalam, Malappuram District, Kerala, India. Coll. Rajmohana K. 28/xii/2011 (ZSI/WGRC/I-R/INV-2186). 1 ex. Nilamboor, Nadukani, Malappuram District, Kerala, India. Coll. Rajmohana K. 29/xii/2011 (ZSI/WGRC/I-R/INV-2189). 1 ex. Karadippara, Shenduruni Wildlife Sanctuary, Kollam District, Kerala, India. Coll. Dhanya Balan. 16/x/2012 (ZSI/WGRC/I-R/INV-2373). 2 ex. Ponmudi, Trivandrum District, Kerala, India. Coll. Dhanya Balan. 15/x/2012 (ZSI/WGRC/I-R/INV-3953).

Habitat: Generally observed under leaf litter and stones.

Remarks:

Lewis (2010a), after comparing the original description of *Arthrorhabdus jonesii* Verhoeff, 1938, described from the Ponmudi Hills, Kerala with *Otostigmus ceylonicus*

Hasse 1887 opined that *Arthrorhabdus jonesii* could be a misplaced *Otostigmus*. Jangi and Dass (1984) and Sureshan *et al*., (2003, 2006a) did not include any new material of this species. But a new species *D.indicus* was described by Jangi and Dass (1984) from the collections from Forest Tramway, Palakkad. In a recent study, Joshi and Edgecombe (2013) synonomised *D.indicus* as *D.jonesii* comparing the molecular and morphometric analysis majorly focusing collections from type locality of *Arthrorhabdus (Trachycormocephalus) jonesii. A.jonesii,* which is solely reported from Ponmudi by Verhoeff (1938) is also removed from Indian Checklist, concluding that it can be a misidentification. The material examined here also included those from the same type locality and it shares similar characters with the original description of *D.indicus* by Jangi and Dass (1984). Hitherto specimens check listed as *D.indicus* (Sureshan *et al*., 2006a) and material collected and studied during the study were placed under *D.jonesii.*

***Digitipes coonoorensis* Jangi and Dass, 1984**

(Plate: 30)

Digitipes coonoorensis Jangi and Dass, 1984: 43.

Digitipes coonoorensis, Sureshan *et al.,* 2006a: *2287*

Digitipes coonoorensis, Joshi and Edgecombe, 2013: 105.

Type Locality: India: 6 Kms North of Railway Station, Coonoor, Nilgiri (Tamil Nadu).

Diagnosis: Antennae composed of 17 antennal articles, two basal antennal segments glabrous. Coxopleural porous area away from dorsal margin, outer margin convex. Coxopleural process tipped with one apical and one lateral spine. Walking leg 20 lacks tarsal spur.

Description: Body length 51mm to 83 mm.

Color: Cephalic plate, basal articles and T1 blue, T2 onwards dark to pale brown, sometimes reverting to blue colour in posterior most tergites (Fig. a, b).

***Head capsule*:** Antennae composed of 17 articles; tapering distally extending up to T3-T4, the basal three articles glabrous. Cephalic plate moderately punctate notched

anteriorly.

Forcipular coxosternum: Each coxosternal tooth plate with 3/4+4 teeth; the outer two fused and separated from the inner (Fig. c). Median prefemoral process dentate with 3-4 teeth.

Tergites: T1 - T6 smooth without any sutures. T6-T20 with complete paramedian sutures. T21 without any sulcus. Lateral margination from T2-T21.

Sternites**:** smooth; anteriorly confined paramedian sutures complete on S2 to S20. S21 posterior end slightly concave and laterally convex (Fig. f).

Coxopleuron**:** Coxopleural process with moderately dense pores, porous area away from dorsal margin, outer margin convex. It posess two apical spines and one lateral spine (Fig. d).

Walking legs**:** 1-20 with two claw spur 1 with tibial spur**.** 1-3 with two tarsal spur and 20 and 21 without tarsal spur (Fig. e).

Ultimate leg**:** Prefemur with 3 ventrolateral. 2 ventromedial and a single dorsomedial spine (Fig. g)

Distribution: India: Tamil Nadu, Kerala and Maharashtra.

Material examined:

01 ex. Amar shola, Vaguvarai, Idukki District, Kerala, India. Coll.K G Emiliyamma. 22/ix/2014. (ZSI/WGRC/I-R/INV-3936); 01 ex. Amar shola, Vaguvarai, Idukki District, Kerala, India. Coll. K G Emiliyamma. 24/ix/2014. (ZSI/WGRC/I-R/INV-4016); 04 ex. Ananirathy, Neyar, Trivandrum District, Kerala, India. Coll.Dhanya Balan. 12/x/2012. (ZSI/WGRC/I-R/INV-2374); 01 ex. Aralam Wildlife Sanctuary, Kannur District, Kerala, India. Coll.Harish K C. 13/ii/2011. (ZSI/WGRC/I-R/INV-3954); 01 ex. Chinna Anamudi, Idukki District, Kerala, India. Coll. K G Emiliyamma. 22/ix/2014. (ZSI/WGRC/I-R/INV-3939); 01 ex. Gavi, Pathanamthitta District, Kerala, India. Coll.Rajmohana. 04/x/2013. (ZSI/WGRC/I-R/INV-3507); 01 ex. Kambilippara shola, Idukki District, Kerala, India. Coll.P M Sureshan. 23/ix/2014. (ZSI/WGRC/I-R/INV-3535); 08. ex Erachippara shola, Idukki District, Kerala, India. Coll.K G Emiliyamma. 23/ix/2014. (ZSI/WGRC/I-R/INV-3957); 01 ex. Kattikulam Coffee Planatation, Wayanad District, Kerala, India. Coll.Suvina. 09/ix/2013. (ZSI/WGRC/I-R/INV-3551). 01 ex. Ladysmith RF, Maraiyathodu, Wayanad District,

Kerala, India. Coll.K G Emiliyamma. 06/iv/2014. (ZSI/WGRC/I-R/INV-3523). 01 ex. Malakkappra, Athirappilly, Thrissur District, Kerala, India. Coll.P M Sureshan. 27/ii/2013. (ZSI/WGRC/I-R/INV-3551). 01 ex. Kazhuthuruthy, Thenmala, Kollam District, Kerala, India. Coll.P M Sureshan. 08/ix/1997. (ZSI/WGRC/10462). 01 ex. Mandeknol, Kasargod District, Kerala, India. Coll.Rajmohana. 01/iii/2013. (ZSI/ WGRC/ I-R/INV-2510). 01 ex. Mannavan shola, Idukki District, Kerala, India. Coll.P M Sureshan. 04/vi/2012. (ZSI/WGRC/ I-R/INV-2231). 01 ex. Mannavan shola, Idukki District, Kerala, India. Coll.P M Sureshan. 04/vi/2012 . (ZSI/WGRC/ I-R/INV-2243). 01 ex. Mannavan shola, Idukki District, Kerala, India. Coll.P M Sureshan. 04/vi/2012. (ZSI/WGRC/ I-R/INV-2257). 01 ex. Methap, Mannavan shola, Idukki District, Kerala, India. Coll.P M Sureshan. 04/vi/2012. (ZSI/WGRC/ I-R/ INV-2222). 12 ex. Nagamala shola, Marayur, Idukki District, Kerala, India. Coll.P M Sureshan. 04/vi/2012. (ZSI/WGRC/ I-R/INV-3521). 01 ex. Orukomban, Vazhachal, Ernakulam District, Kerala, India. Coll.P M Sureshan. 26/ii/2013. (ZSI/WGRC/ I-R/INV-2519). 01 ex. Peppara, Trivandrum District, Kerala, India. Coll.Dhanya. 13/x/2012. (ZSI/WGRC/ I-R/INV-2370). 01 ex. Pettimudi, Eravikulam NP, Idukki District, Kerala, India. Coll.K G Emiliyamma. 19/ix/2014. (ZSI/WGRC/ I-R/INV-3935). 03 ex. Pullardishola, Idukki District, Kerala, India. Coll.K G Emiliyamma. 27/v/2014. (ZSI/WGRC/ I-R/INV-3539). 01 ex. Rosemala, Kollam District, Kerala, India. Coll.K G Emiliyamma. 19/ix/2014. (ZSI/WGRC/ I-R/INV-2381). 01 ex. Thirunelli, Wayanad District, Kerala, India. Coll.Suvina. 11/vi/2013. (ZSI/WGRC/ I-R/INV-3553). 01 ex. Urakkuzhi site 1, Malabar WILDLIFE SANCTUARY, Kerala, India. Coll.K G Emiliyamma. 19/ix/2014. (ZSI/WGRC/ I-R/INV-2360). 02 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll.Dhanya. 31/v/2011. (ZSI/ WGRC/ I-R/INV-2369). 02 ex. Manalar, Thekkady, Idukki District, Kerala, India. Coll.Dhanya. 31/v/2011. (ZSI/WGRC/ I-R/INV-3511). 01 ex. Karakkamedu, Silent Valley NP, Palakakd District, Kerala, India.. Coll. P M Sureshan. 21/ii/2013. (ZSI/ WGRC/ I-R/INV-2515). 03 ex. Poochippara, Silent Valley NP, Palakakd District, Kerala, India. Coll. P M Sureshan. 21/ii/2013. (ZSI/WGRC/ I-R/INV-2513).

Habitat: Generally observed in loose soil, under stone and decaying wood.

Remarks: The species is a common forest dweller, occasionally collected from

plains too. Notable by the absence of tarsal spur on walking leg 20. Jangi and Dass (1984) used it as a taxonomic key character, allowing *D. coonoorensis* (tarsal spur absent) to be distinguished from *D. barnabasi* and *D. indicus* (tarsal spur present). The same character was accepted by Joshi and Edgecombe (2013) as a distinguishing character for the species.

5.6.10. Genus *Ethmostigmus* Pocock, 1898

Heterostoma Newport, 1844a: 275.

Ethmostigmus Pocock, 1898: 327.

Type Species: *Scolopendra trigonopodus* Leach, 1817 by subsequent designation *Ethmostigmus trigonopodus* (Leach) by Attems, 1930: 174.

Diagnosis: Body length 33-160 mm. Forcipules lacking trochanteroprefemoral processes. Leg-bearing segment 7 with spiracles.

Distribution: Indo-Australian and Ethiopian region.

5.6.11. Key to the species of *Ethmostigmus* in Kerala

1. Antennae composed of 2 glabrous basic articles…..
   .....***E. coonooranus*** **Chamberlin.**
   -Antennae composed of 4 glabrous basic articles (Plate 31: b).....
   ..... ***E. rubripes platycephalus*** **(Newport)**

Ethmostigmus coonooranus **Chamberlin, 1920**

Ethmostigmus coonooranus Chamberlin. 1920a: 392**.**

Ethmostigmus coonooranus, Attems. 1930: 178.

Ethmostigmus coonooranus, Khanna. 2008:20.

Ethmostigmus coonooranus, Sureshan *et al*., 2006a: 2287.

Type Locality: India: Coonoor (Tamil Nadu).

Diagnosis: antennae composed of 20 antennnomers; 2 basal glabrous, coxopleural process with 1 apical and 1 lateral spines.

Description: Body length 42mm.

***Colour*:** after preservation: The specimens have pale yellow colour on cephalic plate, tergites and ultimate legs.

***Head capsule*:** Antennae composed of 20 articles; tapering distally, basal 2 articles glabrous. Head capsule curved in anterior end and with almost straight lateral edges. Cephalic plate smooth with a small median notch in anterior part.

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; the inner ones are larger in size. Post dental spur present. Median prefemoral process non-dentate.

Tergites: T1 smooth without any sutures. Paramedian sutures complete on T2-T20. Lateral margination of tergites from T5 to T21. T21 with straight lateral margin and angular posterior end; no sutures.

***Sternites*:** Smooth; crescent shaped paramedian sutures complete on S1 to S19. S20-21 without sutures.

***Coxopleural process*:** tubular with small but distinct pores and poreless strip at apex. It posess one apical spine and one lateral spine.

Walking legs: most of the legs lost, or separated. Walking leg 1 with 1 tarsal spur, 1 claw spur, 1 tibial spur and 1 femoral spur. Walking legs 11-20 with 1 claw spur and 1 tarsal spur.

***Ultimate leg*:** lost in the specimen.

Distribution: India: Tamil Nadu, Kerala.

Material Examined: Description based on specimens included in Kerala checklist by Sureshan *et al*.,(2006a) details given below.

1 ex. Kaduvapallam, Kollam District, Kerala, India. Coll.P. M Sureshan. 01/viii/2007. (Reg No:10463).

Habitat: Not mentioned.

***Ethmostigmus rubripes platycephalus* (Newport, 1845)**

(Plate: 31)

Heterostoma platycephalus platycephalus Newport: 1845.415.

Ethmostigmus platycephalus, Kraepelin. 1903:162.

Ethmostigmus platycephalus platycephalus, Attems. 1930: 181.

Ethmostigmus platycephalus platycephalus, Sureshan *et al*., 2004: 1402.

Ethmostigmus rubripes platycephalus (Newport). By synonomy Schileyko and Stagl. 2004:117-119.

Type locality: Oceano Pacific islands

Diagnosis: Four basal antennal segments glabrous, ultimate leg prefemur with three ventro lateral spines. Coxopleural process tipped with 2-4 spines and bearing dorsally 0-1 spine.

Description: Body length 91mm to 139mm.

***Color*:** Cephalic plate dark to yellowish brown, tergites dark to pale brown, T21 reddish brown, Ultimate legs brick red color, walking legs pale yellowish. Articles greyish (Fig. a).

***Head Capsule*:** Antennal articles 20 (in one specimen 13-20 fused), the basal four glabrous dorsally and three ventrally. Small seta which covers more distal articles (starting from 5th onwards) are arranged in longitudinal parallel rows. Antennae when refluxed reach up to T4. Cephalic plate nearly parallel sided, punctate with an anterior median groove (Fig.b).

***Forcipular coxosternum*:** with 3+3 dentition (Fig.c, d). The inner and outer ones are smaller. (In some specimens outer most teeth of left side appears to be 4 may because of incomplete fusion)

Tergites: Complete paramedian suture from T 3 to T20.T1 with very short posterior paramedian sutures .Complete lateral margination from T3 -T21. Incomplete lateral margination on T6. Dark transverse bands in the posterior edge may be due to prolonged preservation.

Sternites: Paramedian sulci poorly developed as short anterior rudiments from S1-S20. Fine depressions at posterior edge of S2-S7. Bisinuation on the posterior margin on S21 (Fig. e).

***Coxopleuron*:** Longer pointed apically (but not sharp in some specimens) and moderately arcuate dorsally. Coxopleuron process has 2 apical spines and 1 lateral spine. (Fig. f). (In one specimen 2 lateral spines observed: one prominent and 1 small; in one specimen 1 sub apical spine observed). Poreless strip on ventral surface narrowed anteriorly. No dorsal spine observed (1 small dorsal spine in one specimen).
***Walking legs*:** Walking leg 1 with one prefemoral, one femoral, one tibial, 2 tarsal and 2 claw spur. Walking leg 2 with tarsal and 2 claw spur. Walking legs 3 to 20 with 1 tarsal spur and 2 claw spur.
***Ultimate legs*:** Prefemoral spines moderately long (Fig. g). Prefemur apex with 1 posterio-median corner spine, and with 2 dorsolateral, 2 ventrolateral, 2 or more ventromedial spines.

Distribution: India: Kerala, Maharashtra; New Guinea, New Pommern, Yorkland, Solomon Island, Tahiti, Ternate, New Britain, Mollucas, Java (Oriental, Palaearctic and Ethiopian).

Material examined: 06 exs. Manakavala, Periyar Tiger Reserve, Idukki District,Kerala, India. Kerala.India. Coll.PM.Sureshan**.** (RegNo: 9455). 01 ex. Kakkayam, Kozhikode District, Kerala, India. Coll.Dhanya Balan. 13/iii/2012. (ZSI/WGRC/I-R/INV-3946). 01 ex. Kakkayam, Kozhikode District, Kerala, India. Coll. Rajmohana. 07/ii/2013. (ZSI/WGRC/I-R/INV-3531). 01 ex.Wayanad District, Kerala, India. Coll.Syamlal. 01/v/2011. 01 ex. Ladysmith Reserve Forest, Wayanad District, Kerala, India. Coll.K G Emiliyamma. 06/iv/2014. (ZSI/WGRC/I-R/INV-3522); 01 ex.Rosemala, Kollam District, Kerala, India. Coll.K G Emiliyamma. 06/iv/2014. (ZSI/WGRC/I-R/INV-2389); 01 ex. Sairandri, Silent Valley NP, Palakkad District, Kerala, India. Coll.P M Sureshan. 06/iv/2014. (ZSI/WGRC/I-R/INV-2517).

Habitat:
This robust species were generally observed under stones, tree barks, and leaf litter in the interior forest areas of moist deciduous forest patches.

Remarks:
Sureshan *et al*., (2004, 2006a) included *E.platycephalus platycephalus* in Kerala

checklist. Khanna (2008) included the same species in national register of Scolopendromorpha in India. But, Schileyko and Stagl (2004) compared the specimens of *E. rubripes* (Brandt, 1840) with *E.platycephalus* (Newport, 1845) and synonomised *E.platycephalus platycephalus* as *E. rubripes platycephalus*. Hitherto *E.platycephalus platycephalus* in Kerala checklist is replaced by *E. rubripes platycephalus*. Characters of antennal articles, forcipular coxosternum, tergites and ultimate leg spinulation show similarity to the description of *Ethmostigmus rubripes* by Koch (1983) and Schilekyo and Stagl (2004). But, the complete absence of dorsal spines in coxopleural process, fine sulcus at posterior edge of S2-S7, absence of complete median sulcus in S21 and number of spurs in walking leg 3 in the studied specimens shown clear variations from their description. Variation from the original description of *E.rubripes platycephalus* is in the absence of semilunar anterior sulcus on T1 which is absent in the studied specimens.

5.6.12. Genus *Rhysida* Wood, 1862

Rhysida, Wood. 1862**:** 40

Rhysida, Attems. 1930: 183.

Type Species: *Rhysida lithobioides* (Newport)

Diagnosis: Forcipules with prominent trochanteroprefemoral processes. Leg-bearing segment 7 with spiracles.

Distribution: Indo-Australian, Indo-Malayan, Ethiopian, Palaearctic and Neotropical.

About 40 species worldwide.

5.6.13. Key to the species of *Rhysida* in Kerala

1. Ultimate leg prefemur without any spinulation dorsally and ventrally (Plate: 32. g)……..... ***Rhysida aspinosus* sp.nov**
   - Ultimate leg prefemur with prominent spinulation ventrally/ dorsally or both ….....2
2. Ultimate leg segments with clear banding dorsally and ventrally (Plate: 33. c, f) ..... ***R. laetus* sp.nov**.
   -Ultimate leg segments with any such banding dorsally and ventrally.....

.....3

3. Tergites preceding ultimate leg segment ordinarily not marginate laterally and if at all hardly a couple of them involved and that too incompletely and weakly (Plate: 34. b)..... ***R.immarginata immarginata*** **(Porat)**
   - Tergites preceding ultimate leg segment ordinarily not marginate laterally and most of them involved..... 4
4. Ultimate leg prefemur with posteriomedial spiny process.....
   .....***R.longipes longipes*** **(Newport)**
   - Ultimate leg prefemur without posteriomedial spiny process.....
   …….***R.longipes simplicior*** **Chamberlin**
5. Most of the sternites with anteriorly confined suture. Coxopleural process tipped with one to three spines.....**6**
   - Most of the sternites without anteriorly confined suture. Coxopleural process tipped with three spines and one or two prominent lateral spine (Plate: 36. g)....
   .....***R. shenduruniensis*** **sp.nov.**
6. S21 clearly tapering posteriorly. Coxopleural process tipped with three spines (Plate: 37. d)..... ***R.lithobiodes trispinosus*** **Jangi and Dass**
   -S21 clearly tapering posteriorly. Coxopleural process tipped with one or two spines (Plate: 37. i)..... ***R.lithobiodes paucidens*** **Jangi and Dass**

Rhysida aspinosus **sp.nov**

(Plate: 32)

Diagnosis*:* Antennae with 19/21 articles. T5-T19 with paramedian suture. Lateral margination in T21 only. No spinulation in ultimate prefemur.

Description of Holotype: Body length 69 mm.

Colour**:** after preservation in 2% formaldehyde: cephalic plate and tergites shining brown. Walking legs bluish with tarsus yellowish. T21 reddish.

Spiracle: Shape of spiracle oval without any irregular folding in spiracular opening. Antennae with 21 articles, 2 glabrous dorsally, rest with dense hairs both dorsally and ventrally.

Cephalic plate: moderately punctate (Fig. b), with length 1.03× its width.

Tergites: moderately punctate and with complete paramedian suture from T5- T19.

T21 smooth without any suture, with moderately convex lateral margin that converge posteriorly (Fig. c). Lateral margination present only in T21. T21 as long as wide.

Sternites: with small anterior and posterior suture from S5-S20. S21 with concave posterior margin tapering posteriorly.

Forcipular coxosternum: with 4+5 dentition (Fig. a); Trochanteroprefemoral process with three not distinctly defined teeth along inner margin.

Coxopleuron: with moderately dense pores. Coxopleural process small with 2 apical spine, 1 slightly recurved and without any lateral spine (Fig. d).

Walking legs: Walking legs up to 5 with one tibial spur, 2 tarsal spurs and 2 pretarsal spurs. Rest with 2 tarsal spurs and 2 pretarsal spurs (Fig. e).

Ultimate legs: smooth without any dorsal, ventral spines and any prefemoral process (Fig f). Length of tarsus 1 is 1.8× than tarsus 2.

Additional information from Paratypes*:* Body length varies in between 66-64 mm. Specimen from Kolumba, Thattekad (ZSI/WGRC/IR/INV-5282) has forcipular coxosternum with 4+4 dentition. Walking legs up to 6 with one tibial spur. Antennomere 19+17 in ZSI/WGRC/IR/INV-5282 may due to damage.

Etymology: The name of the species derives from the characteristic absence of spines on ultimate leg prefemur.

Material examined:

Holotype: 1 ex. Urulanthanni, Thattekad, Ernakulam District, Kerala, India; Coll. Rajmohana and Party, 03/iv/2013.(ZSI/WGRC/IR/INV-5281)

Paratypes: **2 exs.** Kolumba, Thattekad, Ernakulam District, Kerala, India; Coll. Rajmohana and Party. 04/iii/2013. (ZSI/WGRC/IR/INV-5282).

Habitat: Not known.

Remarks: The specimens were mostly collected from typical moist deciduous forest patches of Thattekad Bird sanctuary of Southern western Ghats. It is unique in character by the total absence of spines on ultimate leg.

***Rhysida laetus* sp.nov.**

(Plate: 33)

Diagnosis*:* T4-T20 with complete paramedian suture. S21 with a median suture. Coxopleuron process small with 2 apical spines. Ultimate leg segments with alternate banding pattern. Spiracle oval and absent in 7th segment.

Description of Holotype*:* Body length 65 mm.

***Colour*:** after preservation in 70% Ethyl alcohol: cephalic plate and tergites with black pigmentation. Ultimate leg femur, tibia, tarsal segments with black pigmentation in proximal end (Fig. c, f). Coxopleuron reddish orange.

Spiracle: Shape of spiracle oval, absent on 7th segment (Fig.b).

Head capsule: Antennae with 19 articles on left (right damaged), 2 glabrous dorsally.

Cephalic plate: punctate with a distinct median notch anteriorly (Fig. e), cephalic plate length 0.98× its width.

Tergites: moderately punctate and with clear pigmentation. Tergite paramedian sutures complete from T4- T20; paramedian suture incomplete in T3. T21 smooth without any suture; with distinctly triangular posterior margin (Fig. c). Lateral margination present only in T21. T21 length 0.80× its width.

Sternites: moderately punctate; with paramedian suture from S5- S20. S21 with bisinuated posterior margin tapering posteriorly (Fig.d).

Forcipular coxosternum: with 4+3 dentition, inner two fused and separated from the outer. Trochanteroprefemoral process with 2 or 3 almost fused teeth along inner margin (Fig.e).

Coxopleuron: with dense pores and with a narrow poreless strip (Fig.d). Coxopleural process laterally bulging, elongated with two small apical spines, and without any lateral spine (Fig.d).

Ultimate legs: with 3 ventro median, 3 ventro lateral spines and 2 dorsolateral spines; 2 claw spurs present (Fig.f). Length of tarsus 1, 1.2× than tarsus 2. Most of the walking legs lost or damaged.

Etymology: The name of the species derives from the Latin word “laetus” means “beautiful” denoting the appearance of specimen.

Material examined:

Holotype: 1 ex. Mlappara, Periyar Wildlife Sanctuary, Idukki District, Kerala, India. Coll. P M Sureshan. 08/2012. (ZSI/WGRC/ 9475).

Habitat:

The type locality is moist deciduous forest.

Remarks*:*

This species is unique in character by the presence of pigmentation on tergites, and banding pattern of coloration, especially on femur, tibia, tarsus 1 and 2. The shape of spiracle is oval but lacks in segment 7 which is a typical character for *Rhysida*. No other reported Indian species of *Rhysida* posess such pigmentation in ultimate legs.

***Rhysida immarginata immarginata* (Porat, 1876)**

(Plate: 34)

Branchiostoma immarginatum, Porat. 1876: 24.

Rhysida nuda immarginata, Attems, 1926: 190.

Rhysida immarginata immarginata, Koch. 1985: 205-214.

Rhysida nuda immarginata, Khanna. 1997a:469.

Rhysida immarginata immarginata, Khanna. 2008: 40.

Type Locality: Manila, Philippines.

Diagnosis: Antennae composed of 3 glabrous basic articles. Coxopleural process with 2 apical spines and lacks lateral spines. T4-T7 with broken anterior and posterior suture. T7-T20 with complete paramedian suture, margination only on T21.

Description: Body length 32-97mm.

Colour: in life*:* The species observed in various colour patterns ranging from pale brown to grape brown in tergites; antennae grape coloured; Cephalic plate, S21, T21, walking legs and ultimate legs orange –reddish to orange (Fig. a); after preservation in 70% ethyl alcohol: Cephalic plate, walking legs and ultimate legs dull orange.

***Head capsule*:** Spiracles oval (Fig. b). Antennae composed of 20 articles; tapering distally, the basal three articles glabrous; extended up to T5 (Fig. c). Cephalic plate

moderately punctate and notched anteriorly.

Forcipular coxosternum: Each coxosternal tooth plate with 4/3 or 4/4 teeth; the outer two fused and separated from the inner. Median prefemoral process dentate with 3 or 4 teeth (Fig.d). 1 prominent dental spur.

Tergites: T1 – T3 smooth without any sutures. T4-T7 with broken anterior and posterior suture. T7-T20 with complete paramedian suture. Margination only on T21.

Sternites**:** Sternite smooth**.** S1 to S19 with very short posterior paramedian suture. S21 gradually narrowing in posterior end with concave posterior margin.

Coxopleural process**:** with moderate pores and poreless strip at apex, posess two apical spines and no lateral spines (Fig. e).

Walking legs**:** 1-2 with 1 tibial, 2 tarsal and 2 claw spur. Rest with 1 tarsal and 2 claw spur.

Ultimate legs**:** Prefemur with 2 ventromedial spine and 2 ventro lateral spines (Fig. f).

Distribution: India: Assam, Andaman & Nicobar Islands, Delhi, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan, Uttaranchal, Uttar Pradesh, Kerala (Present study) and West Bengal. Cosmopolitan in distribution. West Africa, Myanmar, Philippines, Venenzuela, Guatemala (Oriental and Palaearctic).

Material Examined: 2 exs. Thumboormuzhy Farm, Thrissur District, Kerala, India. Coll. Dhanya. 25/xii/2012. (ZSI/WGRC/I-R/INV-4034, 4492). 1 ex. Shendurini Wildlife Sanctuary, Kollam District, Kerala. India. Coll. K N Nair & Party. 16/vii/1981. (ZSI/WGRC/I-R/INV- 3541). 1 ex. Shendurini Wildlife Sanctuary, Kollam District, Kerala. India. Coll. P M Sureshan. 22/v/2014. (ZSI/WGRC/I-R/INV- 3955). 1 ex. Urakuzhy, Kakkayam Wildlife Sanctuary, Kozhikode District, Kerala. India. Coll. Dhanya. 27/vii/2012. (ZSI/WGRC/I-R/INV- 2276). 1 ex. Kottoli, Kozhikode District, Kerala. India. Coll. P M Sureshan. 20/x/2014. (ZSI/WGRC/I-R/INV- 3938). 1 ex. Quilandy, Kozhikode District, Kerala. India. Coll. K N Nair & Party. 07/viii/1982. (ZSI/WGRC/I-R/INV: 2199). 1 ex. Nallalam, Kozhikode District, Kerala. India. Coll. Aswathi. 01/xi/2014. (ZSI/WGRC/I-R/INV-4014). 1 ex. Narayamkulam, Kozhikode District, Kerala. India. Coll. P M Sureshan & Party. 25/ii/2011. (ZSI/WGRC/I-R/INV- 4032). 1 ex. Narayamkulam, Kozhikode

District, Kerala. India. Coll. Mani. 23/vi/2011. (ZSI/WGRC/I-R/INV-4030). 1 ex, Kuttothparambu, Kozhikode District, Kerala. India. Coll. Dhanya. 30/v/2011. (ZSI/WGRC/I-R/INV- 4023). 7 exs. Mannanthara, Kollam District, Kerala. India. Coll. Rajmohana. 17/i/2014. (ZSI/WGRC/I-R/INV- 4018). 1 ex, Mararikulam Beach Resort, Alappuzha District, Kerala. India. Coll. Dhanya Balan. 29/viii/2014. (ZSI/WGRC/I-R/INV- 4013). 1 ex, Madaippara, Kannur District, Kerala. India. Coll. Dhanya. 10/vii/2011. (Reg No: 4025). 7 exs, Puralimala, Trivandrum District, Kerala. India. Coll. Dhanya Balan. 11/x/2012. (ZSI/WGRC/I-R/INV- 2388). 1 ex, Paripputhodu, Kottiyur RF, Kannur District, India. Coll. Dhanya. 13/x/2012. (ZSI/WGRC/I-R/INV-2143). 1 ex, Kummanior, Konni, Pathanamthitta District, Kerala. India. Coll. P M Sureshan. 27/ii/1997. (ZSI/WGRC/I-R/INV-2203). 1 ex, Palamuk, Wayanad District, Kerala. India. Coll. Suvina. 05/x/2013. (ZSI/WGRC/I-R/INV-3549). 1 ex, Kootikkal, Thattekad, Ernakulam District, Kerala. India. Coll. P M Sureshan. 28/xi/2014. (ZSI/WGRC/I-R/INV- 4492). 1 ex, Vyasappara, Chinnar, Idukki District, Kerala, India. Coll. P M Sureshan. 05/0iii/2012. (ZSI/WGRC/I-R/INV-2278).

Habitat:

The species were generally collected from beneath stones, doormats, decaying wood, leaf litter, tree branches. This is a common Scolopendrid species recorded from forest areas as well as residential areas. But it is notable that even though collected from forest areas most of the collection localities are not interior forest areas.

Remarks:

This species is widely distributed throughout India including Himalayan, Central, Northern and Deccan area. It is observed in different colour patterns of orange to red in ultimate legs and cephalic plate. Lewis (2006b) opined that only Australian species are referable to *R.nuda*. Hitherto, the specimens of *R.nuda* included in Kerala checklist by Sureshan *et al*., (2006a) is replaced as *R.immarginata.*

***Rhysida longipes longipes* (Newport, 1845)**

(Plate: 34)

Branchiostoma longipes Newport. 1845**:** 411.

Rhysida longipes, Attems. 1930: 194.

Rhysida longipes longipes, Sureshan *et al.,* 2006a: 2288.

Rhysida longipes longipes, Khanna*,* 2008*:*40.

Type Locality: Not known.

Diagnosis: Antennae long extended up to T4, composed of 17-18 articles, three basal articles glabrous, 4th onwards with numerous setae present dorsally, dense in 4, 5, 6. Coxopleural process tipped with one lateral spines and tipped with 2/3 spines.

Description: Body length 43mm to 65mm.

***Color*:** Cephalic plate, tergites pale green, greenish black to brownish (Fig. g). Antennal articles yellowish, walking legs bluish green with pale yellow basal segment. T21 and ultimate legs orange.

***Head capsule*:** Antennae composed of 17/18 articles; basal 3 glabrous, rest covered with dense setae. Cephalic plate moderately punctate, with anterior suture and median sulci.

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; incompletely fused, outer 1 separated from inner 3. 1 dental spurs each. Median prefemoral process dentate with 3 or 4 teeth (Fig. h)

Tergites: T1 and T2 smooth without any sutures. T3-T20 with paramedian sutures. T21 with a clear median sulcus. Lateral margination from T6/T8-T21.

Sternites: smooth; anterior paramedian sutures complete on S7 to S20. S21 smooth with bisinuate posterior end (Fig. i).

***Coxopleural process*:** long with dense pores, posess one or two apical spines and one lateral spine (Fig. i).

***Walking legs*:** 1-12 with two tarsal spur**,** 12-18 with one tarsal spur, 20 with or without tarsal spur. (Fig. j).

***Ultimate leg*:** Prefemur with 3 dorsal spines, 3 ventro medial spines and 3 ventro lateral spines. No paramedian process (Fig. k).

Distribution: India: Arunachal Pradesh, Delhi, Madhya Pradesh, Uttar Pradesh, Uttaranchal, Goa, Karnataka, Kerala, Maharashtra, West Bengal, Andaman & Nicobar Islands; Australia, East and West Africa, Madagascar, Seychelles, Mexico, Central and South America (Oriental, Indo-Australian, Palaearctic, Ethiopian, Nearctic and Neotropical).

Material examined:

1 ex. Chevayur, Kozhikode District, Kerala, India. Coll.Radhakrishnan.C. 20/iii/2011. (ZSI/WGRC/I-R/INV-4019). 1 ex. Kadalundi, Kozhikode District, Kerala, India. Coll. Emiliyamma. 14/i/2011. (ZSI/WGRC/I-R/INV-4026). 1 ex. Kakkayam, Kozhikode District, Kerala, India. Coll.Sandeep Das. 27/i/2011. (ZSI/WGRC/I-R/INV-4035). 1 ex. Kuttothparambu, Kozhikode District, Kerala, India. Coll.Dhanya Balan. 30/v/2011. (ZSI/WGRC/I-R/INV-4022). 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll.Madhavan. 07/ii/2011. (ZSI/WGRC/I-R/INV-4031). 1 ex. Chittariparambu, Kannur District, Kerala, India. Coll.Dhanya Balan. 24/ii/2011. (ZSI/WGRC/I-R/INV-4027). 2 ex. Kattilappara, Kollam District, Kerala, India. Coll.Dhanya Balan. 30/v/2011. (ZSI/WGRC/I-R/INV-4036). 1 ex. Udayamperoor, Ernakulam District, Kerala, India. Coll.Dhanya Balan. 05/ii/2010. (ZSI/WGRC/I-R/INV-4028). 1 ex. Kodanadu Elephant Kral, Ernakulam District, Kerala, India. Coll. Dhanya Balan. 23/x/2010. (ZSI/WGRC/I-R/INV-4038). 1 ex. Machad, Thrissur District, Kerala, India. Coll.K N Nair & Party. 07/x/1995. (ZSI/WGRC/I-R/INV-2200).

Habitat: *R.longipes* is generally observed in residential areas and plains. General habitats include loose soil, tree shades, beneath stones, decayed wood, termited logs, clothes and doormats, decayed coconut, outer barks of coconut tree and plantain.

Remarks:

It's the common house dwelling centipede species distributed throughout tropics**.**

***Rhysida longipes simplicior* Chamberlin, 1920**

(Plate: 35)

Rhysida simplicior Chamberlin, 1920a: 39.

Rhysida longipes simplicior, Attems, 1930: 194.

Rhysida longipes longipes, Khanna, 2008*:* 40.

Type Locality: India: Coonoor (Tamil Nadu).

Diagnosis: Antennae long, extended up to T4, composed of 17 antennal articles, three basal antennal articles glabrous, 9th onwards a median groove present dorsally. Coxopleural process tipped with one small lateral spine and tipped with 4 spines.

Description: Body length 12mm to 46mm.

***Color*:** after preservation in 70% ethyl alcohol**:** Cephalic plate, tergites pale green to orange. T1& T20 orange red. Antennal articles yellowish, walking legs bluish green. Ultimate leg greyish yellow.

***Head capsule*:** Antennae composed of 17 or 18 articles; basal 3 glabrous, rest covered with dense hairs. 9th onwards a median groove. Cephalic plate moderately punctate, elongate with posterior suture (Fig. a).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth; Median prefemoral process dentate with 3 or 4 teeth (Fig.b).

Tergites: T1 and T2 smooth without any sutures. T3-T20 with paramedian sutures. T21 smooth, without any sulcus or with a small median suture (Fig.c). Lateral margination from T2-T21.

***Sternites*:** moderately punctate; anterior paramedian sutures complete on S6 to S20. Inverted "v" shaped suture from S9 onwards. S21 smooth with posterior end angular (Fig. d).

Coxopleuron: with numerous small pores and poreless narrow median strip. Coxopleural process posess four apical spines and one lateral spine.

***Walking legs*:** 1-20 with two claw spurs**.** 1-4 with two tarsal spur and 2 claw spurs. (Fig.e).

***Ultimate leg*:** Prefemur with 6 ventromedial spines and 2 ventrolateral spines. No paramedian process (Fig. f).

Distribution: India: Delhi, Tamil Nadu and Uttaranchal and Kerala (New record to Kerala).

Material examined:

3 exs. (1 adult+ 3 sub adults). Chittoor, Palakkad District, Kerala, India. Coll.Harish K.C. 10/viii/2011. (ZSI/WGRC/I-R/INV-2443). 1 ex. Mandekol, Kasargod District, Kerala, India. Coll.K. Rajmohana. 01/iii/2013. (ZSI/WGRC/I-R/INV-2512).

Habitat:

Generally sampled from loose soil and areas surrounding trees from residential areas.

Remarks:

This is one of the rare species recorded. It is an Indian endemic species. The collection localities are notable by their position bordering Tamil Nadu (where type locality (Koonoor) is situated) and Karnataka state. The subadults collected from Chittoor, Palakkad are with coxopleural process not well developed and minute apical spines. All the other characters were similar to the adult.

***Rhysida shenduruniensis* sp.nov.**

(Plate: 36)

Diagnosis*:* Antennae with 18 articles. T7-T20 with paramedian suture. Lateral margination in T21 only. Coxopleuron process with 3 apical or one or two lateral spines.

Description of Holotype*:* Body length 71 mm.

Colour: before and after preservation in 2% formaldehyde: Cephalic plate and T21 reddish. Tergites brown. Coxopleuron reddish orange (Fig. b).

Spiracle: Shape of spiracle oval (Fig. c).

Head capsule: Antennae with 18 articles, 3 glabrous dorsally; rest with dense hairs both dorsally and ventrally. Antennae extended up to T5.

Cephalic plate: smooth without any sutures (Fig. a). Cephalic plate length 0.95× its width.

Tergites**:** moderately punctate and with complete paramedian suture from T7- T20. T21 smooth without any suture; with distinctly angular lateral margin (Fig. d). Lateral margination present only in T21. T21 width 0.86× its width (Fig. f).

Sternites: smooth; without any suture. S21 with bisinuated posterior margin tapering posteriorly.

Forcipular coxosternum: with 4+4 dentition (Fig. d), inner two separated from the outer. Trochanteroprefemoral process with four distinctly defined teeth along inner margin.

Coxopleuron*:* with dense pores and with poreless strip. Coxopleural process laterally bulging; elongated with 2 apical spine, and with one lateral spine (Fig. g).

Walking legs: up to 4 with 2 tarsal spur and 2 pretarsal spur. Rest with 1 tarsal spur

and 2 pretarsal spurs (Fig. h and i).

Ultimate leg: with 3 ventro median and 6 ventro lateral spines (Fig. j). Length of tarsus 1, 1.8× than tarsus 2.

Additional information from Paratypes:

Body length varies in between 68-72 mm. Coxopleuron process (ZSI/WGRC/IR/INV-5284) with one apical spine and two lateral spines.

Etymology: The name of the species derives from the type locality "Shenduruni Wildlife Sanctuary".

Material examined:

Holotype: 1 ex. Pandimotta, Shenduruni, Kollam District, Kerala, India, Coll. P M Sureshan, 17/x/2012. (ZSI/WGRC/IR/INV-5283).

Paratypes: 2 ex. Pandimotta, Shenduruni, Kollam District, Kerala, India, Coll. P M Sureshan, 04/iii/2013. (ZSI/WGRC/IR/INV-5284).

Habitat:

Collected beneath stones and decayed bark.

Remarks:

The present collection mostly represents sampling from typical forest patches of Shenduruni Wildlife Sanctuary of Southern Western Ghats. It is unique in character by the presence of elongated coxopleuron process with 1-2 lateral spines. The shape of spiracle (fig. b) is typically similar to genus *Ethmostigmus*, so this robust species may be confused with *Ethmostigmus*. But it is clearly distinct from *Ethmostigmus* due to the presence of well defined four numbers of teeth in trochanteroprefemoral process.

***Rhysida lithobiodes trispinosus* Jangi and Dass, 1984**

(Plate: 37)

*Rhysida lithobioides trispinosus***,** Jangi and Dass, 1984: 48

Rhysida lithobioides trispinosus, Sureshan *et al.,* 2006a*:* 2288.

Rhysida lithobioides trispinosus, Khanna*,* 2008: 40.

Type Locality: Hill behind Film Institute Pune, Maharashtra.

Diagnosis: Antennae long, extended up to T4, composed of 21 antennal articles, three basal antennal articles glabrous, rest covered with minute setae. Coxopleural process small, tipped with three prominent spines.

Description: Body length 49mm- 62mm.

***Color*:** after preservation in 70% alcohol: Cephalic plate, tergites pale green to orange. T1& T20 orange red. Antennal articles yellowish, walking legs bluish green. Ultimate leg greyish yellow.

***Head capsule*:** Antennae composed of 17 or 18 articles; basal 3 glabrous, rest covered with dense hairs. 9th onwards a median groove. Cephalic plate smooth, punctate and with a short median suture (Fig. a).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth, one post-dental spur. Median prefemoral process dentate with 4 teeth (Fig. b).

Tergites: T1 and T2 punctate, without any sutures. T3 with an incomplete paramedian sutures. T4-T20 with complete paramedian sutures. T21 smooth, without any sulcus (Fig.c). Lateral margination from T13.

***Sternites*:** moderately punctate; anterior paramedian sutures complete on S6 to S20. Inverted "v" shaped suture from S9 onwards. S21 smooth with posterior end angular.

Coxopleural process: small, with numerous small pores and poreless narrow median strip. It posess three prominent apical spines (Fig. d). Lateral spines absent.

***Walking legs*:** Walking leg 1 with a femoral and tibial spur**.** 1-18 with two tarsal spurs**,** 19-20 with one tarsal spur. 1-20 with two claw spurs.

***Ultimate leg*:** Prefemur with 1 ventromedial spine and 2 ventrolateral spines. No paramedian process. (Fig. e).

Distribution: Kerala, Tamil Nadu and Maharashtra.

Material examined:

1 ex. Udayamperoor, Ernakulam District, Kerala, India. Coll.Dhanya Balan. 05/ ii/2012. (ZSI/WGRC/I-R/INV-4012). 2 exs. Thoppimudu, Thattekad, Ernakulam

District, Kerala, India. Coll.P M Sureshan. 26/xi/2014. (ZSI/WGRC/I-R/INV-4689).1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll.Dhanya Balan. 20/ix/2012. (ZSI/WGRC/I-R/INV-2353). 2 exs. Kanjerumpizha, Palakkad District, Kerala, India. Coll.P M Sureshan. 02/iii/1999. (ZSI/WGRC/I-R/INV-2198).

Habitat: Generally collected from loose soil and under tree shades in residential as well as forest areas.

Remarks:

This is one of the rare species recorded. It is endemic to Deccan plateau. Collected both from the forest areas as well as from the residential areas.

***Rhysida lithobiodes paucidens,* Pocock, 1897**

(Plate: 37)

*Rhysida paucidens***,** Pocock. 1897.403.

Rhysida lithobioides paucidens, Attems. 1930: 188.

Rhysida lithobioides paucidens, Sureshan *et al.*, 2006a: 2288.

Rhysida lithobioides paucidens, Khanna. 2008: 40.

Type Locality: India: Pondicherry.

Diagnosis: Antennae composed of 19-20 articles. Each coxosternal tooth plate with 4+4 teeth. Median prefemoral process dentate with 4 teeth. Tergites almost smooth. T4-T20 with complete paramedian sutures. T21 smooth, without any sulcus Coxopleural process with 2 apical spines and without lateral spines.

Description:

***Color*:** after preservation, cephalic plate, tergites pale green. T1& T20 greenish. Antennal articles yellowish. Walking legs and ultimate leg greyish yellow.

***Head capsule*:** Antennae composed of 19-20 articles; basal 3 glabrous, rest covered with dense hairs. Cephalic plate sparsely punctate and with a short median suture (Fig. f).

Forcipular coxosternum: Each coxosternal tooth plate with 4+4 teeth, one post-dental spur. Median prefemoral process dentate with 4 teeth (Fig. g).

Tergites: Tergites almost smooth. T4-T20 with complete paramedian sutures. T21 smooth, without any sulcus (Fig. h). Lateral margination from T13.

***Sternites*:** finely punctate; anterior paramedian sutures complete on S6 to S20. S21 rectangular, incurved posteriorly with a median suture (Fig. i).

Coxopleuron: Coxopleural process small with three prominent apical spines and no lateral spines (Fig. i).

***Walking legs*:** 1-18 with two tarsal spurs**.**

***Ultimate leg*:** Prefemur with 1 dorsomedial, 1 ventromedial and 1 ventrolateral spines in distal half . No paramedian process (Fig. j).

Distribution: India: Pondicherry: Tamil Nadu; Somalia (Oriental Region).

Remarks: No material was collected during present study. Diagnosis based on already identified/reported specimen (1 ex. Kottavasal, Aryankavu, Kollam District, India. Coll.P M Sureshan. 15/viii/1997. (ZSI/WGRC/10678).

5.7. Family: Cryptopidae Attems, 1930

Cryptopsii, Kohlrausch, 1881: 53.

Cryptopidae Attems, 1930: 200.

Subfamily: Cryptopinae Verhoeff, 1906

Cryptopidae Verhoeff, 1906**:** 432.

Cryptopinae Attems, 1926: 375.

5.7.1 Genus *Cryptops* Leach, 1814

Cryptops Leach. 1814: 384.

Type Species: *Cryptops hortensis*, Leach

5.7.2. Key to the *Cryptops* species of Kerala

1. Sternites, at least on some anterior segments with trigonal sutures. Ultimate leg femur with saw teeth. .....……2

   -Sternites without trigonal sutures. Ultimate leg femur without saw teeth. (Plate: 38: e)……***C.(C). malabarensis* Dhanya *et al*.,**

2. One distal tubercle on ultimate leg tibia(Plate: 39: f)…..
.....***C.(T) sholavasi* sp.nov.**
-One distal tubercle each on ultimate leg tibia and tarsus 1 (Plate: 40: f, j).....
…… .....***C.(T) lewisi* sp.nov.**

Cryptops (Cryptops) malabarensis Dhanya, Sureshan and Khanna, 2012
(Plate: 38)

Diagnosis: A species of *Cryptops* lacking anterior transverse suture on T1; tergite paramedian sutures from T4 or T5-T20; absence of saw teeth on the ultimate femur (C. *hortensis* group); ultimate leg tibia with 4-7 saw teeth on the tibia and 3-4 on tarsus 1; no accessory spurs associated with the tarsal claw.

Description of Holotype: Body length 23mm.

***Colour*:** before and after preservation in 100% ethyl alcohol: greyish brown with dark subcutaneous pigmentation on tergites (Fig a). Ultimate legs yellow.
Antennae: composed of 17 articles; basal two articles relatively stout. The basal article has long setae distally. An irregular whorl of long setae on the proximal end of articles 1-3, the rest with setae scattered irregularly, not in whorls but the dorsal middle region is not densely covered. Short, fine setae abundant from 6th article onwards (Fig .b).
Cephalic plate: cephalic plate and T1 without sutures, T1 overlying the posterior edge of the cephalic plate (Fig. c).
Forcipular coxosternite: Anterior edge of forcipular coxosternite weakly bilobed (Fig. d) and with four long and one small setae on each side.
Tergites: paramedian sutures from T4 or T5-20. T21 without any sutures and with slightly angular posterior margin.
Sternites: with longitudinal and transverse sulci, longitudinal sulci longer than the transverse. S21 with sides converging very slightly and straight posterior margin.
Coxopleuron: with 9 large pores and with at least 3 minute setae in pore field; 3 or 4 fine setae on posterior margin and up to 5 setae between this and pore field (Fig. g). Posterior area of coxopleuron poreless.

Walking legs: Legs 1-19 with undivided tarsi. No accessory spurs associated with the tarsal claw (Fig. h). Walking leg 20 with dense fine setae ventrally on prefemur, femur and tibia in all specimens.

Ultimate legs: with strong setae on anterior, ventral and posterior surfaces of prefemur and on ventral and posterior surfaces of femur. Median longitudinal glabrous area absent. No Distal tubercle on tibia and tarsus. No saw teeth on the femur (Fig. e); seven saw teeth on the tibia and three on the tarsus1 (Fig. f).

Additional information from Paratypes:

Body length of paratypes varies between 11-21mm. Antennae of left side damaged in ZSI/WGRC/I-R/INV-2079. When compared to the holotype, the number of saw teeth on the ultimate leg tibia varies from four (ZSI/WGRC/I-R/INV-2079), five (ZSI/WGRC/I-R/INV-2080) or six (ZSI/WGRC/I-R/INV-2108, 2109) and on tarsus 1 the variation is either three (ZSI/WGRC/I-R/INV-2080, 2108, 2109) or four (ZSI/WGRC/I-R/INV-2079) saw teeth. The number of coxopleural pores are not clearly countable.

Etymology: The species is named after the type locality- "Malabar Wildlife Sanctuary", Kerala, India.

Material examined:

Holotype: 1 ex. Urakkuzhy, Kakkayam, Kozhikode District, Malabar Wildlife Sanctuary, Kozhikode Dist, Kerala, India. Coll. Dhanya Balan. 01/viii/2011. (ZSI/WGRC/I-R/INV-2111).

Paratypes: 3exs. From type locality. Coll. Dhanya Balan, 29/viii/2011. (ZSI/WGRC/I-R/INV 2080, 2108, 2109); 2 exs, Narayamkulam, Kozhikode District, Kerala, India. Coll.Umesh P.K. 01/iv/2011. (ZSI/WGRC/I-R/INV-2079).

Habitat: The specimens were collected from moist deciduous forest tracts of Southern Western Ghats. All specimens were found in loose soil, about 4-5cm below the surface.

Remarks: The description of *C malabarensis* was made as the first report of Family

Cryptopidae and Genus *Cryptops* from Kerala and Southern Western Ghats. Like the families Plutoniumidae and Scolopocryptopidae and the order Geophilomorpha, the family Cryptopidae includes blind centipedes, lacking ocelli. *Cryptops* Leach, 1815, is the largest genus of the family Cryptopidae, with 153 named species worldwide (Lewis, 2002), in four subgenera i.e., *C.(Cryptops)* Leach, 1815; *C.(Chromatonops)* Verhoeff, 1906; *C.(Haplocryptops)* Verhoeff, 1934 and *C.(Trigonocryptops)* Verhoeff, 1906 (Bonato *et al*., 2011). The smaller size and fragile body, coupled with an abundance of species names often based on inadequate samples and with imprecise descriptions, make cryptopid centipedes a taxonomically difficult group and only seven species in two genera have so far been described from India. The Indian species of *Cryptops* are *Cryptops (C.) feae* Pocock, 1891, *Cryptops (C.) doriae* Pocock, 1891, *Cryptops (C.) kempi* Silvestri, 1924, *Cryptops (C.) setosior* Chamberlin, 1959 and *Cryptops* (*Trigonocryptops*) *orientalis* Jangi, 1955 and *C. (C.) malabarensis* Dhanya *et al*., 2012 (Khanna, 2005, 2008, Dhanya *et al*.,2012).

C.malabarensis is conspicuously different from the other described Indian species of *Cryptops* included in the *C.doriae* group (with saw teeth on the ultimate leg femur) and falls in the old world *C.hortensis* group of Lewis (2011a) (those lacking saw teeth on the ultimate leg femur), which have not yet been reported from India. *C.malabarensis* sp.nov closely resembles *C.decoratus* Lawrence (1960) including in the old world *C.hortensis* group. The two species share the absence of sutures on the cephalic plate and T1; anterior margin of coxosternite almost straight, an overlapping number of Coxopleuron pores (7-9), a similar number of setae in the pore field (at least 3) and ultimate leg characters such as prefemur with long fine setae dorsally, absence of median longitudinal glabrous area, tibia with four and tarsus 1 with two saw teeth. However the new species differs from the holotype description of *C.decoratus*, in with no median ridges on the tergites, no posterior median depression on T21 and the absence of accessory spurs on the pretarsi. *C.decoratus* Lawrence is a Malagasy species closely related to *C.melanotypus* Chamberlin, 1941 from the Philippines, Mauritius and the Seychelles but Lewis (2011a) was unsure of their exact status. However, the strong similarity between the new species and *C.decoratus* and *C.melanotypus* suggests dispersal of a group of closely allied species over a wide area.

***Cryptops (Trigonogonocryptops) sholavasi* sp.nov.**

(Plate: 39)

Diagnosis: A species of *Cryptops* with complete paramedian sulci on cephalic plate; tergite paramedian sutures from T17 or 18; presense of 1 median saw teeth on the ultimate leg femur; 6-8 saw teeth on the ultimate leg tibia and 2-3 saw teeth on ultimate leg tarsus 1.

Description of Holotype: Body length 29mm.

Colour: before and after preservation in 100% ethyl alcohol: ochre. Ultimate legs yellow.

Antennae: composed of 17 antennal articles; basal three articles relatively stout. The basal article has long setae distally. An irregular whorl of long setae on the proximal end of articles 1-7, prominently in 1-4; the rest with setae scattered irregularly, not in whorls. Short, fine setae abundant from 7th article onwards (Fig. a).

Cephalic plate: cephalic plate with complete paramedian sulci, T1 not overlying the posterior edge of the cephalic plate (Fig. b).

Forcipular coxosternite: Anterior edge of forcipular coxosternite slightly convex and with 4 long and 2 small clypeus setae on each side.

Tergites: tergite paramedian sutures from T18 (Fig. c). T21 with a clear posteromedian sulci (Fig. d).

Sternites: with trigonal suture; not prominent. S21 with sides converging very slightly and straight posterior margin (Fig. h).

Coxopleuron: with 37 large pores and with at least 6 long setae in pore field; 2 fine stout setae. Posterior area of coxopleuron poreless (Fig. h).

Walking legs: 1-19 with divided tarsi (Fig. e). No accessory spurs associated with the tarsal claw. Leg 20 with fine setae ventrally and laterally on prefemur, femur and tibia in all specimens.

Ultimate legs: with strong setae on anterior and ventral surfaces of prefemur and femur. One distal tubercle on tibia. 1 median saw teeth on femur, eight median saw tooth on the tibia and two proximal on the tarsus1 (Fig. f, g).

Additional information from Paratypes:

Body length of paratypes varies between 11-21mm. When compared to the holotype,

the number of saw teeth on the ultimate leg tibia varies from 6-8 (Fig. i).

Etymology:

The species is named after the typical collection localities in "shola" forests. In Malayalam language "sholavasi=one who resides in shola".

Material examined:

Holotype: 1ex. Mathikettan Shola NP, Idukki District, Kerala, India. Coll. Dhanya Balan,10/iv/2012. (ZSI/WGRC/I-R/INV-5285).

Paratype: 1 ex. Erachippara Shola, Eravikulam NP, Idukki District, Kerala, India. Coll. Dhanya Balan, 20/v/2014. (ZSI/WGRC/I-R/INV-5286).

Habitat: The specimens were collected from moist deciduous forest tracts of Southern Western Ghats. All specimens were found in loose soil, about 4-5cm below the surface.

Remarks: *C. (T) sholavasi* sp.nov is included in the *C.doriae* group (with saw teeth on the ultimate leg femur). It conspicuously different from the only one described Indian species of *Cryptops (Trigonocryptops)* ie*., Cryptops (Trigonocryptops) orientalis* which was described by Jangi (1955a) from Nagpur, Maharashtra, in characters like number of clypeal teeth in forcipular coxosternite, number of saw teeth in ultimate leg tibia and tarsus1 (Table: 5.1). It shares common characters with *Cryptops (Trigonocryptops) orientalis,* the presence of bisegmented tarsi in legs, number of saw teeth in ultimate leg femur, cephalic plate overlying T1 and transverse suture on T1.

***Cryptops (Trigonogonocryptops) lewisi* sp.nov.**

(Plate: 40)

Diagnosis: A species of *Cryptops* without any suture on cephalic plate; tergite paramedian sutures and lateral crescentric sutures from T3 to T20; presence of one saw teeth on the ultimate leg femur; 8 saw teeth on the ultimate leg tibia and 3-4 on ultimate leg tarsus 1.

Description of Holotype: Body length 28mm.

Colour: before and after preservation in 100% alcohol: ochre. Ultimate legs yellow.

Antennae: composed of 17 antennal articles; basal two articles relatively stout. The basal article has long setae proximally. Three irregular whorls of long setae on the proximal end of articles 1-4; the rest with setae scattered irregularly, not in whorls. Short, fine setae abundant from 4th article onwards (Fig. a).

Cephalic plate: moderately punctate and without any sulci, T1 overlying the posterior edge of the cephalic plate (Fig. b).

Forcipular coxosternite: Anterior edge of forcipular coxosternite slightly convex (Fig. c) and with 6 long and 2 small clypeus setae on one side.

Tergites: paramedian sutures from T3 (Fig. d), crescent shaped suture from T5-T19, oblique sutures from T3-T19. T21 with a posteriomedian sulci and distinct triangular end (Fig. e). Sternites with trigonal suture (Fig. f).

Sternites: S21 with sides converging very slightly and slightly concave posterior margin (Fig.g).

Coxopleuron: with 42 large pores and with small 2-3 setae in pore field; 3 small stout setae posteriorly. Posterior and lateral areas of coxopleuron is poreless (Fig. h).

Legs: Walking legs 1-19 with divided tarsi. No accessory spurs associated with the tarsal claw. Leg 20 with fine setae ventrally and laterally on prefemur, femur and tibia in all specimens.

Ultimate legs: with strong setae on anterior and ventral surfaces of prefemur and femur. One distal tubercle on tibia and tarsus 1. 1 median saw teeth on femur, eight median saw tooth on the tibia and four proximal saw tooth on the tarsus 1
(Fig. i and j).

Additional information from Paratypes

Body length of paratypes is 21mm. When compared to the holotype, the number of saw teeth on the ultimate leg tarsus 1 is 4.

Etymology

The species is named after Dr. J. G. E Lewis for his significant contribution to the taxonomy of Scolopendromorpha.

Material examined:

Holotype: Karadippara Shola, Idukki District, Kerala, India. Coll. P M Sureshan. 20/v/2014. (ZSI/WGRC/I-R/INV-5380).

Paratypes: 2 exs. From type locality. Coll. P M Sureshan. 20/v/2014. (ZSI/WGRC/I-R/INV-5381).

Habitat:

The specimens were collected from moist deciduous forest tracts of Southern Western Ghats. All specimens were found in loose soil, about 4-5cm below the surface. \

Remarks:

Like *C. (T) sholavasi* sp.nov, *C. (T) lewisi* sp.nov is also included *C.doriae* group (with saw teeth on the ultimate leg femur). It conspicuously different from the *Cryptops (Trigonocryptops) orientalis* and *C. (T) sholavasi* sp.nov in characters like number of clypeal teeth in forcipular coxosternite, number of saw teeth in ultimate leg tibia and tarsus1, possession of crescenrtic suture on tergites (Table: 5.1). It shares common characters with *Cryptops (Trigonocryptops) orientalis,* the presence of bisegmented tarsi in legs, number of saw teeth in ultimate leg femur, cephalic plate overlying T1 and transverse suture on T1. It is also interesting to note that, like the reported troglomorphic species of *Cryptops (Trigonocryptops) viz- C (T) longicornis* Ribaut*,* 1915*, C (T) longicornis* troglobius Matic *et al*., 1977 and *C (T) roeplainsensis* Edgecombe, 2005, *C (T) lewisi* also posess long antennae and elongated body. But this species is not restricted to and collected from any cave like habitats as the other troglomorhic species in this subgenus.

5.7.3. Genus *Paracryptops* Pocock, 1891

Paracryptops. Pocock, 1891a**:** 227.

Paracryptops. Attems, 1930: 244.

Type species: *Paracryptops weberi* Pocock

Diagnosis: Body length 16-24 mm. Forcipular coxosternal margin with blunt, rounded or slightly flattened, hyaline lobes; tarsungulum very short.

Distribution: From Indian peninsula to New Guinea, and Antilles (the latter possibly introduced). Only five species worldwide.

5.7.4. Key to the species in genus *Paracryptops* in Kerala

1. Ultimate leg prefemur with external and internal raw of saw teeth in tibia. T21 with complete median suture (Plate: 41: h)..... .....***P. sureshani*** **sp.nov**

   - Ultimate leg prefemur with only external raw of saw teeth in tibia. T21 without complete median suture……..... ……..…… **2**

2. Ultimate leg with 7 or 8 saw tooth on tibia and 3 saw tooth on tarsus 1; coxopleural pores 16-18 (Plate: 42: e, g, h) ……..... .....***P.spinosus*** **Jangi and Dass**

   - Ultimate leg with 5 or 6 saw tooth on tibia and 3 saw tooth on tarsus 1; coxopleural pores 21 to 25 (Plate: 43: e, f, g) .....…… .....***P.sankari*** **sp. nov**

Paracryptops sureshani **sp.nov**

(Plate: 41)

Diagnosis: Cephalic plate and T1 without any sutures. Lateral crescentric sutures and paramedian sutures from T4-T20. Coxopleuron with 12 large pores. T21 with a complete median suture. No saw tooth on the prefemur and femur, eight saw teeth on the tibia and four on the tarsus1.

Description of Holotype: Body length 21mm.

Colour: before preservation: orange or ochre (Fig.a). Colour after preservation in 100% alcohol: greyish with dark pigmentation on T3-T19 and S1-S20.

Antennae: composed of 17 antennal articles; basal two articles relatively stout. The basal article has long setae distally. An irregular whorl of long setae on the distal end of articles 1-3, the rest with setae scattered irregularly. Short, fine setae abundant from 4th article onwards (Fig.b).

Cephalic plate*:* as broad as long (0.9×0.8mm); with hairs and without sutures and impunctate (Fig. c).

Forcipular coxosternite: Anterior edge of forcipular coxosternite rounded (Fig. d) and with 5 long and 3-4 small setae on each side.

Tergites: T1 without sutures. Lateral crescentric sutures and paramedian sutures present T4 onwards. All the Tergites except T21 seems to be wrinkled. Pre-tergites distinct and with median suture (Fig.e). T21 with a complete median suture.

Sternites: with longitudinal and transverse sulci, longitudinal sulci longer than the transverse. S21 small in size and with a curved margin (Fig. e). Legs 1-19 with undivided tarsi.

Coxopleuron: with 12 large pores and; 3 or 4 fine setae on posterior margin (Fig.g). Posterior area of coxopleuron is poreless and with 3-4 spurs in two rows.

***Walking Legs*:** Leg 20 with dense fine setae ventrally on prefemur, femur and tibia in all specimens.

Ultimate legs: with strong setae on anterior, ventral and posterior surfaces of prefemur and on ventral and posterior surfaces of femur. No distal tubercle on tibia and tarsus. Femur bearing a lateral spine distally, tibia with a lateral and median spine distally. No saw tooth on the prefemur and femur (Fig. h); eight on the tibia and four on the tarsus1 (Fig. f, i).

Etymology:

The species is named after Dr. P.M Sureshan in honor to his contribution towards the taxonomy of various faunal groups in India.

Material Examined:

Holotype: 1 ex. Narayamkulam, Kozhikode District, Kerala, India. Coll.Umesh P.K. 29. vii. 2011. (ZSI/WGRC/I-R/INV -2110)

Paratypes: 2 exs. Urakkuzhy, Kakkayam, Malabar Wildlife Sanctuary, Kozhikode District, Kerala, India. Coll. Dhanya Balan. 11/ii/2012. (ZSI/WGRC/I-R/INV- 2012).

Habitat:

Paratype specimens collected from the soil beneath leaf litter from dense forest area. And the Holotype from the rocky terrain of an agroecosystem adjoining forest area.

Remarks:

Worldwide, the genus *Paracryptops* is represented by only 5 species viz., *P.weberi*

Pocock 1891a*, P.brevinguis* Silvestri 1895*, P.inexpectus* Chamberlin 1914*, P.indicus* Silvestri 1924 and *P.spinosus* Jangi and Dass 1978a. Among these, *P.indicus* was described by Silvestri from Tura in Western Meghalaya state which he incorrectly mentioned Assam as locality (Chagas and Shelley, 2004) and *P.spinosus* from New Delhi (Jangi and Dass 1978a). Jangi and Dass erected *P.spinosus* for an individual collected under flower plots in a plant nursery. The present report is the first ever taxonomic account of this genus from Western Ghats and South India. It is also notable that eventhough 31% of the total globally sampled *Paracryptops* belonged to urban environment (Chagas and Shelley, 2004), the present species belongs to forest areas and an undisturbed or rather abandoned agricultural area. *P. sureshani* sp.nov shares the common characters like the number of antennal articles (17), absence of suture on cephalic plate and T1, presence of one lateral spine in femur with *P.indicus* and *P.spinosus*. But it noticeably differ from the known Indian species in the number of coxopleural pores, complete median suture on T21 and number of saw teeth in ultimate leg tibia (Table. 5.2)

***Paracryptops spinosus* Jangi and Dass, 1978**

(Plate: 42)

Paracryptops spinosus Jangi and Dass, 1978: 327-330.

Paracryptops spinosus Khanna*,* 2008:42

Type Locality: India: Delhi

Distribution: India: Delhi

Diagnosis: Cephalic plate and T1-T3 without any sutures. Coxopleuron with 16-18 pores. No saw tooth on the prefemur and femur, 7/8 saw teeth on the tibia and 3 on the tarsus1.

Description: Body length 19-23 mm.

Colour: before and after preservation in 100% alcohol: yellow ochre with pigmentation on T8-T19.

Antennae: composed of 17 antennal articles; basal two articles relatively stout. The basal article has long setae distally. An irregular whorl of long setae on the distal end of articles 1-3, the rest with setae scattered irregularly. Short, fine setae abundant

from 4th article onwards (Fig.a).

Cephalic plate: as broad as long, with hairs and without sutures and unpunctate (Fig. b).

Tergites: T1-T3 without sutures. Lateral crescentric sutures and para-median sutures present T4 onwards. All the Tergites except T21 seems to be wrinkled (Fig. d). T21 without any sutures and with tapered posterior margin.

Sternites: with longitudinal and transverse sulci, longitudinal sulci longer than the transverse. S21 small in size and with a curved margin.

Forcipular coxosternite: Anterior edge of forcipular coxosternite rounded (Fig. c) and with 6 long and 4-7 small setae on each side.

Coxopleuron: with 16 to 18 large to median pores and; 3 or 4 fine setae on posterior margin. Posterior area of coxopleuron poreless (Fig. e).

Walking Legs: Walking Legs 1-19 with undivided tarsi. Leg 20 with dense fine setae ventrally on prefemur, femur and tibia in all specimens (Fig. f).

***Ultimate legs*:** with strong setae on anterior, ventral and posterior surfaces of prefemur and on ventral and posterior surfaces of femur. No distal tubercle on tibia and tarsus. Femur bearing a lateral spine distally, tibia a lateral and median spine distally. No saw tooth on the prefemur and femur (Fig. g); seven to eight on the tibia and three on the tarsus 1 (Fig. g, h).

Distribution: India: Delhi, Kerala (New record to Kerala).

Material Examined:

3 exs; AHADS (Attapady Hills Area Development Society) Campus, Agali, Palakkad District, Kerala, India. Coll. Dhanya Balan. 24/iii/2012. (ZSI/WGRC/I-R/INV-4007).

Habitat:

All the specimens collected from the sandy soil under trees and leaf litter around the trees.

Remarks:

Genus *Paracryptops* is one of the rare genera reported from India. Silvestri (1924)

described *P.indicus* from Siju caves, Assam. Khanna (1994a, 2010) reported *P.indicus* Silvestri from Shilong, Eastern Meghalaya and Ranthambhore National Park, Rajasthan state. Regarding *P.spinosus,* Khanna (2001) cited *P.spinosus* from Delhi (the type locality of species). This is the first report of the species from South India as well as from Western Ghats.

***Paracryptops sankari* sp.nov**

(Plate: 43)

Diagnosis:

Cephalic plate and T1 without any sutures. Lateral crescentric sutures and paramedian sutures from T18-T20. Coxopleuron with 21-25 pores. No saw tooth on the prefemur and femur, 5/6 saw teeth on the tibia and three on the tarsus 1. Anterior edge of forcipular coxosternite rounded with flat edges.

Description of Holotype: Body length 22mm.

Colour: before and after preservation in 100% alcohol: ochre with dark pigmentation on tergites.

Antennae: composed of 17 articles; basal two articles with two whorl of long setae proximally and one whorl with long setae distally. Rest with one whorl proximally. Short, fine setae abundant from 4th article onwards (Fig.a). Tarsangulum with 18 setae in 4 rows.

***Cephalic plate*:** slightly broader than long; with 2-3 hairs and without sutures and unpunctate (Fig. b).

Forcipular coxosternum: Anterior edge of forcipular coxosternite rounded with flat edges (Fig. c) and with four long and two small setae on each side.

Tergites: T1 without sutures. Lateral crescentric sutures T18- T20. T21 without any suture and with straight posterior margin (Fig. d).

Sternites: punctate with longitudinal and transverse sulci, longitudinal sulci longer than the transverse sulci. S21 small in size and with a curved margin (Fig. d). Legs 1-19 with undivided tarsi.

Coxopleuron: with 21 large pores and; 3 or 4 fine setae on posterior margin. Posterior area of coxopleuron is poreless (Fig.e).

Walking Legs: 20 with dense fine setae ventrally on prefemur, femur and tibia in all

specimens.

Ultimate legs: with strong setae on anterior, ventral and posterior surfaces of prefemur and on ventral and posterior surfaces of femur. No distal tubercle on tibia and tarsus. Femur bearing a lateral spine distally, tibia with a lateral and median spine distally. No saw tooth on the prefemur and femur (Fig. f); eight on the tibia and three on the tarsus1 (Fig. g).

Additional information from Paratypes*:* Body length varies between 19-20 mm. Coxopleuron with 25 coxopleural pores (ZSI/WGRC/IR/INV-4009).

Etymology:

The species is named after Dr. S. Sankar in honor to his contribution towards the various studies on Western Ghats forests.

Material Examined:

Holotype: Sairandry, Silent Valley NP, Palakkad District, Kerala,India. Coll. Dhanya Balan. 20.ii.2013. (ZSI/WGRC/I-R/INV-4008).

Paratypes: 2 examples; Sairandry, Silent Valley NP, Palakkad District, Kerala,India. Coll. Dhanya Balan. 20.ii.2013.(ZSI/WGRC/I-R/INV-4009).

Habitat:

All the type specimens were collected from the soil beneath leaf litter in dense forest area.

Remarks:

P. sankari sp.nov shares the common characters like the number of antennal articles (17), absence of suture on cephalic plate and T1, presence of one lateral spine in femur with *P. sureshani* sp.nov*, P.indicus* Silvestri 1924 and *P.spinosus.*But it noticeably differ from the known Indian species in the number of coxopleural pores, number of saw teeth in ultimate leg tibia (Table. 2) and flat edge of forcipular coxosternum.

Table 5. 1: Comparison of major characters of Indian *Cryptops*

Sl no	Name of species	Trigonal Sutures in anterior segments	Ant. Transverse Suture in T1	number of clypeus setae in fcx	UL Femur Saw Teeth	UL Tibia Saw Teeth	UL Tarsus 1 Saw Teeth	Cxp Pores
1	***Cryptops kempi***	A	P	5	0	0	3	40
2	***Cryptops doriae***	A	A	5 - 6	1	5-13	2-5	72
3	***Cryptops setosior***	A	A	12	1	8	3	NK
4	***Cryptops (C) malabarensis***	A	A	5	0	7	3	9
5	***Cryptops (T) orientalis***	P	A	5	1	9	3	22
6	***Cryptops(T) sholavasi* sp.nov**	P	A	6	1	6-8	2-3	37
7	***Cryptops(T) lewisi* sp.nov**	P	A	8	0	8	3-4	42

fcx=forcipular coxosternum; UL: ultimate leg :

cxp= coxopleuron; A=absent; P=Present; NK=not known from literature

Table 5. 2: Comparison of major characters of Indian *Paracryptops*

Sl no	Name of species	Sutures on Tergites	T21 suture	Shape of fcx	UL Tibia Saw Teeth	UL Tarsus 1 Saw Teeth	Cxp Pores
1	***Paracryptops indicus***	Anterior T3-T20	Longitudinal and transverse	Round	9	3	40
2	***Paracryptops spinosus***	Lateral crescentric T4-T20	Absent	Round	7	3	16-18
3	***Paracryptops sureshani* sp.nov.**	Lateral crescentric T3-T20	Complete median	Round	8	4	12
4	***Paracryptops sankari* sp.nov**	Lateral crescentric T18-T20	Absent	Rounded laterally & flat edge	5/6	3	21-25

fcx=forcipular coxosternum; UL: ultimate leg : cxp= coxopleuron

CHAPTER 6
RESULTS AND DISCUSSION

6.1 Diversity and Composition

The present study forms the first comprehensive documentation of the taxonomic account of Scolopendromorphic centipedes from Kerala. And this taxonomic inventory accounted the details of 38 species belonging to 9 genera and 2 families (Table. 6.1). 10 species described new to science and 5 species were reported as the first report from Kerala state. Based on this, a checklist was prepared.

Table 6.1: Checklist Of Scolopendromorpha From Kerala, India

Sl. No	*Species*	*Status*
1	***Cormocephalus indicus* sp.nov.**	NEW SPECIES
2	***Digitipes pseudobarnabasi* sp.nov.**	
3	***Rhysida laetus* sp.nov.**	
4	***Rhysida shenduruniensis* sp.nov.**	
5	***Rhysida aspinosus* sp.nov.**	
6	***Cryotops (Cryptops) malabarensis* Dhanya, Sureshan & Khanna, 2012**	
7	***Cryptops (Trigonocryptops) sholavasi* sp.nov.**	
8	***Cryptops (Trigonocryptops) lewisi* sp.nov.**	
9	***Paracryptops sankari* sp.nov.**	
10	***Paracryptops sureshani* sp.nov.**	

11	***Asanada agharkari* (Gravelyi, 1912)**	NEW REPORTS TO KERALA
12	***Cormocephalus westwoodi westwoodi* (Newport, 1844)**	
13	***Otostigmus (O) orientalis* Porat, 1876**	
14	***Rhysida longipes simplicior* Chamberlin,1920**	
15	***Paracryptops spinosus* Jangi and Dass 1978**	
16	***Cormocephalus dentipes* Pocock, 1891**	REDESCRIPTION
17	***Cormocephalus nigrificatus* Verhoeff, 1937**	
18	***Asanada sukhensis* Jangi & Dass, 1984**	
19	***Digitipes barnabasi* Jangi & Dass, 1984**	
20	***Digitipes coonoorensis* Jangi & Dass, 1984**	
21	***Digitipes jonesii* Jangi & Dass, 1984**	
22	***Digitipes periyarensis* Joshi & Edgecombe, 2013**	
23	***Digitipes pruthii* Jangi & Dass, 1984**	
24	***Ethmostigmus rubrieps platycepahlus* Newport,1845**	
25	***Ethmostigmus coonooranus* Chamberlin , 1920**	
26	***Otostigmus gravelyi* (Jangi & Dass, 1984)**	
27	***Otostigmus politus politus* Karsch,1881**	
28	***Rhysida immarginata immarginata* (Porat,1876)**	
29	***Rhysida lithobiodes trispinosus* Jangi & Dass,1984**	
30	***Rhysida lithobiodes paucidens* Pocock, 1897**	
31	***Rhysida longipes longipes* (Newport, 1845)**	
32	***Scolopendra morsitans* Linnaeus, 1758**	
33	***Scolopendra hardwickei* Linnaeus, 1758**	Khanna (2001), Sureshan *et al*., (2006a), Joshi & Edgecombe (2013)
34	***Scolopendra subspinipes dehaani* Brandt, 1840**	
35	***Asanada indica* Jangi & Dass, 1984**	
36	***Asanada sokotrana* Pocock, 1899**	
37	***Digitipes chhotanii* Jangi & Dass, 1984**	
38	***Otostigmus ruficeps* Pocock, 1890**	

In this study all the new species were described and little known species were redescribed. Images were taken focusing all taxonomic characters in the description. Dichotomous keys were prepared in detail from family level up to species level for identification. Distribution maps were prepared genus wise for analyzing the distribution pattern of species.

It was observed that the genus with the highest number of total species was *Rhysida*. [24% (9 species)]; followed by *Digitipes* [18% (7species)]. (Fig.6.1). District wise distribution of species was also prepared (Table. 6.2)

Fig 6.1: Genus wise diversity of species in Study Area

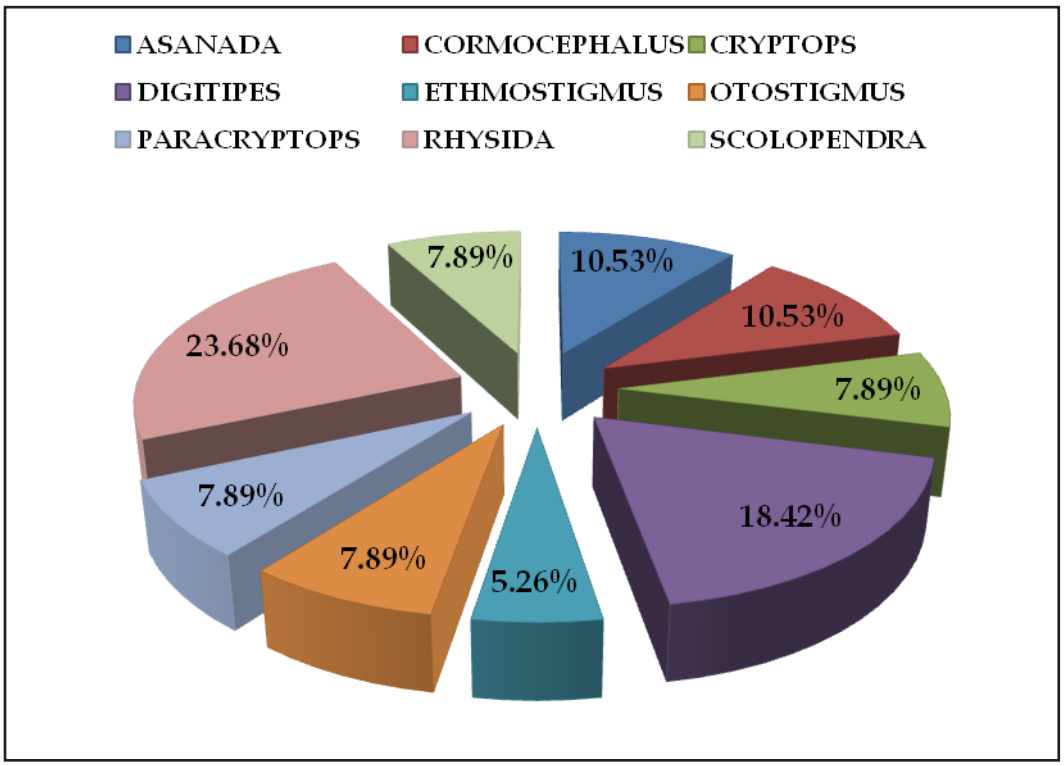


Table 6.2: District Wise Composition of Scolopendromorpha from Kerala

SlNo	*Species*	Trivandrum	Kollam	Alappuzha	Pathanamthitta	Kottayam	Idukki	Eranakulam	Thrissur	Palakkad	Malappuram	Kozhikode	Wayanadu	Kannur	Kasarkod
1	*Cormocephalus indicus* sp.nov.	¥	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*Digitipes pseudobarnabasi* sp.nov.	-	-	-	-	-	-	-	¥	-	-	¥	-	-	-
3	*Rhysida laetus* sp.nov.	-	-	-	-	-	¥	-	-	-	-	-	-	-	-
4	*Rhysida shenduruniensis* sp.nov.	-	¥	-	-	-	-	-	-	-	-	-	-	-	-
5	*Rhysida aspinosus* sp.nov.	-	-	-	-	-	-	¥	-	-	-	-	-	-	-
6	*Cryotops (Cryptops) malabarensis* Dhanya, Sureshan & Khanna, 2012	-	-	-	-	-	-	-	-	-	-	¥	-	-	-
7	*Cryptops (Trigonocryptops) sholavasi* sp.nov.	-	-	-	-	-	¥	-	-	-	-	-	-	-	-
8	*Cryptops (Trigonocryptops) lewisi* sp.nov.	-	-	-	-	-	¥	-	-	-	-	¥	-	-	-
9	*Paracryptops sankari* sp.nov.	-	-	-	-	-	-	-		¥	-	-	-	-	-
10	*Paracryptops sureshani* sp.nov.	-	-	-	-	-	-	-	-	-	-	¥	-	-	-
11	*Cormocephalus westwoodi westwoodi* (Newport, 1844)	¥	-	-	-	-	¥	-	-	-	-	-	-	-	-
12	*Otostigmus (O) orientalis* Porat, 1876	-	-	-	-	-	-	-	-	-	-	¥	-	¥	-
13	*Rhysida longipes simplicior* Chamberlin,1920	-	-	-	-	¥	-	-	-	¥	-	-	-	-	-
14	*Asanada agharkari* (Gravelyi, 1912)	-	-	-	-	-	-	-	-		-	-	¥	-	-
15	*Paracryptops spinosus* Jangi and Dass 1978	-	-	-	-	-	-	-	-	¥	-	-	-	-	-
16	*Cormocephalus dentipes* Pocock, 1891	¥	-	-	-	-	-	-	¥	¥	¥	¥	¥	-	-
17	*Cormocephalus nigrificatus* Verhoeff, 1937	-	¥	-	-	-	¥	-	-	-	¥	¥	-	-	-

18	*Asanada sukhensis* Jangi & Dass, 1984	-	-	-	-	-		-	-	-		¥	-	-	-
19	*Digitipes barnabsi* Jangi & Dass, 1984	¥	¥	-	-	¥	¥	¥	-	-	¥	¥	¥	¥	¥
20	*Digitipes coonoorensis* Jangi & Dass, 1984	¥	¥	-	¥	-	¥	¥	-	¥	-	¥	¥	¥	-
21	*Digitipes jonesii* Jangi & Dass, 1984	-	-	-	-	-	-	¥	-	-	-	-	-	-	-
22	*Digitipes pruthii* Jangi & Dass, 1984	-	¥	-	-	-	-	¥	-	-	-	-	-	-	-
23	*Digitipes periyarensis* Joshi & Edgecombe, 2013	-	-	-	-	-	¥	-	-	-	-	-	-	-	-
24	*Ethmostigmus rubrieps platycepahlus* Newport,1845	-	¥	-	-	-	¥	¥	-	¥		¥	¥		-
25	*Ethmostigmus coonooranus* Chamberlin , 1920	-	¥	-	-	-	-	-	-	-	-	-	-	-	-
26	*Otostigmus gravelyi* (Jangi&Dass, 1984)	-	¥	-	-	-	-	¥	¥	-	-	-	-	-	-
27	*Otostigmus politus politus* Karsch,1881	-	-	-	-	-	-	-	-	-	-	¥	-	¥	-
28	*Rhysida immarginata immarginata*(Porat,1876)	¥	¥	¥	¥	¥	¥	-	¥	-	-	¥	¥	¥	-
29	*Rhysida lithobiodes trispinosus* Jangi & Dass,1984	-	-	-	-	-	-	¥	-	¥	-	¥	-	-	-
30	*Rhysida lithobiodes paucidens* Pocock, 1897	-	¥	-	-	-	-	-	-	-	-	-	-	-	-
31	*Rhysida longipes longipes* (Newport, 1845)	-	-	-	-	-	-	¥	¥	-	-	¥	-	¥	-
32	*Scolopendra morsitans* Linnaeus, 1758	-	¥	-	-	-	¥	¥		¥	¥	¥	¥	¥	¥
33	*Scolopendra hardwickei* Linnaeus, 1758*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	*Scolopendra subspinipes dehaani* Brandt, 1840*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*Asanada indica* Jangi & Dass, 1984*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	*Asanada socotrana* Pocock, 1899*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*Digitipes chhotanii* Jangi & Dass, *1984*	-	¥	-	-	-	¥	-	-	-	-	¥	-	¥	-
38	*Otostigmus ruficeps* Pocock, 1890	-	-	-	-	-	-	-	-	¥	-	-	-	-	-

** No sample studied,locality not in literature; '¥' indicates Presence and '- 'indicates absence of species*

6.2 Ecology -Results & Discussion

Scolopendrid centipedes are a diverse group of invertebrate communities which play significant, but often poorly acknowledged or understood roles in the delivery of soil ecosystem services. It belongs to the category of soil macro fauna i.e., *" an invertebrate group found within terrestrial soil samples which has more than 90 percent of its specimens (individuals) in such samples visible to the naked eye" (*IBOY 2000*)*. As predators, they regulate herbivores; act as ecosystem engineers, litter transformers, decomposers and micro regulators (Moreira *et al*., 2008).

6.2.1 *Species diversity within the habitat:*

In the present study, diversity of Scolopendromorphic centipedes from 3 different ecosystems was analyzed. Shannon Mean, Shannon Exponential Mean and Simpson index were calculated as a measure of diversity within the habitat (Alpha diversity or Point diversity).

Table 6.3: Comparison of Diversity indices within 3 Ecosystems

Diversity Indices	Mean ± SD			Range		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Number of species	13	11	3			
Shannon Mean	2.42 ±0.16	2.23±0.17	1.14±0.16	2.12-2.58	1.9-2.42	0.89-1.38
Shannon Exponential Mean	11.29±1.64	9.41±1.53	3.17±0.52	8.27-13.2	6.71-11.2	2.44-3.97
Simpson Mean	9.83±3.17	8.32±2.65	3.03±1.07	4.87-13.69	4.32-11.53	1.91-5.08

Site 1: Malabar Wildlife Sanctuary, Site 2: Narayamkulam Undisturbed & isolated hilly area , Site3: Kuttothparambu Residential Area

From the above table, the values of indices indicated that Site 1 was relatively diverse than the other 2 sites. Being a rich biodiverse forest Site 1 possess more diversity than Site 2 (Undisturbed & abandoned agricultural land) and Site 3(Residential area). As the habitat quality may be the most vital factor determining the presence of species at a given biota Site 1 being a forest harbors more species.

6.2.2 *Shared Species and Similarity between Diversity & Abundance*

The analysis for comparing the similarity in diversity of ecosystems revealed that Site 1 and 2 is more similar and possess maximum number of shared species. The similarity indices (Jaccard, Sorenson and Morisita Horn) indices also showed the same results indicating the higher level of similarity between Site 1 and 2.

The high diversity in Site 2 is being an unprotected and isolated hilly ecosystem pointed out the significance of "conservation efforts outside protected areas". It supports the opinion that areas outside existing conservation reserves, harboring significant levels of biodiversity need to be targeted for long term conservation (Raman and Mudappa, 2003).

Besides, Site 2 (Narayamkulam) is a hillock adjacent to (about 30.9km away) Malabar Wildlife Sanctuary where site 1 was located.

The maximum number of shared species (7) between these two sites also support the assumption that once it was a pristine forest which later transformed to a rather abandoned and isolated hillock area.

Table 6.4 : Shared Species Analysis between 3 Ecosystems

First Sample	Second Sample	Shared Species Observed	Chao Shared Estimated	Jaccard Classic	Sorensen Classic	Chao-Jaccard-Raw Abundance-based	Chao-Sorensen-Raw Abundance-based	Morisita-Horn
Site 1	Site 2	7	7	0.412	0.583	0.746	0.854	0.545
Site 1	Site 3	1	0	0.067	0.125	0.059	0.111	0.067
Site 2	Site 3	2	0	0.167	0.286	0.442	0.613	0.389

Site 1: Malabar WLS, Site 2: Narayamkulam Undisturbed isolated hilly area, Site3: Kuttothparambu Residential Area

6.3 Impact of Seasonal fluctuations in Diversity Index

Seasons (Premonsoon, Monsoon and Postmonsoon) in Kerala observed to be have an imperative impact on the diversity of Scolopendromorphic centipedes. Species richness varied significantly between sites and seasons (p=0.05). The highest Simpson Mean value was recorded during the month of October (13.69) at Post

Monsoon Period in Site 1(Malabar Wildlife Sanctuary). The minimum value in the index was recorded in the month of March (1.91) at Pre-Monsoon Period in Site3 (Kuttothparambu). Same trend observed in the cases of Shannon Exponential Mean and Simpson Mean. As Monsoon period is defined as the reproductive active time for the Scolopendrid centipede (Lewis, 1972 & 2006b) then there is a chance of increasing the number of organisms in the Post- Monsoon time.

In the discussion of the life histories of Nigerian Centipedes Lewis (1972) pointed out an observation that *Scolopendra amazonica* in order to avoid dry season take refuge in cow dung and *Rhysida nuda togoensis* and *Ethmostigmus trigonopodus* which are virtually absent from superficial habitats may enter deep crevices in soil. In accordance with this observation, present study also pointed out the decreasing pattern of Indices in Premonsoon period (majorly summer months of March and April); it may also due to centipedes' behavioral tendency to avoid desiccation. In the month of December and January very less number of individuals were observed at Site 1 and 2. Even in termited soil and leaf litter of Site 3 where there is a more probable chance of finding centipedes, no specimens were observed. In the same months the activities of associated soil fauna were also negligible.

Fig 6.2: Mean Seasonal Variations of Shannon Index across Site 1, 2 &3

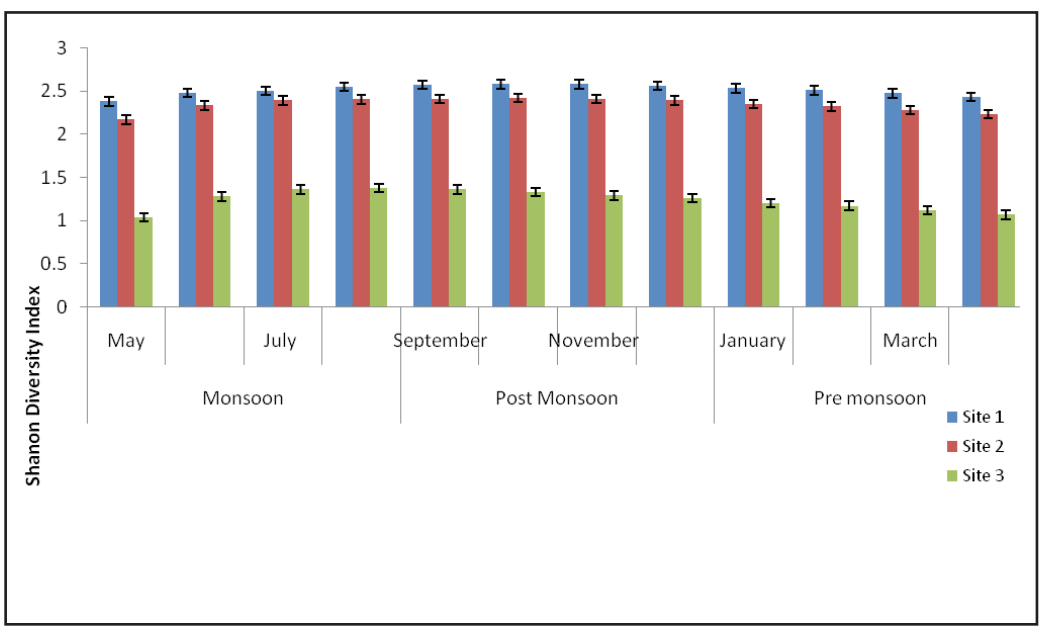


Fig. 6.3: Mean Seasonal Variations of Shannon Exponential Mean across Site 1, 2 &3

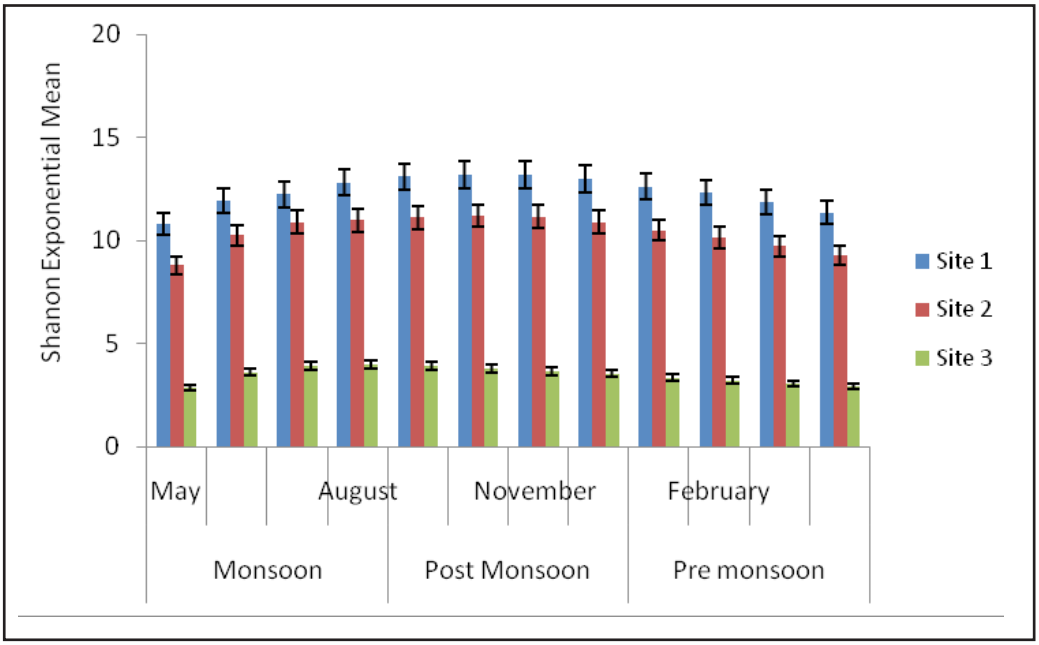
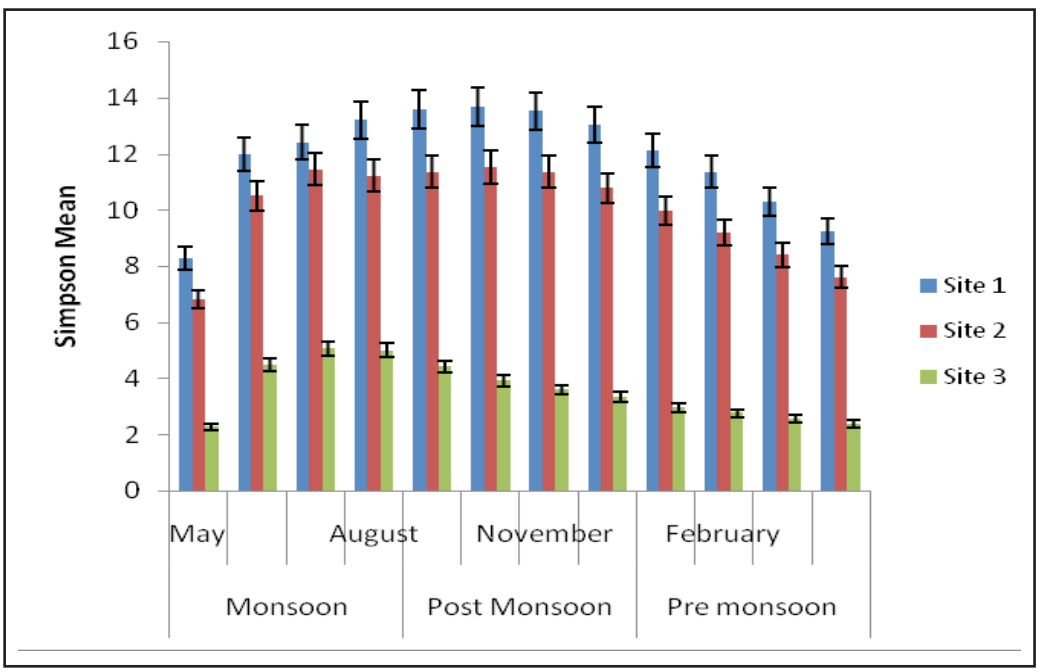


Fig 6.4: Mean Seasonal Variations of Simpson Mean across Site 1, 2 &3



6.4 Seasonal influence on the Soil Properties in Study area

Soil Temperature, Soil pH, Soil Electrical Conductivity (EC), Organic Carbon (OC), Available P, K, Ca and Mg were analyzed during seasons to study the influence of such parameters in diversity of Scolopendromorpha. Seasonal trend in the Physico-Chemical properties is given in Table 6.5.

Table 6.5: Mean Diversity Index and Soil Physico-Chemical properties of three sites across 3 seasons

Sites	Season	Shannon Diversity Index	Soil Temperature	pH	EC (ds/m)	OC%	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
Site 1	**PrM**	2.48	22.75	6.09	0.17	3.2	41.5	104	411.5	138.5
Site 1	**M**	2.47	18	4.6	0.07	2.46	34.5	184.5	509.4	93.4
Site 1	**PsM**	2.57	18.25	5.32	0.7	1.92	26.5	84.5	93	22
Site 2	**PrM**	2.29	25.75	5.52	0.07	3.7	41.45	223.5	616	179
Site 2	**M**	2.32	24	5.53	0.05	3.8	34.45	128	248.9	71
Site 2	**PsM**	2.39	25.25	4.76	0.8	3.15	27.2	53.5	162	28
Site 3	**PrM**	1.14	27	5.51	0.07	3.1	42.9	134.5	811.5	211.5
Site 3	**M**	1.26	24.25	4.9	0.11	2.26	36.5	138.5	812.2	79.3
Site 3	**PsM**	1.31	25.75	4.91	0.1	3.12	27.2	131	192	49

Site 1: Forest; Site 2: Undisturbed & isolated hilly area; Site 3:Resedential Area
PrM:Pre Monsoon; M:Monsoon; PsM: Post Monsoon

Soil Temperature:

In general, variations observed in Soil temperature of three ecosystems across the seasons (Table. 4). The least average temperature was observed in Site 1 during monsoon and the highest recorded at Site 3 during post-monsoon. The high rainfall in the higher altitude areas of Malabar Wildlife sanctuary where Site 1 located can be the reason for the lowest soil temperature reported. Being a residential area, Site 3 recorded the higher values during the dry seasons of pre- monsoon. Shannon diversity index also shown the same trend as soil temperature so we can predict that the temperature influences the diversity pattern.

The same observations were reported in the following studies. Abrahamsen' (1971) studied the effect of temperature and moisture content on soil fauna and observed

that temperature and moisture content of the soil play a critical role in the distribution and diversity of soil organisms. Jabin (2004) conducted the litter accumulation treatments for studying the effect of change in mean temperature on soil biota and revealed that the abundance of centipedes varied in accordance with temperature differences.

Soil pH:

In general, the average pH of soil from three sites during three seasons recorded in the range of slightly acidic i.e., 4.6 to 6.09 (Table 4).The seasonal trend in Shannon Diversity Index also showed the same pattern as the seasonal trend of soil pH. A similar observation was reported from Jabin (2004) in which the author discussed that the arthropods with a calcareous exoskeleton demonstrated the highest correlations within the soil fauna, as they were positively correlated to pH-value.

Soil Organic Carbon:

Increased Organic Carbon (OC) in pre-monsoon (3.2%) in site 1 may be attributed to higher level of leaf fall in the forest area which may lead to increase in Soil OC content, Similarly excessive soil erosion due to rainfall can be a reason for lower level OC during monsoons (Table 6.5). Kirby and Potvin (2007) find a correlation between biodiversity and organic carbon in soils and suggested that increase in biodiversity as the reason for excessive organic carbon in forests. The excessive mulching in soil from leaf litter may create a different microclimate on premonsoon, than the litter free monsoon season during which there is decreased oxidation of humus formed in summer. The seasonal trend in Shannon Diversity Index also showed the same pattern as the seasonal trend of Soil OC. The present study also revealed that there is comparatively high OC and lower diversity at Site 3 than Site 1 and 2.

Soil Chemical properties:

In general, the seasonal trend in Shannon Diversity Index also showed the same pattern as the seasonal trend of Soil Chemical parameters. The available P will be lower in natural forests (Site 1) because there is no artificial fertilizers were utilized there.

6.5 Influence of Soil properties on Shannon Diversity Index

Important abiotic factors that observed influencing the diversity and richness of Scolopendrids are temperature, pH, OC, EC, chemical parameters and seasonal fluctuations.

In the three sites (Site 1, 2 and 3) temperature seemed to have a significant influence on diversity index and showed a positive correlation of r = 0.754 (Site 1) and r = 0.966 (Site 2) and r = 0.551(Site 3). In the case of pH, index at Site 1 showed a positive correlation r =954, while it was very insignificant in Site 2 and 3. Where to EC diversity in three sites showed a negligible correlation only (r = 0.037 (Site 1) and r = 0.204 (Site 2) and r = 0.340 (Site 3). However in the case of OC and K, site 3 showed a high correlation of r = 0.864 (OC) and r = 0.840 (K) where in site 2 and 3 it showed a very negligible correlation. Across three of the sites K showed high correlation r = 0.840 (Site 3) and r = 0.500 (Site 1) and a low correlation r = 0.190 (Site 2). Ca and Mg seem to be less correlated with diversity and showed lower correlation values. From these observations it can be presumed that, in soil ecosystems temperature play a significant role in the diversity of scolopendrid centipedes. Besides, Scolopendrids likely to be prefer alkaline soils and shows a high diversity in alkaline rich soils. EC of soils seemed to be not influencing the Scolopendrids.

While OC, K and Ca influence these organisms, the contents of Mg and P seems to be less influencing. Jabin (2004) in studies on influence of soil attributes to the distribution pattern of soil arthropods in temperate deciduous forest reported that arthropods with a calcareous exoskeleton showed the highest correlations within the soil fauna, as they were positively correlated to pH-value and (Ca+Mg+K)/Al molar ratio. In the case of present study at Site 1 also since it's a forest habitat a positive correlation of diversity with pH is reported, the cases of Ca and K also showed similar effects. But the correlation of Mg is reported against their observations. In another investigation by (Shakir and Ahmed, 2015) on influence of blend of meteorological and edaphic factors on soil arthropod abundance observed that soil temperature and soil organic matter showed significant positive correlation with abundance, which supports the present findings. They also discussed that soil moisture and soil pH showed no significant correlations which is applicable to reported observations.

6.6 Associated Fauna in the Study Area

Being a diverse forest area in the quadrates of site 1 a vast and diverse associated fauna were found which includes soil beetles, leeches, ants, termites, Lithobiomorphic centipedes, Geophilomorphic centipedes, geckos, earwig, Collembolans, Blattaria cockroaches, millipedes, earthworms and scorpions. In the quadrates of site 2 too, a vast and diverse associated fauna were found including Black ants, snake ant, coleopteran beetles, Geophilomorphic and Lithobiomorphic centipedes. A less diverse associated fauna were observed at Site 3 consisting majorly of ants, dermoptera and Salticidae spiders.

6.7 Observations on distribution across Altitude gradient:

Apart from these observation focusing to study sites, during the general taxonomic studies its observed that in high altitude area (1500-1700 asl) scolopendrid centipedes were represented less in number and diversity but Geophilomorphic centipedes were plenty. And above this altitude in some forest patches like Sholas only lithobiomorphic centipedes were observed indicating a possible influence of climatic along with altitudinal variations on centipede diversity.

Regarding the distribution of Scolopendromorpha across altitude gradients, the study areas of Kerala state are categorized into eight altitudinal gradients. The results showed that the altitudinal zone of 10-200 has highest number of species accumulation (18 species) and the zone of 1200-1400 possess the lowest diversified zone as less number of species (3 species) present here (Table 6.6).

Table 6.6: Relative abundance of Scolopendromorpha across altitudinal gradient

Altitude Gradient (Mtrs asl)	Number of species	Relative abundance
10-200	18	47.37%
200-400	6	15.79%
400-600	8	21.05%
600-800	15	39.47%

800-1000	6	15.79%
1000-1200	8	21.05%
1200-1400	3	7.89%
1400 and above	6	15.79%

6.8 Observations on the parental care: (Plate 44 : Fig a-c)

Egg laying and brooding behavior in Indian Scolopendrid centipedes is not a well documented area of study but there are short communications on the parental care of the species *Cormocephalus dentipes* Pocock by Tilak and Roy (1988), Jangi & Dass (1984), Yadav (1994) and Khanna (per .comm.). During the present study, two such notable observations on parental care were noticed and recorderd. The brooding of *Rhysida immarginata* was observed in an unprotected and isolated hilly area adjoining a moist deciduous forest on a laterite hill at foothills of Western Ghats. The centipede was observed about 5 cm below the soil surface which was ploughed for Ginger cultivation. The soil temperature at the time of observation was 26^0C and the soil pH was 4.2. At the time of observation, the mother centipede was found coiled around the ball like clutch of embryonic stadia, with the ventral surface touching the clutch, and dorsal surface exposed.

The same posture of mother centipede typical for Scolopendromorpha was also reported by earlier workers in the order Craterostigmomorpha (found only in Tasmania and New Zealand) and placodesmatic Geophilomorphs (Edgecombe *et al*., 2010). The clutches consisting of about 34 embryonic stadia were clustered together and each stadium was transparent, pale white in colour and coiled (Fig a).On disturbance, the female recoiled and moved away from the clutch, thus scattering the stadia apart. When forcefully reintroduced into the scattered clutch, the female did not care the hatchlings and tried to burrow in the soil by to-and-fro movements of thoracic and prothoracic appendages. After about an hour it searched for the hatchlings and tried

to settle it together using the prothoracic and thoracic appendages.

Then, it again coiled around the partly settled clutch in a rather loose way using its mouthparts and prothoracic appendages, only to abandon the hatchlings after an hour most.

Besides, an individual of *Digitipes barnabasi* in brooding (Fig. b) was also observed during faunistic surveys at Kappalamudu, Kottayam Dist., Kerala on the month of July, 2011 (Post Monsoon Time). The centipede was observed in a rubber plantation adjoining a moist deciduous forest patch on a hillock, about 5 cm below the soil surface which was exposed for the faunistic collection.

At the time of observation, the mother centipede was found coiled around the ball like clutch of embryonic stadia (Fig b), with the ventral surface touching the clutch, and dorsal surface exposed. The clutches consisting of about 34 embryonic stadia were clustered together and each stadium was transparent, pale white in colour and coiled (Fig. c).

The disturbance in soil detached some of the stadia which were collected for study. A similar observation was also recorded from the Site 1 for ecological studies at Malabar Wildlife Sanctuary, where an adult *Rhysida/ Ethmostigmus* with 18 numbers of stadium were observed in the month of September 2011 (Post Monsoon) after prolonged rain of days. The brooding was observed in between stones and when disturbed for clear observation mother escaped leaving back the stadium. It was also notable that in the month of September most of the specimens observed in all the study area were majorly subadults.

6.9 Observations on the moulting and hibernation:

During present study some of the specimens were collected in their moulting stages and difficult to identify due to vague taxonomic characters (Plate 44 : Fig.d). Microscopic examination of such specimens revealed that it may be the condition similar to Stage B (in which the cuticle begins to harden) in moulting procedure (Rajulu, 1973). An interesting observation on the “almost hibernation’ like behavior

was observed in *Digitipes* and *Cormocephalus* species in high altitude habitats especially in winter and summer seasons. While collection these individuals it was observed that the specimens were inert beneath the soil (Plate 44 : Fig. e). Even after disturbance they didn't turn up and no movement was observed for a prolonged time. It could be an adaptive measure to tide over the adverse climatic conditions like water scarcity and low temperature.

6.10 Observations on the ectoparasitism of acari:

Like other arthropods, centipedes are frequently found to have mites attached to them. The six legged larvae of trombidiids and resting stage (hypopus) of several species of Tyrogliphidae are found as ectoparasites on centipedes (Lewis, 2006b). Interestingly during the microscopic examinations of a specimen of *Digitipes coonoorensis,* the ectoparasitism by Acari mites were observed. The specimen was an adult one, and the parasites about 2-3mm in size and whitish in colour and oval in appearance seemed to attach with the soft tissues near genital organs and spiracles (Plate 44 : Fig. f).

CHAPTER 7
SUMMARY

Scolopendromorpha are a diverse group of invertebrate communities which play significant, but often poorly acknowledged or understood roles in the delivery of soil ecosystem services. Due to lacunae in taxonomic and ecology studies of this group, they are largely been ignored in conservational studies. Despite the importance of this fauna, knowledge on the taxonomy and ecology of Scolopendromorpha in Kerala is scanty.

The major objectives of the present work were: to make a systematic revision of the Scolopendromorphic centipedes (Chilopoda: Scolopendromorpha) of Kerala which includes the habitats of southern Western Ghats by undertaking extensive field surveys and collection of specimens from different soil ecosystems, to describe new taxa and redescribe known taxa based on the material to be collected through field surveys and study collections in museum depositories, to prepare identification keys to genera and species of Scolopendromorpha occurring in Kerala and to provide basic knowledge about the ecology of Scolopendrid centipedes of Kerala.

The study area for taxonomic study was Kerala state, India. Stratified random sampling was done for the collection of samples from 14 districts of Kerala. Unidentified and identified samples from the faunal depository of WGRC, ZSI were

also studied based on their area of collection and included in the study.

The ecological studies were carried out in three sites (Site 1: Malabar Wild life sanctuary, Site 2: Narayamkulam undistrurbed isolated hillock, Site 3: Kuttothparambu Residential Area). Studies on diversity and soil analysis were conducted in these sites for a period from April 2011 to November 2012. Soil sampling and analysis were carried out in three seasons (Pre-Monsoon, Monsoon and Post- Monsoon) across the sites. Soil Temperature, pH, Electrical Conductivity (EC), Organic Carbon (OC), Available P, K, Ca and Mg were analysed to study the influence of such parameters in diversity of Scolopendromorpha.

The study accounted the taxonomic details of 38 species belonging to 9 genera and 2 families. During the study, 10 species were described as new to science. They were *Cormocephalus indicus* sp.nov., *Digitipes pseudobarnabasi* sp.nov., *Rhysida laetus* sp.nov, *Rhysida shenduruniensis* sp.nov., *Rhysida aspinosus* sp.nov., *Cryotops (Cryptops) malabarensis* Dhanya *et al,* 2012, *Cryptops (Trigonocryptops) sholavasi* sp.nov., *Cryptops (Trigonocryptops) lewisi* sp.nov., *Paracryptops sankari* sp.nov. and *Paracryptops sureshani* sp.nov.. Besides, 1 family, 2 genera, 5 species were reported for the first time from Kerala state. Family Cryptopidae Kohlrausch, genus *Cryptops* Leach, genus *Paracryptops* Pocock were the first report from Kerala and Southern Western Ghats**.** The newly reported species were *Cormocephalus westwoodi westwoodi* (Newport, 1844), *Otostigmus (O) orientalis* Porat, 1876, *Rhysida longipes simplicior* Chamberlin, 1920, *Asanada agharkari* (Gravely, 1912) and *Paracryptops spinosus* Jangi and Dass 1978. Taxonomic account of species included detailed diagnosis, key to species, distribution and habitat of the species.

The results based on comparison on alpha diversity within three sites pointed out that Site 1 was relatively more diverse than the other two sites. The analysis for comparing the similarity in diversity of ecosystems revealed that Site 1 and 2 are more similar and possess maximum number of shared species.

The ecological studies based on soil analysis of the selected areas revealed the

correlation between soil parameters and diversity of scolopendromorpha. In the three sites (Site 1, 2 and 3) temperature seemed to have a significant influence on diversity index and showed a positive correlation of r = 0.754 (Site 1) and r = 0.966 (Site 2) and r = 0.551(Site 3). In the case of pH, index at Site 1 showed a positive correlation r =954, while it was very insignificant in Site 2 and 3. In the case of EC, diversity in three sites showed a negligible correlation only (r = 0.037 (Site 1) and r = 0.204 (Site 2) and r = 0.340(Site 3). However in case of OC and K, site 3 showed a high correlation of r = 0.864 (OC) and r = 0.840(K) where in site 2 and 3 it showed a very negligible correlation. Across three of the sites K showed high correlation r = 0.840 (Site 3) and r = 0.500 (Site 1) and a low correlation r = 0.190(Site 2). Ca and Mg seem to be less correlated with diversity and showed lower correlation values. Another important findings during the study were observations on parental care, distribution in accordance with altitudinal gradients.

The study resulted in documenting, at least partially, one of the least studied groups of animals i.e., Scolopendromorpha in Kerala and described 38 species, ten new to science. Species diversity in relation to seasons and its impact on diversity of Scolopendromorpha are also revealed as the major findings of this study. The present documentation on taxonomic account and ecological observations can be the fundamental for long term studies on this fauna.

BIBLIOGRAPHY

Abrahamsen, G. (1971). The influence of temperature and soil moisture on the population density of *Cognettia sphagnetorum* (Oligochaeta: Lumbricidae) in cultures with homogenized raw humus. *Pedobiologia*, 11: 417-424.

Ahmed, S. (1980). On a collection of centipedes (Scolopendromorpha: Scolopendridae and Cryptopidae) from Andaman and Nicobar Islands, *Rec. zool. Surv. India, 77: 25-30*

Ahmed,S.(1983). On the new records of centipedes (Scolopendromorpha: Scolopendridae) from Madhya Pradesh, India. *Bull. Zool. Surv. India,* 5 (1): 11-13.

Attems, C. (1909). Myriopoden. In: L. Schultze(e.d.): Forschungsreise im westlichen und zentralen Südafrika ausgeführt in den Jahren 1903-1905. Denkschriften der medizinisch.*naturwissenschaftlichen Gesellschaft*, 14: 1-52.

Attems, C. (1926). Chilopoda. In: Kükenthal W. & Krumbach Th. (eds.), *Handbuch der Zoologie.* Berlin und Leipzig: De Gruyter, 4(1): 239-402.

Attems, C. (1928). Neue Scolopendriden der Museen Wien und Hamburg. Zoologischer Anzeiger, Leipzig, 78(11/12): 279-309.

Attems, C. (1930). Myriapoda 2. Scolopendromorpha. In: Schulze, F. E. & Kükenthal, W. (ed.), *Das Tierreich*, Berlin: Walter de Gruyter, 54: 1–308.

Attems, C. (1938). Myriopoden von Hawaii. *Proc. Zool. Soc. Lon,* 108B: 374.

Aurebuch, S. I. (1951). The centipedes of the chicago areas with special reference to their ecology. *Ecol. Monogr*, 21:61-63.

Balbiani, E. G. (1890). Etode anatomique et histologique sur le tube digestiv de *Cryptops*. *Arch. Zool. Exp. Gen*, 8: 8-12.

Bhatnagar., A. and Rao, R. J. (**2004).** Biodiversity Conservation in the proposed Amarkant Biosphere Reserve- Central India. *Tigepaper,* 31(4): 10-16.

Bollman, C.H. (1893). Classification of the Syngnatha. *Bull. U. S. Natl. Mus,* 46: 163-167.

Bonato, L., Edgecombee, G., Lewis J. G.E., Minelli, A., Pereira, L.A., Shelley, R. M. and Zapparoli, M. (2010). A common terminology for the external anatomy of centipede (Chilopoda). *Zookeys,* 69:17-51.

Bonato, L., Edgecombe, G.E. and Zapparoli, M. (2011). Chilopoda – Taxonomic overview. In: *Minelli, A.* (ed.), *Treatise on Zoology. The Myriapoda.* The Netherlands: Brill: Leiden, 1: 392-407.

Bonato L., Chagas Junior A., Edgecombee G.D., Lewis J.G.E., Minelli A., Pereira L.A., Shelley R.M., Stoev P. and Zapparoli M. (2016). ChiloBase 2.0 - A World Catalogue of Centipedes (Chilopoda)**.** Retrievable at *http://chilobase.biologia.unipd.it.*

Brandt, J.F. (1840). Observations sur les espèces qui composent la genre Scolopendra suivies des caractères des espèces qui se trouvent dans le Museum zoologique de l'Académie des Sciences de St. -Pétersbourg et de quelques coups d'oeil sur leur distribution géographiqu. *Bulletin Scientifique. Académie Imperiale des Sciences de Saint Pétersbourg*, 7(11): 152.

Brolemann, H.W. (1930). Éléments d'une faune des myriapodes de France. *Chilopodes. Imprimérie Toulousaine*, *Toulous*e, XIX+405: 100.

Bücher,l W. (1942). Contribucao ao eataudo dos orgaos sexuais externois das species do genero Scolopendra Linne mais frequentes no Brasil. *Mem. Inst. Butantan.* 14: 65-95.

Bücherl, W. (1946). Novidades systematics na ordem Scolopendromorpha. *Mem. Inst. Butantan,* 19: 135- 157.

Bücherl, W. (1971). Venomous chilopodes or centipedes. In: *Venomous animals and their venoms.* Newyork: Academic Press. 3: 169-196.

Bücherl, B. (1974). Die Scolopendriden der Noetropischen Region. *Sym. Zool. Soc. Myriapoda*, 32: 99-133.

Cardoso, P., Erwin T. L., Paulo, A.V., Borges, B. and New, **T. R. (2011)**. The seven Impediments in invertebrate conservation and how to overcome them. *Biol. Conserv*, 144 (2011): 2647–2655.

Chagas, Jr. A., and Shelley, R. M. (2004). Rediscovery and redescription of the centipede *Paracryptops inexpectus* Chamberlin, 1914, with an account of the genus (Scolopendromorpha: Cryptopidae: Cryptopinae). *Zootaxa*, 475: 1-8.

Chamberlin, R.V. (1913). Two new Otostigmini from India. *Ent. News,* 24: 73-76.

Chamberlin, R.V. (1914). Notes on chilopods from the East Indies. *Ent. News*, 25: 390.

Chamberlin, R.V. (1920a). On some Myriapods collected in India in 1916 by C.A.Kefold. *Univ. Cakif. Pub. Berkley*, 19:189-403.

Chamberlin, R.V. (1920b). The Myriapoda of the Australian Museum. *Bull.Mus. Comp.Zool,* 64(1): 1-269.

Chamberlin, R.V. (1941). Three new centipeds of the genus Cryptops. *J. Entomol. Zoo*, 33: 41

Chamberlin, R.V. (1944). On a collection of centipedes from Indo-Australian Archipelago. *Notulae naturae,* 147: 1-14.

Chamberlin, R.V. (1959). Entomologische Ergebnisse der Deutschen Indien\ Expedition 1955 – 1958. On some Chilopods from India. *Ent. Mitt. Zool. Staatsinstt. Mus,* 19: 1-4.

Chao, J. L., and Chang, H.W. (2008). Neotype designation for two centipedes, *Scolopocryptops curtus* (Takakuwa, 1939) and *Cryptops nigropictus* Takakuwa, 1936, and a review of species of Scolopendromorpha (Chilopoda) in Taiwan. *Coll. and Res*, 21:1-15.

Cloudsley-Thompson, J.L. (1958). *Spiders, scorpions, centipedes and mites.* London: Pergamon.

Colwell, R. K. (2009). EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.2. User's Guide and application published at: *http://purl.oclc.org/estimates*.

Cornwall, J. W. (1916). Some centipedes and their venom. Indian. *J. Med. Res,* 3(541): 547.

Crabill, R. E. Jr. (1953). Concerning a new genus *Dinocryptops* and nomenclatorial status of *Otocryptops* and *Scolopocryptops* (Chilopoda: Scolopendromorpha: Cryptopidae). *Ent. News*, 64: 96.

Crabill, R. E. Jr. (1955). Proposed use of planery power to designate for the genus "*Scolopendra"* Linnaeus, 1758 (Class, Myriapoda) a type species in harmony with accustomed usage. *Bull. Zool. Nomencl,* 11(4): 134-135.

Dhanya, B., Sureshan, P.M. and Vinod, K. (2012). A new species of centipede of the genus *Cryptops* Leach (Scolopendromorpha: Cryptopidae) from Southern Western Ghats with a key to the species of Cryptops in India. *J.threat. taxa,* 4(4): 2510-2514.

Dhanya, B., Sureshan, P. M. and Sankar, S. (2013). Biodiversity in non-

protected areas, with a special focus on the Scolopendormorphic centipedes of Puliyampoyil Hills, Calicut, Kerala-A foothill of Southern Western Ghats. Science Chronicle, 2(1&2): 2013.

Donovan, E. (1810). *The Natural History of British Insects.* London. 14: 23.

Dugon, M. M. and Arthur, W. (2012). Prey orientation and the role of venom availability in the predatory behaviour of the centipede *Scolopendra subspinipes mutilans* (Arthropoda: Chilopoda). *J. Insect. Physiol*, 58: 874–880. doi: 10.1016/j.jinsphys.2012.03.014

Edgecombee, G.D. (2005). A troglomorphic species of the centipede *Cryptops (Trigonocryptops*) (Chilopoda: Scolopendromorpha) from Western Australia. *Rec. West. Aust. Mus*, 22: 315-323.

Edgecombee, G. D. (2007). Centipede systematics: progress and problems. *Zootaxa*, 1668:327–41

Edgecombee, G. D., Bonato, L. and Giribet, G. (2010). Brooding in *Mecistocephalus togensis* (Geophilomorpha: Placodesmata) and the evolution of parental care in centipedes (Chilopoda). *Int. J. Myriapod.* 04/2010; 3. doi: 10.1163/187525410X12578602960506.

Ernst, A., Rosenberg, J. and Hiken, G. (2009). Structure and distribution of antennal sensilla in the centipede *Cryptops hortensis* (Donovan, 1810) (Chilopoda: Scolopendromorpha). *Soil. Org,* 81(3): 399-41.

Fabricius, C. (1781). Species insectorum exhibentes eorum differentias specificas synonoimiya auctorum loca Natalia metamorphosin adiectis observationibus descriptionibus. C. E. Bohnii: Hamburgi and Kilonii, 1:VIII+552.

Girard. (1853). Myriapoda. In: Marcy R.B (ed.), Report on exploration of the Red River of Louisiana expedition in 1852 - Senate Executive [Doc.] No. 54, 32d Congress, 2d Session - R. Armstrong, Washington: 320.

GoK. (2007). *State of Environment Report Kerala 2007*. Trivandrum: Kerala State Council for Science Technology and Development. 1:1-12. Retrieved from *http://envfor.nic.in/sites/default/files/Kerala_SoE2007-V1_0.pdf.*

.

Gravely, F.H. (1910). The distribution of Oriental Scolopendridae. *Rec. Indian Mus,* 5 (1): 161-172.

Gravely, F.H. (1912a). Two new species of Scolopendridae. *Rec. Indian Mus,* 7 (4): 415- 417.

Gravely, F.H. (1912b). Zoological results of Abhor expedition 1911-12. *Rec. Indian Mus,* 8 (1): 69-73:72.

Haase, E. (1880). *Schleisiens Chilopoden I*. Chilopoda Anamorpha. Inaugural dissertation. Thesis, Breslau.

Haase, E. (1886). Die Indisch-australianischen Myriapoden, I. Chilopoden, *Abh. Ber K. zool.Anthr. Ethnogr. Mus., Dresden*, 5: 1 –118 (1887).

Haase, E. (1887). Die Indisch-Australischen Myriopoden. Pt. I. Chilopoden -Abhandlungen und Berichte des Königlichen Zoologischen und. Anthropologisch. *Ethnogr. Mus., Dresden*, 5: 1-118: 69.

Hammer, Ø., Harper, D.A.T. and Ryan, P.D. (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica* 4(1): 9pp. Retrieved from *http://palaeo-electronica.org/2001_1/past/issue1_01.htm*

Holloway, J.D. and Stork, N.S. (1991). The dimensions of biodiversity: The use of invertebrates as indicators of human impact. In D.L. Hawksworth (ed). *The Biodiversity of Microorganisms and Invertebrates: Its role in Sustainable Agriculture*. Wallingford: CAB International, 37-62.

Huising, J. and Okoth, P. (2009). Characterisation of Below-Ground Biodiversity in selected benchmark areas in Kenya **.** *Tropical and Subtropical Agroecosystems*, 11 : 3-4.

Hayes, T. and Ostrom, E. (2005). Conserving the World's Forests: Are Protected Areas the Only Way?" *Ind. Law. Rev,* 38(3): 595–61

IBOY. (2000). Soil macrofauna: an endangered resource in a changing world. Report of an international workshop held at IRD, Bondy (France) 19–23 June 2000. Downloadable at URL: http://www.bondy.ird.fr/lest/iboy/workshop-report.pdf.

Jabin, M., Mohr, D., Kappes, H. and Topp, W. (2004). Influence of deadwood on density of soil macro-arthropods in a managed oak-beech forest. *Forest Ecol. Manag*, 194, 61–69.

Jangi, B.S. (1955a). On the Chilopod fauna (Scolopendromorpha) of Nagpur, India. *Ann.Mag. nat. Hist,* 12, *8: 69-80.*

Jangi, B.S. (1955b). On some aspects of morphology of centipede *Scolopendra morsitans* Linn. (Scolopendridae). *Ann. Mag. Nat. Hi.,* 8:597-607.

Jangi, B.S. (1957). The reproductive system in the female of the centipede Scolopendra morsitans Linn. (Scolopendridae). *Ann. Mag. Nat. Hi.,* 12(10): 232-240.

Jangi, B.S. (1959). Further notes on the taxonomy of the centipede *Scolopendra morsitans* Linn. (Scolopendridae). *Ent. News,* 70: 253-257.

Jangi, B.S. (1960). On the Indian Animal Types, 9. Scolopendra, the Indian Centipede. *The Indian Zoological Memoirs, J. Zool. Soc. India*, I-xiv, 1- 109.

Jangi, B.S. (1961). The skeletomuscular mechanism of the so called anal legs in the centipede *Scolopendra amazonica* (Scolopendridae). *Ann. Ent. Soc. Am*. 54:861.

Jangi, B.S. (1964). Sensory Physiology of the anal legs of centipedes. *Curr. Sci*, 33:237-238.

Jangi, B.S. and Dass, C.M.S. (1975). A new form of "sexual dimorphism" in the Indian centipede *Cormocephalus (Cormocephalus) dentipes* Pocock (Scolopendridae) and its bearing on taxonomy of the species. *J.zool. Soc,* India, 27 (1 & 2):113-116.

Jangi, B.S. (1976). Centipede venoms and poisoning. In Anthony T, TU. (ed.), *Handbook of Natural Toxins*. Newyork: Marcel Dekker Inc, 2: 333-368.

Jangi, B.S. and Dass, C.M.S. (1977). Chemoreceptive function of the poison fang in the centipede *Scolopendra morsitans*. *L. Ind. J. Exp. Biol,* 15:803-804.

Jangi, B.S. and Dass, C.M.S. (1978a). Identity and redescription of Indian centipede *Pseudocryptops agharkari* Gravely (Chilopoda: Scolopendromorpha: Scolopendridae). *J.nat. Hist,* 12: 423-426.

Jangi, B.S. and Dass, C.M.S. (1978b). A new species of the genus *Paracryptops* from India, with remarks on the generic and specific characters (Chilopoda: Scolopendromorpha: Cryptopidae). *Zool. J. Linn. Soc,* 64: 327-330.

Jangi, B.S. and Dass, C.M.S. (1979). Redescription of the Indian centipede *Scolopendra mazbii* Gravely (Chilopoda: Scolopendromorpha: Scolopendridae). *Ent. Mon. Mag,* 115: 161-164.

Jangi, B.S. and Dass, C.M.S. (1980a). Revisional notes on the taxonomy of the Indian centipede, *Cormocephalus dentipes* Pocock, with redefinition of the species (Chilopoda: Scolopendromorpha: Scolopendridae). *J. nat. Hist,* 14: 49-53

Jangi, B.S. and Dass, C.M.S. (1980b). A new species of *Trachycormocephalus* Kraepelin (Chilopoda: Scolopendridae). *Ent. Mon. Mag,* 116: 67-70

Jangi, B.S. and Dass, C.M.S. (1984). Scolopendridae of Deccan. *J.Scient.Indl. Res,*43 (2): 27-54.

Jones, C. G., Lawton, J. H. and Shachack, M. **(1997).** Positive and negative effects of organisms as physical ecosystem engineers. *Ecology*, 78(7): 1946–1957.

Joshi, J. and Karanth, K.P. (2011). Cretaceous-Tertiary diversification among select scolopendrid centipedes of South India. *Mol. Phylogenet. Evolv*, 60: 287–294. doi: 10.1016/j.ympev.2011.04.024

Joshi, J. and Karanth, K.P. (2012). Coalescent method in conjunction with niche modelling reveals cryptic diversity among centipedes in the Western Ghats of South India, *PLoS ONE,* 7, doi: e42225. 10.1371/journal.pone.0042225

Joshi, J. and Edgecombe, G. D. (2013). Revision of the scolopendrid centipede Digitipes Attems,1930, from India (Chilopoda: Scolopendromorpha): reconciling molecular and morphological estimates of species diversity. *Zootaxa*, 3626 (1). 99-145.

Karsch, F. (1881). Chinesische Myriopoden und Arachnoideen. Berliner *Entomologische Zeitschrift*, 25: 219-220.

Khanna, V. (1977a). Observations on the food and feeding habits of *Scolopendra valida* Lucas. *Geobios*, 4: 51-53.

Khanna, V. (1977b). Studies on the centipede genus *Trachycormocephalus* Kraepelin (Myriapoda: Scolopendrtomorpha: Scolopendridae) from Rajasthan, India. *Orient. Ins,* 11 (1): 151-156

Khanna,V. (1993). Myriapods in relation to soil: Their identification, Collection and Preservation. *Earthworm Res. and vermiculture,* Kolkata: Zool. Surv. India*,* 123-128.

Khanna, V. (1994a). Centipede Fauna of NE States, India (Chilopoda: Scolopendromorpha). *Rec. Zool. Surv. India,* 94(2-4): 459-472.

Khanna, V. (1994b). Centipede Fauna of Corbett National Park, Uttar Pradesh, India (Chilopoda: Scolopendromorpha: Scolopendridae). . *Rec. Zool. Surv. India*, 94 (2- 4): 329- 350.

Khanna, V. (1994c). Chilopoda: Scolopendridae. In: *Fauna of Conservation Area Series 5: fauna of Rajaji National Park,* Kolkata: Zool. Surv. India*,* 309-316.

Khanna, V. (1994d). Chilopoda: Some ecological observations on the centipede *Cormocephalus* Pocock, with comments on "sexual dimorphism" in the species and on the status of *Cormocephalus pseudonudipes* Jangi and Dass, 1984. In: Fauna *of Conservation area Series 5: Fauna of Rajaji National Park,* Kolkata: Zool. Surv. India, 237-243

Khanna, V. (1994e). Chilopoda: Scolopendromorpha: Scolopendridae). In: Himalayan Ecosystem series. Pt.1: Uttar Pradesh. Kolkata: Zool. Surv. India, 111-113.

Khanna, V. (1997). Chilopoda. In: Fauna *of Conservation Area Series: Fauna of Nanda Devi Biosphere Reserve,* Kolkata: Zool. Surv. India, 105-106

Khanna, V. (1998). Centipedes of Pichola Lake area, Udaipur, Rajasthan (Chilopoda: Scolopendromorpha). In: *Fauna of Fresh Water ecosystem; Fauna of Pichola Lake, Rajasthan*, Kolkatta: Zool. Surv. India, 1-3

Khanna, V. (2001). A check-list of the Indian species of the centipedes (Chilopoda: Scolopendromorpha). *Annals of Forestry*, 9 (2): 199-219.11.

Khanna, V. (2003). Diversity of Scolopendrid centipedes (Chilopoda: Scolopendromorpha) in Himalayan ecosystem and adjacent areas - a review. *Rec. Zool. Surv. India*, 101 (3-4): 207-223.

Khanna, V. (2004). Myriapod diversity in Arunachal Pradesh with a checklist of Scolopendrid centipedes. *Annals of forestry*. 12(2): 259-267.

Khanna, V. (2005). Trends in the distribution of centipedes (Chilopoda: Scolopendromorpha: Scolopendridae and Cryptopidae) known from India. *Annals of Forestry,* 13 (1): 130-140.

Khanna, V. (2006). A checklist of centipedes (Chilopoda: Scolopendromorpha) from Central India. *Zoos' print Journal*. 21(2): 2164-2166.

Khanna, C. (2007). Centipede Fauna of Corbett National Park, Uttar Pradesh, India. In: *Faunal resources of Western Doon Shiwalik,* Kolkata: Zool. Sur, Ind. 1:145.

Khanna,V. (2008). National Register of the valid species of Scolopendrid Centipedes (Chilopoda: Scolopendromorpha) in India. *Biosystematica,* **1**(2): 33-45

Khanna, V. (2010). Chilopoda: Scolopendromorpha . In: Fauna of Ranthambhore National Park, Conservation Area Series, Kolkata: Zool. Surv. India. 43: 61-66.

Khanna, V. and Kumar, A. (1984). Scolopendrid centipedes of Western Himalaya, U.P., with an annotated list of Indian species (Chilopoda: Scolopendromorpha: Scolopendridae). *Uttar Pradesh. J. Zool,* 4(1): 83-98.

Khanna, V. and Tripathi, J.C. (1984). Observations on the seasonal incidence within the centipede genus *Cormocephalus* (Chilopoda: Scolopendridae). *Uttar Pradesh. J. Zool,* 4(2): 217-219.

Khanna, V. and Tripathi, J.C. (1985). On a new species of the centipede genus *Rhysida* Wood from Himachal Pradesh, India (Chilopoda: Scolopendridae: Otostigmini). *Annals entomol.,* 3(1): 19-24.

Khanna, V. and Tripathi, J.C. (1986). On a new species of the centipede genus *Otostigmus* Porat from Himachal Pradesh, India (Chilopoda: Scolopendridae: Otostigmini). *Annals entomol.,* 4 (1): 35-39

Khanna, V. and Tripathi, J.C. (1987). *Trachycormocephalus paranudus,* a new Scolopendrid centipede from Hissar district, Haryana, India. *Bull. Soc. Ent. Ital. Genova*, 119: (2): 91-93.

Khanna, V. and Yadav, B.E. (1997). Indian species of the centipede genus *Scolopendra,* with a key to their identification (Chilopoda: Scolopendridae). *Rec. Zool. Surv. India,* 96 (1-4): 211-220.

Kirby, K.R. and Potvin, C. (2007). Variation in carbon storage among tree species: Implications for the management of a small-scale carbon sink project. *Forest Ecol. Manag*, 246 (2-3): 208- 221.

Koch, L. (1878). Japanesische Arachniden und Myriapoden. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien,* 27: 791.

Koch, L.E. (1983). A taxonomic study of the centipede genus *Ethmostigmus* Pocock (Chilopoda: Scolopendridae: Otostigminae) in Australia. *Aust. J. Zool*, 31: 835-849: 837.

Koch, L.E. (1985). Taxonomy of the Australian genus *Rhysida* Wood (Chilopoda: Scolopendridae: Otostigminae). *J. nat. Hist.* 19: 205-214.

Koch, L. and Bergman, M.A. (1984). The Zoogeography and Phylogenetic relationships of three genera of Australian centipedes (Chilopoda: Scolopendridae). *Aust. J. Zool,* 32: 507-518.

Kohlrausch, E. (1878). *Beiträge zur Kenntniss der Scolopendriden*. Inaugural-Dissertation, Marburg, 22.

Kohlrausch, E. (1881). Gattungen und Arten der Scolopendriden. *Archiv. Fü.r Naturgeschichte*, 47: 50-132

Kraepelin, K. (1903). Revision der Scolopendriden (Scolopendromorpha). *Mitt. Mus.,*Hamburg, 20: 1-276.

Kraepelin, K. (1908). In: W. Michaelsen & R. Hartmeyer (ed.). Die Fauna Südwest-Australiens Ergebnisse der Hamburger südwest-australischen Forschungsreise 1905. 2, Lief 8: 105–128.

Kremen, C., Colwell, R.K., Erwin, T.L., Murphy, D.D., Noss, R.F. and Sanjayan, M.A. (1993). Terrestrial arthropod assemblages: their use in conservation planning. *Conserv. Biol,* 7: 796–808.

Kronmüller, C. and Lewis, J.G.E. (2012). Review of the subspecies of *Scolopendra subspinipes* Leach, 1815 with the new description of the South Chinese member of the genus *Scolopendra* Linnaeus, 1758 named *Scolopendra hainanum* spec. nov. (Myriapoda, Chilopoda, Scolopendridae). *Spixiana*, 35 (1): 19-27.

Kronmüller, C. and Lewis, J.G.E. (2015). On the function of the ultimate legs of some Scolopendridae (Chilopoda, Scolopendromorpha). *ZooKeys.* 510:269-278. doi: 10.3897/zookeys.510.8674.

Laterille, P.A. (1817). Les Myriapodes. In, *Le regne animal.* 3G.L.C.F. D Cuvier. (ed). Paris: Deterville.

Lavelle, P. and A. V. Spain. (2001). Soil Ecology. Amsterdam, NL: Kluwer Scientific Publication: 153.

Lawrence, R.F. (1955). Chilopoda. Results of the Lund University Expedition in 1950-1951 .*South African Animal Life*, 2: 4-56.

Lawrence, R. (1960). Faune de Madagascar 12.*Myriapodes Chilopodes*,76-84.

Lawrence, R.F. (1975). The Chilopoda of South West Africa .*Cimbebasia*, *Series* A, 4: 35-45.

Lawrence, R. F. (1984). *The Centipedes and Millipedes of Southern Africa*. Cape Town & Rotterdam: A. N. Balkema.

Leach, W.E. (1814). *The Edinburgh Encyclopedia,* In: Brewster D (ed.). 7: 408–409.

Leach, W.E. (1815). A tabular view of the external characters of four classes of animals which Linné arranged under Insecta, with the distribution of the genera composing three of these classes into orders etc., and descriptions of several new genera and species. *Trans. Linn. Soc. London*. 1 (11):306-400.

Leach, W.E. (1817). The zoological miscellany, being the descriptions of new ar interesting animals. III. XII. In: *The characters of the genera of the class Myriopoda*. London: Taylor, 3: 36.

Lewis, J.G.E. (1968). On the identity of African centipedes Ethmostigmus australianus stechowi Verhoeff and Pseudocryptops walkeri Pocock (Chilopoda: Scolopendromorpha). *J. Nat. Hist.* 2: 173-176.

Lewis, J.G.E. (1972). The population density and biomass of of the centipede Scolopendra amazonica (Bucherl) (Scolopndromorpha: Scolopendridae) in sahel savannah Nigeria. *Ent. Mon. mag*, 108: 16-18.

Lewis, J.G.E. (1973). The taxonomy, distribution and ecology of centipedes of the genus Asanada (Scolopendromorpha: Scolopendridae) in Nigeria. *Zool. J. Linnean. Soc*, 97–112.

Lewis, J.G.E. (1978). Variation in tropical scolopendrid centipedes: problems for the taxonomist. *Abh. Verh. Naturwiss. Ver. Hamburg. (NF),* 21/22: 43-50.

Lewis, J. G. E. (1981). *The Biology of Centipedes*. Cambridge, England: Cambridge University Press.

Lewis, J.G.E. (1986). The genus *Trachycormocephalus*, a junior synonym of *Scolopendra*, with remarks on the validity of the other genera of the tribe Scolopendrini (Chilopoda: Scolopendrini). *J. nat. Hist.,* 20: 1083-1089.

Lewis, J.G.E. (1992). Scolopendrid centipedes from Nepal and Kashmir (Chilopoda: Scolopendromorpha). *Senckenbergiana boil.* 72(4/6): 435-456.

Lewis, J.G.E. (1996). The type specimens and identity of the species described in the genus *Otostigmus* (subgenus *Otostigmus*) by R.I. Pocock in the collection of the Natural History Museum, London (Scolopendromorpha: Scolopendridae), *J. nat. Hist,* 30 : 823-834.

Lewis, J.G.E. (1999). On the genus *Cryptops* Leach in Nepal with redescriptions of *Cryptops australis* Newport and *C. doriae* Pocock (Chilopoda: Scolopendromorpha: Cryptopidae). *Senckenbergiana. boil.* 79: (1): 19-38.

Lewis, J.G.E. (2001). The scolopendrid centipedes in the collections of the National Museum of Natural History in Sofia (Chilopoda: Scolopendromorpha: Scolopendridae). *Historia Naturalis Bulgarica*, 13: 5-51.

Lewis, J.G.E. (2002a). The true identity of the Ethiopian centipede *Scolopendra gardullana* Attems (Chilopoda: Scolopendromorpha; Scolopendridae). *Afr. Invertebr*, 43: 1-3:1.

Lewis, J.G.E. (2002b). A re-examination of 11 species of Otostigmus from the Indo-Australian region described by R. V. Chamberlin based on types specimens in the collection of the Museum of Comparative Zoology, Harvard (Chilopoda; Scolopendromorpha; Scolopendridae). *J. Nat. Hist,* 36: 1687-1706.

Lewis J.G.E. (2002c). The scolopendromorph centipedes of Mauritius and Rodrigues and their adjacent islets (Chilopoda: Scolopendromorpha). *J. Nat. Hist.*. 36: 96.

Lewis, J.G.E. (2003). On the identity of the various taxa that have been assigned to *Otostigmus (O.) politus* Karsch, 1881 and forms related thereto (Chilopoda: Scolopendromorpha). *Arthropoda. Sel,* 12: 193-206.

Lewis, J.G.E. (2004a). Type specimens of three species of *Otostigmus* described from Indo-China by Carl Attems (Chilopoda; Scolopendromorpha: Scolopendridae). *Ann. Naturhist. Mus., Wien*, 105 B: 27-53.

Lewis J.G.E. (2004b). Redescription and reassessment of the type material of the African centipedes *Otostigmus reichardti* Kraepelin and *Otostigmus tanganjikus* Verhoeff, with remarks on the genera *Digitipes* Attems, *Otostigmus* Porat and *Rhysida* Wood (Chilopoda Scolopendromorpha). *Afr. Invertebr*, 45: 179-286: 280.

Lewis, J.G.E. (2006a). On the scolopendromorph centipede genus *Mimops* Kraepelin, 1903, with a description of a new family (Chilopoda: Scolopendromorpha) . *J. Nat. Hist*, 40: 1231 – 1239: 248.

Lewis, J. G. E. (2006b). *The Biology of Centipedes*. Cambridge: Cambridge University Press. 9780521034111. 1-457.

Lewis, J. G. E. (2009). A review of some characters used in the taxonomy of Cryptops (subgenus Cryptops) (Chilopoda: Scolopendromorpha: Cryptopidae). *Soil Organisms*. 81: 505-518.

Lewis, J.G.E. (2010a). A key and annotated list of the *Scolopendra* species of the Old World with a reappraisal of *Arthrorhabdus* (Chilopoda: Scolopendromorpha: Scolopendridae). *Int. J. Myriap*, 3: 83-122.

Lewis, J.G.E. (2010b). A revision of the *rugulosus* group of *Otostigmus* subgenus *Otostigmus* Porat, 1876 (Chilopoda: Scolopendromorpha: Scolopendridae). *Zootaxa*, 2579: 1-29.

Lewis, J. G. E. (2010c). On the function of the ultimate legs of Cryptops and Theatops (Chilopoda, Scolopendromorpha). *Int. J. Myriap.* 3 (2010) 145-151. doi: 10.1163/187525410X12578602960542.

Lewis J.G.E. (2011a). A review of the species in the genus *Cryptops* Leach, 1815 from the Old World related to *Cryptops (Cryptops) hortensis*(Donovan, 1910) (Chilopoda, Scolopendromorpha). *Int.J. Myriap*. 4: 11-50.

Lewis J.G.E. (2011b). Redescription and validity of *Cryptops nanus* Attems, 1938 from Hawaii (Chilopoda: Scolopendromorpha). *Ann. Nat.hist. Mus. Wien,* B(112): 133-136.

Lewis, J.G.E. (2012). Scolopendromorph centipedes from Seychells with a review of previous records. *Phelsuma,* 15: 8-25.

Lewis, J.G.E. (2014). Paedomorphosis in the scolopendrid centipede genus *Asanada* (Chilopoda: Scolopendromorpha) explains incongruence between morphological and molecular data sets. *Zootaxa,* 3785:38-44. doi: 10.11646/zootaxa.3785.1.3.

Lewis, J.G. E. and Cole, N. C. (2007). *Rhysida longipes longipes* (Newport, 1845) in the Chagos Islands. *Phelsuma*, 15:82 – 84.

Linnaeus C. (1758). *Systema Naturae*. Editio Decima. Holmiae, 1: 637.

Manfredi, P. (1953). Miriapodi Italiani (VIII Contributo). *Atti della Società Italiana di Scienze Naturali,* 92: 117-122.

Manton, S.M. (1952). The evolution of arthropod locomotory mechanisms. Part 3. The locomotion of Chilopoda and Pauropoda. *J. Linn. Soc.(Zool),* 42:118-66**.**

Manton, S.M. (1958). Habitats of life and evolution of body design in Arthropoda. *J. Linn. Soc.(Zool),* 44:58-72**.**

Manton, S.M. (1964). Mandibular mechanisms and evolution of arthropods, *Phil. Trans. R. Soc*. B. 247: 1-183.

Manton, S.M. (1977). *The Arthropoda, habitats, functional morphology and evolution.* Oxford: Clarendon press.

Maschwitz, U., Lauschke, U. and Würmli, (1976). Hydrogen cyanide producing glands in a Scolopendra, Asanada sp. (Chilopoda, Scolopendridae). *J. chem. Ecol.* 5(6): 901-907.

Matic, Z., Negrea, S.G., and Martinez, F. C. (1977). Recherches sur les Chilopodes hypogés de Cuba. In: Résultats des Expéditions Biospéléologiques Cubano-Roumaines à Cuba. II . *Editura Academiei Republicii Socialiste Romania*, Bucuresti, 2: 277-30.

Meinert, F. (1886). Myriapopda Musei centabrigensis. Part I. Chilopoda. *Proc. Amer. Phil. Soc.,* 23: 161-233.

Minelli A., Bonato, L. and Dioguardi, R. (2006 onwards). *Chilobase:a web resource for Chilopoda taxonomy.* Publicly searchable at *http://chilobase.bio.unipd.it*

Moreira, F. M. S., Huising, E. J. and Bignell, D.E. (2008). A Handbook of Tropical Soil and Biology: Sampling and Characterization of Below-ground Biodiversity. London, UK: Earthscan.1- 16.

Nair, S.C. (1991). *The Southern Western Ghats: A Biodiversity Conservation Plan*. New Delhi, INTACH.

New, T.R. (1999). Untangling the web: spiders and the challenges of invertebrate. *J. Insect. Conserv*. 4:251-256

Newport, G. (1844a). Conclusion of the monograph on the Myriapoda Chilopoda. *Proc. Lin. Soc. Lon*, 1: 191-197: 193.

Newport, G. (1844b). A list of the species of Myriapoda, Order Chilopoda, contained in the cabinets of the British Museum with synoptic descriptions of forty-seven new species. *Ann. Mag. Nat. Hist.,* 13: 94-101.

Newport, G. (1845). Monograph of the class Myriapoda order Chilopoda; with observations on the general arrangement of the Articulata . *Trans. Linn. Soc, London*, 19: 265-302, 349-439: 411.

Pereira, L. A. (2000). The preparation of centipedes for microscopical examination with particular reference to the Geophilomorpha. Bulletin of the British

Myriapod and Isopod Group, 16: 22–25.

Peters, W. (1855). Über die Myriapoden im allgemeinen und insbesondere über die in Mossambique beobachteten Arten dieser Familie. *Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin*, 14: 2.

Plateau, F. (1886). Recherches sur la perception de la lumiere par les Myriapodes aveugles. *J. anat. Physiol*, 22: 431: 457.

Pocock, R.I. (1890). Report upon a small collection of Scorpions and centipedes sent from Madras by Mr. Edgar Thurston of Government Central Museum. *Ann. nat. Hist.,* ser.6, 5: 244-249.

Pocock, R.I. (1891a). Notes on the synonymy of some species of Scolopendridae with descriptions of new genera and species of the group. *Ann. nat. Hist.,* ser.6, 7: 51-68 and 221-231.

Pocock, R.I. (1891b). On the Myriopoda of Burma. Part 2. Report upon the Chilopoda collected by Sig. L. Fea and Mr. E. W. Oates. *Annali del Museo Civico di Storia Naturale di Genova,* (2)10: 401-432.

Pocock, R.I. (1892). Report upon two collections of Myriapoda sent from Ceylon by Mr. E. E. Green and from various parts of Southern India by Mr. Edgar Thurston of the Government Central Museum Madras. *Journal of the Bombay Natural History Society*, 7(2): 131-174.

Pocock, R.I. (1893) Report upon two collections of Myriapoda sent from Ceylon by Mr.E.E.Green and various parts of south India by Mr. Edgar Thurston of Government Central Museum, Madras. *J. Bombay nat. Hist. Soc.,* 7: 131-171.

Pocock, R.I. (1896), Chilopoda and Diplopoda. *Biologia Centrali Americana*: 217: 28.

Pocock, R.I. (1897). Solifugae, Scorpiones, Chilopoda and Diplopoda. Appendix C. In: Donaldson Smith A. (ed.), *Through unknown African Countries*. New

York: Greenwood Press, XVI + 454: 403.

Pocock, R.I. (1898). List of the Arachnida and "Myriopoda" obtained in Funafuti by Prof. W.J. Sollas ad Mr. Stanley Gardiner, and in Rotuma by Mr. Stanley Gardiner. *Ann. Mag. Nat. Hist*, (7)1: 327.

Pocock, R, I. (1899). The expedition to Sokotra. Descriptions of the new species of scorpions centipedes and millipedes. *Bull.Lpool Mus*, 2: 7-9: 9.

Porat, C.O. von. (1871). Myriopoda Africae australis in Museo Regio Holmiensi asservata recensuit. Pars I. Chilopoda . *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar*, 28: 1135-1167.

Porat, C.O. von. (1876). On nagra exotica Myriapoder. *Bih.K. Svenska vetensk. Handb.,* 4(7): 1-48.

Rajulu, G. S. (1973). Moulting, moult cycle of a centipede Ethmostigmus spinosus (Chilopoda: Myriapoda). *Curr. Sci*, 42: 205-206.

Raman, T. R. S. and Mudappa, D. (2003). Bridging the gap: Sharing responsibility for ecological restoration and wildlife conservation on private lands in the Western Ghats. *Social Change,* 33(2&3): 129 -141.

Rathinasabhapathy, B. and Daniel, B.A. (1997). Notes on Tiger centipede (*Scolopendra hardwickei* Newport) from Coimbatore Zoological Park Site, Anaikatty, Western Ghats. *Zoos Print,* 12 (8): 1.

Ribaut, H. (1915). Biospeologica XXXVI. Notostigmophora, Scolopendromorpha, Geophilomorpha. *Archives de Zoologie Expérimentale et Générale*, 55: 323-346

Ruiz, N. and Lavelle, P. (2008). Soil Macrofauna Field Manual-Technical Level. FAO.Rome. Retrieved from *http://www.fao.org/3/a-i0211e.pdf*.

Schileyko, A.A. (1992). Scolopenders of Viet-Nam and some aspects of the system of Scolopendromorpha (Chilopoda: Epimorpha). *Arthropda. Sel,* 1(1), 5–19.

Schileyko, A.A. (1996). Some problems in the systematics of the order Scolopendromorpha (Chilopoda). *Mem. Mus. Natn. Hist. Nat*, 169: 293-297.

Schileyko, A.A. and Pavlinov, I.J. (1997). A cladistic analysis of the order Scolopendromorpha (Chilopoda). *Entomologica Scandinavica Supplement*, 51, 33–40.

Schileyko, A.A. and Stagl, V. (2004). The collection of scolopendromorph centipedes (Chilopoda) in the Natural History Museum in Vienna: a critical re-evaluation of former taxonomic identifications. *Ann. Nat.hist. Mus. Wien*, Serie B, 105B: 67-137.

Schowalter, T.D. and Ganio, L.M. (2003). Diet, seasonal and disturbanceinduced variation in invertebrate assemblages. Y. Basset, V. Novotny, S.E. Miller and R.L. Kitching (Ed). *Arthropods of tropical forests*. Cambridge, UK: Cambridge University Press, 315–328.

Shakir, M. M. and Ahmed, S. (2015). Seasonal abundance of soil arthropods in relation to meteorological and edaphic factors in the agroecosystems of Faisalabad, Punjab, Pakistan. *Int. J. Biometeorol*. 59(5): 605-16, doi 10.1007/s00484-014-0874-9.

Shelley, R.M. (1997). The Holarctic centipede subfamily Plutoniuminae (Chilopoda: Scolopendromorpha: Cryptopidae) (nomen correctum ex subfamily Plutoniinae Bollman, 1893). *Brimleyana*, 24, 51–113.

Shelley, R. M. (2000). The centipede order Scolopendromorpha in the Hawaiian Islands (Chilopoda). Bishop. *Mus. Occ. Pap,* 64: 41.

Shelley, R., Perreira,W. D. and Yee, D.A. (2004). The centipede *Scolopendra morsitans* L., 1758, new to the Hawaiian fauna, and potential representatives of the "*S. subspinipes* Leach, 1815, complex" (Scolopendromorpha: Scolopendridae: Scolopendrinae). *Insecta mundi,* 0338: 1-4.

Silvestri, F. (1895). Chilopodi e diplopodi della Papuasia. *Annali del Museo Civico di Storia Naturale di Genova*, 34: 629

Silvestri, F. (1924). Myriapoda from Siju Caves, Garo Hills, Assam. *Rec. Indian Mus,* 31: 263-267.

Siriwut, W., Edgecombee, G.D., Sutcharit, C., Tongkerd,P. and Panha, S. (2015a). First record of the African-Indian centipede genus *Digitipes* Attems, 1930 (Scolopendromorpha: Otostigminae) from Myanmar, and the systematic position of a new species based on molecular phylogenetics. *Zootaxa*, 3931 (1): 071–087.

Siriwut, W., Edgecombee, G.D., Sutcharit, C., Tongkerd, P. and Panha, S. (2015b). The Centipede Genus Scolopendra in Mainland Southeast Asia: Molecular Phylogenetics, Geometric Morphometrics and External Morphology as Tools for Species Delimitation**.** *PLoS ONE,* 10(8), retrieved from *http://dx.doi.org/10.1371/journal.pone.0135355*.

Sureshan, P.M., Yadav, B.E. and Radhakrishnan, C. (2003). An illustrated key to the identification of centipedes (Chilopoda: Scolopendromorpha) of Kerala. *Zoos'. Print*, 19, 1401–1407.

Sureshan, P.M., Khanna, V. and Radhakrishnan, C. (2006a). Additional distributional records of scolopendrid centipedes (Chilopoda: Scolopendromorpha) from Kerala. *Zoos'. print*, 21(6): 2285-2291.

Sureshan, P.M., Dash, S. and Samanta, T. (2006b). On a Collection of Scolopendrid Centipedes (Chilopoda: Scolopendromorpha) from Orissa with Notes on Some New Distributional Records. *Rec. zool. Surv. India*: l06(3): 27-34

.

Sureshan, P.M. and Yadav, B.E. (2008a). Chilopoda: Scolopendromorpha.In: *Fauna of Lonar Wildlife Sanctuary, Conservation Area Series*. Kolkata: Zool. Surv. India, 37:155-158.

Sureshan, P.M. and Yadav, B.E. (2008b). Chilopoda: Scolopendromorpha.In: *Fauna of Goa, State Fauna Series*. Kolkata: Zool. Surv. India, 16:73-77.

Takakuwa, Y. (1935). On three Japanese chilopods. *Dobutsugaku Zasshi,* 47: 289-294.

Takakuwa, Y. (1936). Über die japanischen Cryptops Arten. *Trans. Sapporo. Nat. Hist. Soc,* 14: 236-241.

Takakuwa, Y. (1939). Bothropolys-Arten aus Japan. *Transact. Nat. His. Soc, Formosa*, 29: 103-110.

Takakuwa, Y. (1940). Eine neue Art von Otostigmus (Chilopoda) aus Formosa. *Transact. Nat. His. Soc, Formosa,* 30: 209.

Tilak, R. and Roy, P. (1988). On an interesting case of parental care and distribution of *Cormocephalus dentipes* Pocock (Chilopoda: Scolopendromorpha: Scolopendridae). *J. Bombay. Nat. Hist. Soc.* 85 (1): 228-229.

Verhoeff, K.W. (1906). Vergleichend-morphologische Studie über die coxopleuralen Körperteile der Chilopoden, mit besonderer Berücksichtigung der Scolopendromorpha, ein Beitrag zur Anatomie und Systematik derselben, nebst physiologischen und phylogenetischen Mitteilungen und Aus. *Nova Acta Leopoldina*. 86: 353-500.

Verhoeff, K.W. (1907). Chilopoda. In: Bronn H. G. (ed*), Klassen und Ordnungen des Tierreiches*. Winter: Leipzig, 5 (2): 725

Verhoeff, K.W. (1934). Beiträge zur Systematik und Geographie der Chilopoden. Zoologische Jahrbücher, *Abteilung für Systematik,* 66: 39.

Verhoeff, K.W. (1937). Zwei neue Myriapoden -Gattungen aus Indien und ihre stellung. *Zool. Anz.,* 120: 81-89.

Verhoeff, K.W. (1938). Chilopoden Studien, zur Kenntnis der Epimorphen. *Zool. Jahrb. (Syst.)*, 71: 338-388.

Wood, H.C.jr. (1861). Description of new species of Scolopendra in the collection of the Academy. *Proc. Acad. Nat. Philadelphia,* (1861): 11.

Wood, H.C. Jr. (1862). On the Chilopoda of North America with a catalogue of all

the specimens in the collection of the Smithsonian Institution. *J. Acad. Nat. Sci. Phila,* 5(1): 5-52.

Würmli, M. (1972). Chilopoda von Sumba und Flores II. Geophilomorpha Lithobiomorpha Scutigeromorpha. *Verhandlungen der Naturforschenden Gesellschaft in Basel,* 82: 93.

Yadav, B.E. (1993a). Colour variation in the centipede *Scolopendra morsitans* Linn. (Myriapoda: Chilopoda) from Maharashtra. *Rec. zool. Surv. India,* 93 (1-2): 159-160.

Yadav, B.E. (1993b). On a collection of centipedes (Myriapoda: Chilopoda) from Pune, Maharashtra. *Rec. zool. Surv. India,* 93 (1-2): 165-174.

Yadav, B.E. (1994). The scolopendrid centipedes. *Science and Culture*. 60(6-12):77-79.0

Yadav, B.E. (2001). Centipedes (Chilopoda: Scolopendridae). In: *Fauna of Nilgiri Biosphere Reserve*, Fauna of Conservation Area Series, Kolkata: Zool. Surv. India. 11:39-44.

Yadav, B.E. (2005). Chilopoda: Scolopendromorpha . In: *Fauna of Melghat Reserve*, Conservation Area Series, Kolkata: Zool. Surv. India, 24: 401-410.

Yadav, B.E. (2006a). Chilopoda: Scolopendromorpha**.** In: *Fauna of Tadoba Andhari Tiger Reserve*, Conservation Area Series, Kolkata: Zool. Surv. India, 25: 279-282.

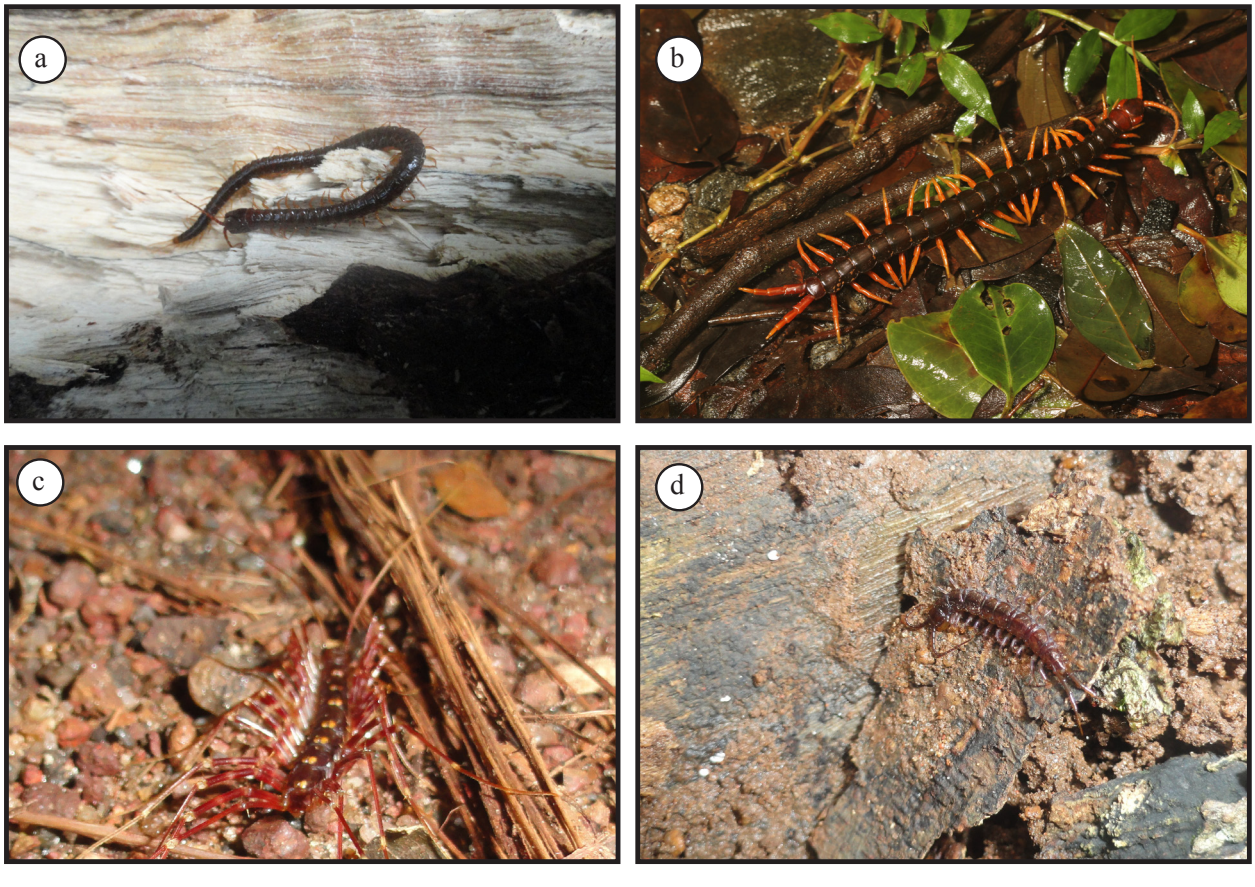
Yadav, B.E. (2006b). Chilopoda: Scolopendromorpha . In: *Fauna of Sanjay Gandhi National Park*, Conservation Area Series, Kolkata: Zool. Surv. India, 26: 125-129.

Yadav, B.E. (2009). Chilopoda: Scolopendromorpha. In: *Fauna of Bhimasankar Wildlife Sanctuary,* Conservation Area Series, Kolkata: Zool. Surv. India, 42: 1-12.

Biodiversity. (n.d) GoK: Information & Public Relation Department. Retrieved January 15, 2016 from. *http://www.prd.kerala.gov.in/biodiv.htm.*

Invertebrate conservation. (n.d). Newyork, NY: AMNH. Retrieved from *http://www.amnh.org/our-research/center-for biodiversityconservation/research species-based-research/invertebrate-conservation/.*

Plate - 1



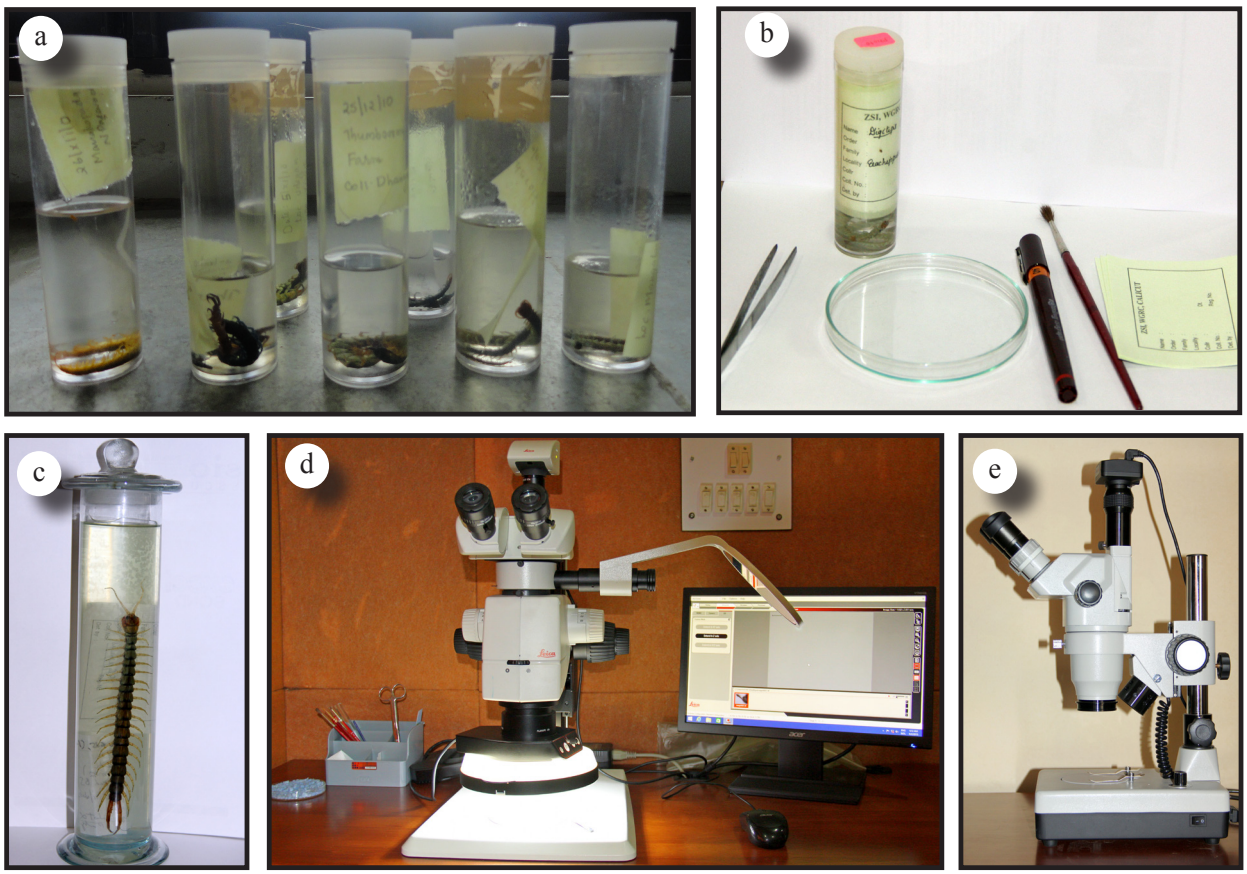
Orders of Class Chilopoda

a. Geophilmorpha
b. Scolopendromorpha
c. Scutigeromorpha
d. Lithobiomorpha

Plate - 2

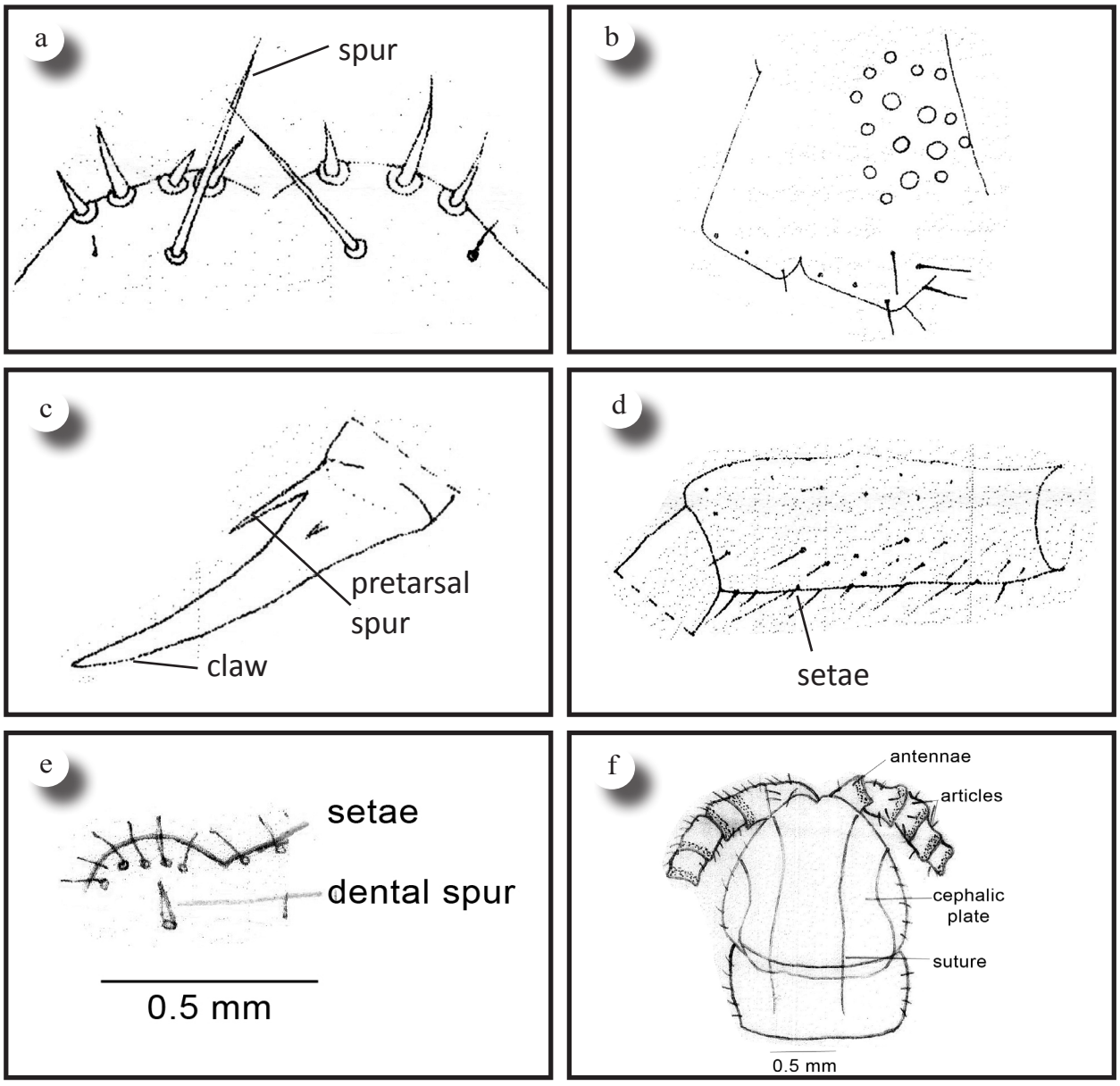
Habitats and collection methods

Plate - 3



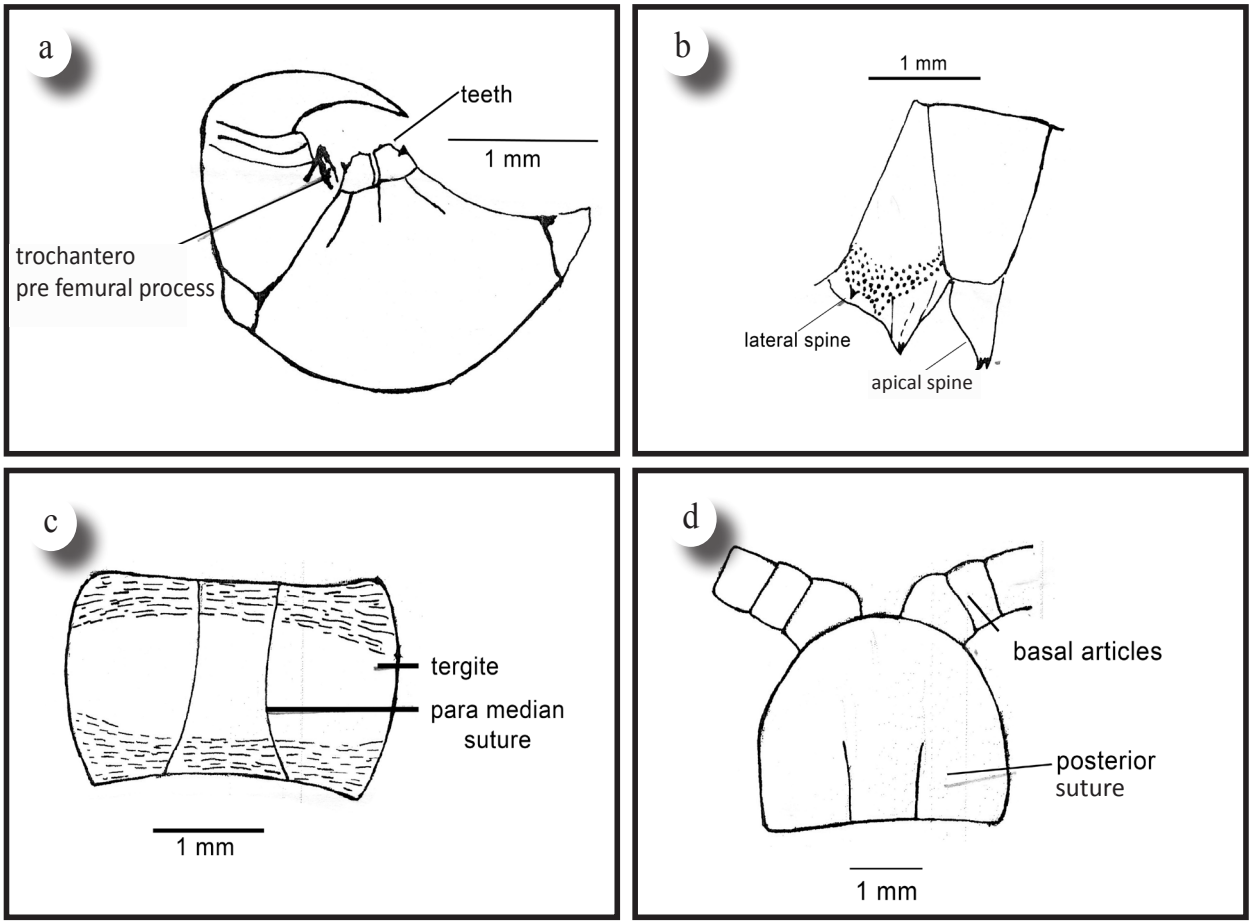
Storing, Preservation, Identification and Photographic equipments

Plate - 4



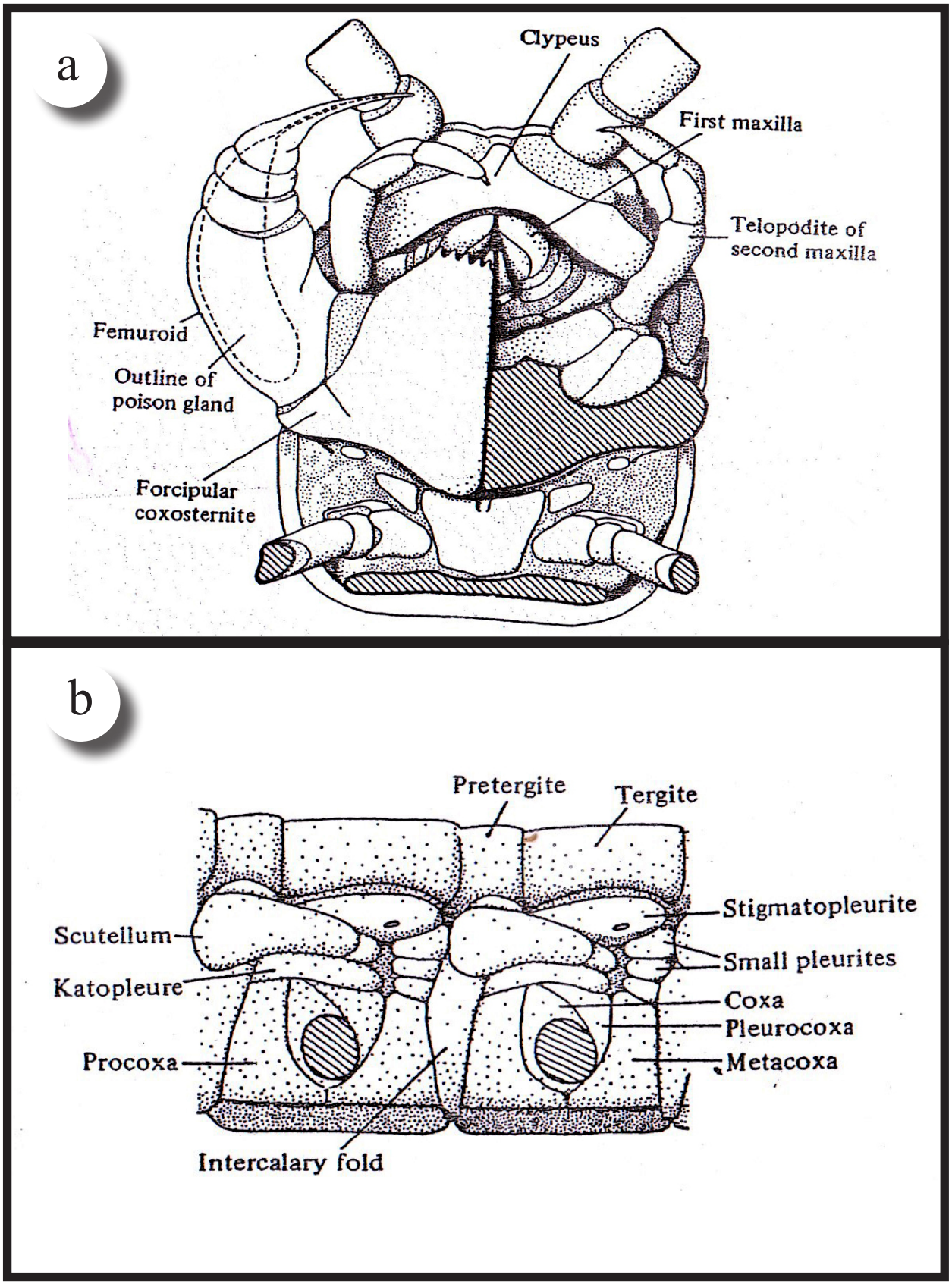
a.Anterior margin of forcipular coxosternite with spurs
b.Coxopluron with hairs
c. Claw with pretarsal spur
d. Seta from ultimate leg prefemur(after Lewis, 2011)
e. Anterior margin of forcipular coxosternite with dental spur and seate
f. Antennal article with hairs and cephalic plate with sutures

Plate - 5



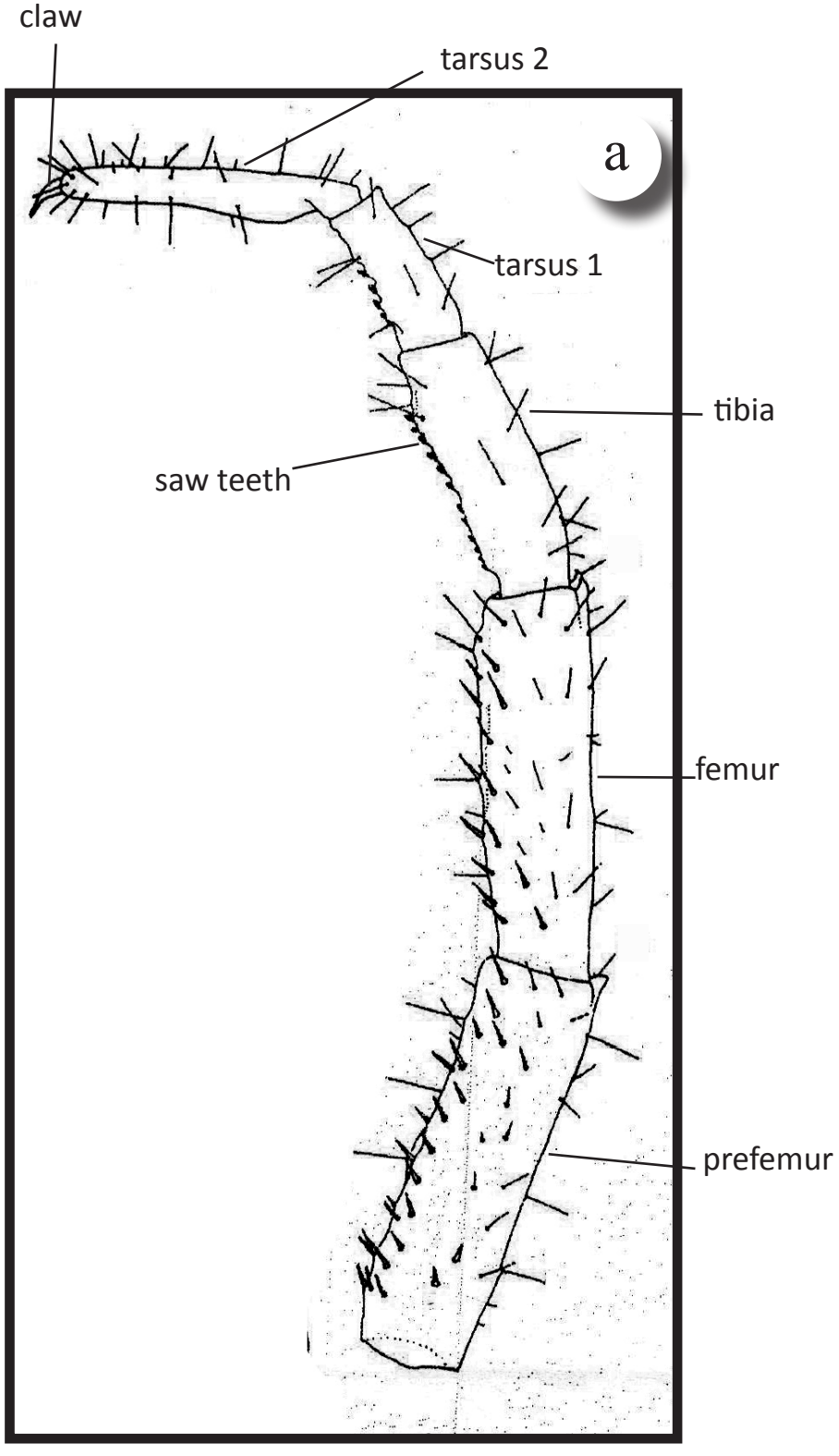
a.Cephalic plate and forcipular segment
b.Coxopleuron
c.tergite with paramedian sutures
d.Cephalic plate with posterior sutures

Plate - 6



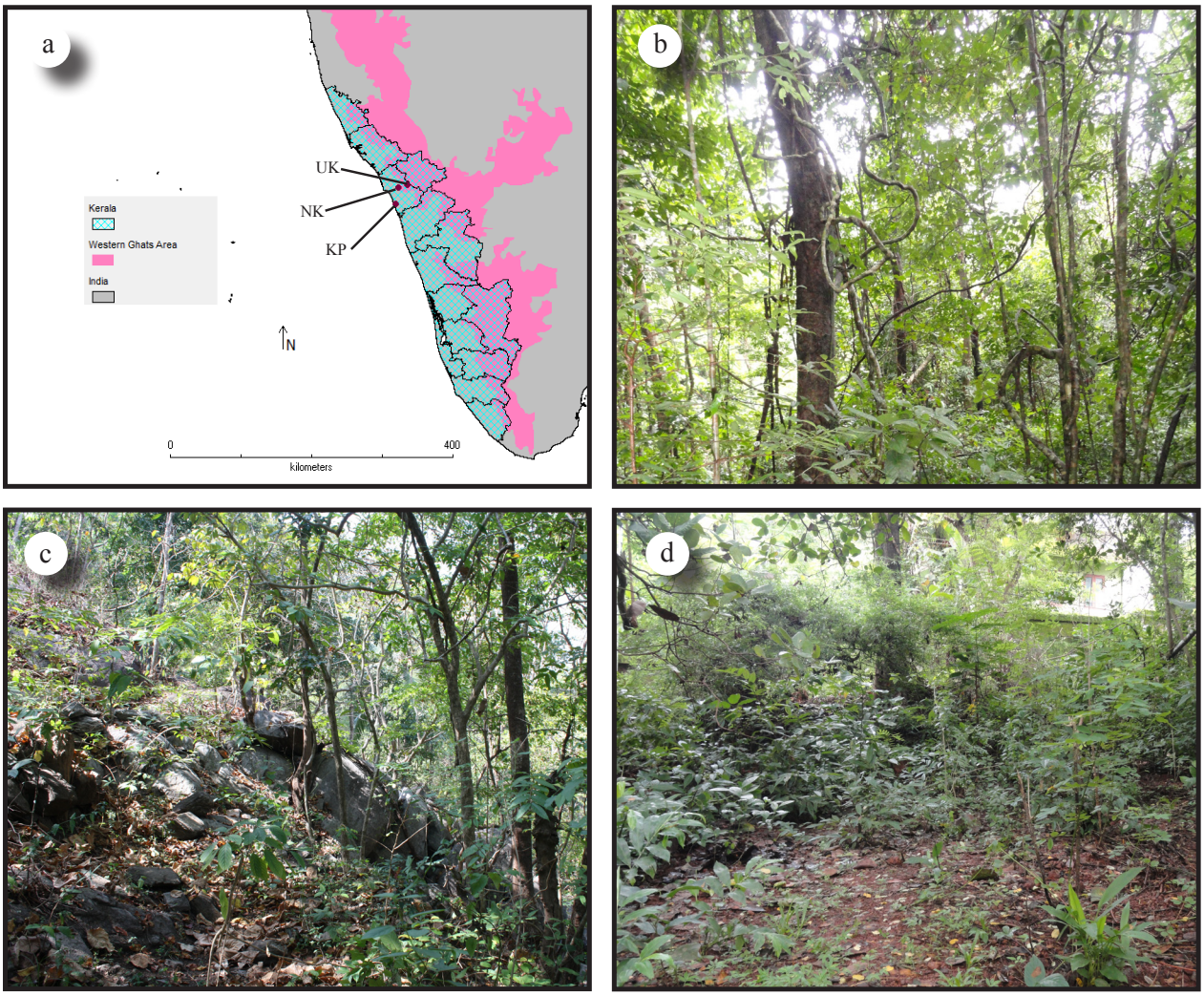
a.Ventral view of head, forcipules and first leg bearing segment (after Rilling, 1968)
b.Lateral view of two trunk segments (after Manton, 1965)

Plate - 7



a. Ultimate leg (after Brolemann, 1930)

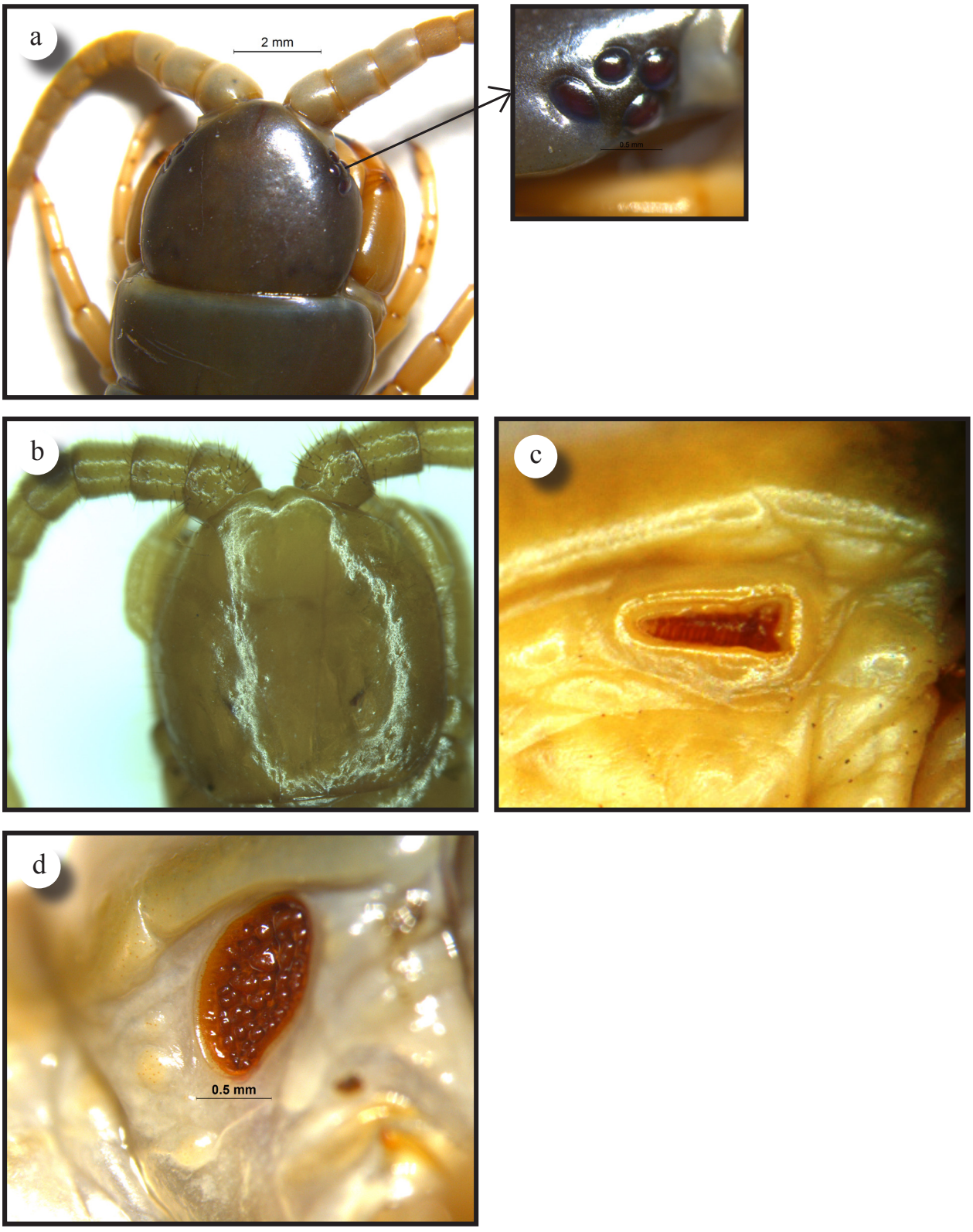
Plate - 8



Study Areas for Ecological studies

a. Map showing study areas for ecological studies.
b. Site 1: Urakkuzhy, Kakkayam, Malabar Wildlife Sanctuary(UK)
c. Site 2:Narayankulam, Kozhikode (NK)
d. Site 3: Kuttothparambu, Kozhikode(KP)

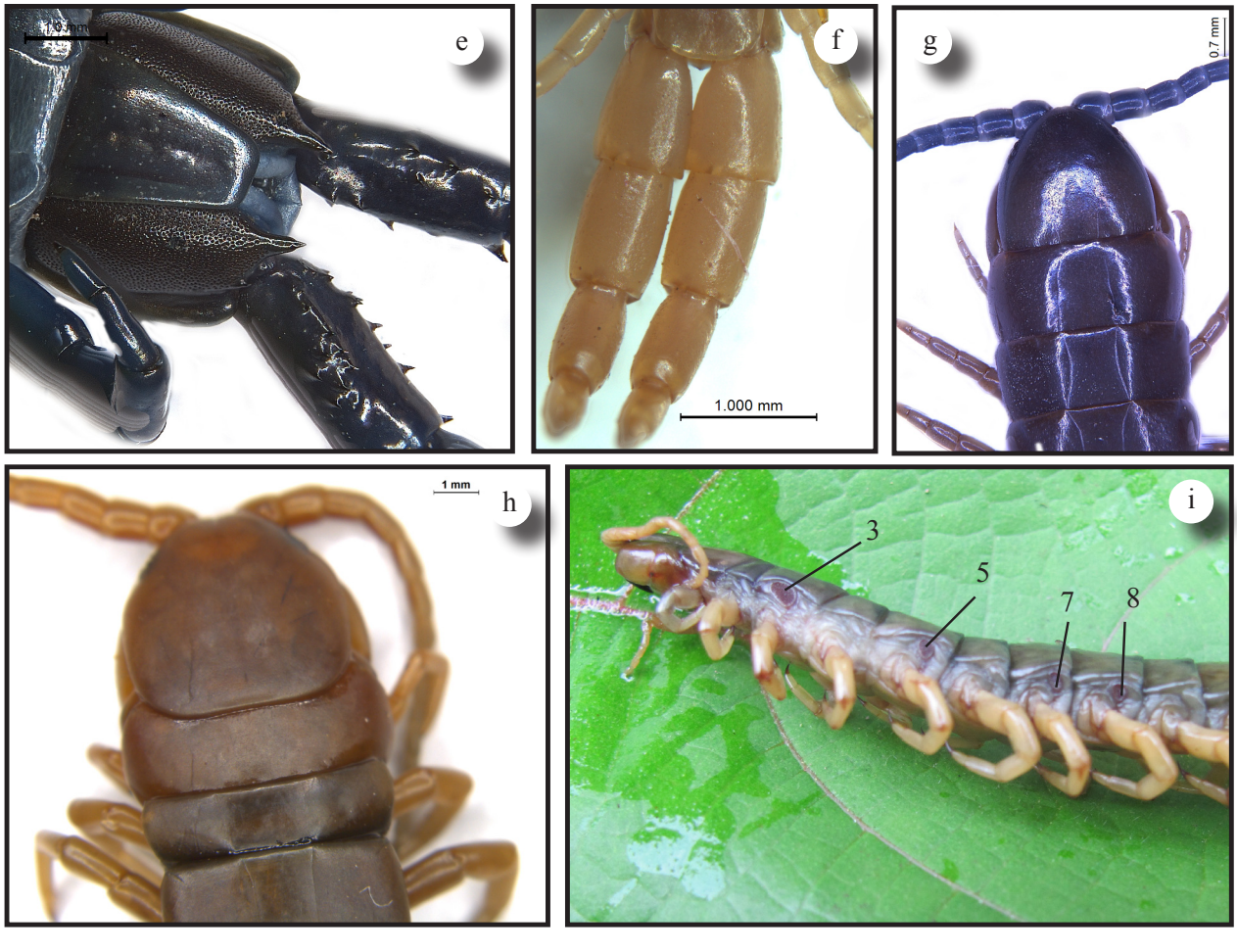
Plate - 9



Key characters of Scolopendromorpha

a. ocelli
b. absence of ocelli
c. triangular spriracle
d. oval spiracle

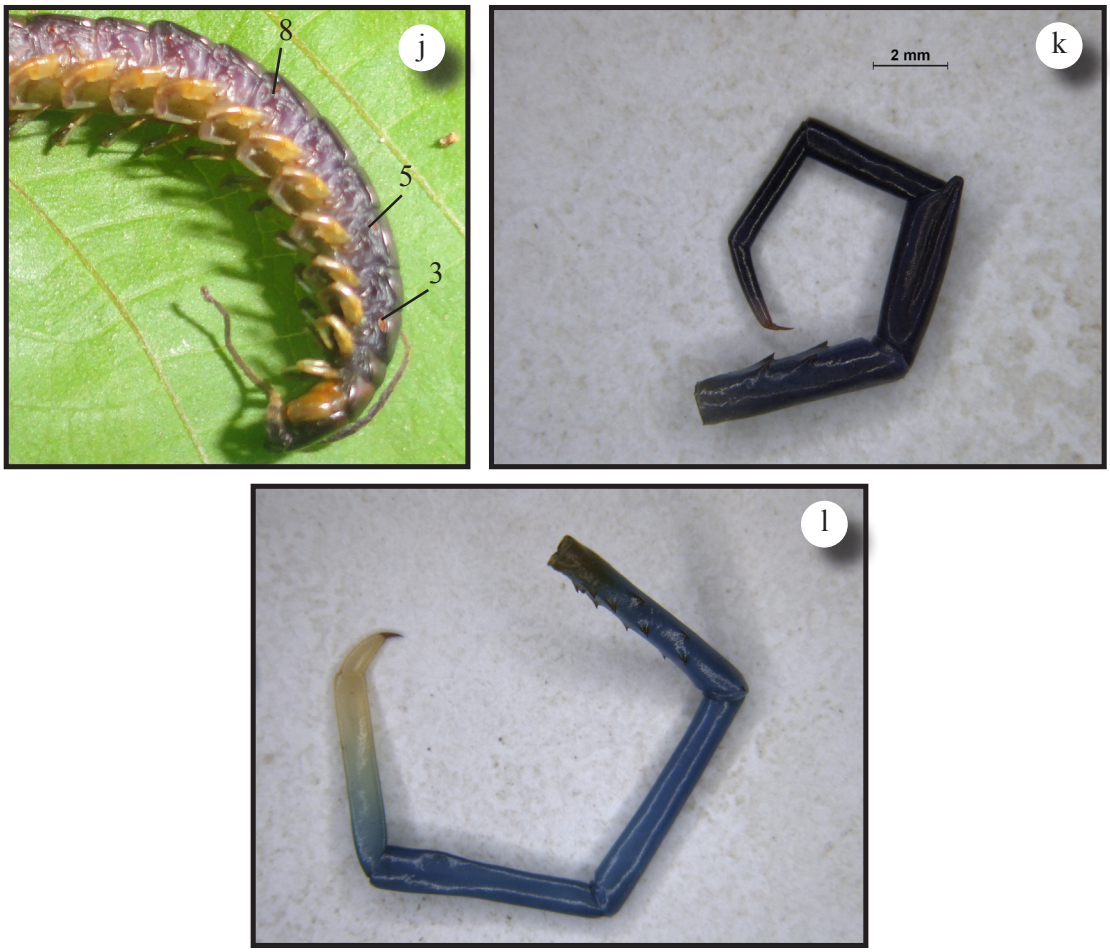
Plate - 10



Key characters of Scolopendromorpha

e. coxopleural process
f. absence of coxopleural process
g. cephalic plate overlapping T1 posteriorly
h. cephalic plate overlapping T1
i. presence of spiracle on 7th segment

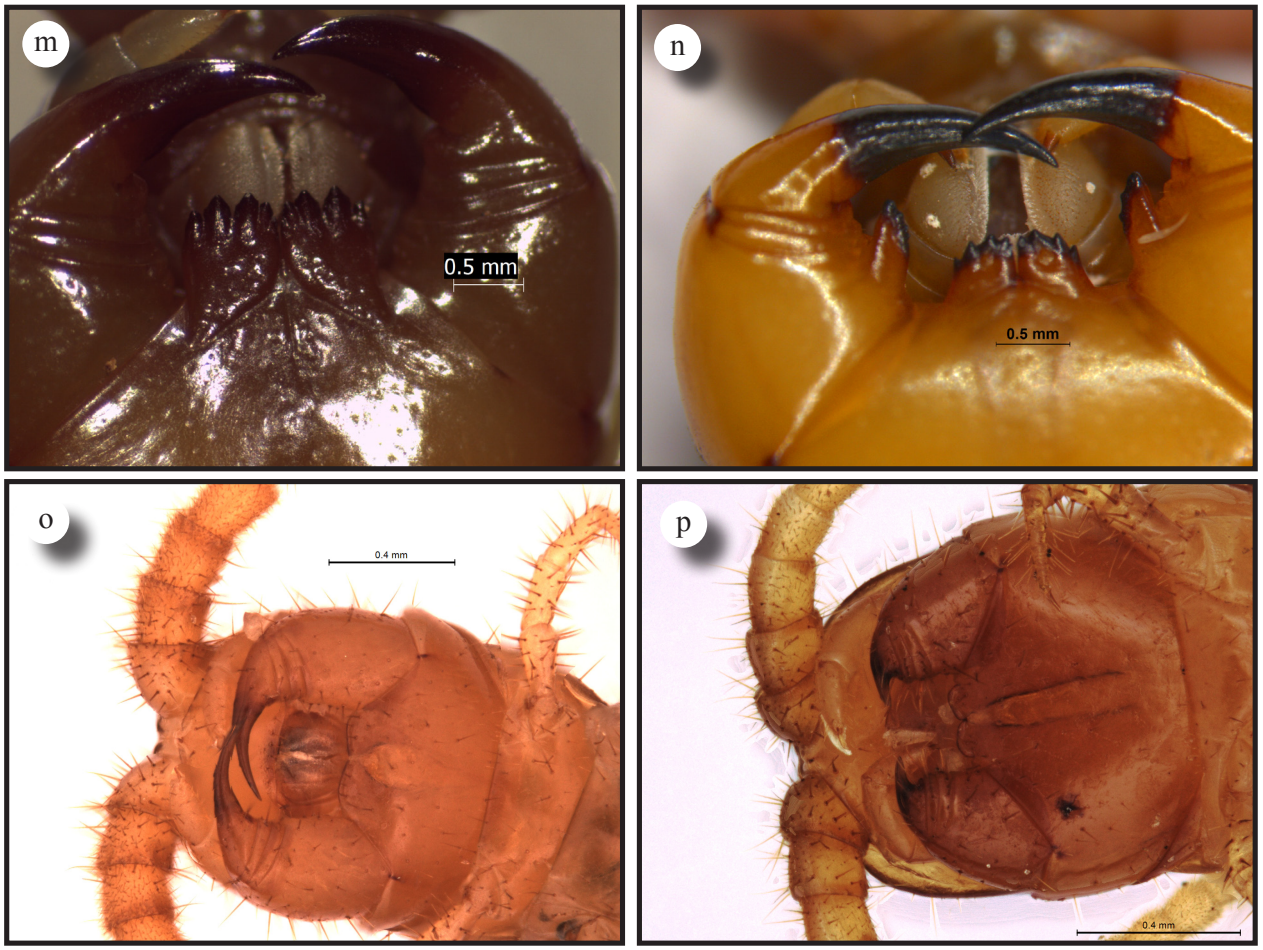
Plate - 11



Key characters of Scolopendromorpha

j. absence of spiracle on 7th segment
k. ultimate leg femur in male with postrio median process
l. ultimate leg femur without posterio median process

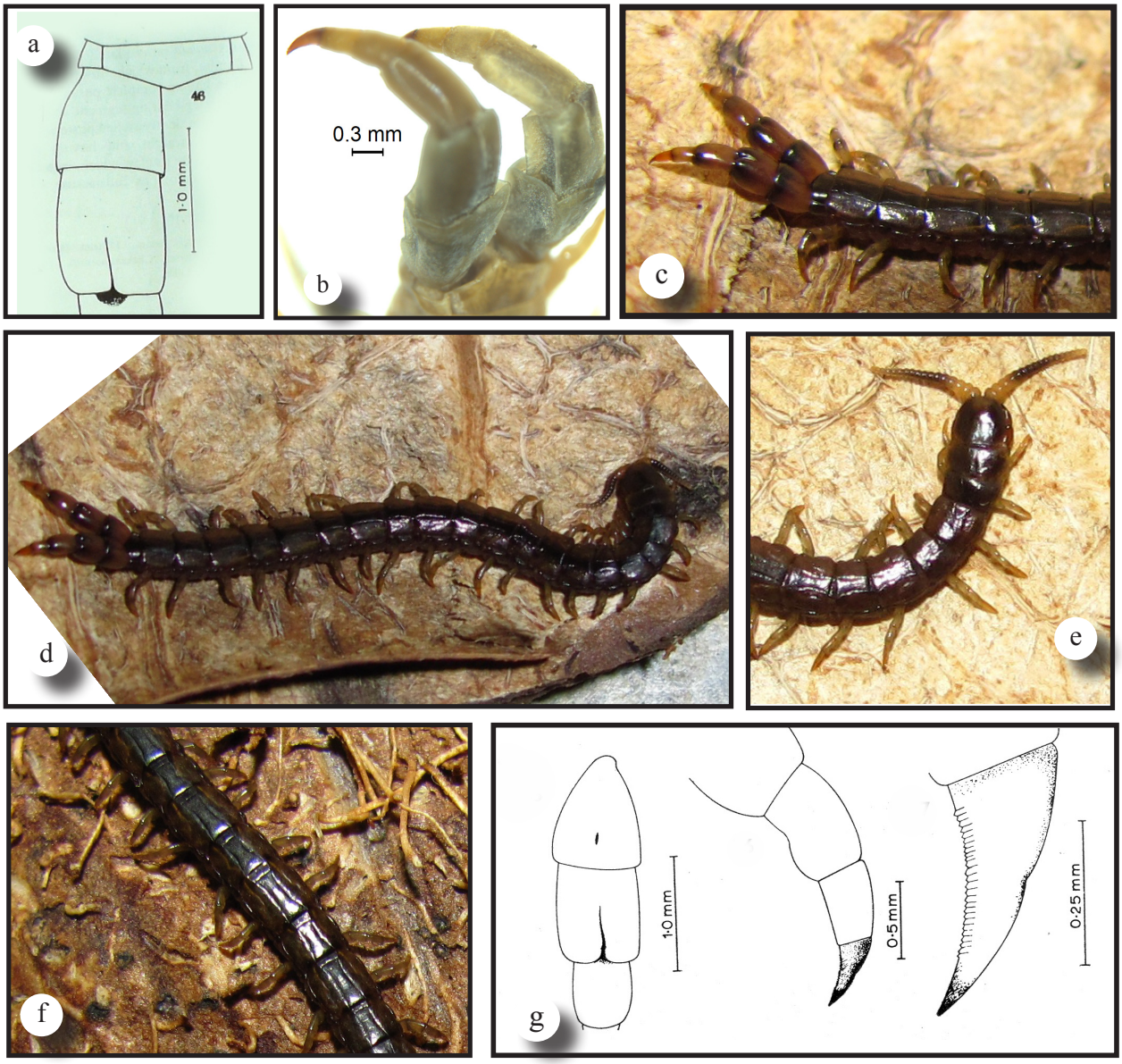
Plate - 12



Key characters of Scolopendromorpha

m. maxillepede without medial dental process
n. maxillipede with medial dental process
o. developed tarsangulum
p. short tarsangulum

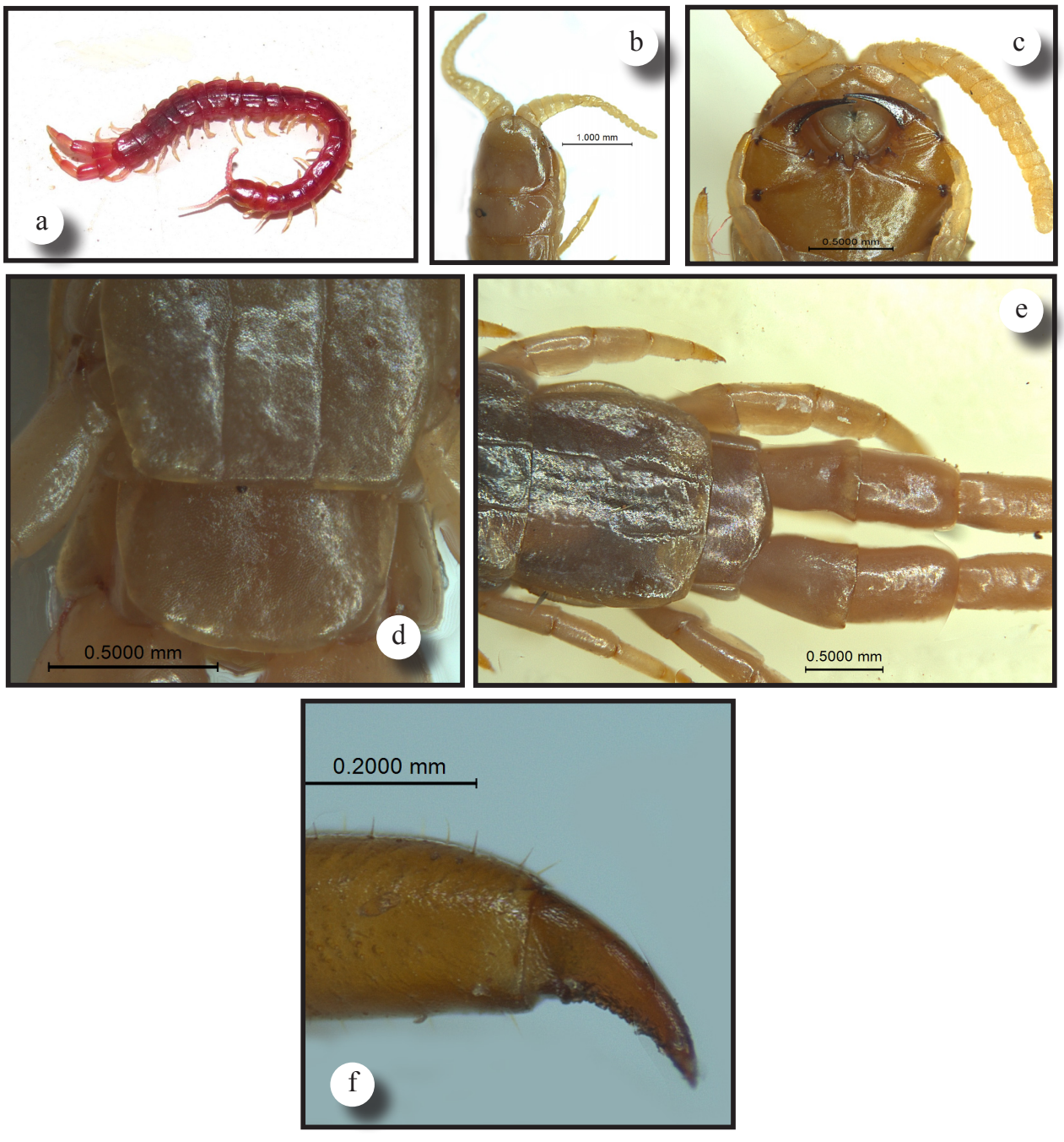
Plate - 13



Asanada sukhensis Jangi and Dass

a. Ultimate leg after Jangi and Dass, 1984
b. Ultimate leg and posterior tergites
c. Ultimate leg prefemur
d. *Asanada sukhensis* in life
e Anterior tegites, cephalic plate and antennae
f. Middle tergites with sutures
g. Ultimate leg femur and claw

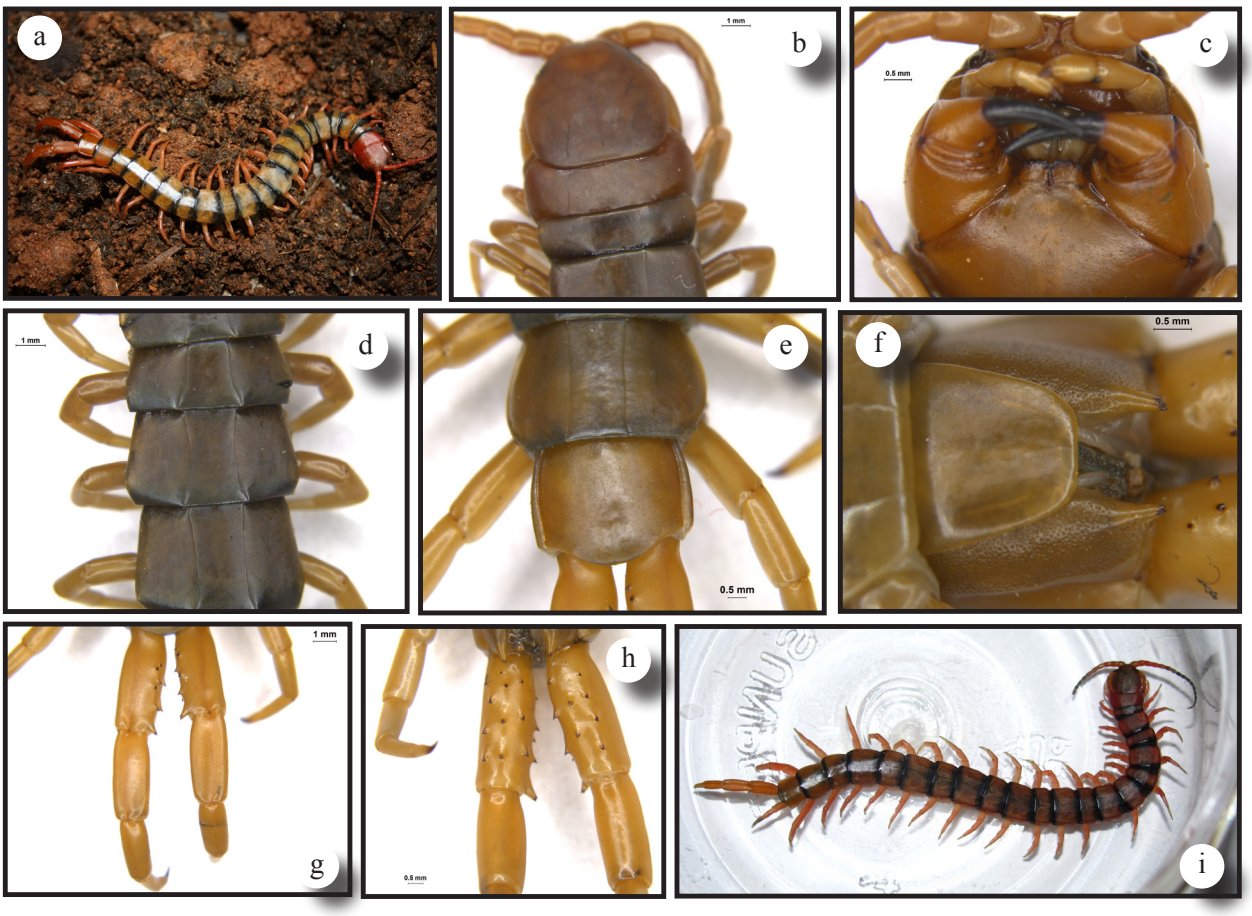
Plate - 14



Asanada agharkari (Gravelyi, 1912)

a. *A. agharkari* in life
b. cephalic plate and antennae
c. forcipular coxosternum
d. S21
e. T21 and ultimate leg prefemur(dorsal view)
f. Ultimate leg claw

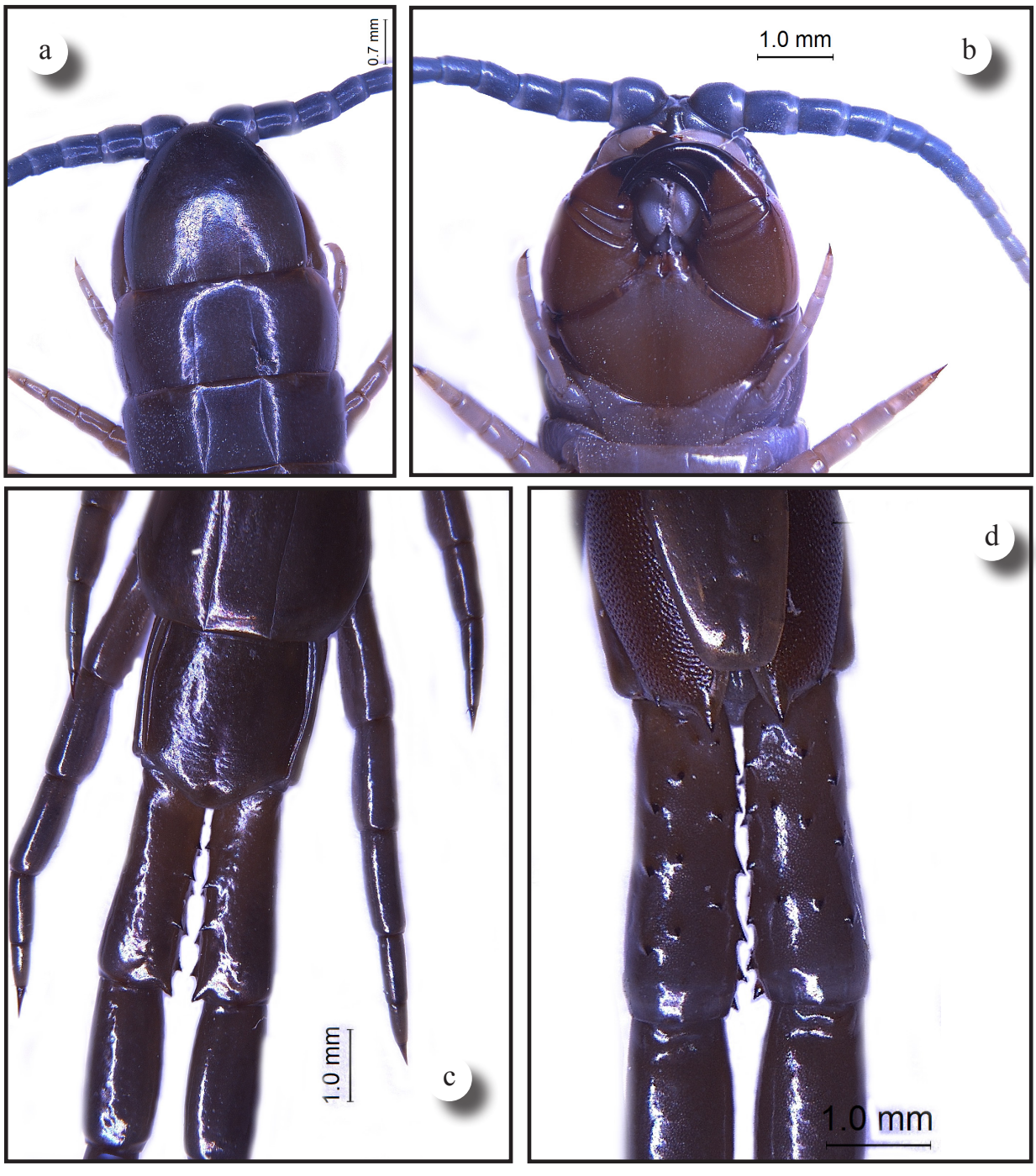
Plate - 15



Scolopendra morsitans Linnaeus

a. *S. morsitans*(in life)
b. Head capsule
c. Forcipular coxosternum
d. Tergites showing paramedian sutures
e. T21
f. S21 and coxopleuron
g. Ultimate leg (dorsal view)
h. Ultimate leg (ventral view)
i. *S. morsitans* with regenerated ultimate leg.

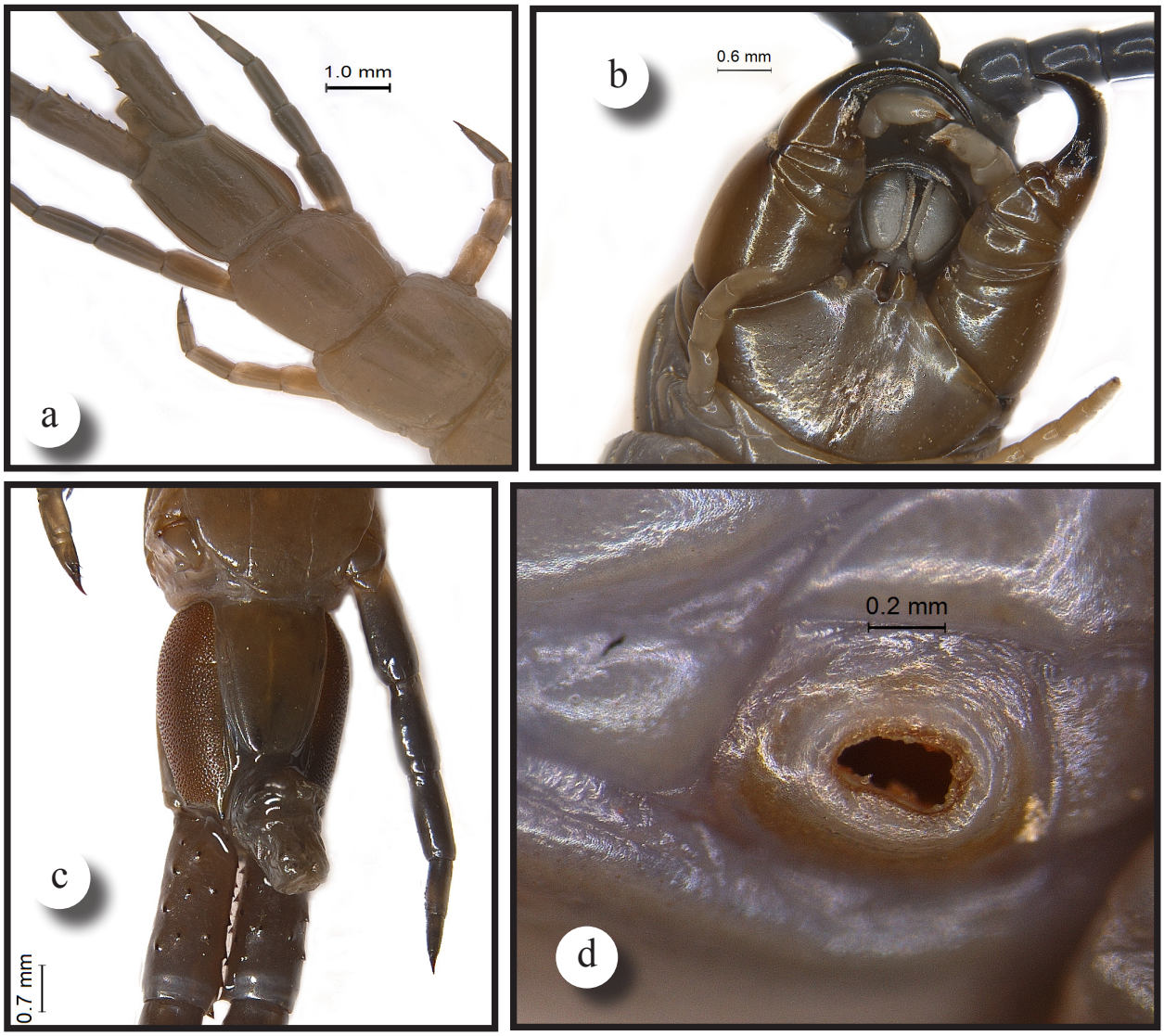
Plate - 16



Cormocephalus indicus sp.nov. Holotype

a. Head capsule
b. Forcipular coxosternum
c. T21 & Ultimate leg (dorsal view)
d. S21 , coxopleuron and ultimate leg (ventral view)

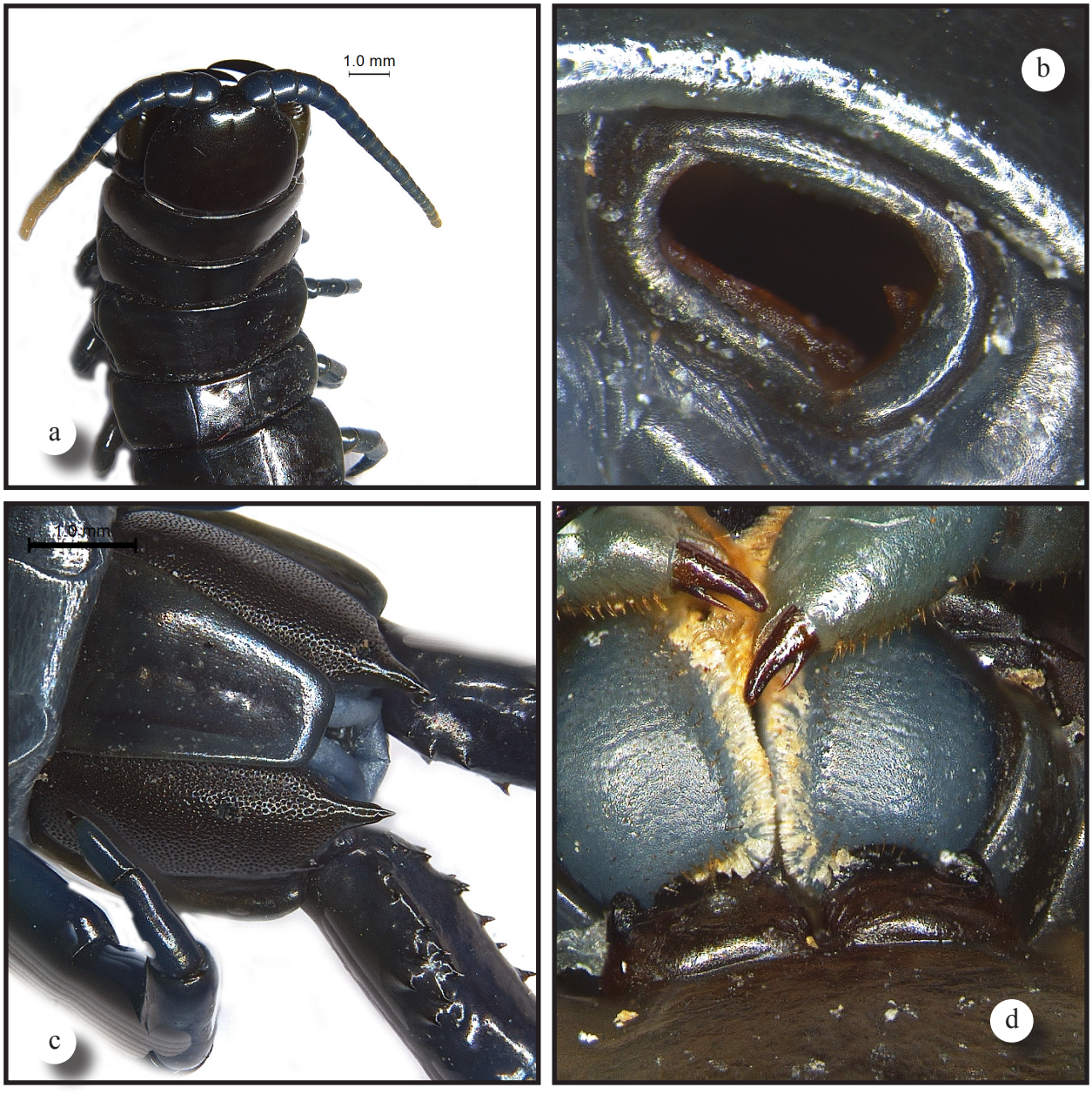
Plate - 17



Cormocephalus indicus sp.nov. Paratype

a. T21 & Ultimate leg (dorsal view)
b. Forcipular coxosternum
c. S21 , coxopleuron and ultimate leg (ventral view)
d. Spiracle.

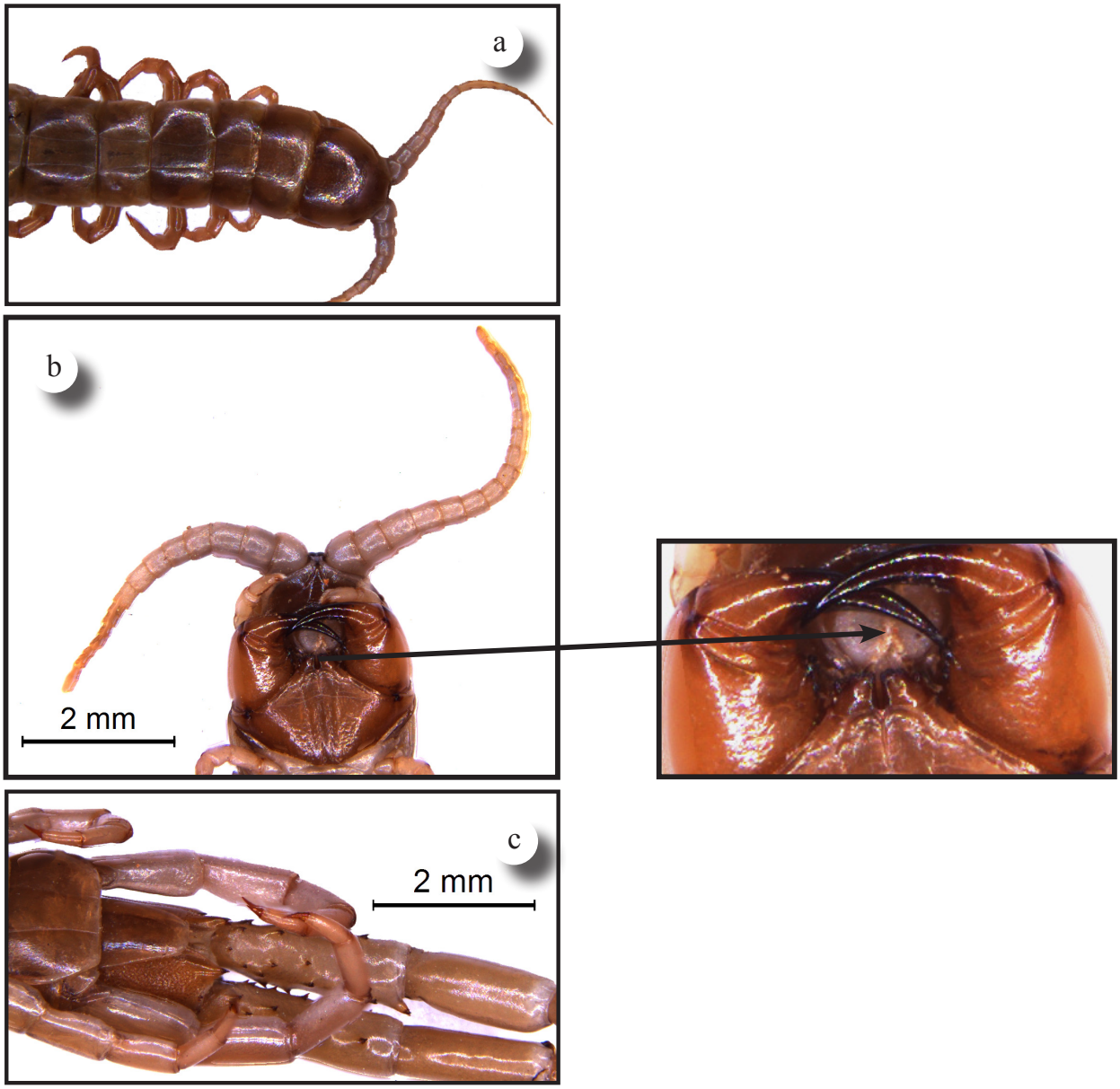
Plate - 18



Cormocephalus westwoodi westwoodi (Newport)

a. antennae
b. spiracle
c. S21 , coxopleuron and ultimate leg (ventral view)
d. forcipular coxosternum

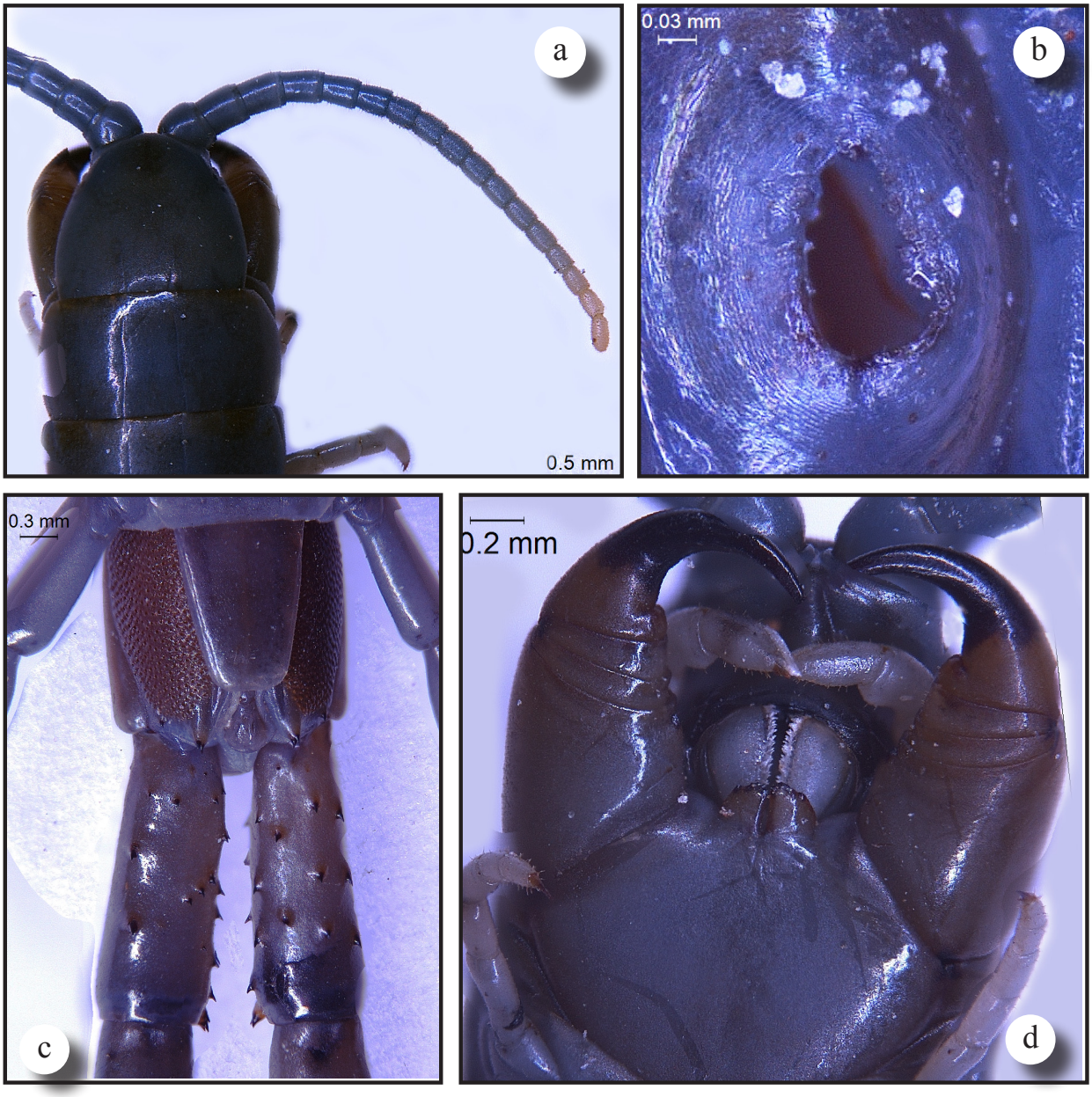
Plate - 19



Cormocephalus dentipes Pocock

a. anterior tergites, cephalic plate and antennae
b. forcipular coxosternum
c. S21 , coxopleuron and ultimate leg (ventral view)

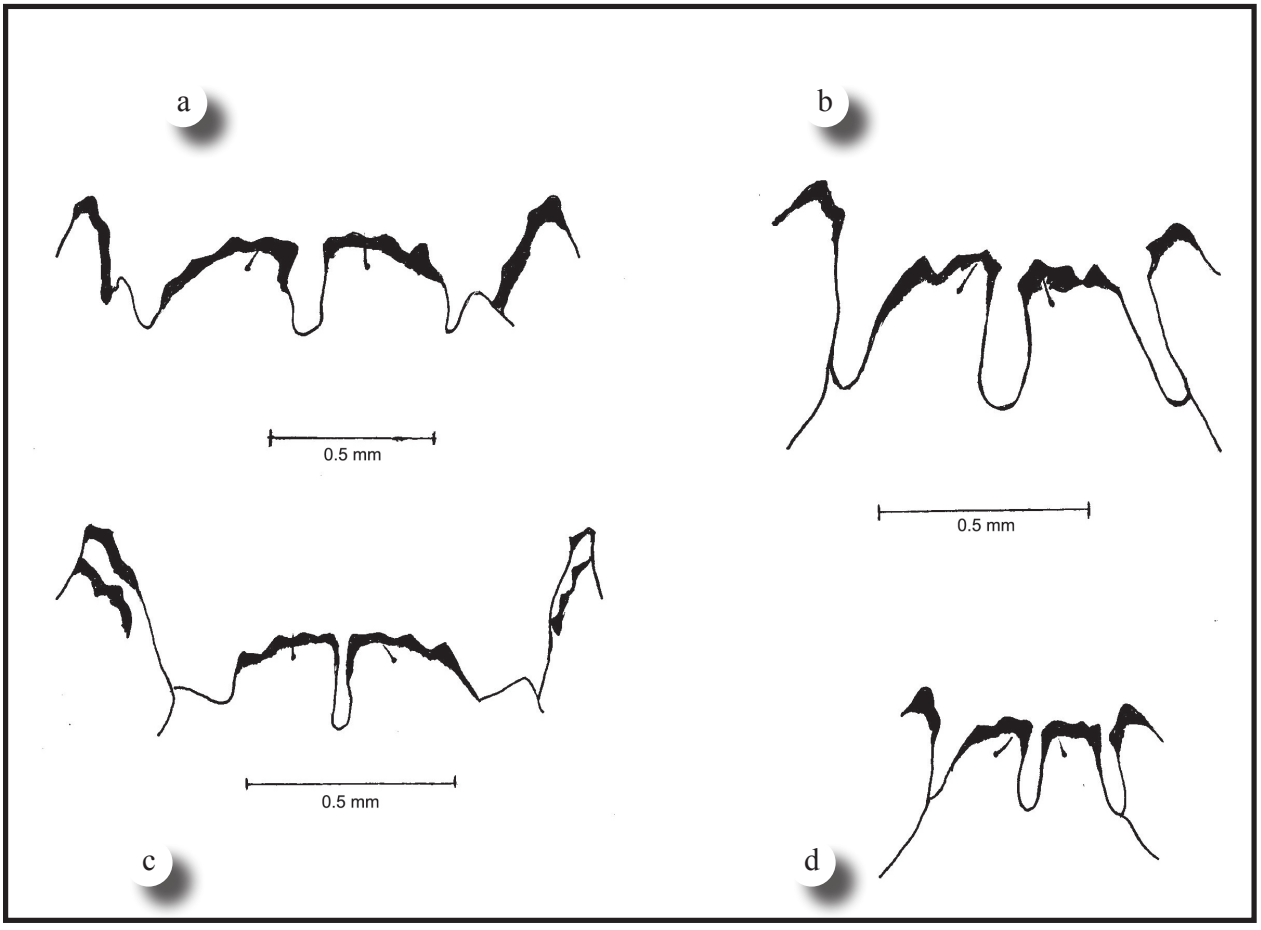
Plate - 20



Cormocephalus nigrificatus Verhoeff

a. antennae
b. spiracle
c. S21 , coxopleuron and ultimate leg prefemur(ventral view)
d. forcipular coxosternum

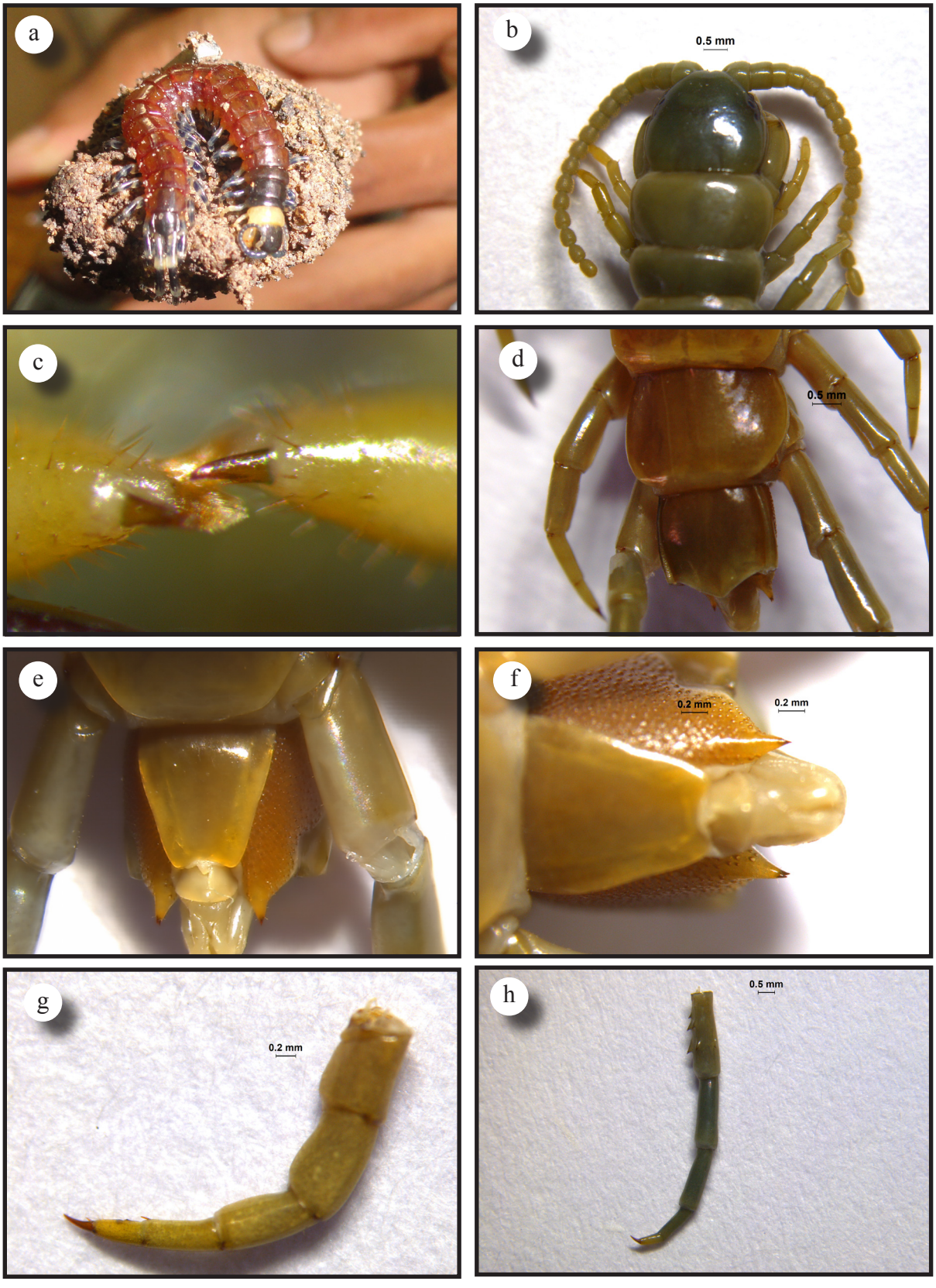
Plate - 21



Dentition in forcipular coxosternal toothplate and trochanteroprefemoral process

a. *Cormocephalus westwoodi westwoodi* (ZSI/WGRC/IR/INV-2230)
b. *Cormocephalus indicus* sp.nov. (ZSI/WGRC/IR/INV-2386)
c. *Cormocephalus dentipes* (ZSI/WGRC/IR/INV- 3546)
d. *Cormocephalus nigrificatus* (ZSI/WGRC/IR/INV- 2376)

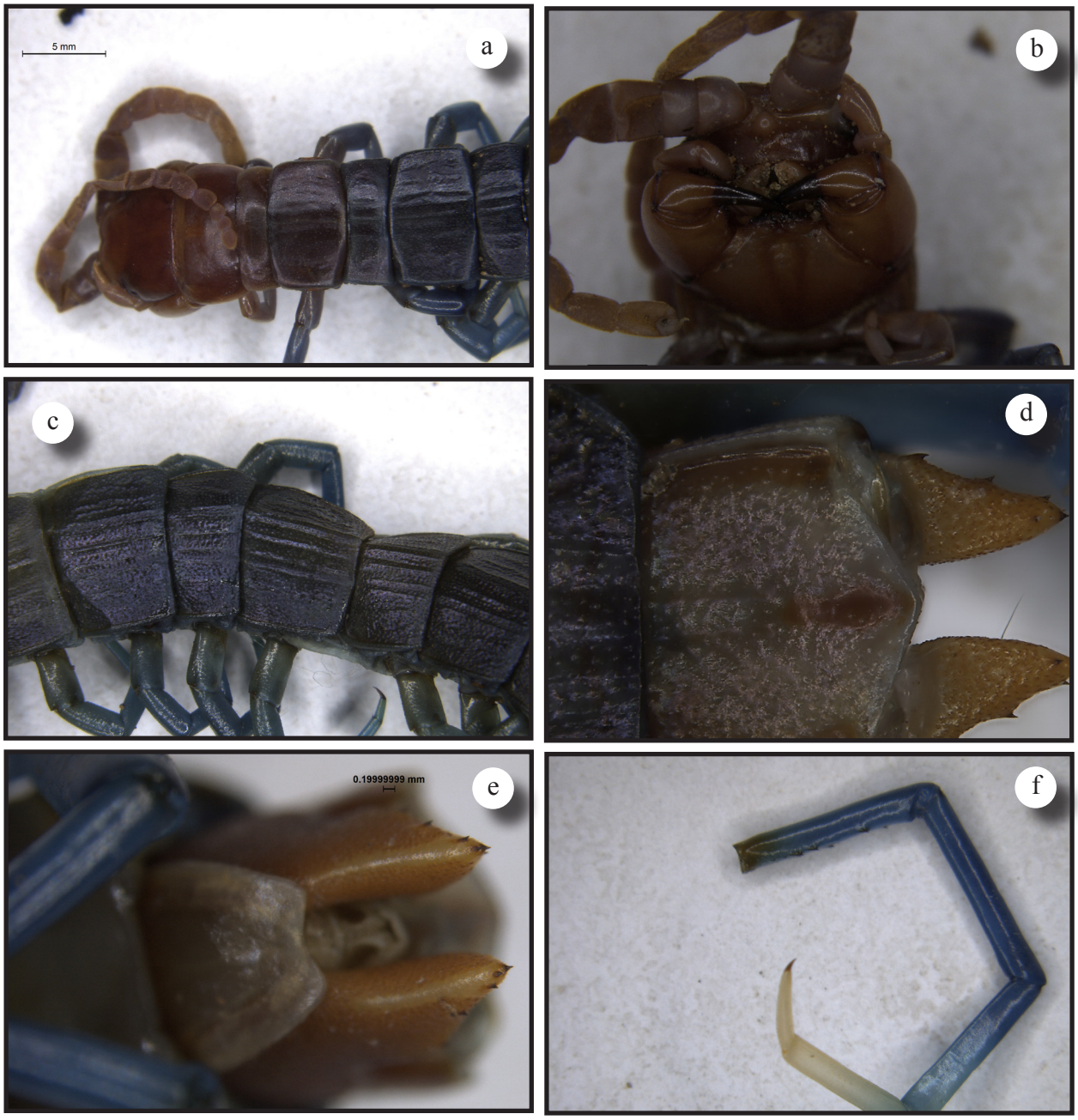
Plate - 22



Otostigmus politus politus Karsch

a. *O. politus politus* (in life) b. Cephalic plate and antennae c. 2nd maxilliped
d. T-21 e. S-21 f. S-21 and coxopleuron
g. Walking leg h. Ultimate leg (ventrolateral view)

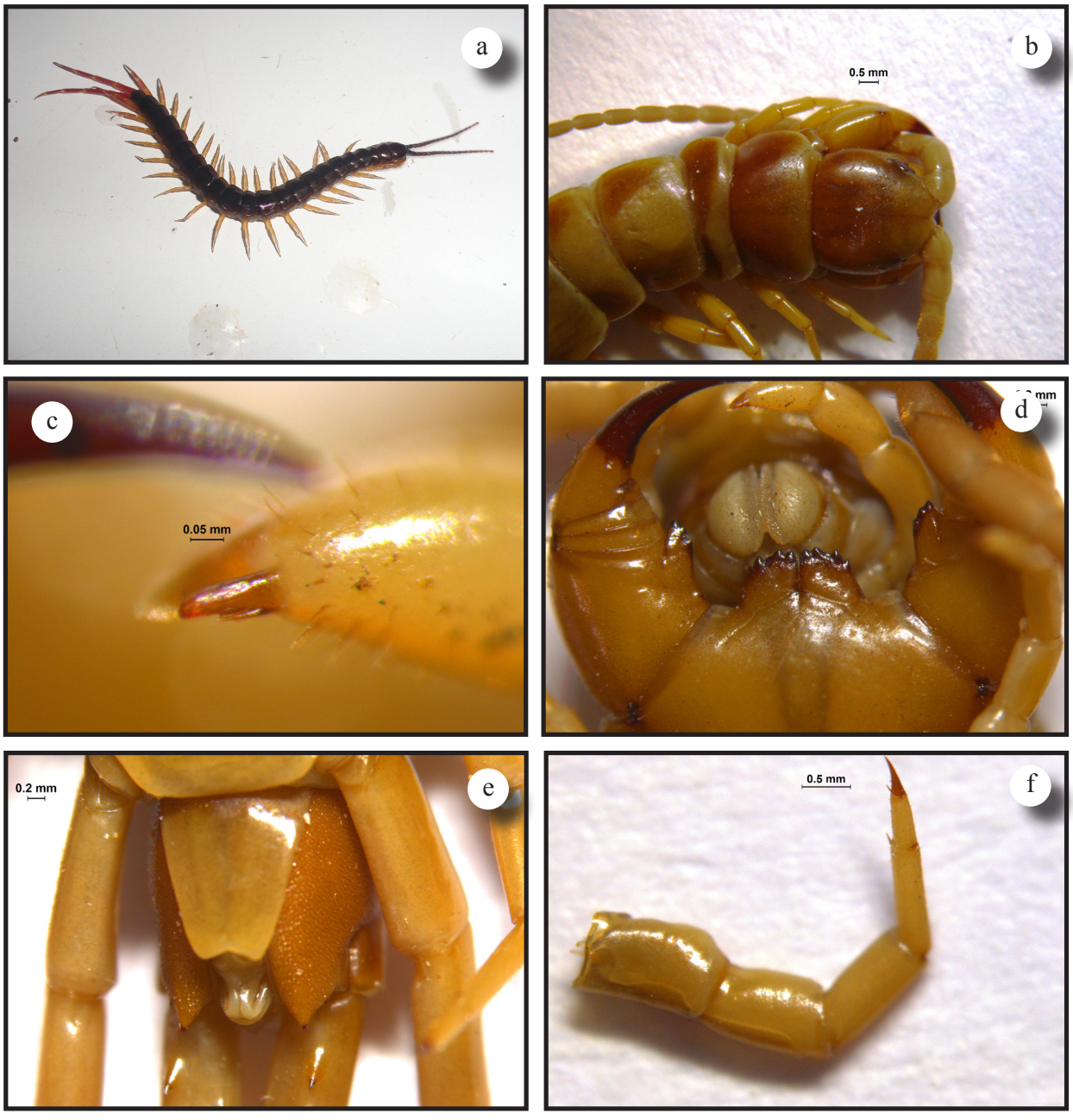
Plate - 23



Otostigmus gravelyi (Jangi and Dass)

a. Cephalic plate and anterior tergites
b. Forcipular coxosternum
c. Middle tergites with keels
d. T21
e. S21 and coxopleuron
f. Ultimate leg (ventrolateral view)

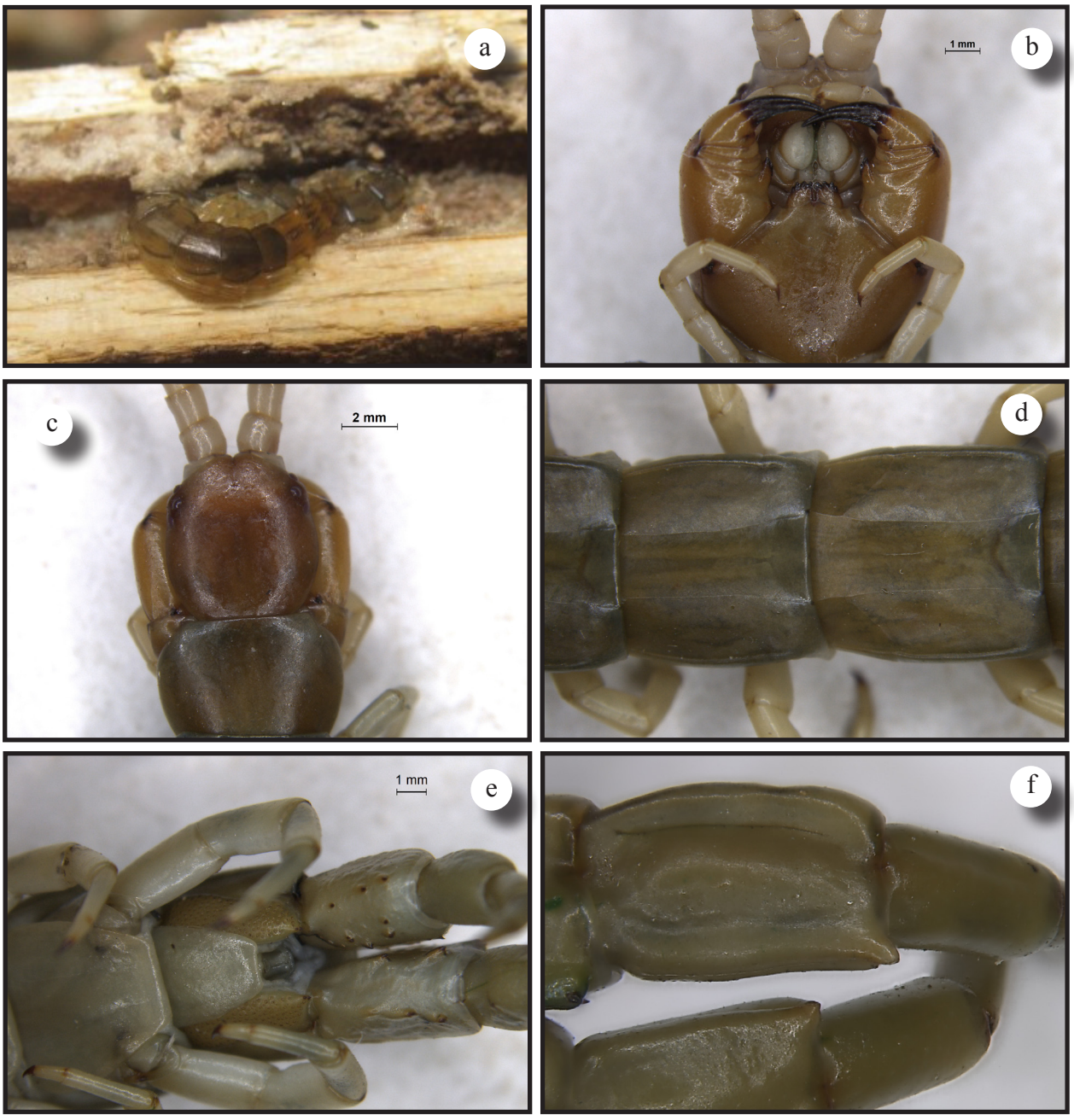
Plate - 24



Otostigmus orientalis Porat

a. *O. orientalis* (in life)
b. Cephalic plate and antennae
c. 2nd maxilliped
d. Forcipular coxosternum
e. S-21 and coxopleuron
f. Walking leg

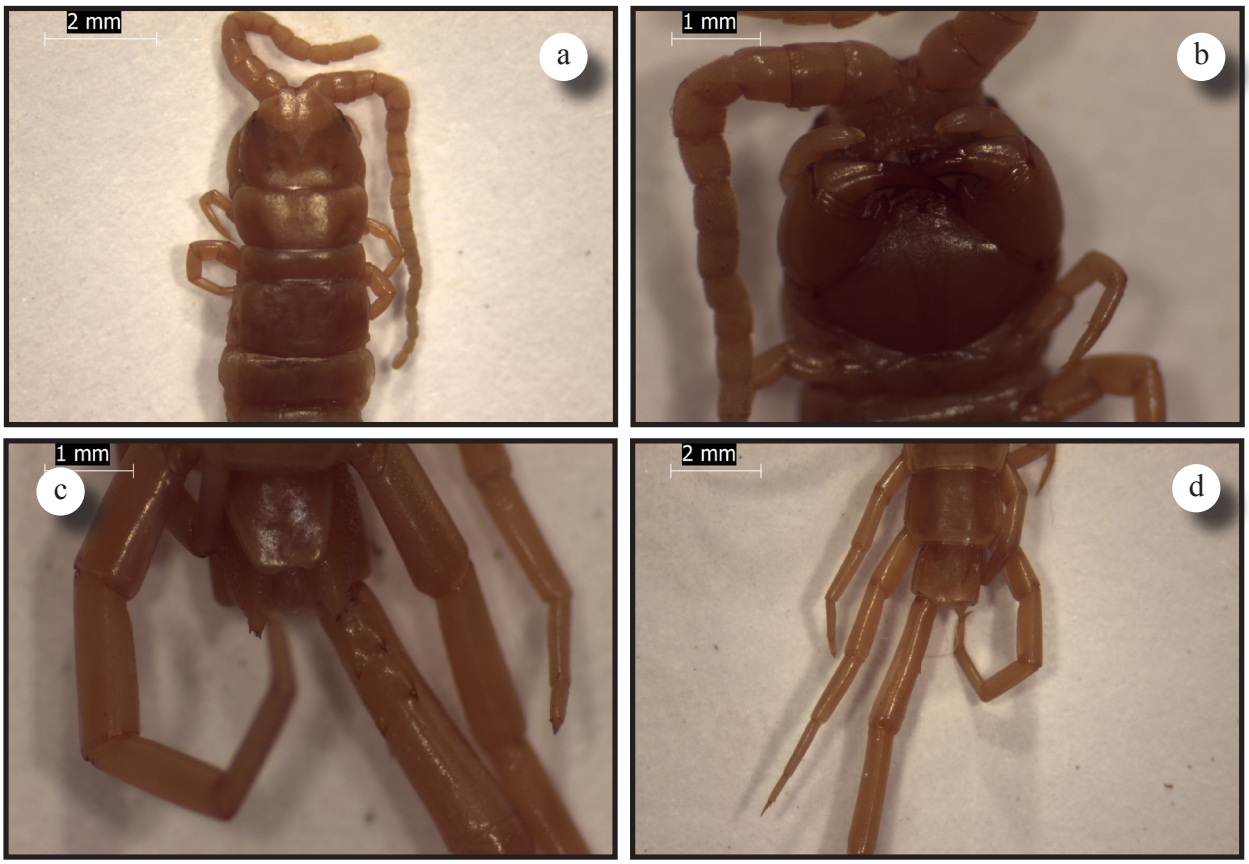
Plate - 25



Digitipes periyarensis Joshi and Edgecombe

a. *D. periyarensis* (in life)
b. Forcipular coxosternum
c. Cephalic plate and antennae
d. Middle tergites
e. S21, coxopleuron and ultimate leg prefemur
f. Ultimate leg
g. prefemur (dorsal view)

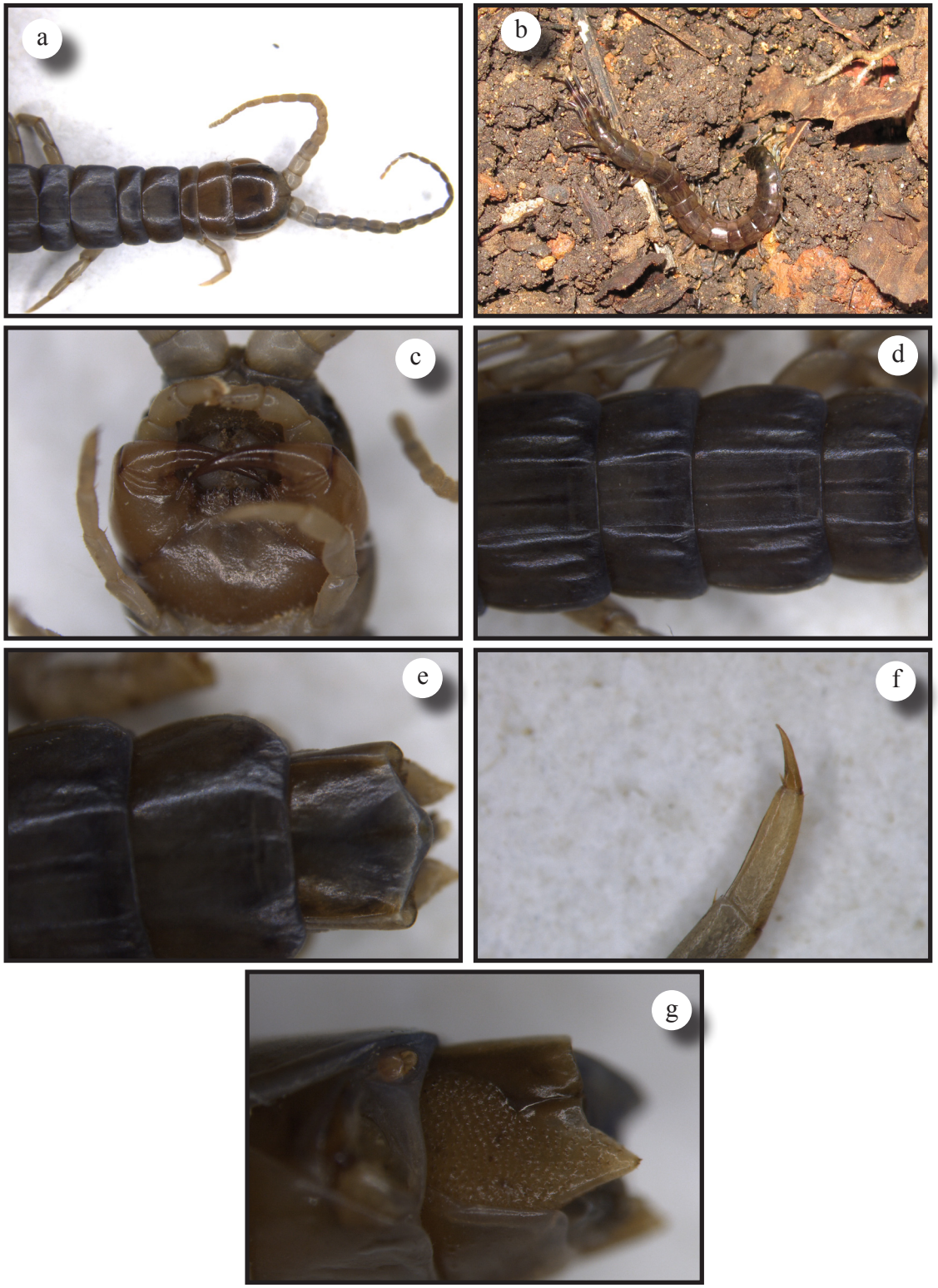
Plate - 26



Digitipes chhotanii Jangi and Dass

a. Cephalic plate, antennae and anterior tergites
b. Forcipular coxosternum
c. S21, coxopleuron and ultimate leg prefemur
d. T21 and Ultimate leg prefemur (dorsal view)

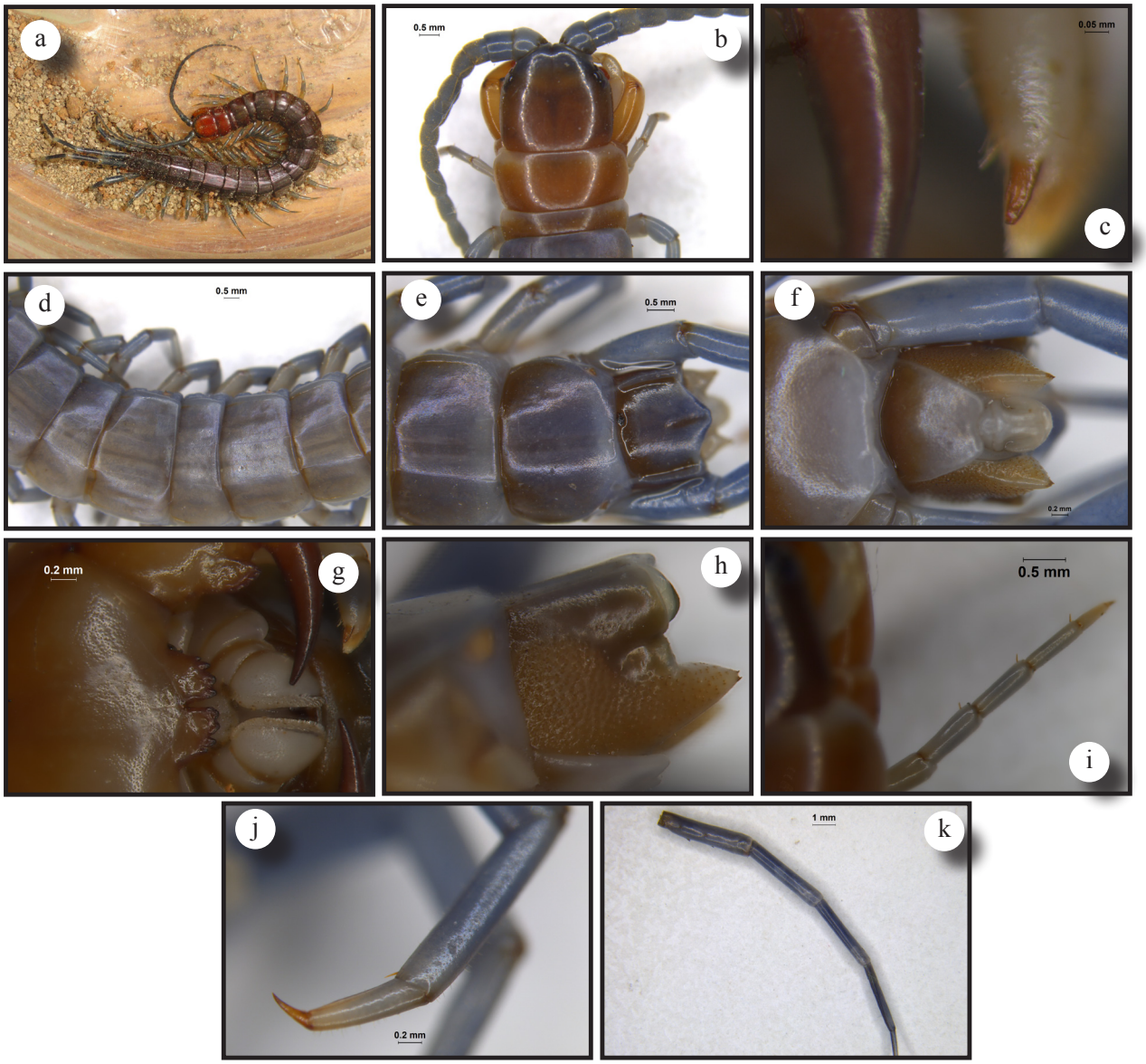
Plate - 27



Digitipes barnabasi Jangi and Dass

a. Cephalic plate, antennae and anterior tergites
b. *D. barnabasi* - in life
c. Forcipular coxosternum
d. Middle tergites with sutures and keels
e. T21
f. 20th walking leg with pretarsal spur
g. coxopleuron

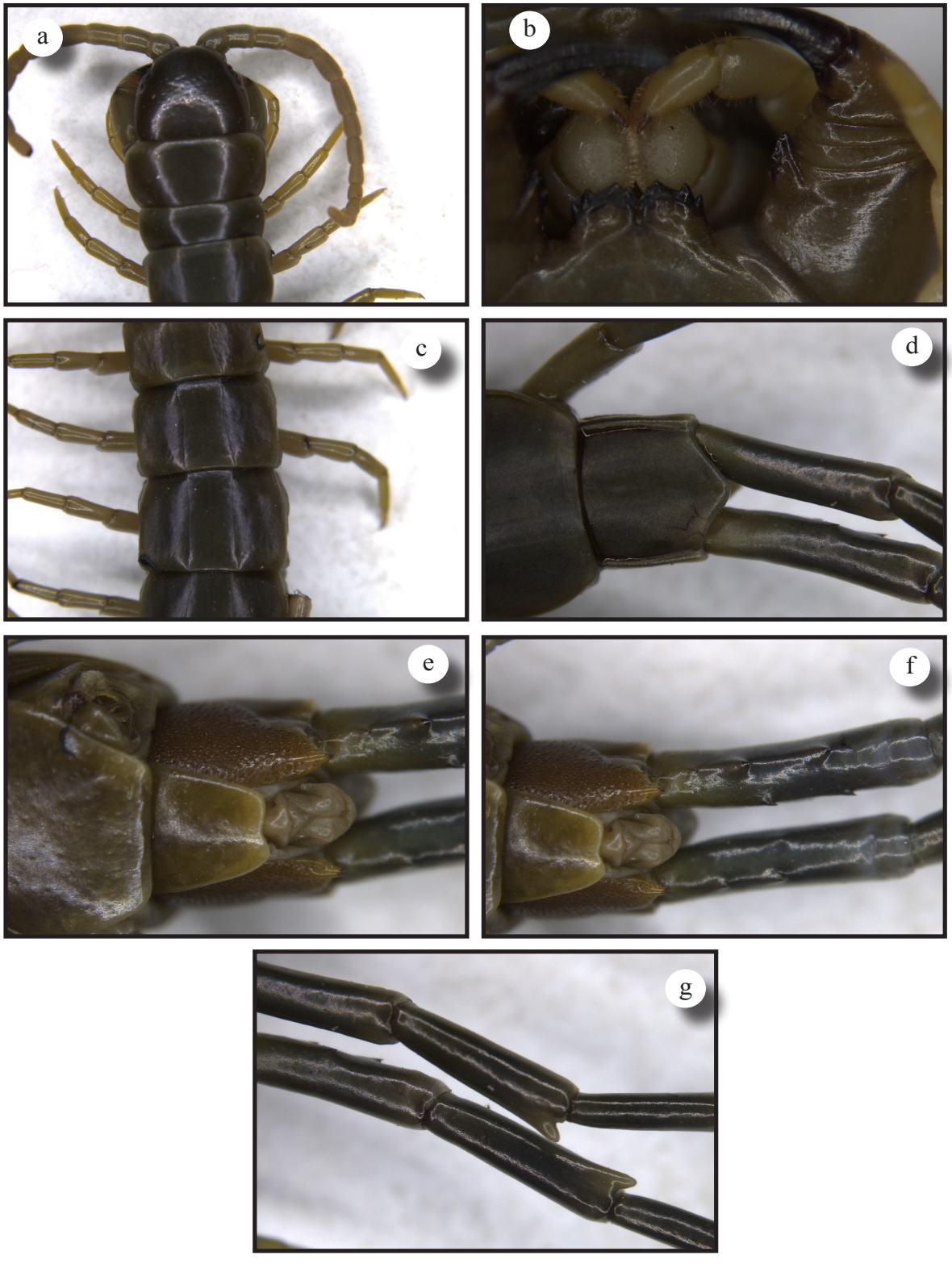
Plate - 28



Digitipes pseudobarnabasi sp.nov

a. *D. pseudobarnabasi* - in life
b. Cephalic plate, antennae and anterior tergites
c. 2nd maxilllipede with spur
d. Middle tergites with sutures
e. T21
f. Coxopleuron
g. Forcipular coxosternum
h. 20th walking leg with pretarsal spur
i. Walking leg 1
j. Walking leg 20
k. Ultimate leg

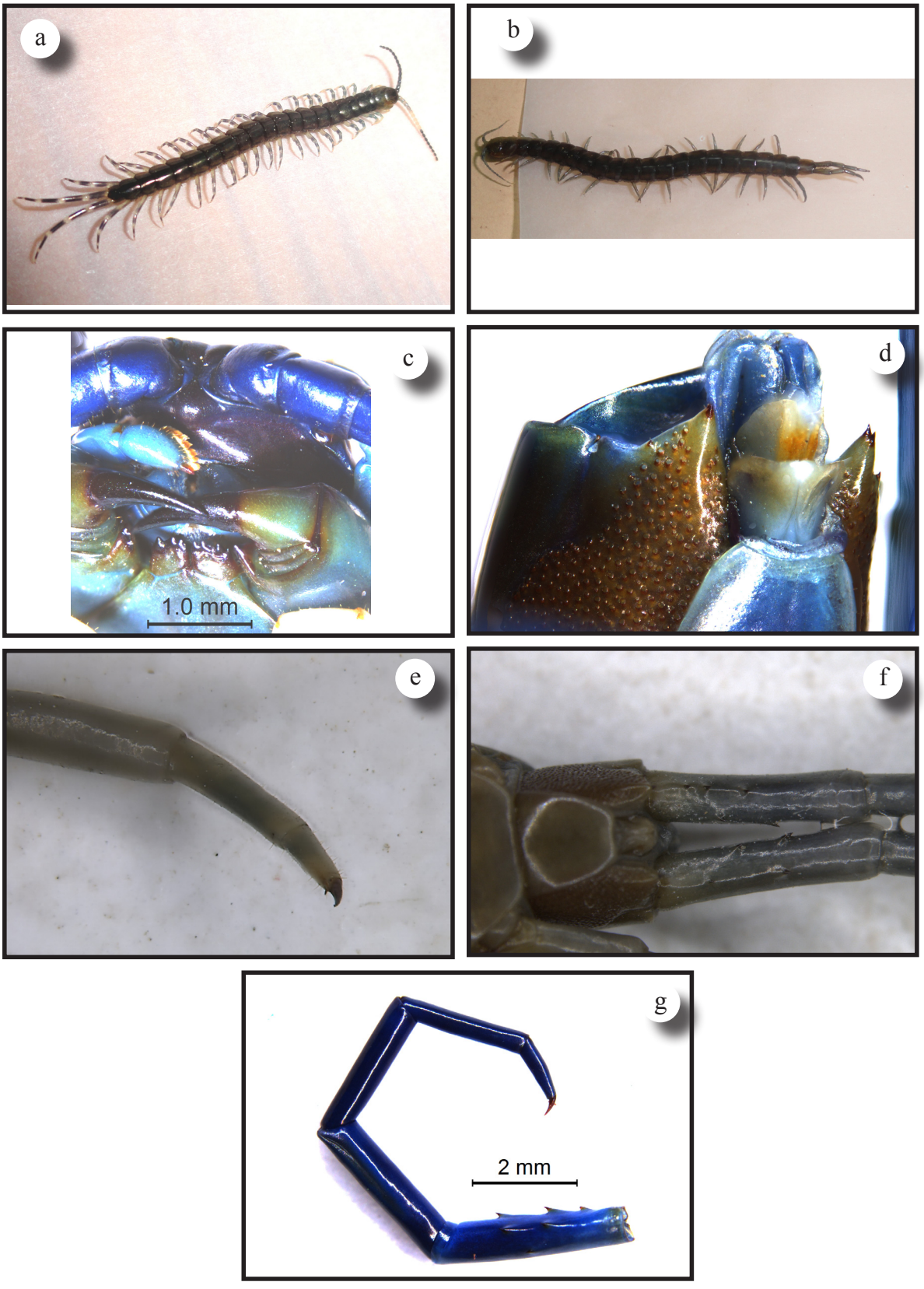
Plate - 29



Digitipes jonesii Jangi and Dass

a. Cephalic plate, antennae and anterior tergites
b. Forcipular coxosternum
c. Middle tergites with sutures
d. T21
e. S21 and Coxopleuron
f. S21, Coxopleuron and ultimate leg prefemur
g. Ultimate leg prefemur with posterior process

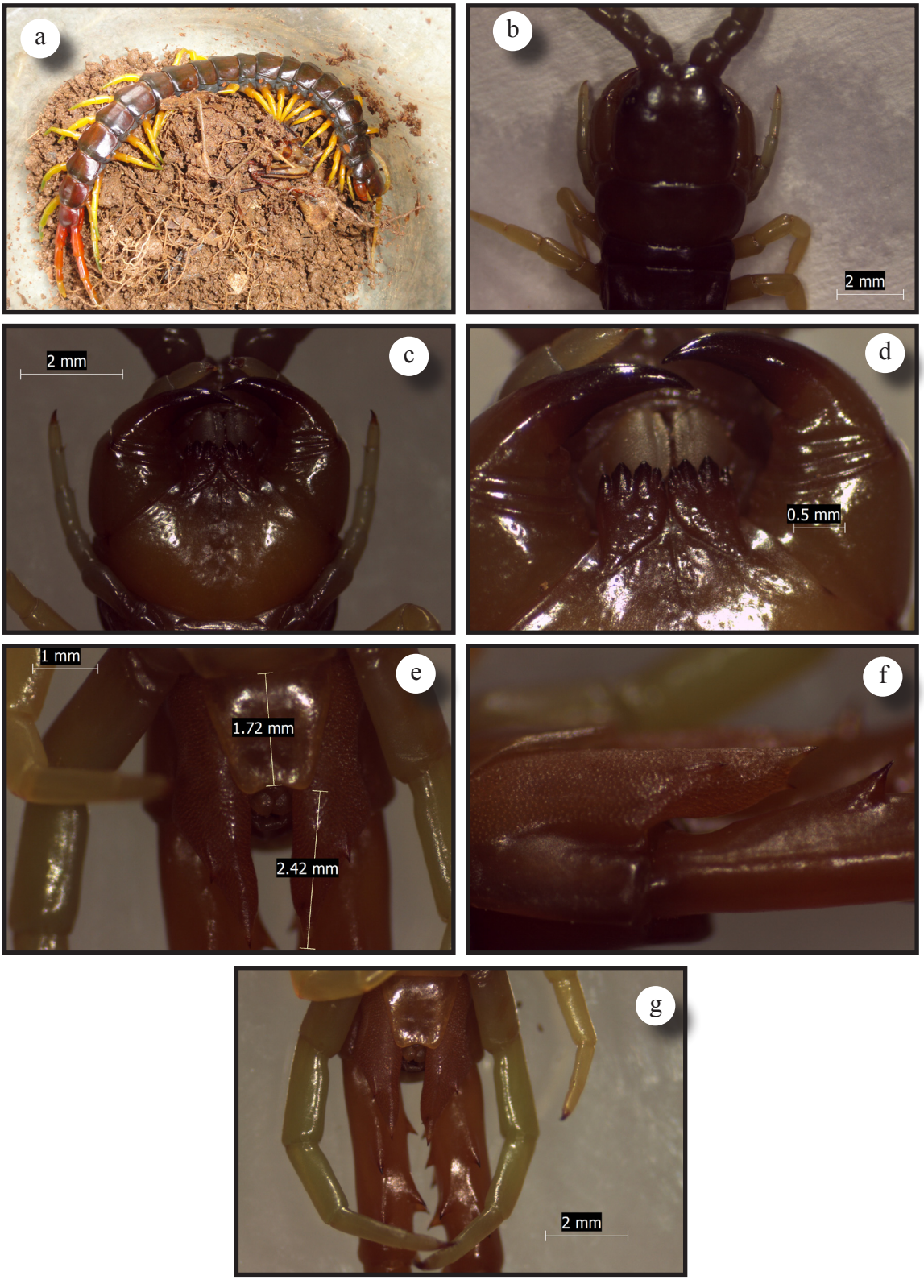
Plate - 30



Digitipes coonoorensis Jangi and Dass

a,b. *D. coonorensis* (in life)
c. Forcipular coxosternum
d. S21 and Coxopleuron
e. Walking leg 20
f. S21 and coxopleuron
g. Ultimate leg

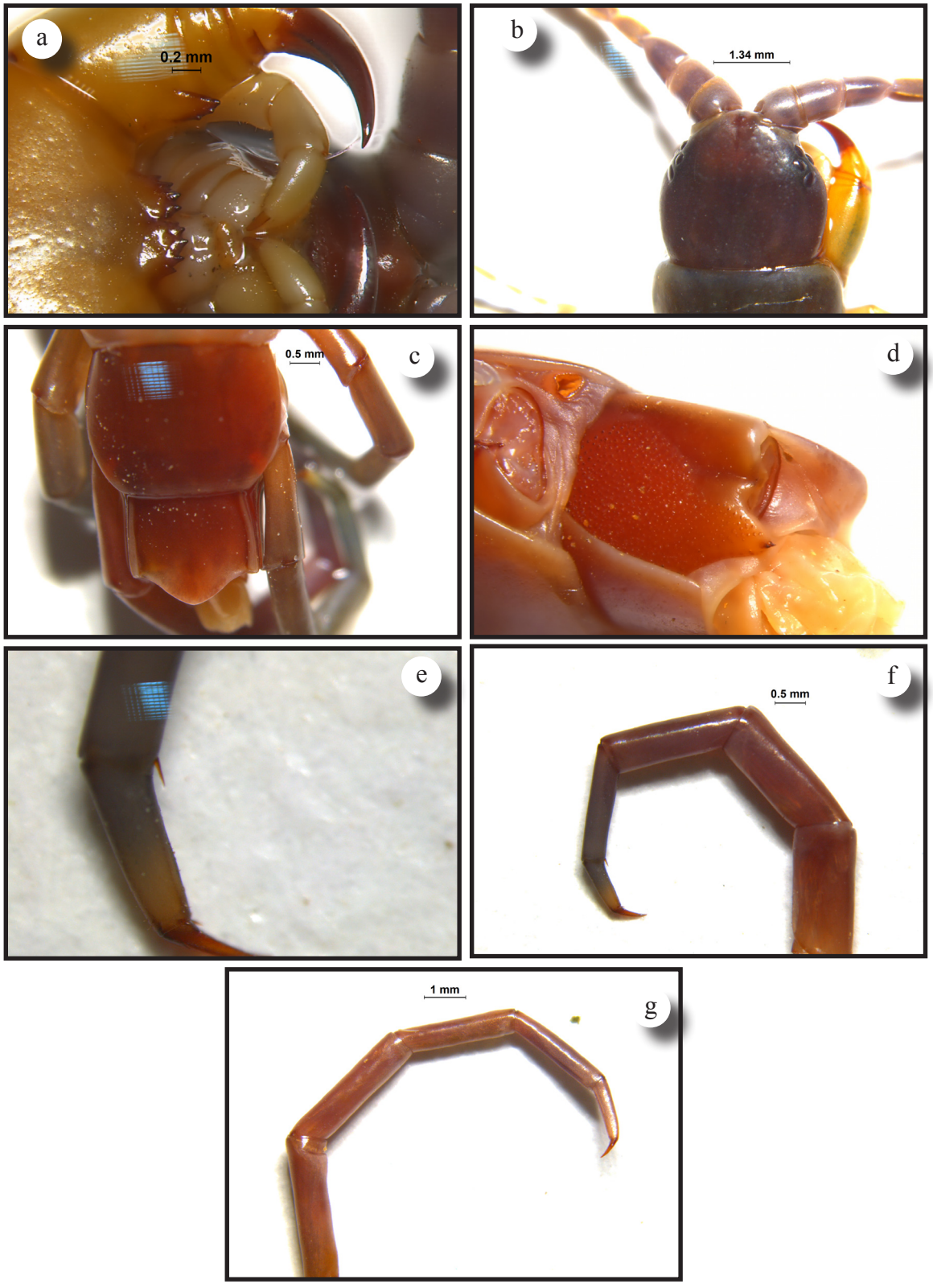
Plate - 31



Ethmostigmus rubripes platycephalus Newport

a. *E. rubripes platycephalus* (in life)
b. Cephalic plate and basal antennal articles
c. Forcipular coxosternum
d. Teeth on forcipular coxosternum
e. S21
f. coxopleuron
g. Ultimate leg prefemur

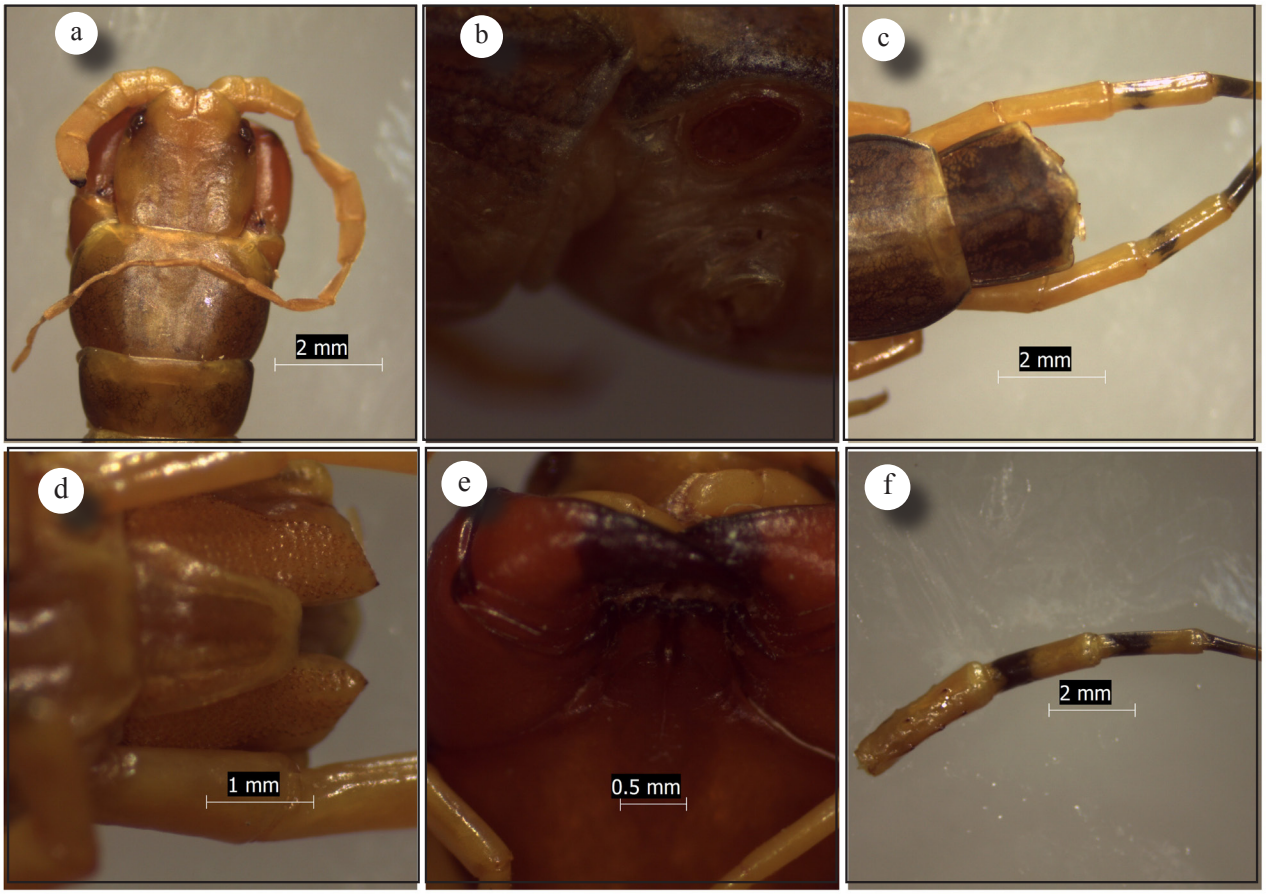
Plate - 32



Rhysida aspinosus sp.nov.

a. Forcipular coxosternum
b. Cephalic plate and basal antennal articles
c. T21
d. Coxopleuron
e. Walking leg 20
f,g. Ultimate leg

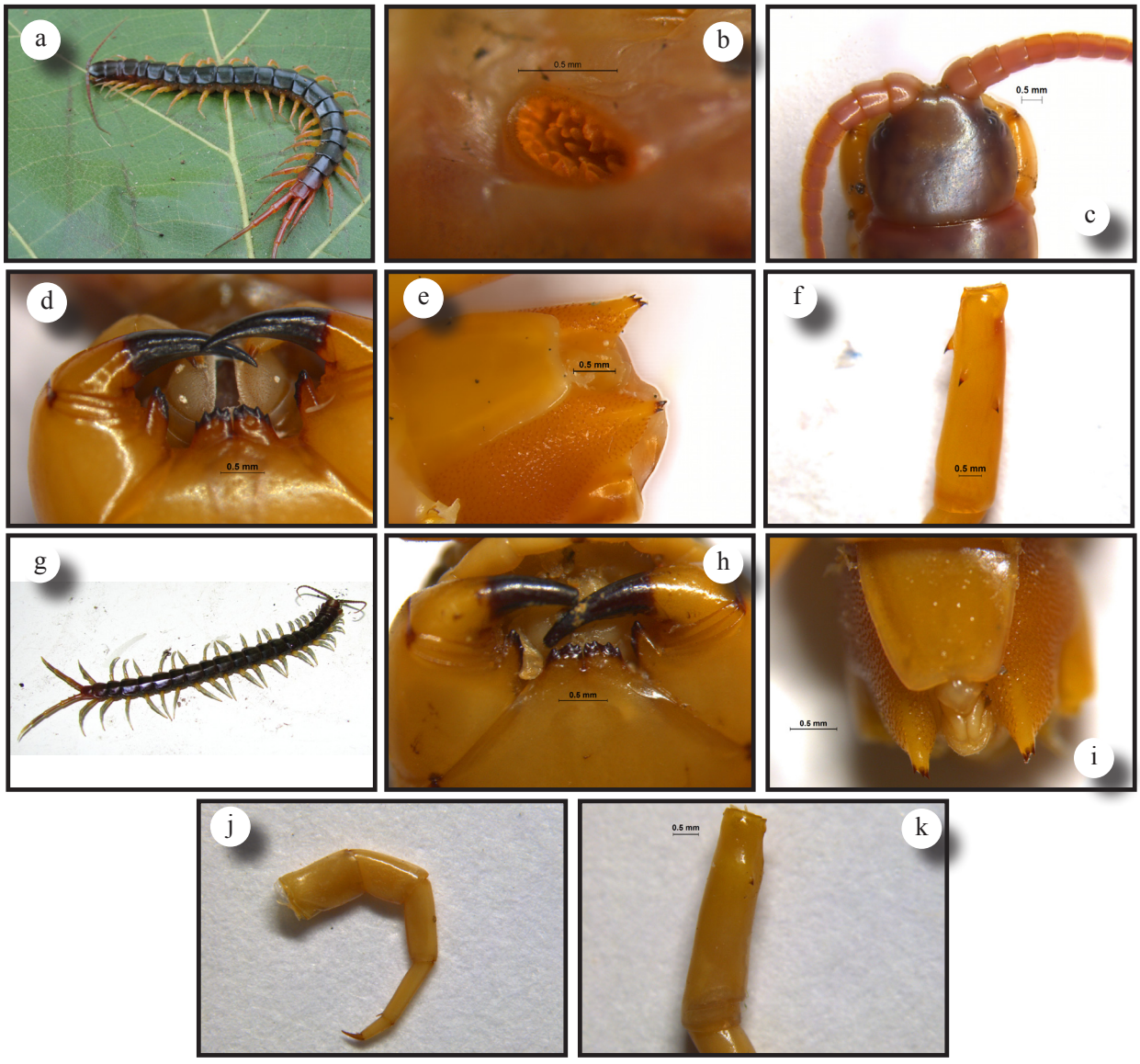
Plate - 33



Rhysida laetus sp.nov.

a. Cephalic plate and basal antennal articles
b. spiracle
c. T21 and Walking leg 20
d. S21 and Coxopleuron
e. forcipular coxosternum
f. Ultimate leg

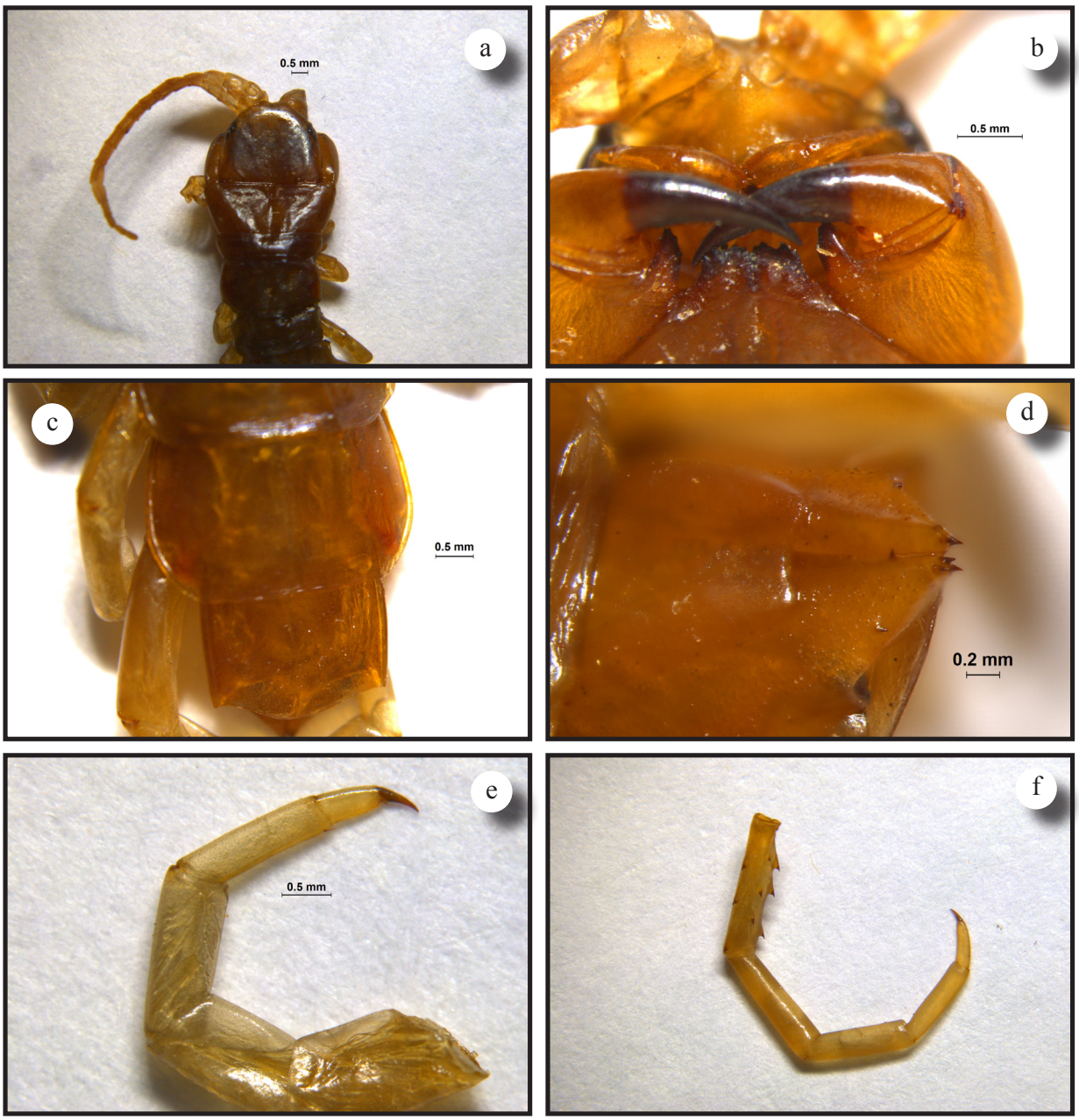
Plate - 34



Rhysida immarginata immarginata (Porat)

a. *R. immarginata immarginata* (in life)
b. spiracle
c. Cephalic plate and basal antennal articles
d. forcipular coxosternum
e. coxosternum
f. Ultimate leg prefemur
Rhysida longipes longipes (Newport)
g. *R. longipes longipes* (in life)
h. forcipular coxopleuron
i. coxopleuron
j. Walking leg 20
f. Ultimate leg prefemur

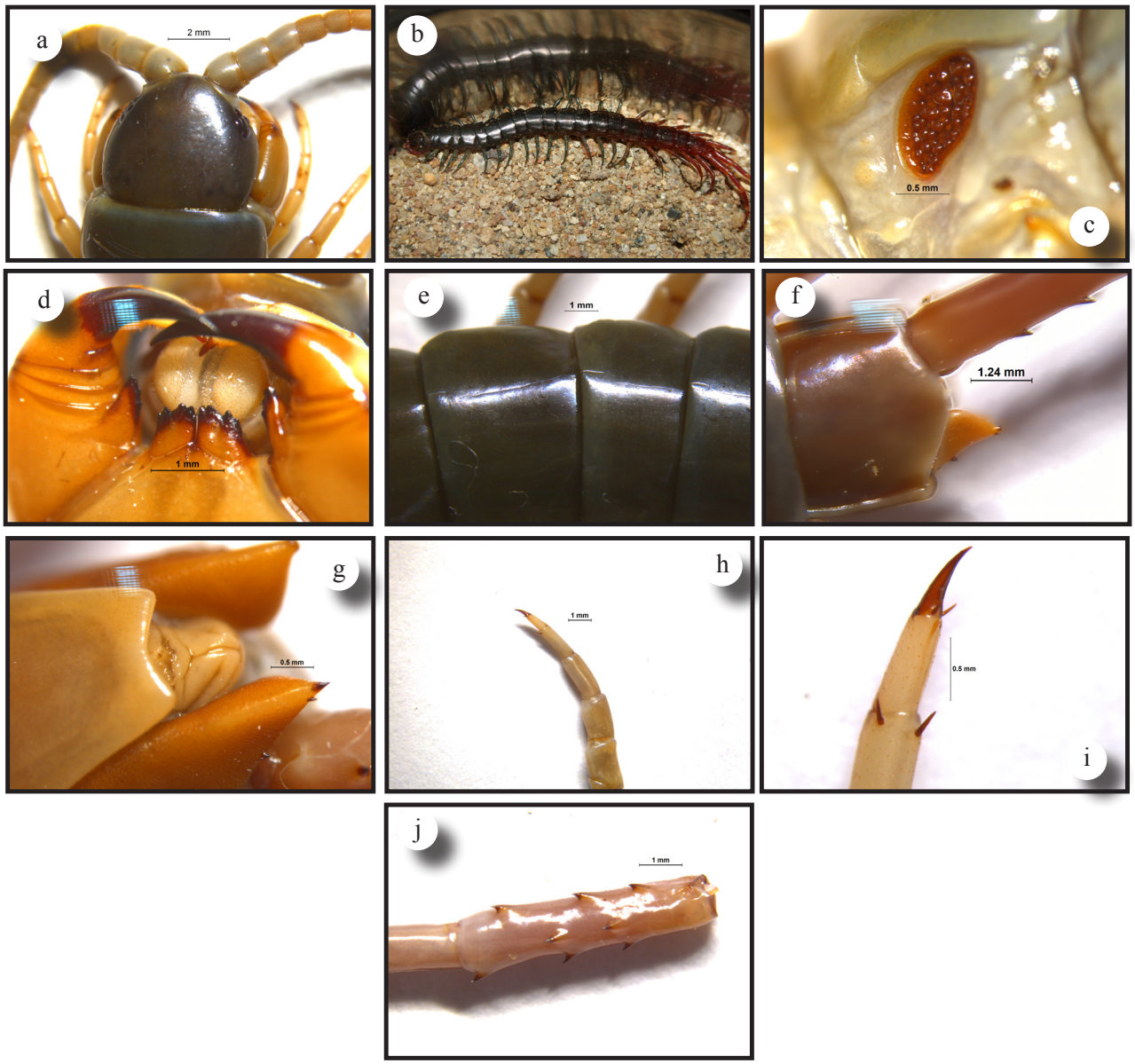
Plate - 35



Rhysida longipes simplicior Chamberlin

a. Cephalic plate and basal antennal articles
b. forcipular coxosternum
c. T21
d. coxopleuron
e. Walking leg 20
f. Ultimate leg prefemur

Plate - 36



Rhysida shenduruniensis sp.nov.

a. Cephalic plate and basal antennal articles
b. *R. shenduruniensis* (in life)
c. spiracle
d. Forcipular coxosternum
e. middle tergites
f. T21
g. S21 and Coxopleuron
h. Walking leg 20
i. Walking leg tarsal spur and claw spur
j. Ultimate leg prefemur

Plate - 37

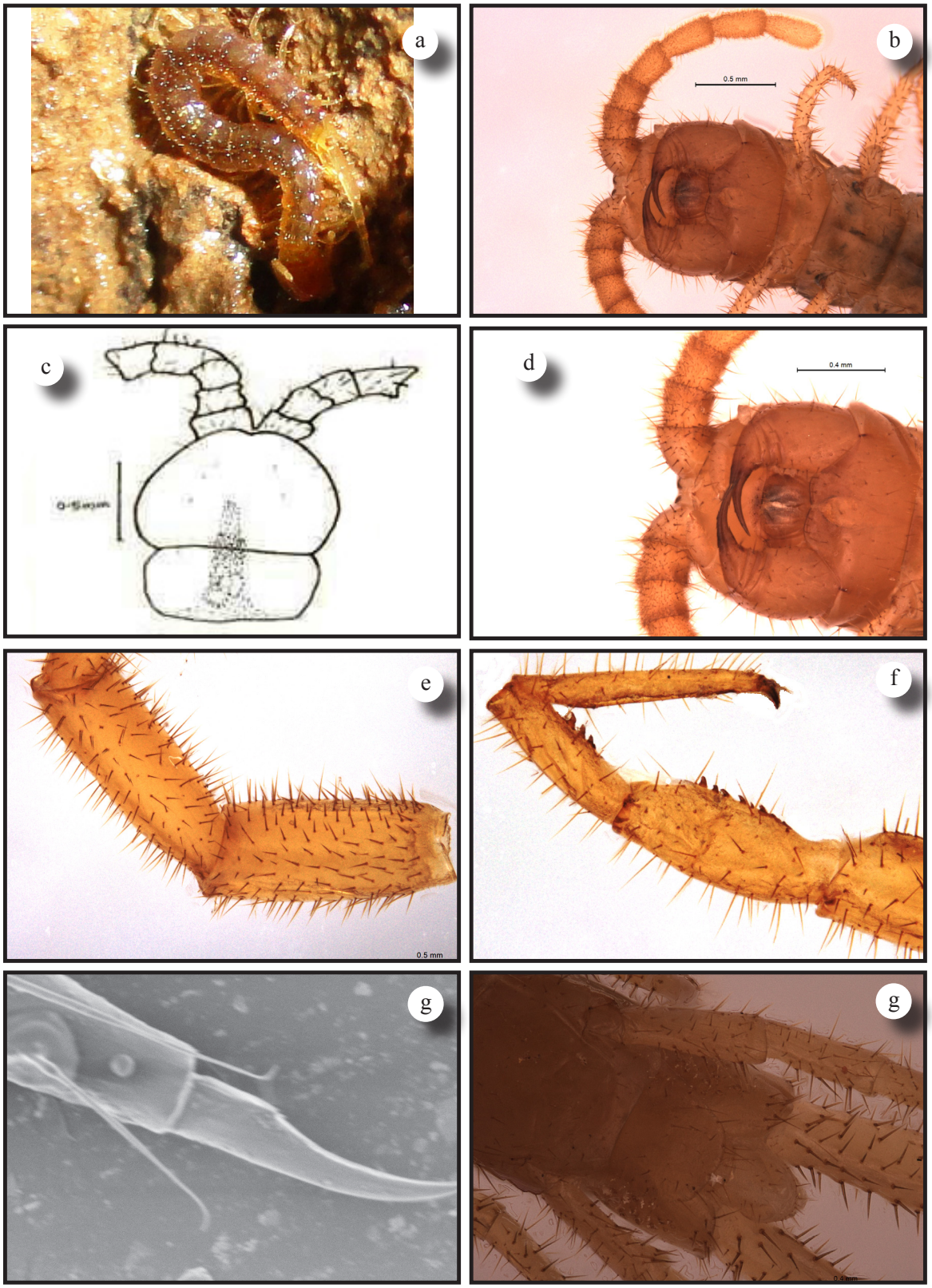
Rhysida lithobiodes trispinosus Jangi and Dass

a. Cephalic plate and basal antennal articles
b. Forcipular coxosternum
c. T21
d. S21 and Coxopleuron
e. Ultimate leg prefemur

Rhysida lithobiodes paucidens Pocock

f. Cephalic plate and basal antennal articles
g. Forcipular coxosternum
h. T21
i. S21 and Coxopleuron
j. Ultimate leg prefemur

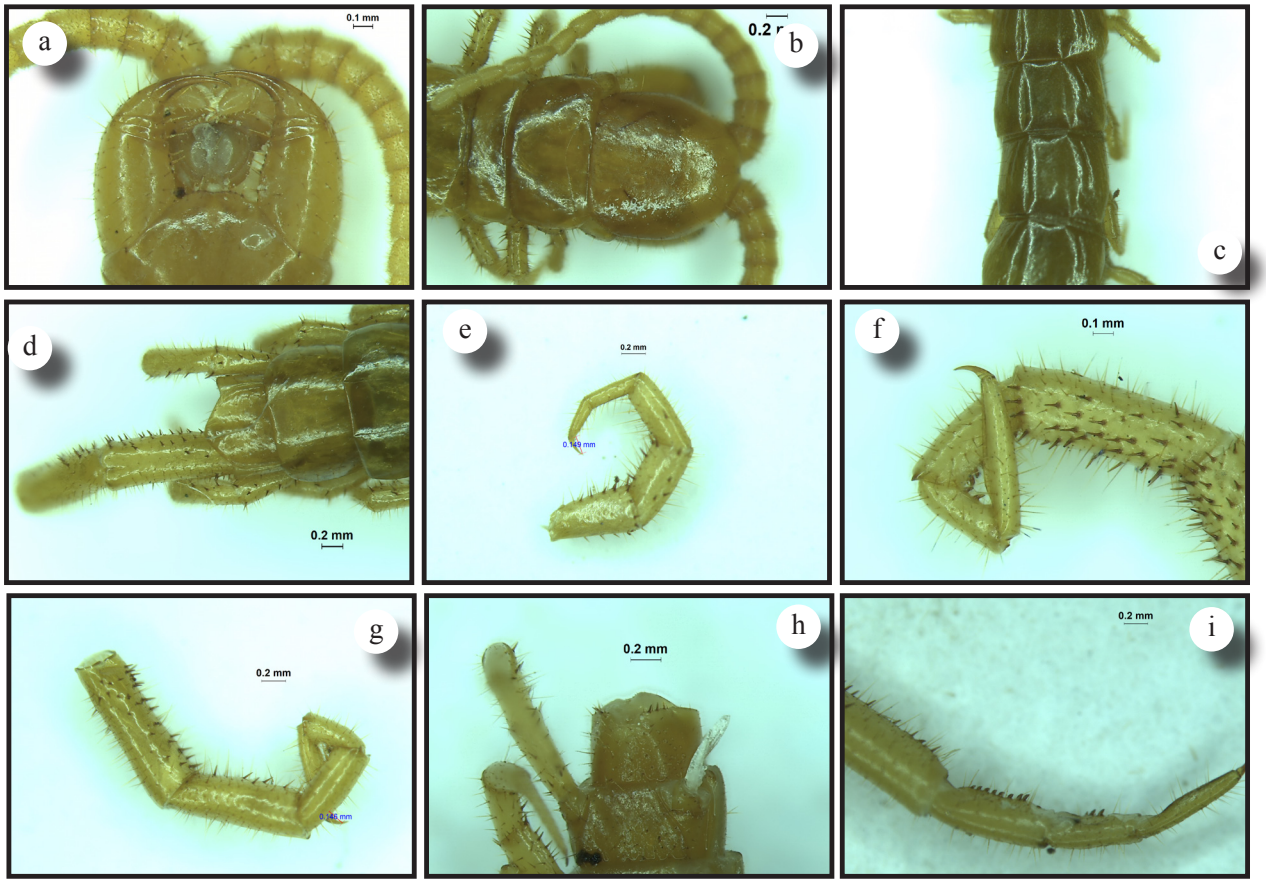
Plate - 38



Cryptops (Cryptops) malabarensis Dhanya ***et al.,***

a. *Cryptops (Cryptops) malabarensis* (in life)
b.antennal articles
c. Cephalic plate and basal antennal articles
d.Forcipular coxosternum
f. Ultimate leg tibia, tarsus
e.Ultimate leg prefemur

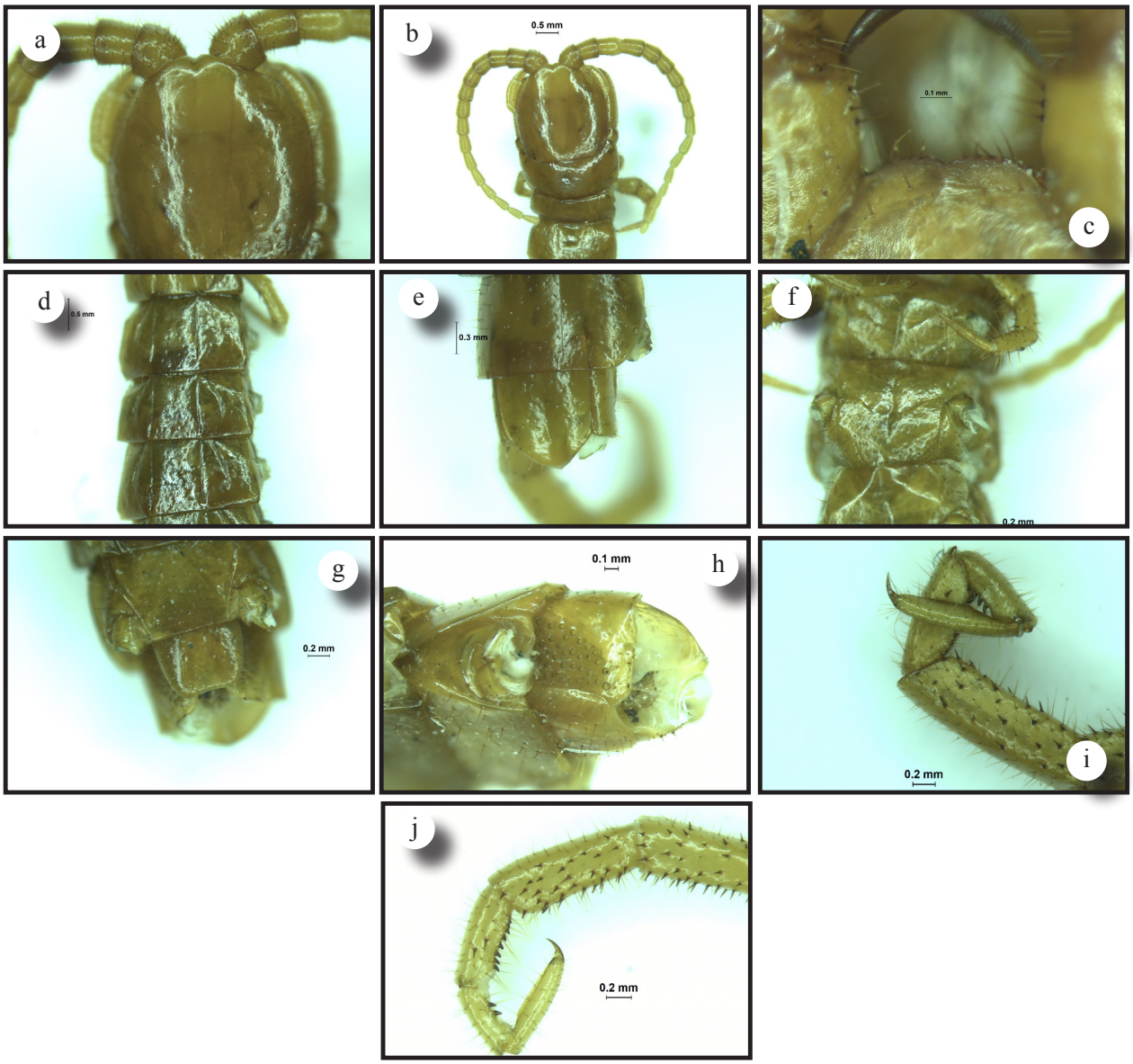
Plate - 39



***Cryptops (Trigonocryptops) sholavasi* sp.nov.**

a. Forcipular coxosternum
b. Cephalic plate and basal antennal articles
c. Middle tergites
d. T21
e. Walking leg 20 with segmented tarsi
f. Distal tubercle on Ultimate leg tibia
g. Ultimate leg
h. S21
i. saw teeth on tibia and tarsus 1

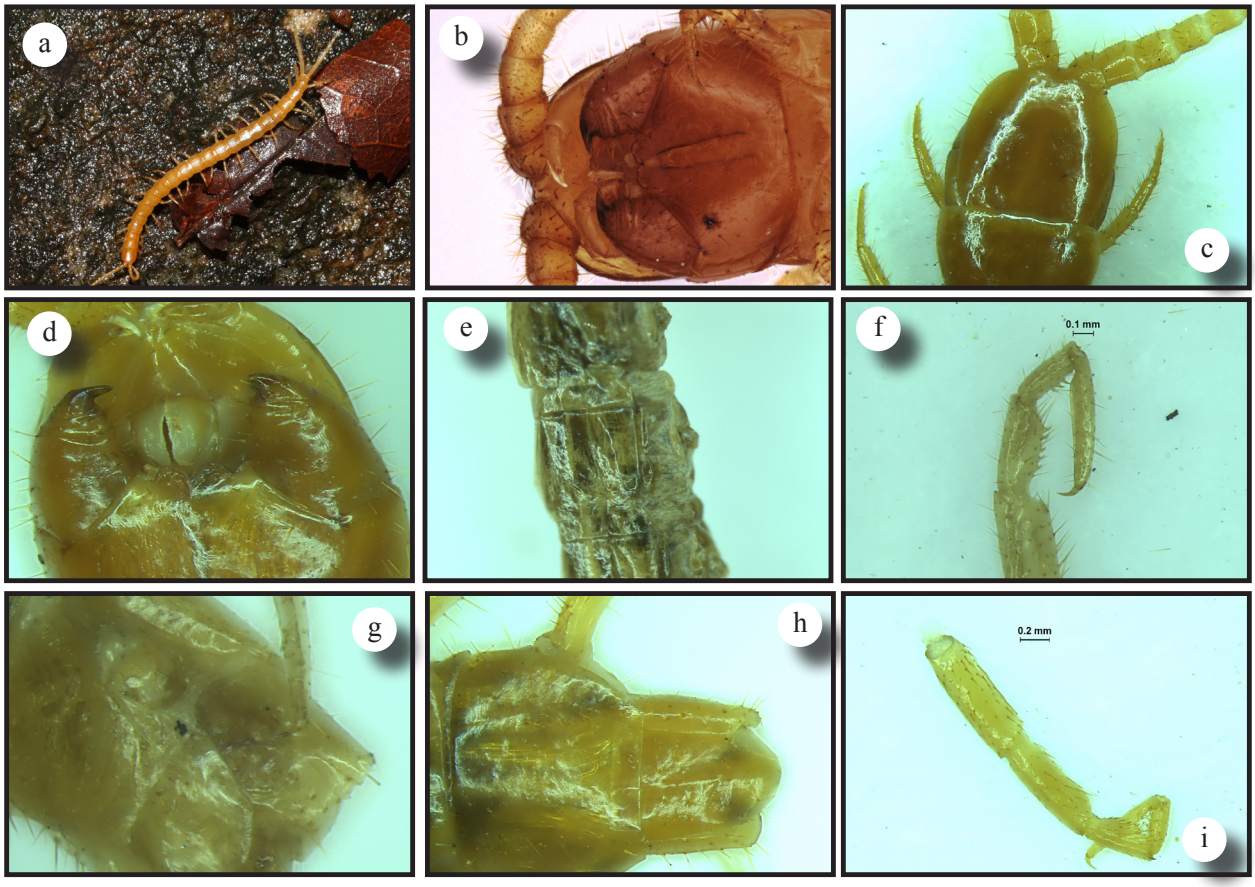
Plate - 40



Cryptops (Trigonocryptops) lewisi sp.nov.

a. Cephalic plate and basal antennal articles
b. Antennal articles
c. Forcipular coxosternum
d. Middle tergites
e. T21
f. Trigonal sutures on tergites
g. S21
h. Coxopleuron
i. Distal tubercle on Ultimate leg tibia
j. saw teeth on tibia and tarsus 1

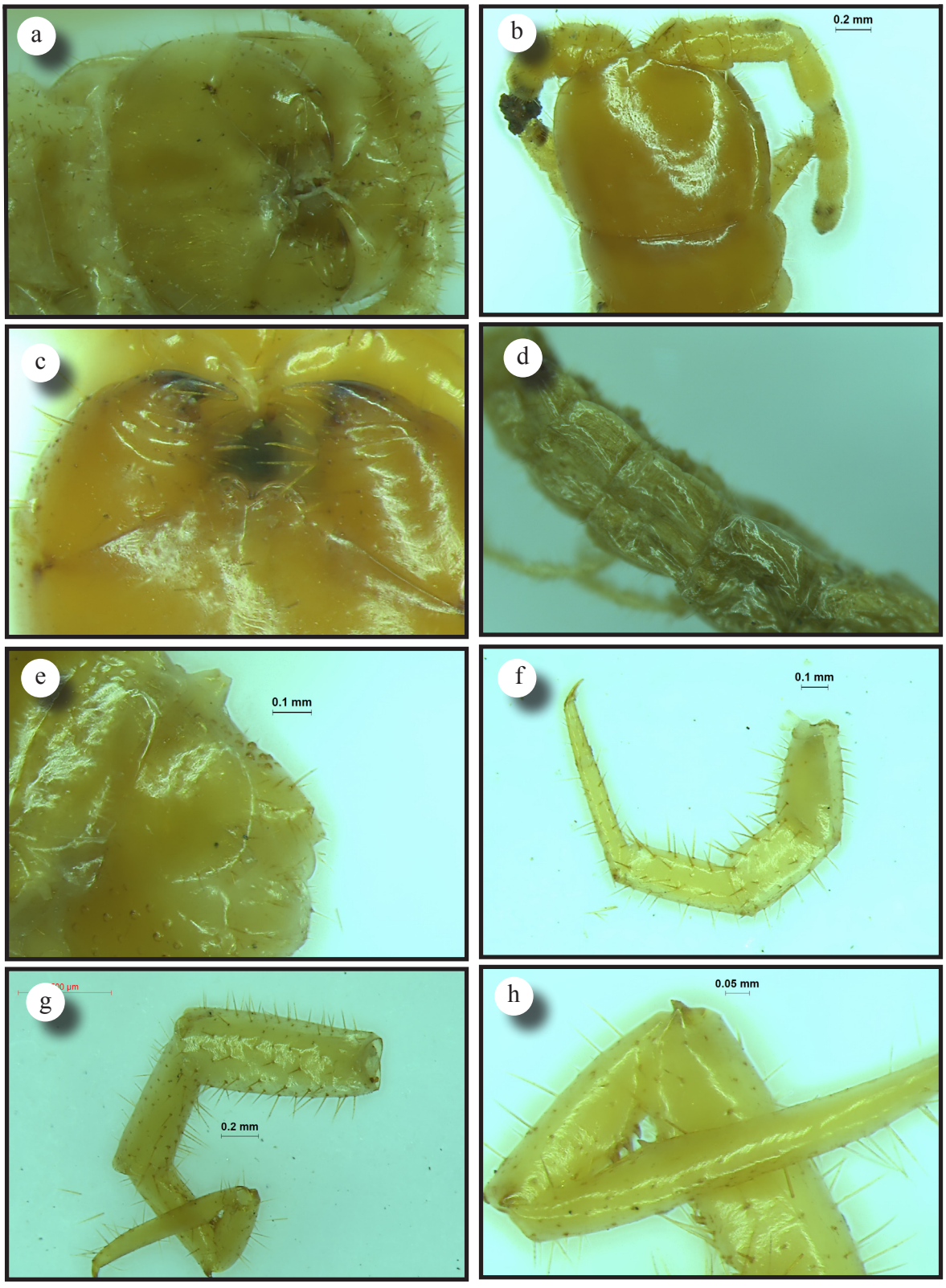
Plate - 41



Paracryptops sureshani sp.nov.

a. *P. sureshani* (in life)
b. Cephalic plate and forcipules
c. Cephalic plate and basal antennal articles
d. Forcipular coxosternum
e. Middle tergites
f. Ultimate leg
g. T21
h. Coxopleuron
i. Ultimate leg

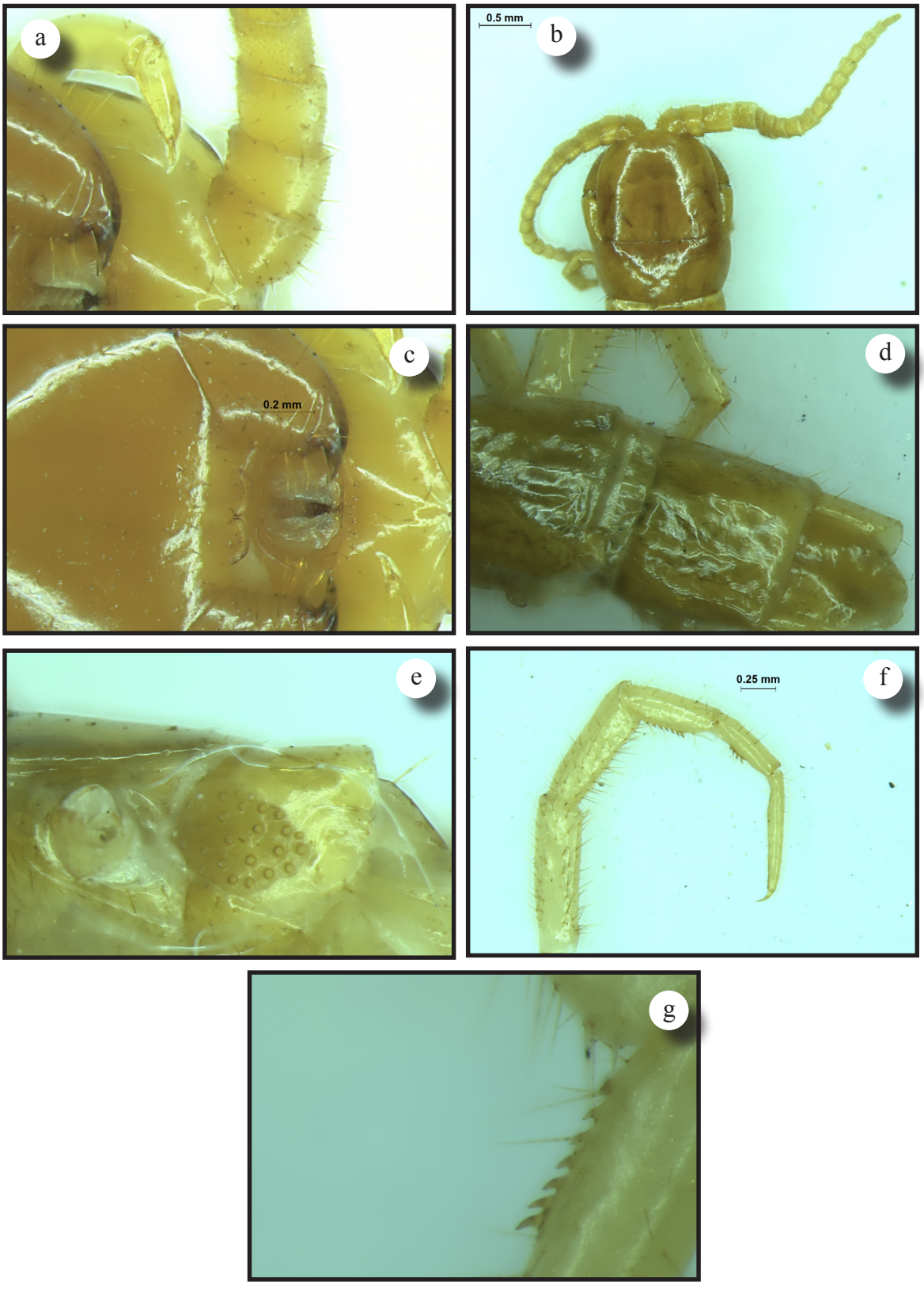
Plate - 42



Paracryptops spinosus Jangi and Dass

a. Cephalic plate and forcipules
b. Cephalic plate and basal antennal articles
c. Forcipular coxosternum
d. Middle tergites
e. S21 and Coxopleuron
f. Walking leg 20
g. Ultimate leg
h. Tubercle on ultimate leg prefemur and tibia

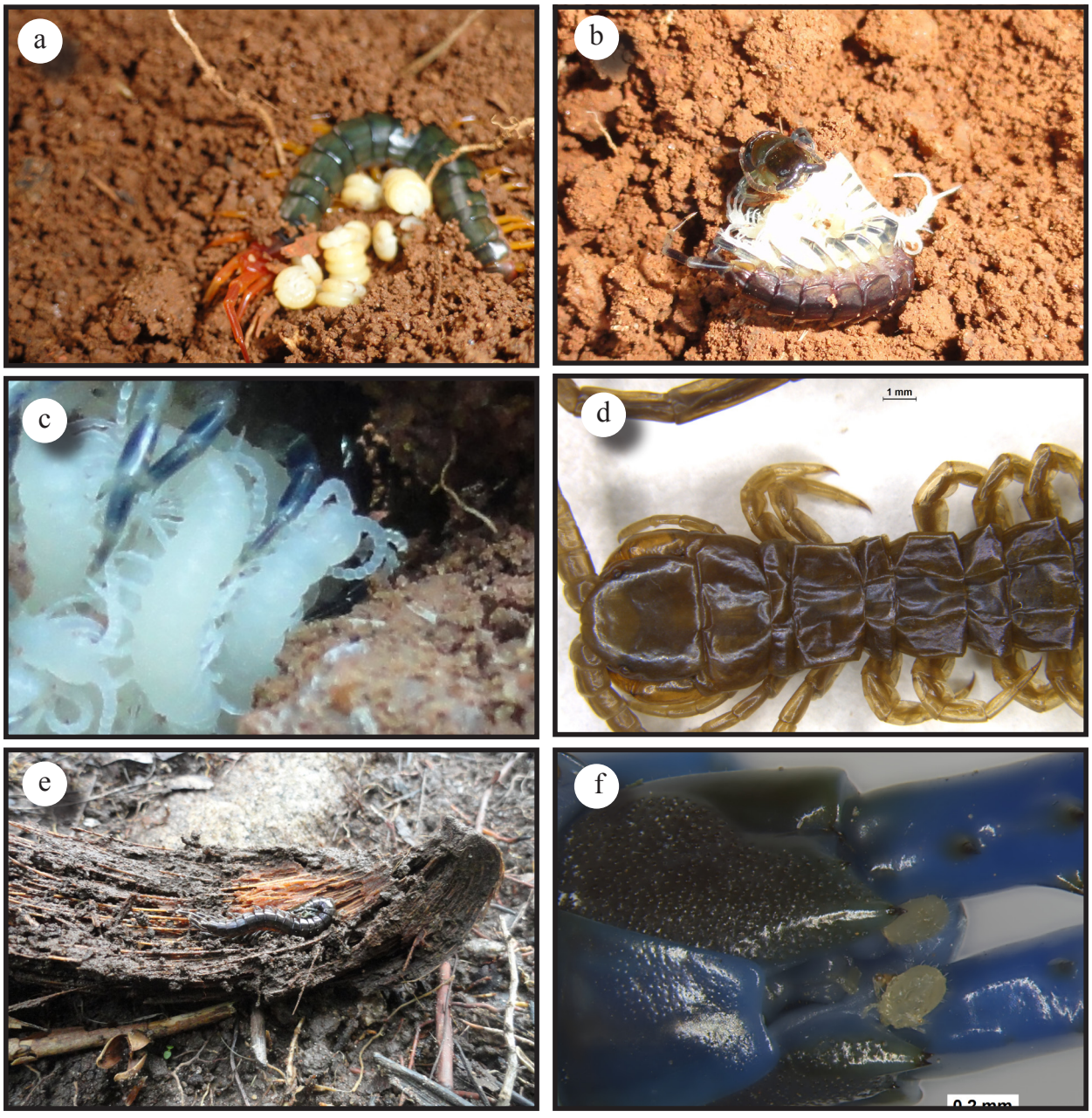
Plate - 43



Paracryptops sankari sp.nov.

a. forcipules
b. Cephalic plate and basal antennal articles
c. Forcipular coxosternum
d. Middle tergites
e. Coxopleuron
i. Ultimate leg
j. Sawteeth

Plate - 44



a. *Rhysida immarginata* in parental care
b. *Digitipes barnabasi* in parental care
c. stadium
d. moulted individual
e. *Cormocephalus* sps. in hibernation inside a coconut trunk
f. Ectoparasitism of Acari on *Digitipes coonoorensis*

APPENDIX 1

DISTRICT WISE LIST OF COLLECTION LOCALITIES

District	Locality
	SOUTHERN KERALA
Alappuzha	Alappuzha civil station ward, Marari beach resort, Alappuzha, Mararikulam
Kollam	Kattilappara, Karadippara,(Shenduruni),Kazhuthuruthi ,thenmala,Mannanthara,(Shenduruni),Pandimotta(Shenduruni),Rosemala,Deer Park(Thenmala)
Kottayam	Kappalamood, Mutholi, Pala, Kadappattoor
Pathanamthitta	Gavi, Periyar WLS,Kummanoie, Konni,Mellathodu, Pampa,Palakappara,
Trivandrum	Ananirathi, Neyar WLS,Pandipath,Peppara ,Puravimala(Neyar),Neyar Dam Island,Ponmudi

CENTRAL KERALA	
Eranakulam	Cochin,Karadippara,Kodanadu elephant cral,Kodanadu, kolombo,(Thattekad),Kallippara, Thoppimudu(thattekad)Thattekad),Kkoottikal(Thattekad),Malayattoor,Manikamangalam,N.Paravur,PachamalaTthattekad),thoppimudu(Thattekad),Kolumba(Thattekad),Udayamperoor,Vaduthala, Urulamthanni(Thattekad).
Idukki	870mile shola under Umayamala,Amar shola,Anamudi shola,Chinnar,Chinna Anamudi, Nellppattikudi,Churulippetty,(Chinnar),Forest IB(Marayur),Idalimotta, Mannavan shola,Irachippara shola,Kadalar shola,Kadalar water fall, Rajamala,Kadavari, Randam thodu,Kambalip parachola,(marayur),Karadippara chola,Kurinjimala op(Hut),Manavan Shola,Mathikettan check post,Mathikettan Shola, Methap(Mannavan Shola),Meenmutty,Mullekudy,Nagamalacholai,Pambadumshola,Pettimoodu,Pullardichola(Mannavan shola),Santhanpara,Thekkady, Manalar,Vallakadavu, Thekkady
Palakkad	Agaly,Attappady,Choolannoor Peacock sanctuary,Dhoni,GovtCollegeCampus(Chittoor),Havlok bungalow(SilentValley),IB,Mukkali(SilentValley),Kanjerumpuzha,Karakkamedu(SilentValley),Malampuzha,Panthamthod(SilentValley),Poochippara(SilentValley),Pudunagaram,sairandri(Silent Valley),Seetharakundu,Valayar, Karimala, Padippara(Parambikulam)
Thrissur	Orukomban,Vazhachal,Machad,Malakkappara,Peechi,Olakkara,KFRI campus,Thumboormuzhy Dam site, Athirappilly, Thumboormuzhy farm.

NORTHERN KERALA	
Kozhikode	Chevayur,EastHill,kadalundi,kakayam,kodenchery campus,kottuli,krishnamenon museum, east hill,kuttothparambu,nallalm,Narayankulam,pavangad,Quilandy,Ravindra Estate(Malabar WLS),thuruthimala,Urakkuzhy Sie1(Malabar WLS,Urakkuzhy Site2(Malabar WLS,Ambalappara, Kakkayam(Malabar WLS), Vadagara
Kannur	Paithalmala, Aralam WLS,Chittariparamba,Kannavam RF,Kannur,KottiyurWLS,Madaippara,Kuriakosethodu,Meeenmutty(Aralam WLS)
Kasargod	Paripputhodu,Peruva,Bellipady,Mandekol,Maruthome,Ranipuram
Malappuram	Nadukani(Nilambur),New amarambalm, Panappuzha(New Amarambalam),Thannikuzhy, Karipur
Wayanad	Chembra peak,Chethalayam,Kattikulam,Ladysmith RF,Maragada(Muthanga),Meenmutty Water falls,Palamukku,Periyapeak,Thirunelli,Tholpetty(Muthanga), Kurichyad

APPENDIX 2
(PLATE : 4-7)

Terms used for various types of impressions on the body surface.

Suture- generally linear; the impressions corresponding to the ridge between two immovable sclerites

Sulcus- elongated shallow impressions in a sclerite , generally.

Depression- large and not elongated shallow impressions in a slerite.

Fossa- deep, large and elongated impressions in a sclerite

Terms used for various types of projections on the body surface.

Tubercle- usually rounded and stout projections, non-articulated.

Spinous process - large, pointed projections, non-articulated.

Spine- small, pointed projections, non-articulated.

Hair- slender projections, non-articulated.

Seta-, slender projections, generally articulated at the base.

Spur- spine-like projections, generally articulated at the base.

Sensillum- projections which are articulated at the base, observed in various shapes, sensorial in function.

An alphabetical index of terminology recommended by Bonato *et al*., (2010) terms is provided below,

Cephalic capsule

cephalic capsule- integument of the head to the exclusion of its appendages.

cephalic plate- dorsal side of the cephalic capsule.

cephalic median sulcus- median longitudinal sulcus on the anterior part of the cephalic capsule.

cephalic transverse suture- transverse suture on the anterior part of the dorsal side of the cephalic capsule.

cephalic paramedian suture- one of the paired paramedian sutures on the cephalic plate

cephalic basal plate- one of the paired sclerites at the posterior corners of the cephalic plate.

ocellus- simple vision organ, appearing as a single convex lens.

Antenna

Antenna- one of the paired most anterior appendages on the head.

Antennal **article**: one of the rigid sectors along the antenna.

Clypeus and labrum

Clypeolabrum- antero-ventral part of the cephalic capsule, located posterior to the antennae and between the cephalic pleurites.

Clypeus: sclerite on the antero-ventral part of the cephalic capsule, to the exclusion of the labrum.

Labrum: posterior part of the clypeolabrum, sometimes delimited from the clypeus by a suture

Mandible

mandible - one appendage of the first pair of the mouth-parts.

gnathal edge- distal margin of the mandible

mandibular trunk- main part of the mandible, to the exclusion of the manubrium and the gnathal edge.

mandibular cruciform suture- pair of crossed sutures on the mandibular

mandibular accessory denticle- one of the denticles arranged in rows on the mandibular teeth

mandibular tooth- sclerotised, large, subconical, projection on a mandibular dentate lamella

First maxillae

first maxillae- pair of appendages and associated basal sclerites between the mandibles and the second maxillae.

first maxillary coxa-part of the coxosternite corresponding to a coxa, of the first maxillae

first maxillary coxosternite- entire sclerite corresponding to sternite and coxae of the first maxillae.

first maxillary telopodite-one of the paired projections, usually articulated at the base, on the anterior margin of the first maxillary coxosternite, lateral to the coxal projections.

first maxillary basal article- the most basal article of the first maxillary telopodite.

second maxillae

second maxillae- pair of appendages and associated basal sclerite, posterior to the first maxillae.

forcipular segment

forcipular segment- the segment bearing forcipules.

forcipular tergite- main tergite of the forcipular segment

forcipular coxosternite- entire sclerite corresponding to sternite and coxae of the forcipular segment.

forcipular coxopleural suture-suture between the forcipular pleurite and the forcipular coxae or coxosternite.

coxosternal tooth- sclerotised, short, subconical projection on the anterior margin of the forcipular coxosternite.

coxosternal tooth plate- one of the paired sclerotised, flat, teeth-bearing projections on the anterior margin of the forcipular coxosternite.

forcipuletelopodite of the forcipular segment.

forcipular trochanteroprefemur- first article of the forcipule.

forcipular trochanteral suture/sutures: trace of suture on the forcipular trochanteroprefemur.

forcipular femur- second article of the forcipule.

forcipular tibia- third article of the forcipule.
forcipular tarsungulum- ultimate article of the forcipule.

Leg-bearing segment

leg-bearing segment- segment of the trunk bearing paired walking appendages.
Tergite of leg-bearing segment: sclerite on the dorsal side of a leg-bearing segment.
margination of tergite- marginal ridge on a tergite
pretergite- anterior sclerite of the two dorsal sclerites of a leg bearing segment.
Metatergite- posterior sclerite of the two dorsal sclerites of a leg-bearing segment
paramedian sulcus or suture of tergite- one of the paired paramedian longitudinal sutures or sulci on a tergite.
anterior transverse sulcus or suture of tergite- transverse suture or sulcus on the first trunk tergite.
cruciform suture of tergite- pair of crossed sutures on the first trunk tergite.
oblique suture of tergite- one of the paired oblique sutures on some anterior trunk tergites
lateral longitudinal suture of tergite- one of the paired longitudinal sutures close to the lateral margins of a tergite.
lateral crescentic sulcus of tergite- one of the paired curved, sublongitudinal sulci on a tergite.
Spiracle- one of the paired openings of the tracheae on the lateral sides of a leg-bearing segment.
Sternite/sternites of leg-bearing segment- sclerite on the ventral side of a leg-bearing segment.
Presternite- anterior region of the single sternite of a leg-bearing segment, or anterior sclerite of the two ventral sclerites of a leg-bearing segment.
Metasternite- posterior region of the single sterniteof a leg-bearing segment, or posterior sclerite of the two ventral sclerites of a leg-bearing segment
transverse sulcus of sternite -transverse sulcus on a sternite.
median longitudinal sulcus of sternite- mid-longitudinal sulcus on a sternite.
cruciform sutureof sternite- the pair of transverse and median longitudinal sulci on a sternite.
Endosternite- posterior projection of a sternite, covered by the sternite of the

following segment.

leg

leg- one of the paired appendages of the trunk to the exclusion of the forcipules and the gonopods.

leg **coxa**- the most basal article of a leg.

leg **trochanter**- small, basal most article of a telopodite.

leg **prefemur**- second article of a telopodite.

leg **femur**- third article of a telopodite.

leg **tibia**-fourth article of a telopodite.

leg **tarsus**-fifth article of a telopodite, when ultimate.

tarsal article- one of the articles of a biarticulated region of the leg corresponding to the tarsus.

tarsus1-the basal article of two tarsal articles.

tarsus 2- the distal article of two tarsal articles

pretarsus- apical element articulated at the tip of a leg.

Claw- pretarsus in shape of a claw

accessory spine- slender, pointed projection at the base of the claw.

ultimate leg-bearing segment

ultimate leg-bearing segment- leg-bearing segment bearing the ultimate pair of legs.

tergite of the ultimate leg-bearing segment: main tergite of the ultimate leg-bearing segment.

sternite of the ultimate leg-bearing segment: main sternite of the ultimate leg-bearing segment.

ultimate leg- one of the legs of the ultimate pair.

Coxopleuron

Coxopleuron- basal element of the ultimate leg, corresponding to coxa and pleurites.

coxopleural process- posterior process of the coxopleuron.

coxopleural **spine**- spine on the coxopleuron.

coxal pore- one of the pores of the coxal organs on posterior legs.

pore-field-part of the surface of the coxa or coxopleuron of the ultimate legs

containing the coxal pores.

prefemoral spine- spine on the prefemur of ultimate and/or penultimate legs.
prefemoral process- process, usually bearing spines, on the prefemur of the ultimate legs.
prefemoral **corner spine**- spine on the distal end, on the mesal side, of the prefemur of ultimate legs.
saw tooth- one of the directly pointed projections arranged in rows on the tibia and tarsus 1 of ultimate legs.
ultimate leg pretarsus- pretarsus of the ultimate leg.

terminal part of the body
intermediate tergite- tergite posterior to the tergite of the ultimate leg-bearing segment, corresponding to the intermediate sternite.
intermediate sternite- sternite between the sternite or metasternite of the ultimate leg-bearing segment and the first genital Sternite

Pattern of teeth on the tooth-plates in Scolopendromorpha. The number of teeth is
indicated for the right and the left side, separated by a plus (n right + n left).
Leg-bearing segments and pairs of legs. Each leg-bearing segment, or the corresponding
pair of legs, is indicated by an Arabic number, from the most anterior/ or the first one (1) to the most posterior one.
Tergites and sternites of the leg-bearing segments. Each tergite and sternite is indicated by T and S respectively, followed by an Arabic number, from the most anterior ones (T1 and S1) to the most posterior ones.

A new species of centipede of the genus *Cryptops* Leach (Scolopendromorpha: Cryptopidae) from southern Western Ghats with a key to the species of *Cryptops* in India

Dhanya Balan [1], P.M. Sureshan [2] & Vinod Khanna [3]

[1,2] Western Ghat Regional Centre, Zoological Survey of India, Calicut, Kerala 673006, India
[3] SaiDrishti, 151, AshokVihar, Salawala,Dehra Dun, Uttarakhand 248001, India
Email: [1] dhanyamkrishna@gmail.com (corresponding author), [2] pmsuresh43@yahoo.com, [3] drvkhanna51@gmail.com

Abstract: A new species of blind cryptopid centipede of the genus *Cryptops* Leach belonging to the *hortensis* group viz. *Cryptops (C.) malabarensis* is described from the southern Western Ghats, Kerala, India and the family Cryptopidae (Scolopendromorpha) is reported for the first time from the area. Affinities of the new species with a Madagascar species are discussed and a key to separate the Indian species of *Cryptops* is also provided.

Keywords: Chilopoda, Cryptopidae, *Cryptops malabarensis* sp. nov, key, new species, Scolopendromorpha, southern Western Ghats.

Date of publication (online): 26 April 2012
Date of publication (print): 26 April 2012
ISSN 0974-7907 (online) | 0974-7893 (print)

Editor: Gregory D. Edgecombe

Manuscript details:
Ms # o3035
Received 14 December 2011
Final received 06 February 2012
Finally accepted 30 March 2012

Citation: Balan, D., P.M. Sureshan & V. Khanna (2012). A new species of centipede of the genus *Cryptops* Leach (Scolopendromorpha: Cryptopidae) from southern Western Ghats with a key to the species of *Cryptops* in India. *Journal of Threatened Taxa* 4(4): 2510–2514.

Acknowledgement: We are grateful to Dr. K. Venkataraman, Director, Zoological Survey of India, Kolkata and C. Radhakrishnan, Officer-in-Charge, Western Ghat Regional Centre, Zoological Survey of India, Calicut for providing facilities and encouragement. DB is grateful to Ministry of Environment and Forests, Govt. of India for awarding the Junior Research Fellowship and to Dr. John Lewis, UK, for the timely help and advice on matters of taxonomy, assistance with the literature and for useful comments on the manuscript. DB is also thankful to Dr. S. Shankar, Senior Scientist, Kerala Forest Research Institute, Peechi, Kerala for guidance on matters concerned with the studies in soil ecology. We are grateful to PCCF, Kerala Forest and Wildlife Department for the study permission and Staff, Malabar Wildlife Sanctuary for their encouragement and support during the study. Thanks are also due to Mr. P.K. Umesh, Mr. K.C. Harish and Mr. R.A. Aswanth for assistance rendered during the field trips.

The Western Ghats in India, with its very diverse assemblage of flora and fauna is one of the hotspots of biodiversity (Myers et al. 2000). With a few exceptions, the invertebrate fauna of the Western Ghats has been inadequately studied both in terms of their diversity and conservation priorities (Kunte in press). Though an integral part of the soil ecosystems, the fauna of scolopendromorph centipedes (Chilopoda: Scolopendromorpha) of the Western Ghats is still little known except for the pioneering works by Attems (1930), Jangi & Dass (1984), Yadav (1993) and Sureshan et al. (2006). A perusal of the literature reveals the occurrence of 40 species of scolopendrid centipedes belonging to eight genera and two families in the Western Ghats. Like the families Plutoniumidae and Scolopocryptopidae and the order Geophilomorpha, the family Cryptopidae are blind centipedes, lacking ocelli. *Cryptops* Leach, 1815, is the largest genus of the family Cryptopidae, with 153 named species worldwide (Lewis 2002), in four subgenera i.e., *C.* (*Cryptops*) Leach, 1815; *C.* (*Chromatonops*) Verhoeff, 1906; *C.* (*Haplocryptops*) Verhoeff, 1934 and *C.* (*Trigonocryptops*) Verhoeff, 1906 (Bonato et al. 2011). The smaller size and fragile body, coupled with an abundance of species names, often founded on inadequate samples and with imprecise descriptions, make cryptopid centipedes a taxonomically difficult group and only seven species in two genera have so far been described from India. The Indian species of *Cryptops* are *Cryptops* (*C.*) *feae* Pocock, 1891, *Cryptops (C.) doriae* Pocock, 1891, *Cryptops* (*C.*) *kempi* Silvestri, 1924, *Cryptops* (*C.*) *setosior* Chamberlin, 1959 and *Cryptops* (*Trigonocryptops*) *orientalis* Jangi, 1955 (Khanna 2005, 2008).

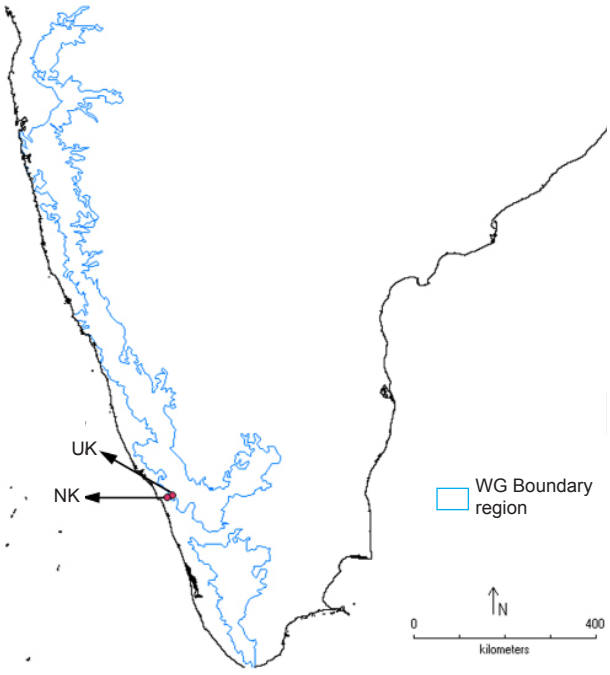


Figure 1. Location of the Western Ghats in southern India with the two localities of *Cryptops malabarensis* sp.nov. indicated by coloured circles.
UK - Urakkuzhy, Malabar Wildlife Sanctuary; NK - Narayankualam.

Materials and Methods

During the faunal exploration surveys, interesting specimens of cryptopids were collected from the forested tracts of southern Western Ghats and its foot-hills (Fig. 1). The collections represent the first record of the family Cryptopidae from the area and permit the description of a new species of *Cryptops*. The new species shows very close affinity with *C. decoratus* Lawrence, 1960, which has its distribution in Madagascar (holotype), Mauritius (Lewis 2002), and the Seychelles (Lewis 2007). The specimens are deposited in the Zoological Survey of India, Western Ghat Regional Centre, Calicut (ZSIC), Kerala, India.

Digital imaging was carried out using a Leica M205A stereomicroscope and a Leica DFC-500 digital camera. Scanning electron micrographs were captured with a Jeol JCM-5000 Neoscope bench-top SEM. The terminology used by Bonato et al. (2010) is followed in this paper.

Cryptops (Cryptops) malabarensis sp. nov. (Figs. 2-3 and Images 1–5)

Material examined

Holotype: 01.viii.2011, 11°32’40.59”N & 75°55’33.40”E, elevation 641.2m, Urakkuzhy, Kakkayam, Malabar Wildlife Sanctuary, Kerala, India, coll. Dhanya Balan, (ZSI/WGRC/I-R/INV 2111) (Images 1–5).

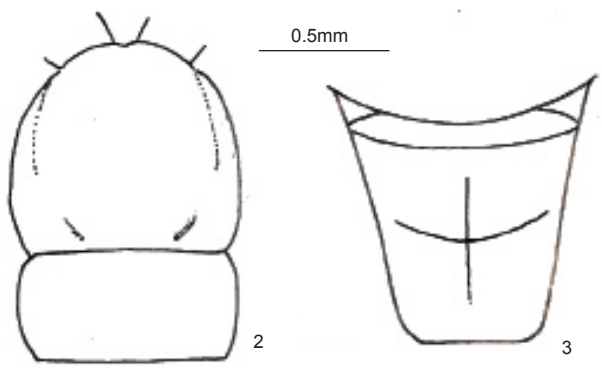
Paratypes: 29.viii.2011, three specimens, from type locality, coll. Dhanya Balan (ZSI/WGRC/I-R/INV 2080, 2108, 2109); 01.iv.2011 two specimens, 11°30’26.98”N & 75°48’24”E, elevation 145m, Narayamkulam, Calicut District, Kerala, India, coll. P.K. Umesh (ZSI/WGRC/I-R/INV 2079).

Diagnosis: A species of *Cryptops* lacking anterior transverse suture on Tergite-1; tergite paramedian sutures from tergite 4 or 5–20; absence of saw teeth on the ultimate femur (C. *hortensis* group); ultimate leg tibia with 4–7 saw teeth on the tibia and 3–4 on tarsus one; no accessory spurs associated with the tarsal claw.

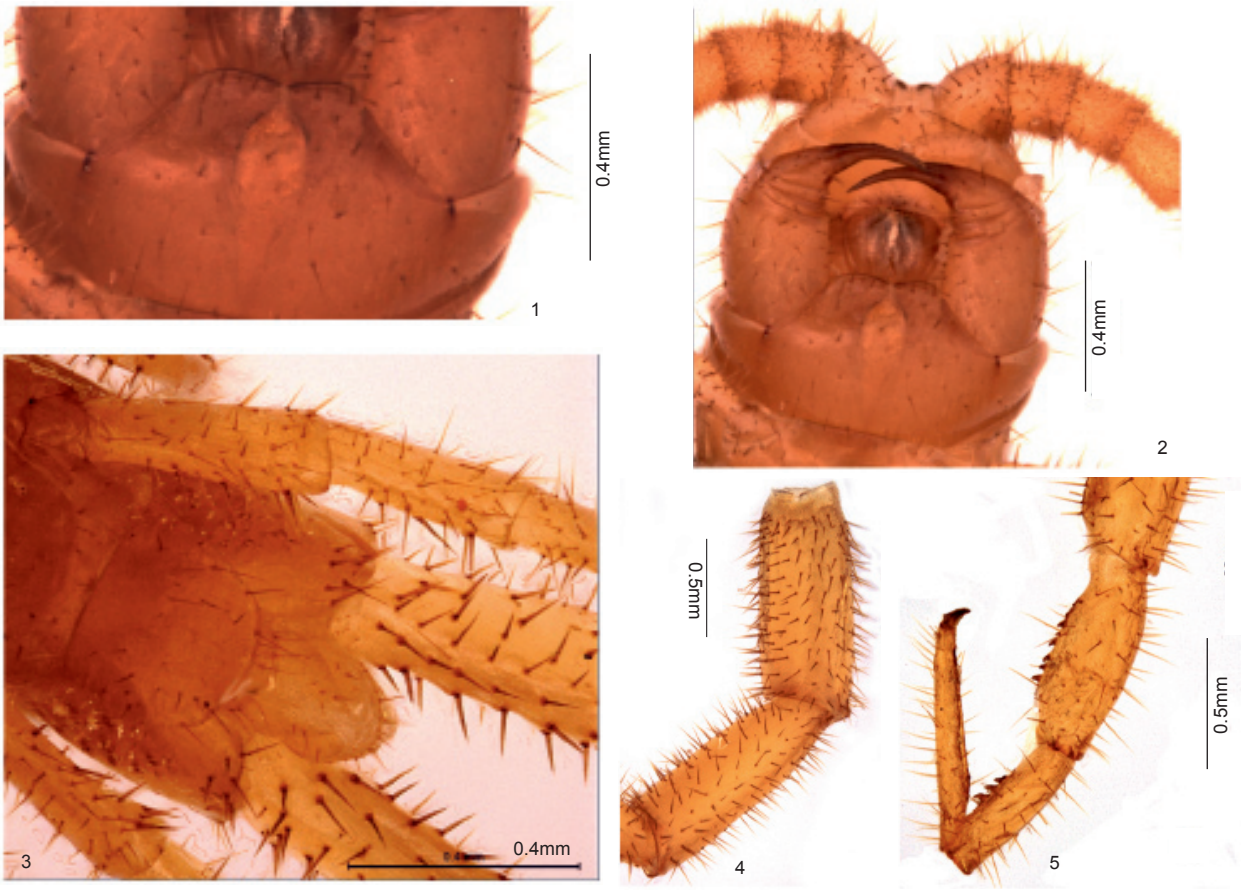
Description of holotype

Body length 23mm. Colour (before and after preservation) greyish-brown with dark subcutaneous pigment on tergites. Ultimate legs yellow.

Antennae composed of 17 articles; basal two articles relatively stout with long setae distally. An irregular whorl of long setae on the proximal end of articles 1–3, the rest with setae scattered irregularly, not in whorls but the dorsal middle region is not densely covered. Short, fine setae abundant from 6th



Figures 2–3. *Cryptops (Cryptops) malabarensis* sp. nov. (ZSI/WGRC/I-R/INV 2108)
2 - Cephalic plate and Tergite-1; 3 - Sternite suture



Images 1–5. *Cryptops (Cryptops) malabarensis* sp. nov. (ZSI/WGRC/I-R/INV 2109). © WGRC, ZSI, Calicut
1 - Forcipular coxosternum; 2 - Cephalic plate ventral; Sternite-21; Prefemur and femur; Tarsus and tibia

article onwards (Images 4 & 5).

Cephalic plate and tergite one without sutures, tergite one overlying the posterior edge of the cephalic plate (Fig. 2). Anterior edge of forcipular coxosternite weakly bilobed (Image 1) and with four long and one small setae on each side. Tergite paramedian sutures from tergite 4 or 5–20. Tergite 21 without sutures and with slightly angular posterior margin. Sternites with longitudinal and transverse sulci, longitudinal sulci longer than the transverse (Fig. 3). Sternite 21 with sides converging very slightly and straight posterior margin (Images 2 & 8). Legs 1–19 with undivided tarsi. No accessory spurs associated with the tarsal claw (Image 9).

Coxopleuron with nine large pores and with at least three minute setae in porefield; three or four fine setae on posterior margin and upto five between this and porefield. Posterior area of coxopleuron is poreless.

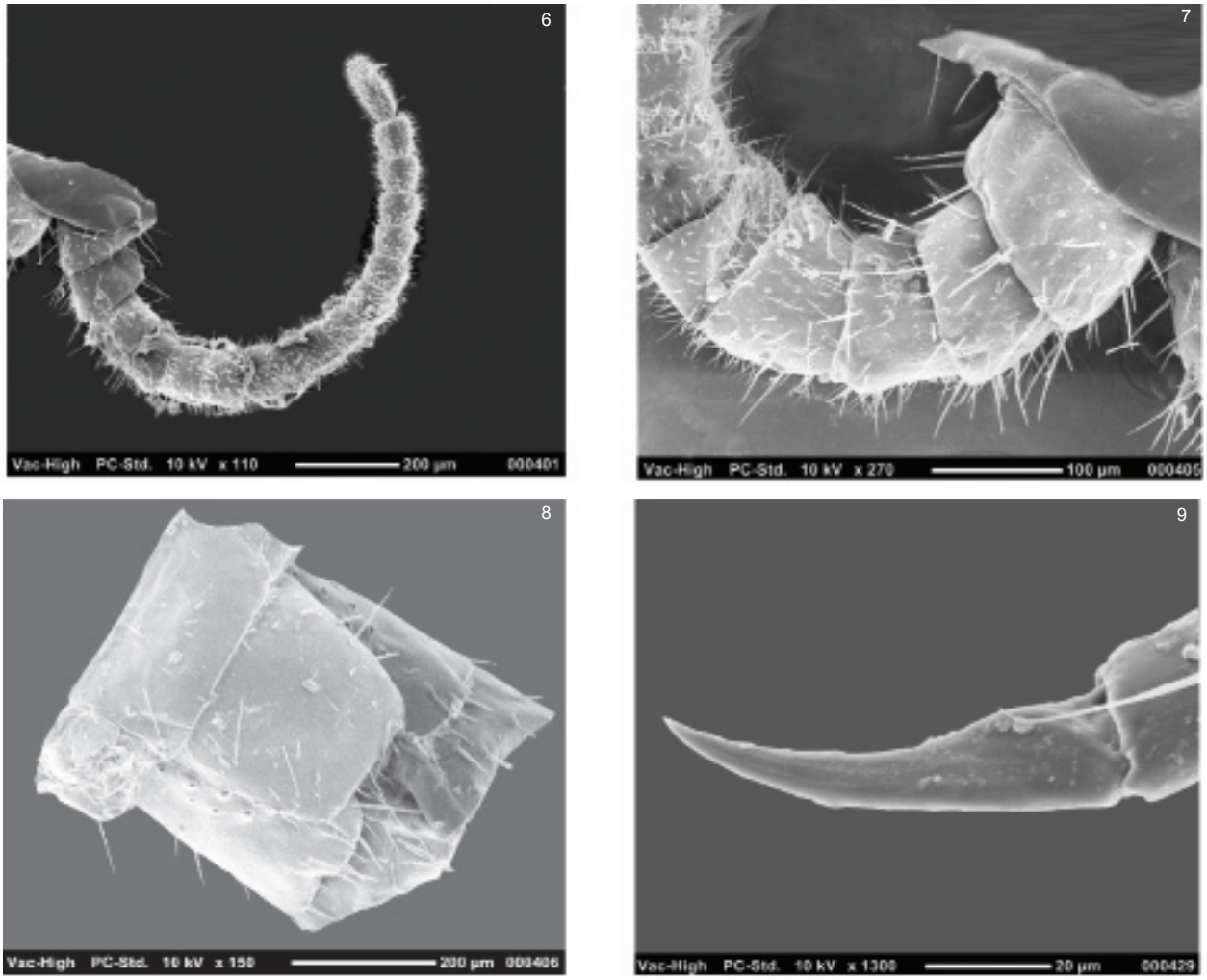
Leg 20 with dense fine setae ventrally on prefemur, femur and tibia in all specimens. Ultimate legs with strong setae on anterior, ventral and posterior surfaces of prefemur and on ventral and posterior surfaces of femur. Median longitudinal glabrous area absent. No distal tubercle on tibia and tarsus. No saw tooth on the femur (Image 4); seven on the tibia and three on the tarsus 1 (Image 3).

Additional information from paratypes

Body length of paratypes varies between 11–21 mm. Antennae of leftside is damaged in 2079. When compared to the holotype, the number of saw teeth on the ultimate leg tibia varies from four (2079), five (2080) or six (2108, 2109) and on tarsus 1 the variation is either three (2080, 2108, 2109) or four (2079) saw teeth. The number of coxopleural pores are not clearly countable.

Etymology

The species is named after the type locality "Malabar Wildlife Sanctuary", Kerala, India.



Images 6–9. *Cryptops (Cryptops) malabarensis* sp. nov. (ZSI/WGRC/I-R/INV 2080). © WGRC, ZSI, Calicut
6 - Dorsal view of antenna; 7 - Basal antennal articles; Sternite-21; Pretarsus of leg from middle trunk

Table 1. Ecological observations from the sampling sites

Physiographic category	Midland	Highland
Sampling sites	Narayamkulam	Kakkayam
Altitude	145m	641m
Atm. temp	24–30 ^{0}C	19–28 ^{0}C
Distance from water source	120m	75m
Type of vegetation	agro ecosystem near a semi deciduous forest patch	moist deciduous forest
Soil temperature	23–27^{0}C	15–25^{0}C
soil pH	4.91	4.76
Org. Carbon	3.12	9.15

Ecological observations

Habitat: The specimens were collected from moist deciduous forest tracts of southern Western Ghats. All specimens were found in loose soil, about 4–5 cm below the surface. Ecological parameters of the two collection localities during the period of March–April 2011 are provided in Table 1.

Discussion

Cryptops malabarensis sp. nov. is conspicuously different from the other described Indian species of *Cryptops* included in the *C. doriae* group (having saw teeth on the ultimate leg femur); and falls in the Old World *C. hortensis* group of Lewis (2011) (those lacking saw teeth on the ultimate leg femur), which have not yet been reported from India. *C. malabarensis* sp. nov. closely resembles *C. decoratus* Lawrence (1960), which is also

Key to the *Cryptops* species of India

1. Sternites, at least on some anterior segments with trigonal sutures ……..... ……..... ……(Subgenus *Trigonocryptops) C. (T) orientalis* Jangi
- Sternites without trigonal sutures (Subgenus *Cryptops*) 2
2. Ultimate leg femur with saw teeth…….....3
- Ultimate leg femur without saw teeth…… ……..... ***C. malabarensis* sp. nov.**
3. Tergite 1 with an anterior transverse suture. .....*C. kempi* Silvesteri
- Tergite 1 without anterior transverse suture. 4
4. Each side of forcipular coxosternite convex and with 12 submarginal setae…..……*C. setosior* Chamberlin
- Each side of forcipular coxosternite only slightly convex with 3 or 4 long and one or 2 small setae ……..... ……..... ……*C. doriae* Pocock

a member of the Old World *C. hortensis* group. The two species share the absence of sutures on the cephalic plate and tergite one; anterior margin of coxosternite almost straight, an overlapping number of coxopleural pores (7–9), a similar number of setae in the porefield (at least three) and ultimate leg characters such as prefemur with long fine setae dorsally, absence of a median longitudinal glabrous area, tibia with four and tarsus 1 with two saw teeth. However the new species differs from the holotype description of *C. decoratus*, in having no median ridges on the tergites, no posterior median depression on tergite 21 and the absence of accessory spurs on the pretarsi. *C. decoratus* is a Malagasy species closely related to *C. melanotypus* Chamberlin, 1941 from the Philippines, Mauritius and the Seychelles but Lewis (2011) was unsure of their exact status. However, the strong similarity between the new species and *C. decoratus* and *C. melanotypus* suggests dispersal of a group of closely allied species over a wide area.

REFERENCES

Attems, C. (1930). Myriopoda. 2. Scolopendromorpha. *Das Tierreich. De Gruyter, Berlin* 54: 1–308.

Bonato, L., G. Edgecombe, J.G.E. Lewis, A. Minelli, L.A. Pereira, R.M. Shelley & M. Zapparoli (2010). A common terminology for the external anatomy of centipede (Chilopoda). *Zookeys* 69: 17–51.

Bonato, L., G.D. Edgecombe & M. Zapparoli (2011). Chilopoda - Taxonomic overview, pp. 363–443. In: Minelli, A. (ed.). *Treatise on Zoology - The Myriapoda*—Vol. 1. Brill, Leiden, 530pp.

Chamberlin, R.V. (1959). Entomologische Ergebnisse der Deutschen Indien-Expedition 1955–1958. On some chilopods from India. *Entomologische Mitteilungen* 19: 21–24.

Jangi, B.S. (1955). The chilopod fauna (Scolopendromorpha) of Nagpur India. *Annals and Magazines of Natural History* 12.7: 69–80.

Jangi, B.S. & C.M.S. Dass (1984). Scolopendridae of the Deccan. *Journal of Scientific and Industrial Research* 43(1): 27–54.

Khanna, V. (2005). Trends in the distribution of centipedes from India. *Annals of Forestry* 13(1): 130–140.

Khanna, V. (2008). National register of the valid species of Scolopendrid centipedes (Chilopoda: Scolopendromorpha) in India. *Biosystematica* 1(2): 33–45.

Kunte, K. (2011 in press). Biogeographic origins and habitat use of the butterflies of the Western Ghats, south-western India. In: Priyadarshan, D.R., K.A. Subramanian, M.S. Devy & N.A. Aravind (eds.). *Invertebrates in the Western Ghats - Diversity and Conservation.* Ashoka Trust for Research in Ecology and the Environment, Bengaluru.

Lawrence, R. (1960). Faune de Madagascar 12. *Myriapodes Chilopodes* 76–84.

Leach, W.E. (1815). A tabular view of the external characters of four classes of animals which Linné arranged under Insecta, with the distribution of the genera composing three of these classes into orders etc., and descriptions of several new genera and species. *Transactions of the Linnaean Society of London* (Series 1) 11: 306–400.

Lewis, J.G.E. (2002). The scolopendromorph centipedes of Mauritius and Rodrigues and their adjacent islets (Chilopoda: Scolopendromorpha). *Journal of Natural History* 36: 96.

Lewis, J.G.E. (2007). Scolopendromorph centipedes from Seychelles with a review of previous records (Chilopoda: Scolopendromorpha). *Phelsuma* 15: 8–25.

Lewis, J.G.E. (2011). A review of the species in the genus *Cryptops* Leach, 1815 from the Old World related to *Cryptops (Cryptops) hortensis* (Donovan, 1910) (Chilopoda, Scolopendromorpha). *International Journal of Myriapodology* 4: 11–50.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca & J. Kent (2000). Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.

Pocock, R.I. (1891). On the Myriopoda of Burma. Part 2. Report upon the Chilopoda collected by Sig. L. Fea and Mr. E.W. Oates. *Annali del Museo Civico di Storia Naturale di Genova* (Series 2)10: 401–432.

Silvestri, F. (1924). Myriapoda from the Siju Cave, Garo Hills, Assam. *Record of the Indian Museum* 26: 71–79.

Sureshan, P.M., V. Khanna & C. Radhakrishnan (2006). Additional distributional records of scolopendrid centipedes (Chilopoda: Scolopendromorpha) from Kerala. *Zoos' Print Journal* 21(6): 2285–2291.

Yadav, B.E. (1993). Scolopendridae (Chilopoda) of Western Ghat with some first records from the state of Maharashtra, India. *Records of Zoological Survey of India* 93(3–4): 321–328.

BIODIVERSITY IN OUTSIDE PROTECTED AREAS, WITH A SPECIAL FOCUS ON THE SCOLPENDROMORPHIC CENTIPEDES OF PULIYAMPOYIL HILL, CALICUT, KERALA- A FOOTHILL OF THE SOUTHERN WESTERN GHATS

[1]DHANYA BALAN, [2]SURESHAN P.M AND [3]SANKAR S.

[1,2]Western Ghats Regional Centre, Zoological Survey of India, Calicut-673006, Kerala, India

[3]Kerala Forest Research Institute, Peechi, Trissur, Kerala, India.

Correspondence to: dhanyamkrishna@gmail.com

Abstract: The concept of biodiversity conservation conventionally meant for those areas under legal protection. But some non-protected areas are also vital both in case of diversity as well as richness of its flora and fauna. If unprotected natural and semi-natural lands are managed in a manner that allows for persistence of native species, we can realize significant additional biodiversity gains. Promoting the conservation of biodiversity outside traditional protected areas, including on lands 'where people live and work' should be practised after the empirical studies on such areas. The present study aims to understand the diversity and richness of Scolopendromorphs a least studied but common centipedes (Chilopoda: Scolopendromorpha), in a non-protected and isolated hilly area at Puliyampoyil (N 11° 30' 26.98"; E 75° 48'24.11"Elevation 200m asl) in Kottur Grama Panchayath, located about 38km east of Kozhikode city and a foothill of Southern Western Ghats. After a pilot study, five quadrates (10m x10m each) were laid for the random sampling. Monthly observations were made during March 2011 to October 2011.The time spent in each quadrate were 40minutes. Number of species and individuals were recorded and diversity indices were analysed using Estimate S statistical software. After seven months of observation a total of 11species under 6 genera in 2 families were identified, which accounted for 47.82 % of total species reported from Kerala. Shannon Exp SD index and Simpson mean were recorded ranging from 0.83 to 0.40 and 6.42 to 6.25, respectively. Even though outside protected area, it niches for highly diverse and rich fauna so a conservation strategy that incorporates informal protection traditions is essential for successful biodiversity conservation.

Key Words: Conservation, biodiversity, outside protected areas, Southern Western Ghats, centipedes, Scolopendromorpha

INTRODUCTION

Despite impressively rapid growth of protected land and marine areas worldwide -- today totalling over 100,000 in number and covering 17 million square kilometres of land and 2 million square kilometres of oceans -- biodiversity is in steep decline(Science Daily (July 28, 2011). The biodiversity of the Western Ghats, one of the eight biodiversity hotspots in the world, is degrading fast despite conservation efforts. And the major conservation issues behind this alarming fact are habitat loss and fragmentation due to developmental activities and overstress by population explosion. Ecologists today recognise that much of the once pristine forests, that have been transformed to secondary forests, as well as areas outside existing conservation reserves, harbouring significant levels of biodiversity need to be targeted for long term conservation (Raman and Mudappa, 2003).

Even in 1988 itself Janzen pointed out that "the only feasible step is conservation of biodiversity by using the living biotic debris and inocula from nearby intact areas to restore habitats". And the global gap analysis revealed that much biodiversity falls outside protected areas (Langhammer et al., 2007). The new idea of Community Reserves and Heritage sites by State biodiversity Board and Local Government Bodies is emerged as a result of conserving such diverse areas. And the present study is an attempt to understand the diversity of such a key area outside the conserved area.

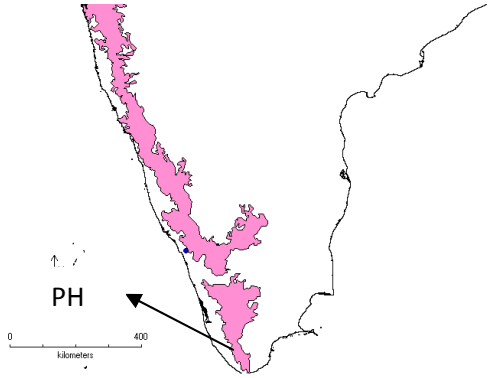
Most of the research to date has focused on providing vertebrate data for conservation assessment, and for many groups of invertebrates we lack even basic information in tropical ecosystems (Fisher and Robertson, 2002). This is particularly true for the group of fauna in discussion here i.e., centipede (Chilopoda: Scolopendromorpha) of the Western Ghats forests, a recognized global hot spot of biodiversity in India (Myers et al. 2000). A perusal of literature reveals the existence of 682 species, excluding subspecies, globally, representing 17

valid genera of the family Scolopendridae and 9 genera of family Cryptopidae(Khanna,2008) .In Kerala, 23 species of Scolopendrid centipedes belonging to 8 genera and 2 subfamilies are reported (Sureshan et al.,2006).

MATERIALS AND METHODS

Study area

Puliyampoyil (N 11° 30' 26.98"; E 75° 48'24.11"Elevation 200m asl) is an isolated hillock in Narayamkulam, Kottur Grama Panchayath, situated about 38km east of Kozhikode city.



1

2

Fig.1 Location of the Western Ghats in South India and the study area Puliyampoyil Hills indicated by coloured circles. PH: Puliyampoyil Hill

Fig. 2 a photograph from study site

Methodology

After a pilot study five quadrates (10m x10m each) were laid for the random sampling. Monthly observations were made during March 2011 to October 2011.The time spent in each quadrate was 40minutes.Taxonomic keys by Jangi and Dass (1984), Sureshan

et al.,(2006) and Dhanya et al.,(submitted) were used for identification of species. For calculating the diversity indices Estimate S software was utilized (Colwell, 2009).

Shannon Diversity Index

This index can be applied to biological systems which are derived from a mathematical formula used in communication area by Shannon in 1948 (Mandaville, 2002). It's the most preferred index among the other diversity indices. The value of Shannon index obtained from empirical data usually falls between 1.5 and 3.5 and rarely surpasses 4(Margalef, 1972). The values above 3.0 indicate that the structure of habitat is stable and balanced; the values under 1.0 indicate that there are pollution and degradation of habitat structure.

$H' = -\Sigma [(ni / N) \times (\ln ni / N)]$

H': Shannon Diversity Index

ni: Number of individuals belonging to i species

N: Total number of individuals

Simpson Diversity Index

It's a diversity indices derived by Simpson in 1949 (Mandaville, 2002). Simpson index values (D) are between 0 – 1.

$D = [\Sigma ni (ni -1)] / N (N-1)$

D: Simpson Diversity Index

ni: Number of individuals belonging to i species

N: Total number of individuals

Value "D" is the probability of two individuals belonging to same species .But for representing the assemblage, this value should be expressed as the complement 1-D or Reciprocal 1/D form (Magurran, 2005). Here the reciprocal form is calculated.

RESULTS

Species composition

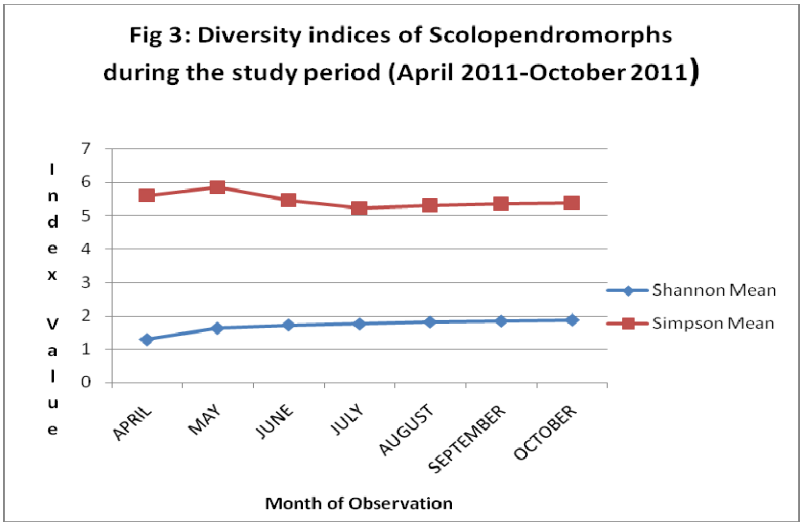
During the study period of five months, a total of 11 species under 5 genera in 2 families were identified, which accounted for 47.83% of total species reported from Kerala(Table 1).Among them Family Cryptopidae as well as the genera *Cryptops* Leach and *Paracryptops* Pocock turned out to be the second reports from the southern Western Ghats. Rare species like *Asanada sukhensis* was also reported.

Table1:MONTHLY OCCURENCE OF SCOLOPENDROMORPHA AT PULIYAMPOYIL HILLS, NARAYAMKULAM

SL NO	TAXA	MONTH OF OBSERVATION						
		APR	MAY	JUN	JUL	AUG	SEP	OCT
	ORDER:SCOLOPENDROMORPHA FAMILY :SCOLOPENDRIDAE SUBFAMILY:SCOLOPENDRINAE							
	TRIBE:SCOLOPENDRINI							
1	*Scolopendra morsitans* Linnaeus, 1758	*	*	-	-	-	-	*
2	*Cormocephalus sps*	-	-	-	*	-	-	-
	TRIBE:ASANDINI							
3	*Asanada sukhensis* Jangi and Dass, 1984	-	-	-	-	*	-	-
	SUBFAMILY:OTOSTIGMINAE							
	TRIBE:OTOSTIGMINI							
4	*Digitipes barnabasi* Jangi and Dass, 1984	-	-	*	-	-	-	-
5	*Digitipes coonoorensis* Jangi and Dass, 1984	*	-	-	*	*	*	*
6	*Digitipes* sps 1	-	*	*	-	-	-	-
7	*Rhysida longipes*(Newport 1845)	-	-	*	-	-	-	-
8	Rhysda immarginata immarginata(Porat 1876)	*	*	*	-	*	*	*
	FAMILY:CRYPTOPIDAE							
9	*Cryptops* sps 1	*	-	*	*	*	*	*
10	*Cryptops* sps 2	*	-	-	-	-	-	-
11	*Paracryptop*s sps1	-	-	-	*	*	-	-

*Observed - Not observed

Species diversity indices showed below indicates the diversity richness of the Scolopendrid fauna in the study area (Figure. 3)



DISCUSSION

The diversity indices of Scolopendrids in the study area is comparable with the reports from Malabar Wildlife Sanctuary (WLS), the nearest notified conservation area (table. 2). The defined similarities, especially in Shannon's H focusing the similarity between the diversity of these study area.

Table 2: A comparative view on the diversity indices of Present study with Malabar WLS

MONTH	Shannon Mean H'		Simpson Mean 1/D	
STUDY AREA	PRESENT STUDY at PULIYAMPOYIL HILLS	MALABAR WLS(after Dhanya and Sureshan(2011)	PRESENT STUDY at PULIYAMPOYIL HILLS	MALABAR WLS(after Dhanya and Sureshan(2011)
APRIL	1.29	1.39	5.61	6.64
MAY	1.63	1.84	5.86	7.66
JUNE	1.73	2.01	5.46	8.16
JULY	1.76	2.07	5.23	8.11
AUGUST	1.82	2.13	5.32	8.28

A similar attempt was carried out by Umesh et al.,(2011) in their checklist of Reptilian fauna in Puliyampoyil hills and they reported 35 species of reptiles including the interesting account of rare Common Hump nose pit viper(*Hypnale hypnale*) and Russell's viper (*Daboia russelii*) from the same area . And the curious reports of sighting of Leopard at the area by dailys(Mathrubhumi, and Umesh pers. Comm.) . All these interesting findings pointed to the importance of such ecosystem as Tabarelli(2010) explains it "as the inherent/intrinsic biodiversity ability to persist and recover within human-modified landscapes has emerged as a 'trump card' in the conservation battle, renewing our hope in a more sustainable development of the tropical region. The diversity in the non-conserved area is earlier reported in the Studies of Madayipara, Kannur District, Kerala, a laterite hillock, at alone has documented having notable results of 111 species of butterflies, 42 species of dragonflies, 13 species of fishes, 14 species of amphibians, 168 species of birds and 21 species of mammals (Jaffer and Radhakrishnan, 2005).

So, if there is diverse flora and fauna outside the conservation area it has to be protected but without "implementing stated policies and resist elite groups who have traditionally pursued the exploitation of the forest." This is the right way as accepted by today's ecologists and stakeholders. Raman and Mudappa (2003) in their studies at Valaparai plateau at Anamali Hills also recommended a complementary strategy to develop conservation plans for protection and improvement by ecological restoration of isolated areas and degraded areas on private lands. Local level protection can be implemented because recent studies, counter to the presumption that local people are either unable or unwilling to identify forest management requirements and make appropriate rules, IFRI studies(Hayes and

Ostrom, 2005) on the efficiency of protected areas in different countries including India on forest management show that resource users are capable of crafting forest rules.

CONCLUSION AND RECOMMENDATIONS

For mitigating the impoverishment of our biotas a system of protected areas combined with appropriate levels of biodiversity persistence within human-modified landscapes is the need of the hour. For finding out the more vital diverse areas empirical as well as extensive taxonomic surveys can be implemented for getting a clear picture of how much "outside diversity" we have. As a preliminary part of this an attempt we can even focus the results of graduate and post-graduate level students projects undertaken to study the non conserved areas like their own campus and native place. As our forefather protect the diversity in 'kavu' and in their backyards we want to go back to a vision where we can conserve the biota in the area "where people live and work". It can be designed as an ecological restoration programme to avoid biotic homogenization and introduction of alien species as well to maintain the natural biota. As Meine (1988) says "Conservation is not merely thing to be enshrined in outdoor museums, but a way of living on the land". Leopard's (1933) concept of providing farmers with tools to improve conditions on their property and thus enhancing their own lives can be applicable to conserving the outside diversity.

REFERENCE

Colwell, R. K. 2009. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.2. User's Guide and application published at: http://purl.oclc.org/estimates.

Dhanya, B., and Sureshan P. M., 2011**.** Need for an integrated approach in understanding below-ground diversity of Scolopendrid centipedes –A case study in Malabar Wild Life Sanctuary, Kerala, India. Paper presented at National Seminar on held a

Fisher, B. L. and Robertson, H., 2007. Comparison and origin of forest and grassland ant

assemblage in the high plateau of Madagascar. Biotropica 34: 155-167.

Jangi, B. S., Dass, C.M.S., 1984**.** Scolopendridae of the Deccan. *Journal of Scientific and Industrial Research*, **43** (1): 27-54.

Janzen, D. H., 1998**.** Gardenification of wildland nature and the human footprint. Science 279:1312-1313.

Khanna, V. , 2008. National Register of the valid species of Scolopendrid centipedes (Chilopoda: Scolpendromorpha) in India. Biosystematica. 1 (2)-33-45.

Langhammer, P.F., Bakarr, M.I., Bennun, L.A., Brooks, T.M., Clay, R.P., Darwall, W., De Silva, N., Edgar, G.J.,Eken, G., Fishpool, L.D.C.,Fonseca, G.A.B. da, Foster, M.N., Knox, D.H., Matiku, P., Radford, E.A.,Rodrigues, A.S.L., Salaman, P., Sechrest, W., and Tordoff, A.W., 2007. Identification and Gap Analysis of KeyBiodiversity Areas: Targets for Comprehensive Protected Area Systems. Gland, Switzerland: IUCN.

Leopold, Aldo., 1933**.** Game Management. Charles Scribner's Sons. Reprinted in 1986 by University of Wisconsin Press, Madison**.** ISBN: 0299107744

Magurran, A.E., 2005**.** Measuring Biological Diversity. Blackwell Science Ltd. Australia. 238- 243.

Mandaville, S.M., 2002 .Benthic Macroinvertebrates in Freshwater – Taxa Tolerance Values, Metrics, and Protocols. *Project H - 1. (Nova Scotia: Soil & Water Conservation Society of Metro Halifax).*

Margalef, R., 1972.Measuring Biological Diversity, Blackwell Publishing Company. U.S.A.

Meine, Curt., 1988**.** Aldo Leopold: His Life and Work. Madison, Wis.: University of Wisconsin Press. ISBN 0-299-11490-2

Muhamed Jafer Palot and C. Radhakrishnan., 2005**.** Faunal diversity of a laterite hill system at Madayipara, Kannur district, Kerala State, India. Zoological Survey of India. Kolkata.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B.da Fonseca and J. Kent., 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853–858.

Raman, T. R. S and Mudappa, D., 2003**.** Bridging the gap: Sharing responsibility for ecological restoration and wildlife conservation on private lands in the Western Ghats. Social Change 33(2&3): 129 – 141

Sureshan, P.M., Khanna, V and Radhakrishnan, C., 2006.Additional distributional records of scolopendrid centipedes (Chilopoda: Scolopendromorpha) from Kerala. *Zoos' print Journal* .**21**(6): 2285-2291.

Tabarelli, M., 2010**.** Tropical Biodiversity in Human-Modified Landscapes: What is our Trump Card?. Biotropica, 42: 553–554. doi: 10.1111/j.1744-7429.2010.00678.x

T. Hayes and E. Ostrom., 2005**.** Conserving the World's Forests: Are Protected Areas the Only Way?" *Indiana Law Review* 38, no. 3: 595–617

Umesh P K, Shyamlal, S and R.A. Aswanth., 2011. An inventory of Reptilian fauna of Puliyampoyil, Balusserry, Kozhikode district, Kerala. Malabar Trogon. Vol.9(1&2).

United Nations University, 2011, July 28. Ongoing global biodiversity loss unstoppable with protected areas alone. *ScienceDaily*. Retrieved December 15 , 2011, from http://www.sciencedaily.com/releases/2011/07/110728123059.htm

Mathrubhumi , December, 20, 2011. Page- 5.

United Nations Decade on Biodiversity

Conservation Area Series, 46

FAUNA OF BHADRA WILDLIFE SANCTUARY AND TIGER RESERVE KARNATAKA

Zoological Survey of India

Zool. Surv. India
Fauna of Bhadra Wildlife ... and Tiger Reserve, Conservation Area Series, **46**:97-100, 2013

CHILOPODA : SCOLOPENDROMORPHA

P.M. SURESHAN AND B. DHANYA

Western Ghat Regional Centre, Zoological Survey of India,
Calicut- 673 006, Kerala, India

INTRODUCTION

Centipedes are soil arthropods of economic importance, playing a major role as components of terrestrial food chains and also aid in the process of fragmentation and decomposition of leaf litter. Out of the 687 species, including subspecies, belonging to 17 valid genera known globally, 90 species, belonging to 8 genera of family Scolopendridae and 3 genera of the family Cryptopidae are known from India (Khanna, 2008). Centipede fauna of Deccan plateau and Himalayan ecosystems are taxonomically fairly well documented (Jangi & Dass, 1984, Khanna 2001, 2003, 2008, Yadav, 1993 a, b, 2009). Though southern Western Ghats provide rich habitats for the centipedes, little information is available on their diversity from the area (Khanna, 2010, Sureshan et al, 2006, Yadav, 2001). The present communication is based on the study of a small collection of Scolopendrid centipedes made from the Bhadra Wildlife Sanctuary, Karnataka, located in the southern Western Ghats. A total of 4 species belonging to 2 genera and 2 subfamilies are reported here from Bhadra Wildlife sanctuary. The specimens studied are deposited in Zoological Survey of India, Western Ghat Regional Centre, Calicut, Kerala.

SYSTEMATIC ACCOUNT

Phylum ARTHROPODA

Class CHILOPODA

Order SCOLOPENDROMORPHA

Family SCOLOPENDRIDAE

Subfamily SCOLOPENDRINAE

1. ***Cormocephalus dentipes*** Pocock, 1891

1891. *Cormocephalus dentipes* Pocock. *Ann.nat.Hist.Soc.*, **6**.7.6

1984. *Cormocephalus pseudonudipes*, Jangi & Dass, *J.Scient.Indl.Res.*, **43**(2):37

2001. *Cormocephalus dentipes* Pocock, Lewis ,2001.*Historia Naturalis Bulgarica*,**13**:58

2009. *Cormocephalus dentipes* Pocock, Yadav.*Fauna of Bhimasankar Wildlife Sanctuary, Conservation area Series*, **42:** 224

Diagnosis: Length 51mm (approx.). All legs without tarsal spurs. Dental plate of Maxillipedes with 4 teeth and a post-dental spur. 1-20th tergal segments with a pair of complete paramedian sutures; endtergite without longitudinal median sulcus; lateral tergal emargination present on segments 15-21. Sternites punctate and with 2 complete paramedian sutures on 2-20. Coxopleural process tipped with 2 spines.

Material examined: 1 ex. India: Karnataka: Bhadra WLS, Rashiguda, forest range - Muthhod, N 13^{0}25'05", E 75^{0}39'46", Alt. 1232 Metre , 16.xi..2006, Coll.K.G Emiliyamma (Reg no: ZSI/WGRC/I-R/INV-2065).

Distribution :India : Madhya Pradesh , Orissa, Karnataka , Kerala, W. Bengal, Andaman-Nicobar Islands, Uttar Pradesh, Bihar, Delhi, Himachal Pradesh, Meghalaya, Maharashtra, Mizoram, Uttarakhand

Remarks: The species is endemic to India and reported here for the first time from Karnataka. In the specimen studied an abnormality is observed on the right anal-leg prefemur. It appears to be incompletely two segmented and with varying distribution pattern of spines. Besides, the right coxopleuron lacks lateral spine.

Subfamily OTOSTIGMINAE

Tribe OTOSTIGMINI

2. ***Rhysida lithobioides paucidens*** **Pocock, 1897**

1897. *Rhysida paucidens* Pocock, D.Smith,Unknown African Countries,app,c,p.403.

1930. *Rhysida lithobiodes paucidens.*Attems,*Das Tier.,Scolopendromorpha,***54**(2):188.

2001. *Rhysida lithobiodes paucidens* Pocock. Khanna. *Ann. For.,* **9** (2):211.

2008. *Rhysida lithobiodes paucidens* Pocock. Khanna. *Biosystematica.*, **1**(20):40

Diagnosis: Length 49mm (approx).18 antennomeres with minute hairs. Sternites with anteriorly confined short suture, first 8 or more pair of legs with 2 tarsal spur. Coxopleural process without lateral spines and tipped with 2 spines, 21st Sternite hardly tapering posteriorly.

Material examined : 1 ex (anal leg broken) India: Karnataka, Bhadra WLS. Sukhlahatti Guest House, Lakkavalli, N 13° 36'87"E 75° 39'07", Alt. 734 Metre, 4.xi.2007. Coll.K.G Emiliyamma. (Reg no: ZSI/WGRC/I-R/INV-2068).

Distribution : India: Kerala, Tamil Nadu, Maharashtra, Uttarakhand Karnataka.

Remarks: This species occurs in Deccan peninsula and Uttarakhand and reported here for the first time from Karnataka

3. *Rhysida lithobiodes trispinosus* Jangi & Dass,1984

1984. *Rhysida lithobiodes trispinosus* Jangi & Dass, .*Scient.Indl.Res.*, **43**(2):48

2001. *Rhysida lithobiodes trispinosus* Jangi & Dass.Khanna. *Ann.For.*, **9**(2):211

2008. *Rhysida lithobiodes trispinosus* Jangi & Dass.Khanna.*Biosystematica*,**1**(2):40

Diagnosis: Length. 62mm (approx). Antennae with 21 antennomeres, basal 3 glabrous. Cephalic plate smooth with a short median groove anteriorly. Tergites smooth, punctured and with a complete paramedian suture on tergites 4 - 20. 21st tergite without sulcus. Lateral emargination from 13th tergite onwards. Sternites with short paramedian sulcii confined anteriorly. 21st Sternite tapering caudad and with prominent convex lateral margins and concave posterior margin. Dental plate with 4 teeth and a post-dental spur each; median prefemoral process quadridentate. Coxopleura with conical end and tipped with 3 spines.

Material examined: 1 ex. (anal legs broken) India: Karnataka: Bhadra WLS, Kodhi,Forest range- Hebbal, N 13° 28'83" E 75° 32'52", Alt. 754 Metre , 18.xi.07,Coll.Md.Jafer Palot. Reg No: ZSI/WGRC/I-R/INV-2067.

Distribution: India, Kerala, Tamil Nadu, Maharashtra, Karnataka, Uttar Pradesh.

Remarks: This species is endemic to Deccan.

4. *Rhysida* sp.

Diagnosis: Length 51mm (approx).Tergites except the anterior ones with complete paramedian sutures.Tergite preceding 21st leg bearing segments not marginate,

Material examined: 1 ex, India: Karnataka, Bhadra WLS Mathikere. Forest Range-Lakkavalli N 13° 42'.54" E7 5° 37'.97", Alt. 652 Metre , 28.ii.2009.Coll.Md.Jaffer Palot. (Reg.No. ZSI/WGRC/I-R/INV-2069).

Remarks. The specimen comes closer to *Rhysida immarginata*, but not confirmed due to lack of anal legs.

SUMMARY

Four species of Scolopendrid centipedes belonging to two genera under two subfamilies have been recorded form Bhadra Wild life Sanctuary, Karnataka, of which *Rhysida lithobioides paucidens and Cormocephalus dentipes* are first records from Karnataka. All species are reported for the first time from the Sanctuary.

REFERENCES

Jangi, B. S.; Dass,C.M.S.1984 Scolopendridae of the Deccan. *Journal of Scientific and Industrial Research*, **43** (1): 27-54.

Khanna, V .2001.A check-list of the Indian species of the centipedes (Chilopoda: Scolopendromorpha). *Annals of Forestry*, **9** (2): 199-219.

Khanna, V. 2003. Diversity of Scolopendrid centipedes (Chilopoda: Scolopendromorpha) in Himalayan ecosystems and adjacent areas - A review. *Rec.zool.Surv.India.*, **101**(3-4): 207-223.

Khanna, V. 2008. National Register ofthe valid species ofScolopendrid Centipedes (Chilopoda: Scolopendromorpha) in India. *Biosystematica,* **1**(2):33-45

Khanna, V .2010.Chilopoda:Scolopendromorpha. *Fauna of Tamil Nadu, State Fauna Series.* Zool. Surv. India. **17**:145-148.

Sureshan ,P.M.;Khanna, V.;Radhakrishnan,C.2006.Additional distributional records of of Scolopendrid Centipedes (Chilopoda: Scolopendromorpha) from Kerala .*Zoos'Print Journal* ,**21**(6):2285-2291.

Yadav.B.E. 1993.a. On a collection of centipedes (Myriapoda : Chilopoda) from Pune, Maharashtra. *Rec. zooo.Surv.India.*, **93**(1-2): 165-174.

Yadav,B.E.1993.b. Scolopendridae (Chilopoda) of Western Ghats with some first records for the state of Maharashtra. *Rec. zool.Surv.India.*, **93**(3-4): 321-328.

Yadav, B. 2001. Centipedes (Chilopoda : Scolopendridae) *In Fauna of Nilgiri Biosphere Reserve.Cons. Area Series,* **11**: 39-44. Zool. Surv. India (Ed. Director, ZSI)

Yadav ,B.E.2009. Chilopoda :Scolopendromorpha:Scolopendridae. *Fauna of Bhimashankar Wild Life Sanctuary,Conservation Area Series,* **42:** 231-250.