

อนุกรมวิธานของตะขาบอันดับ Scolopendromorpha ในพื้นที่จังหวัดพังงา

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

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ปีการศึกษา 2555

ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

บทคัดย่อและแฟ้มข้อมูลฉบับเต็มของวิทยานิพนธ์ตั้งแต่ปีการศึกษา 2554 ที่ให้บริการในคลังปัญญาจุฬาฯ (CUIR)

เป็นแฟ้มข้อมูลของนิสิตเจ้าของวิทยานิพนธ์ที่ส่งผ่านทางบัณฑิตวิทยาลัย

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Taxonomy of Centipedes Order Scolopendromorpha  
in Phang Nga Province Areas

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A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Science Program in Zoology

Department of Biology, Faculty of Science

Chulalongkorn University

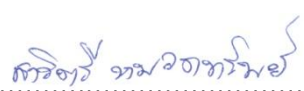


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สาวิตรี หมวดทรัพย์: อนุกรมวิธานของตะขาบอันดับ Scolopendromorpha ในพื้นที่จังหวัดพังงา (TAXONOMY OF CENTIPEDES ORDER SCOLOPENDROMORPHA IN PHANG NGA PROVINCE AREAS) อ. ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. ดร. สมศักดิ์ ปัญญา, อ. ที่ปรึกษาวิทยานิพนธ์ร่วม: Prof. Henrik Enghoff, Ph.D., 113 หน้า.

ได้ทำการเก็บตัวอย่างตะขาบในอันดับ Scolopendromorpha ตั้งแต่ปี พ.ศ. 2553 จนถึงปี พ.ศ. 2554 ในหลายพื้นที่ของจังหวัดพังงาทั้งบนแผ่นดินใหญ่ และหมู่เกาะต่างๆในทะเลอันดามัน ประกอบด้วยอุทยานแห่งชาติห้าแห่งได้แก่ อช.ศรีพังงา อช.เขาหลัก-ลำรู่ อช.เขาลำปี-หาดท้ายเหมือง อช.หมู่เกาะสิมิลัน อช.หมู่เกาะสุรินทร์ และพื้นที่สวนได้แก่ สวนยางพารา สวนปาล์มน้ำมัน และสวนผลไม้ และเกาะอีกสามแห่งได้แก่ เกาะระ-พระทอง เกาะมุก และ เกาะคอเขา ลักษณะสถานฐานวิทยาภายนอกที่เป็นหลักในการจำแนก ได้แก่ แผ่นหัว, แผ่นหลัง, อวัยวะด้านข้างทั้งสองของแผ่นท้องปล้องสุดท้าย, เขี้ยวพิษ, รูหายใจ, ขาเดิน และ ขาคู่สุดท้าย ในการศึกษาครั้งนี้ได้พบตะขาบเพียง 1 วงศ์คือ Scolopendridae ประกอบด้วย 2 วงศ์ย่อย Scolopendrinae และ Otostigminae, 5 สกุล และ 9 ชนิด ประกอบด้วย *Asanada brevicornis*, *Scolopendra subspinipes dehaani* (Scolopendrinae); *Otostigmus astenus*, *O. glaber*, *O. multidentis*, *O. scaber*, *Otostigmus* sp., *Rhysida nuda nuda*, *R. nuda immarginata*, *Sterropristes violaceus* (Otostigminae) ซึ่งชนิด *Scolopendra subspinipes dehaani* พบได้ทั่วไปเกือบทุกพื้นที่ของการศึกษายกเว้นที่หมู่เกาะสิมิลัน นอกจากนี้ยังพบได้ตามบ้านเรือน ตะขาบสายพันธุ์นี้เป็นที่รู้จักกันเป็นอย่างดี คุร้าย มีพิษรุนแรง พบได้ตามบ้านเรือนทั่วไป และเป็นอันตรายต่อมนุษย์ *Scolopendra subspinipes* นี้อาจถูกนำเข้ามาในหลายๆ พื้นที่ และขณะนี้กลายเป็นสายพันธุ์ที่พบได้ทั่วไป ส่วนชนิด *Otostigmus astenus* พบในทุกพื้นที่ศึกษา อย่างไรก็ตามยังคงมีข้อมูลไม่มาก พอที่จะรายงานเกี่ยวกับเกี่ยวกับสายพันธุ์นี้ ตะขาบชนิด *Sterropristes violaceus* เพิ่งมีการบรรยายลักษณะจากการศึกษาครั้งนี้เป็นครั้งแรก พบเฉพาะที่หมู่เกาะสิมิลันและหมู่เกาะสุรินทร์ และเป็นชนิดที่หายากมาก และเป็นสายพันธุ์ที่สามที่มีการบรรยายลักษณะไว้สำหรับสกุลนี้ ตะขาบชนิด *Asanada brevicornis* พบเฉพาะที่ หมู่เกาะสิมิลันและสุรินทร์ เช่นเดียวกับ *S. violaceus* ส่วนตะขาบอีกห้าชนิดนั้นพบในพื้นที่ที่หลากหลาย ที่ได้อภิปรายแล้วในผลการศึกษานี้ การสำรวจทางนิเวศวิทยาในอนาคต จะเป็นการเพิ่มความรู้ในเรื่อง ความสัมพันธ์ทั้งภายในและระหว่างชนิด และบทบาททางนิเวศวิทยา นอกจากนี้ ในส่วนของอภิปรายผลได้อภิปรายเรื่องของชนิดย่อยของตะขาบ scolopendromorph ไว้ด้วย

ภาควิชา...ชีววิทยา.....ลายมือชื่อ..........  
 สาขาวิชา...สัตววิทยา.....ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก..........  
 ปีการศึกษา...2555.....ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม..........



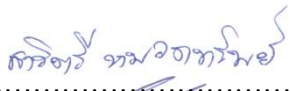

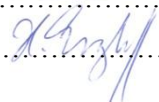
# # 5272577223 : MAJOR ZOOLOGY

KEYWORDS : SCOLOPENDROMORPHA/ CENTIPEDES/ PHANGNGA PROVINCE

SAWITREE MUADSUB : TAXONOMY OF CENTIPEDES ORDER SCOLOPENDROMORPHA IN PHANG NGA PROVINCE AREAS.

ADVISOR : PROF. SOMSAK PANHA, Ph.D., CO-ADVISOR : PROF. HENRIK ENGHOFF, Ph.D., 113 pp.

Centipedes of the order Scolopendromorpha were sampled during 2010-2011 in several localities of Phang Nga Province both on the mainland and on islands in the Andaman Sea. The collecting sites include three national parks on the mainland (Sri Phang Nga, Khao Lak-Lam Ru, Khao Lampi-Hat Tai Muang) as well as plantations (rubbers, oil palms, fruits etc.), and five islands (Ra and Phra Thong, Similan, Surin, Muk and Koh Khao). The main significant morphological characters used for identification are head plate, tergites, coxopleural process, forcipular tarsungulum, spiracles and ultimate legs. After morphological investigations, only 1 family (Scolopendridae) 2 subfamilies (Scolopendrinae and Otostigminae), 5 genera, 9 species 3 subspecies were identified. There are *Asanada brevicornis*, *Scolopendra subspinipes dehaani* (Scolopendrinae); *Otostigmus astenus*, *O. glaber*, *O. multidentis*, *O. scaber*, *Otostigmus* sp., *Rhysida nuda nuda*, *R. nuda immarginata*, *Steropristes violaceus* (Otostigminae). *Scolopendra subspinipes dehaani* is quite common, occurring in all localities except Similan Island. This species is known as an aggressive venomous centipede, also occurring in household areas and harmful to humans. *Scolopendra subspinipes* has been introduced into many areas and is now a cosmopolitan species. *Otostigmus astenus* was also found in all observed localities. However, there still is not much information about this species. *Steropristes violaceus* has just been described under this study and occurs only in Similan and Surin Islands. This is a very rare species, it is the third species ever described for this genus. *Asanada brevicornis* was found only on Surin and Similan islands, like *S. violaceus*. The other five species were found in various localities which are discussed in the report. Further ecological surveys are needed to obtain knowledge about intra- inter-specific relationships as well as ecological roles of these animals. A discussion of subspecies in scolopendromorph centipedes is presented.

Department : ...Biology.....	Student's Signature..... 
Field of Study : ...Zoology.....	Advisor's Signature..... 
Academic Year : ...2012.....	Co-advisor's Signature..... 

## Acknowledgements

I am grateful to my advisor Professor Dr. Somsak Panha and co-advisor Professor Dr. Henrik Enghoff for their generous support, encouragement, and guidance throughout this thesis. I would also express my sincere appreciation to the committee members; Associate Professor Dr. Kumthorn Thirakhupt, Assistant Professor Dr. Chirasak Sutcharit, Professor Dr. Visut Baimai for their constructive comment and suggestions.

I am also much indebted to Dr. Piyatida Pimvichai, Dr. Piyoros Tongkerd, for their help. I also thank members of Animal Systematics Research Unit, Department of Biology, Faculty of Science, Chulalongkorn University for their kind assistance in collecting the materials used in this study. Thanks to Miss Thita Krutchuen for excellence drawing.

We also thank the staff of the Plant Genetic Conservation Project initiated by Her Royal Highness Princess Maha Chakri Sirindhorn and the Navy Special Warfare Unit of The Royal Thai Navy for providing us with considerable help and encouragement which made our fieldwork at Similan and Surin Islands possible.

This research was supported by the Thai government budget 2011, under the Research Program on Conservation and Utilization of Biodiversity and the Center of Excellence in Biodiversity, Faculty of Science; the 90<sup>th</sup> Anniversary of Chulalongkorn University Fund; the National Research University Project of Thailand FW646A (2011–2013).

Finally, I also express my deep gratitude to my parents for their encouragement, love and caring which make everything possible.

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# CHAPTER I

## INTRODUCTION

Centipedes are one of the four major lineages of the Myriapoda, they distributed in all continents except the Antarctic. The greatest species diversity of centipedes are occurring in the Tropical and warm Temperate regions (Edgecombe and Giribet, 2007). Centipedes are terrestrial arthropods, most species inhabit under leaf litter, soil, stones, bark, rotten wood in forest, grass land, desert and cave (Edgecombe and Giribet, 2007). They are importance predators in terrestrial ecosystems, especially scolopendromorph centipedes, the largest centipedes in the world (Malta et al., 2008). Carpenter and Gillingham (1984) reported giant centipede, *Scolopendra alternans*, with 20 cm body length attacked a marine toad, *Bufo marinus*. In addition, Molinari et al. (2005) reported the predation by centipedes, *S. gigantea* on three species of bats, *Mormoops megalophylla*, *Pteronotus davyi* and *Leptoncyteris curasoeae*. Almost all of the centipedes having the venom glands connected to maxillipeds, modified to arrest preys. When human or victims was bitten by centipedes, it usually manifests burning pain, paresthesia and edema and may develop into superficial necrosis (Malta et al., 2008). These scolopendromorph centipedes are large enough to bite through human skin (Southcott, 1976). There have been reports of severe effects from centipede bites. In addition, the death was reported, as seven year old of child was reported died after being bitten on the head (Pineda, 1923) and the death of a 21 year old female in Thailand was reported the cause from centipede bitten (Balit et al., 2004), although the effects in this case were more consistent with an early allergic reaction but the genus *Scolopendra* is probably responsible for many of the more severe effects reported in tropical regions. Therefore, the scolopendromorph centipedes are the most important in medical and toxicological research (Bush et al., 2001).

Centipedes are classified into class Chilopoda which subdivided into 5 living orders including. 1) Scutigermorpha, house centipede, are mainly occur in tropical and subtropical, and have 15 pairs of very elongate legs. 2) Lithobiomorpha are short bodies and with 15 pairs of legs. 3) Scolopendromorpha, giant centiptde, usually has

21 or 23 pairs of legs, and centipede in this order was reported bitten to human. 4) Geophilomorpha or worm-like centipede, they have elongate body about 31 to 191 pairs of legs and are soil dwelling. 5) Craterostigmomorpha, the endemic to New Zealand and Tasmania, have with 15 pairs of legs (Lewis, 1981). In addition, the Devonobiomorpha is an extinct order which there fossil recorded in middle Devonian about 420 million years (Shear and Bonamo, 1988).

The subclass Chilopoda composed of five extant centipede orders, there are about 350 genera and 3,200 species have been described so far. The scolopendromorph centipedes include 500 species (Adis and Harvey, 2000). The scolopendromorph centipedes have long evolutionary history, which dated back to the late Carboniferous (Shear et al. 1998). Recently, the classification of scolopendromorphs consisted of 3 families: Scolopendridae (16 genera), Cryptopidae (7 genera), and Scolopocryptopidae (8 genera) (Schileyko, 1996; Shelley, 2002). However, Attems (1930) proposed subdivision of the Scolopendromorpha into 2 families by the present or absent of ocelli. (Scolopendridae) and without ocelli (Cryptopidae). The Scolopendridae was subdivided into 2 subfamilies: Scolopendrinae and Otostigminae.

Centipedes called “Takarp” in Thai, they are mostly known as giant centipedes which found in households in various hidden shelters such as under piles of litters, logs, other materials including piles of books. During flooding the habitats will be effected to centipedes making them escape to hide everywhere in the house and near by shelters which will cause human accidents by centipedes bitten. The common Thai *Scolopendra subspinipes* or red centipedes are quite well known. In 1910, Alcock et al. recorded 7 species of scolopendromorph from Thailand. After in 1986, Eason studied the Lithobiidae oder Lithobiomorpha from Thailand and found 6 new described species of *Lithobius* and a new described subspecies *Australobius feae* (Pocock, 1891). Recently in ChiloBase there are 13 species of centipede, but some species has never been recorded in ChiloBase such as *Ethmostigmus bisuleatus* (Attems, 1930), *Otostigmus rugulosus* from Sakunotayan waterfall in Phitsanulok Province and *Asanada brevicornis* from Nakon Sawan province (Vahtera, et al.,



2012). The previous records for Thailand confirmed 16 species of centipedes of which 9 species are from the order Scolopendromorpha (Alcock et al., 1910; Attems, 1930; Lewis, 2001; Bonato et al., 2012).

Thailand is situated in a hot and humid climatic zone which supports a variety of tropical ecosystems and within two major biogeographical regions, the Indochinese region in the North and the Sundaic region in the South, apart from the effect of these two regions within the Indomalayan Realm (Mackinnon and Mackinnon, 1996). So, flora and fauna from each region are peculiar especially southern of Thailand, consists many type forests such as rain forest, moist evergreen forest, mangrove forest, peat swamp and beach forest. In addition, there are some plateaus, lowland and islands both in the Gulf of Thailand and Andaman Sea. This is interesting region for studies biodiversity in both fauna and flora. Centipedes are one of animals that mostly found in this region, in the southern and other regions are seldom reported species diversity of centipedes. The systematic studies are of interest for interpretation of scolopendromorph centipedes evolution, however the basic taxonomy is the first priority to be seriously investigated prior the accurate systematic analysis will be carried out in the future.

Phang Nga province is the sampling locality for this study. It is a good representative areas along the shoreline of the Andaman Sea in the south of Thailand, connected to the west side of the Malay Peninsula. There are diverse ecosystems such as rainforest, beach forest, peat swamp, mangrove, mountain, plateau, low land, sea, islands, cave, waterfall, stream, grass land, agricultural area etc. Because the abundance and beautiful locations of natural ecosystems, making this province famous as tourist attraction. The main productions for people are from agricultural products which modified the areas for farming for examples rubber plantation, the oil palm plantation and orchards which mostly harmonized with various kinds of fruits. There is Phuket Mountain which connected with Tenasserimi Mountain Ranges, and the highest peak is about 1,397 meters. There are seven national parks, containing varieties of wild flora and fauna. There are some endermic species of flora and fauna such as *Crinum thaianum* J. Schulze or called “water onion” white lily-like flowers

belong in family Amaryllidaceae which is a vulnerable plants (Charan Leeratiwong and Saijai Jornead, 2005), and *Amphidromus classarius* a tree snail in the family Camaenidae from Tachai island (Jirasak Sutcharit and Somsak Panha, 2005). The habitat diversity in Phan Nga province refer to diversity of life. There should be various good reservoirs for centipede diversity in this area.

This study is one of an effort to survey and identify centipedes in Thailand focusing in southern regions of Phang Nga province. Species descriptions, diversity and habitat diversity are reported and discussed in the following chapters.

### **Objectives**

1. To study taxonomy of scolopendromorph centipedes in Phang Nga province using morphological method.
2. To report habitat characteristics of scolopendromorph centipedes.

### **Anticipated Benefit**

The taxonomic clarification of centipedes in Thailand will be an important information for a great benefit for biodiversity management and will be used in other applied field of science such as Toxicology.

## CHAPTER II

### LITERATURE REVIEW

Centipedes are mostly carnivores and predominantly predators, they are the main group of predators in terrestrial ecosystems consuming various kinds of prey of both invertebrate and small vertebrate animals (Edgecombe and Giribet, 2007). They have powerful claws and the venom glands connected to maxillipedes that use for capturing the preys and for protection from enemies. Most of the centipedes usually have small claws, which unable to inject through human skins. But, the house centipedes (Scutigermorpha) and the giant centipede (Scolopendromorpha) can inflict painful 'bites' (Alexander, 1984; Burnett et al., 1986; Elston, 1999 and Bush et al., 2001). The giant scolopendromorph centipedes, *Scolopendra* spp. are usually reported bitten people in several areas in the world. The symptom or effects by centipedes venom are skin redness, swelling, pain severity and duration, itchiness, manifest burning pain and edema, which may develop into superficial necrosis (Bush, 2001; Balit et al., 2004; Malta et al., 2008).

Although the giant centipedes are dangerous and produce venom, the Southeast Asian people use the venom from giant centipedes of probably from the genus *Scolopendra* mix with some herbal plant extract making "centipede whisky". They superstition to this kind of traditional medicines will remove aphrodisiac, and back and muscle pain (Thailandunique, 2012).

In Thailand, the giant centipedes (*Scolopendra* spp.) are the most easily recognized from Thai people, and they are large enough to bite through human skin (Southcott, 1976). During the great flooding in 2011, several hundred of people who suffer from flooding were bitten by the giant centipedes (Somkid Homhuan, 2012).

The centipedes that cause the severe effects on human health, an even cause to dead to 7 years old child and 21 years old woman by the centipedes of the family Scolopendridae (Pineda, 1923; Balit et al., 2004).

The giant centipedes are belonged to the order Scolopendromorpha, which are important for Thai public health (Tassanawut Thienpanya and Winai Wanakul, 2008). However, the fundamental knowledge on biology, ecology, diversity and systematics on the scolopendromorph centipedes in Thailand are not existed (Bush et al., 2001). In

1910, Alcock et al. recorded 7 species of scolopendromorph from Thailand. After in 1986, Eason studied the Lithobiidae order Lithobiomorpha from Thailand and found 6 new described species of *Lithobius* and a new described subspecies *Australobius feae* (Pocock, 1891). Recently in ChiloBase there are 13 species of centipede, but some species has never been recorded in ChiloBase such as *Ethmostigmus bisuleatus* (Attems, 1930), *Otostigmus rugulosus* from Sakunotayan waterfall in Phitsanulok Province and *Asanada brevicornis* from Nakon Sawan province (Vahtera, et al., 2012). The previous records for Thailand confirmed 16 species of centipedes of which 9 species are from the order Scolopendromorpha. However, this numbers are still far from the high estimation of 100-150 species (Alcock et al., 1910; Attems, 1930; Lewis, 2001; Bonato et al., 2012).

## 2.1. The classification of the order Scolopendromorpha

Attems (1930) and Lewis (1981, 2003) used numbers of legs for classification among the centipede orders which the order Scolopendromorpha has 21 or 23 pairs of legs. Four families are recognized within the order Scolopendromorpha (Attems, 1930; Lewis, 1981; Shelley, 2002). The family Scolopendridae contains 4 ocelli on each side of cephalic plate, while the families Scolopocryptopidae and Cryptopidae have no ocelli, and the family Mimopidae have only one ocellus on each side (Lewis, 2006). The different between the families Scolopocryptopidae and Cryptopidae are the former described families containing 23 pairs of leg and coxopleurons with long and slender processes, while the latter family containing 21 pairs of legs and coxopleurons without processes (Chao, 2002; Chao and Chang, 2003).

The subfamilies Scolopendrinae of Scolopendridae presented calyx of spiracles usually divided with a three lapped valve for identification, as in Otostigminae and Sterropristinae, calyx of spiracles without valves. The difference between Otostigminae and Sterropristinae are that the latter subfamily has saw-like teeth on forcipules claw, while the former subfamily has simple claw (Verhoeff, 1937).

In the subfamily Otostigminae, the unique characters of the *Edentistoma* are the sternites with unpaired paramedian sulci and coxosternal without tooth plates use

for generic separation. While, the unique characters of the genus *Alipes* are tibia and tarsi on ultimate legs liked leaf, and the genus *Ethmostigmus* are prefemur of coxosternum without an inner spine (Chamberlin, 1958; Schileyko and Stagl, 2004). The difference between the genus *Digitipes* and *Otostigmus* containing a cylindrical appendix on femur of ultimate legs and pretarsus of 2<sup>nd</sup> maxillae without a side spine, the genus *Otostigmus* having no cylindrical appendix and pretarsus of 2<sup>nd</sup> maxillae with a side spine (Lewis, 1981). The characters use to separate between the genus *Rhysida* and *Alluopus* are tarsus 1 of ultimate legs protruding over the base of the very small tarsus 2 in *Alluopus*, but tarsus 1 of ultimate legs ordinary and without protruding tarsus 2 in *Rhysida* (Koch, 1985).

In the subfamily Scolopendrinae, most of the genera having 21 pairs of legs except in the genus *Scolopendropsis* has 23 pairs of legs. The genus *Asanada* has very short antennae and coxopleurons without pores (Jangi, and Dass, 1978; Schileyko and Stagl, 2004). The genus *Rhoda* have the tarsus 1 shorter than tarsus 2, coxopleurons truncated and without processes (Schileyko and Stagl, 2004). In the *Campylostigmus* and *Cormocephalus* have no tarsal spines on all legs, but the *Campylostigmus* have pleural wrinkles on spiracles while the *Cormocephalus* having no pleural wrinkles on spiracles (Schileyko and Stagl, 2004). Characters for separated *Psiloscolopendra* because with coxopleural processes short, conical and with one spine but *Hemiscolopendra* and *Akymnopellis* with coxopleural processes long, slender, cylindrical and with several spines. This two genera used distribution for identification, *Hemiscolopendra* distributed in North America and *Akymnopellis* distributed in South America. Genus *Arthrorhabdus* and *Scolopendra* used the height of coxosternal teeth for identification because, *Scolopendra* with Coxosternal teeth short, not extending beyond the forcipular trochanteroprefemoral processes but *Arthrorhabdus* large, extending beyond the forcipular trochanteroprefemoral processes (Pocock, 1891; Koch, 1984).

## 2.2. Historical review of the order Scolopendromorpha

The Order Scolopendromorpha was nominated by Newport in 1845, which originally comprised of only one family Scolopenfridae and 3 subfamilies:

Scolopendrinae, Heterostomonae and Cormocephalinae. Later, Kraepelin (1903) used the number of ocelli to separate the Scolopendridae into 3 subfamilies as Scolopendrinae and Otostigminae which contain 4 ocelli, and the Cryptopinae without ocelli. Attems (1930) reclassified the Scolopendromorpha again, by dividing into 2 families Scolopendridae with ocelli and the Cryptopidae without ocelli.

Verhoeff (1937) examined the centipedes from Penang, Malaysia of which many new species and new genera were introduced. The unique and distinct characters of the *Malaccolabis metallica*, which are now reclassified into the genus *Sterropristes* (Muadsub et al., 2012). Verhoeff (1937) also proposed the new subfamily Sterropristinae which composed of two monotypic genera, *Sterropristes* and *Malaccolabis*. However, none of subsequent specimens of this subfamily were examined, and the subfamily seems not to be widely accepted.

Schileyko (1992) proposed the new classification of the Scolopendromorpha, using the number of body segment and number of spiracle, and later separated the Scolopendrophorha into 3 families 8 subfamilies. The subdivision of the Scolopendridae is composed of three subfamilies using the spiracles as principal characters. There are Scolopendrinae, Otostigminae and Sterropristinae.

Shelley (2002) proposed the classification of the three families of the Scolopendromorpha. Shelley and Mercurio (2005) proposed a new centipede subfamily Ectonocryptopinae from Mexico and analysed the subfamily relationships, and a key to subfamilies and genera of the Scolopocryptopidae were proposed.

### **2.3. Ecology**

Centipedes are carnivores and predominantly predators and prey important role in the terrestrial ecosystem, which they can predate on various kinds of preys. They are nocturnal, which avoiding desiccation during the dry condition by spending most of the time in damp or humid environments such as under rocks, fallen leaves, crevices and under the bark of trees (Cloudsley-Thompson, 1959). In laboratory, the

scolopendromorphs are able to consume on invertebrates as well as several vertebrates: reptiles, amphibians, small mammals, bats and birds (Okeden, 1903; Shugg, 1961; Lewis, 1981; Molinari et al., 2005).

#### **2.4. Diversity and Distribution of the order Scolopendromorpha**

The class Chilopoda is a one of the four major lineages of subphylum Myriapoda. The fossil records confirmed the origin dated back to 430 million years (Edgecombe and Giribet, 2007). Taxonomy is the basic report on the centipedes story which pursued people to pay attention and learn more about centipedes. The general and specific characteristics have been gradually interpreted to the frontier of classification. The order Scutigleromorpha, Lithobiomorpha and Craterostigmomorpha have 15 pairs of legs, but in the order Geophilomorpha segments ranges from 31 to 191 pairs of legs and in the order Scolopendromorpha varies from have 21 to 23 pairs. The numbers of segment are relevance to the development pattern within centipedes (Hughes and Kaufman, 2002; Chipman et al., 2004). The development of segments is an important key question for centipede evolution (Edgecombe and Giribet, 2007). Because epimorphosis (Scolopendromorpha and Geophilomorpha) starts with the complete adult segments, but anamorphosis (Scutigleromorpha, Lithobiomorpha and Craterostigmomorpha) increase segments after hatching. The order Scutigleromorpha possesses 4 pairs of legs after hatching, Lithobiomorpha has 6–8 pairs of legs and Craterostigmomorpha has 12 pairs of legs (Edgecombe and Giribet, 2007).

There are not many fossil records of the order Scolopendromorpha, there are 2 species of Paleozoic fossils, *Mazoscolopendra richardsoni* Mundel, 1979 and *Palenartrus impressus* Scudder, 1890 both were found in Upper Carboniferous from Mazon Creek, Illinois and in Nova Olinda Member, Crato Formation of Brazil found new genus and species of *Cratoraricrus oberlii* in Lower Cretaceous, the new species has the brief dominant characters of tarsi, sternites with paramedian grooves, prefemora and femora of slender ultimate legs (Wilson, 2003).

#### **2.5. Scolopendromorph zoogeography**

Centipedes are widely distributed in the world, some species occurs in overlapping zones such as temperate and tropical regions. The records are compiles in the following next paragraph.

There are many species of scolopendromorphs in Africa including savanna ecosystem are reported about 130 species in four orders (Druce et al., 2004). The information of African scolopendromorph diversity was published in many papers, there are about 9 genera: *Alipes*, *Asanada*, *Cormocephalus*, *Cyrtops*, *Digitipes*, *Ethmostigmus*, *Otostigmus*, *Rhysida* and *Scolopendra*, and 141 species have been confirmed (Attems, 1930; Verhoeff, 1941; Chamberlin, 1951; Machado, 1951; Lawrence, 1960, 1968; Demange, 1963, 1965; Koch, 1985; Zapparoli, 1989, 1990; Dobroruka, 1968; Schileyko, 1995; Schileyko and Stagl, 2004; Lewis, 1967, 1973, 1999, 2001, 2002, 2003, 2004, 2005, 2007, 2010; Lewis et al., 2006; Akkari et al., 2008; Kronmüller, 2010).

There are several publications with well studied in Europe on centipedes diversity, However, the scolopendromorphs shared about 5 genera: *Cormocephalus*, *Cryptops*, *Scolopendra*, *Plutonium* and *Theatops*, and 35 species have been recorded (Attems, 1930; Kos, 1990; Minelli, 1982; Zapparoli, 2006, 2009; Simaiakis et al., 2007).

Crabill (1960) reported a new American genus of cryptopid centipede with an annotated key to the scolopendromorph genera from America and north of Mexico and reported 14 genera of scolopendromorphs in North America. There are *Anethops*, *Arthrorhabdus*, *Cryptops*, *Dinocryptops*, *Ethmostigmus*, *Hemiscolopendra*, *Kethops*, *Newpotia*, *Otostigmus*, *Rhysida*, *Scolopendra*, *Scolopocryptops*, *Theatops* and *Thalkethops* (Chamberlin, 1958).

A dominant group of the scolopendromorphs in the New World is the family Scolopocryptipidae in South America. Its species have 23 pairs of legs, with 2 genera recorded as *Dinocryptops* and *Scolopocryptops* (Shelley, 2002). And the diversity of Scolopendridae composes of approximately 11 genera: *Scolopendropsis*, *Hemiscolopendra*, *Akymnopellis*, *Cormocephalus*, *Cryptops*, *Mimops*, *Newportia*, *Otostigmus*, *Rhodo*, *Rhysida* and *Scolopendra*, and 144 species were reported (Chagas, 2003, 2004, 2008; Koch et al., 2008; Shelley, 2008 and Bonato et al., 2012).



The records of scolopendromorph centipedes in Australia started from Koch (1985), and Koch and Colless (1986) reported 9 genera and 35 species of scolopendrid centipedes. Attems (1930) and Edgecombe (2006) reported 2 species of the genus *Cryptops* in Australia. The approximate diversity of scolopendromorphs is 10 genera: *Scolopendra*, *Arthrorhabdus*, *Asanada*, *Colobopleurus*, *Cormocephalus*, *Cryptops*, *Otostigmus*, *Ethmostigmus*, *Notiasemus*, and *Rhysida*, which 38 species have been recorded (Chamberlin, 1920; Koch, 1982, 1983, 1984; Lewis, 2002).

The two geographic characters of Asian temperate and tropical regions making many diverse habitats, so the scolopendromorph centipedes are also diverse (Table 2-1). There are some taxonomic works have been published and contributed the knowledge on centipedes widely.

— Two genera, seven species of the genus *Cryptops* and *Scolopocryptops* were reported from Japan (Takakuwa, 1936; Shinohara, 1984; Shelley, 2002).

— Five genera consist of *Cryptops*, *Ethmostigmus*, *Otostigmus*, *Rhysida*, *Scolopendra* and *Scolopocryptops*, with 16 species were recorded from Taiwan (Attems, 1930; Takakuwa, 1936; Lewis, 2001, 2010; Chao, 2002, 2008; Shelley, 2002; Schileyko and Stagl, 2004).

— Eighth genera consist of *Alluopus*, *Asanada*, *Cryptops*, *Ethmostigmus*, *Otostigmus*, *Paracryptops*, *Rhysida*, *Scolopendra* and *Scolopocryptops*, with 26 species were recorded from Vietnam (Attems, 1930; Attems, 1953; Schileyko, 1992, 1995; Negrea, 1997; Lewis, 2001, 2002, 2003, 2010; Shelley, 2002; Schileyko and Stagl, 2004; Edgecombe, 2005).

— Six genera consist of *Asanada*, *Cormocephalus*, *Cryptops*, *Ethmostigmus*, *Otostigmus*, *Psiloscolopendra* and *Scolopendra*, with 15 species were recorded from Myanmar (Attems, 1930; Schileyko, 1995; Lewis, 1999, 2001, 2010; Schileyko and Stagl, 2004).

— Four genera consist of *Ethmostigmus*, *Otostigmus*, *Rhysida* and *Scolopendra*, with 4 species were recorded from Cambodia (Attems, 1930; Lewis, 2001, 2007; Schileyko and Stagl, 2004).

— Four genera consist of *Ethmostigmus*, *Otostigmus*, *Rhysida calcarata* and *Scolopendra* with 5 species were recorded from Laos (Attems, 1930, 1953; Lewis, 2001; Schileyko and Stagl, 2004; Schileyko, 2007).

— Four genera consist of *Cryptops*, *Ethmostigmus*, *Malaccolabis* and *Otostigmus*, with 9 species were recorded from Peninsular Malaysia (Verhoeff, 1937; Lewis, 2001, 2010; Schileyko and Stagl, 2004).

The records of scolopendromorph centipedes in Thailand started from Alcock et al. (1910) recorded 7 species of scolopendromorphs from Thailand. Recently, Bonato et al. (2012) recorded in ChiloBase 3 species, but some species has never been recorded in ChiloBase such as *Ethmostigmus bisuleatus* (Attems, 1930), *Otostigmus rugulosus* from Sakunotayan waterfall in Phitsanulok Province and *Asanada brevicornis* from Nakon Sawan province (Vahtera, et al., 2012). The previous records for Thailand confirmed 9 species from the order Scolopendromorpha (Alcock et al., 1910; Attems, 1930; Lewis, 2001; Bonato et al., 2012) (Table 2-2).

**Table 2-1.** List species of the scolopendromorph centipedes recorded in neighboring countries. Presence and absence of each species indicated by + and – respectively (Attems, 1930, 1953; Lewis, 1999, 2001, 2010; Schileyko, 2007; Schileyko and Stagl, 2004; Shelley, 2000; Verhoeff, 1937).

Taxa	Cambodia	Laos	Myanmar	Malaysia (Peninsular)	Vietnam
<b>Family Cryptopidae</b>					
<b>Subfamily Cryptopinae</b>					
<i>Cryptops doriae</i>	-	-	+	-	+
<i>C. feae</i>	-	-	+	-	-
<i>C. malaccanus</i>	-	-	-	+	-
<i>C. spinipes</i>	-	-	-	-	+
<i>Paracryptops indicus</i>	-	-	-	-	+
<b>Family Scolopendridae</b>					
<b>Subfamily Otostigminae</b>					
<i>Ethmostigmus pygomegas</i>	-	-	+	-	-
<i>E. rubripes</i>	+	+	+	+	+
<i>Otostigmus aculeatus</i>	-	+	-	-	+
<i>O. amballae</i>	-	-	-	-	+
<i>O. astenus</i>	-	-	-	-	+
<i>O. ceylonicus</i>	-	-	+	-	-
<i>O. feae</i>	-	-	+	-	-
<i>O. loriae</i>	-	-	-	-	+
<i>O. multidentis</i>	-	-	-	-	+
<i>O. noduliger</i>	-	-	-	+	-
<i>O. oatesi</i>	-	-	+	-	-
<i>O. pahangiensis</i>	-	-	-	+	-
<i>O. politus</i>	-	-	-	-	+
<i>O. reservatus</i>	-	-	-	-	+
<i>O. rugulosus</i>	-	-	+	-	-
<i>O. scaber</i>	+	-	+	+	+
<i>O. spinosus</i>	-	-	+	+	-
<i>O. sulcipes</i>	-	-	-	+	-
<i>O. trisulcatus</i>	-	-	-	+	-
<i>O. voprosus</i>	-	-	-	-	+
<i>O. ziesel</i>	-	-	-	-	+
<i>Rhysida calcarata</i>	+	+	+	-	-
<i>R. leviventer</i>	-	-	+	-	-
<i>R. marginata</i>	-	-	-	-	+
<i>R. nuda</i>	-	-	+	-	-
<i>Sterropristes metallicus</i>	-	-	-	+	-
<b>subfamily Scolopendrinae</b>					
<i>Alluopus demangei</i>	-	-	-	-	+
<i>Asanada brevicornis</i>	-	-	+	-	+
<i>Cormocephalus pygmaeus</i>	-	-	+	-	-
<i>Psiloscolopendra feae</i>	-	-	+	-	-
<i>Scolopendra calcarata</i>	-	-	-	-	+
<i>S. morsitans</i>	-	-	-	-	+

Taxa	Cambodia	Laos	Myanmar	Malaysia (Peninsular)	Vietnam
<i>S. mirabilis</i>	-	-	-	-	+
<i>S. pinguis</i>	-	-	+	-	-
<i>S. subspinipes dehaani</i>	+	+	+	-	+
<i>S. subspinipes subspinipes</i>	-	-	-	-	+
<i>Scolopocryptops melanostomus</i>	-	-	-	-	+
<i>S. rubiginosus</i>	-	-	-	-	+
<i>S. sexspinosus</i>	-	-	-	-	+
<i>S. spinicaudus</i>	-	-	-	-	+

**Table 2-2.** List species of the scolopendromorph centipedes recorded in Thailand. Presence and absence of each species indicated by + and – respectively.

Taxa	Alcock et al., 1910	Attems, 1930	Lewis, 2001	Vahtera et al., 2011	Bonato et al., 2012
<b>Family Scolopendridae</b>					
<b>Subfamily Scolopendrinae</b>					
<i>Asanada brevicornis</i>	-	-	-	+	-
<i>Scolopendra subspinipes dehaani</i>	+	+	-	-	+
<b>Subfamily Otostigminae</b>					
<i>Ethmostigmus bisulcatus</i>	+	+	-	-	-
<i>Ethmostigmus platycephalus</i>	+	-	-	-	-
<i>Ethmostigmus rubripes</i>	-	-	-	-	+
<i>Otostigmus rugulosus</i>	+	-	+	+	-
<i>Otostigmus scaber</i>	+	+	+	-	+
<i>Rhysida calcarata</i>	+	-	-	-	-
<i>Rhysida nuda</i>	+	-	-	-	-

## CHAPTER III

### MATERIALS AND METHODS

Phang Nga province is located on the east of the Andaman Sea between 8 27 52.3 N and 98 32 E. The total areas about 4,170.885 km<sup>2</sup> by 1425.931 km<sup>2</sup> of agricultural lands, the forest area 1,142.50 km<sup>2</sup> and other 1,602.454 km<sup>2</sup>, approximately 57% of the area are mangrove forest and rainforest (Lilittam, 2009). Landscapes of Phang Nga province are generally mountainous, flat plain and the islands. The west coast of the province is the granitic and limestone hills above the Ranong and Mergui fault. The eastern exhibits the green shale to gray sandstone, and the inner part of it terrane. The general climate is tropical monsoon, which is influenced by the southeast monsoon and the northeast monsoon. The summer is from January to April, and the rainy season is from May to December. Therefore, Phang Nga's living depending on primarily agriculture especially the rubber, oil palms, and the orchards are mostly mixed of fruit such as mangosteen, durians, rambutans, satos, wollongongs (Somkid Homhuan, 2010).

#### 3.1 Study site

The study sites were selected both from mainland and islands of Phang Nga Province. The mainland are trespass by human for agricultural such as palm oil plantations, rubber plantations and fruit orchards (Fig. 3-1). The mainlands are non trespass as the national parks as Sri Phang Nga N.P., Khao Lak - Lam Ru N.P. and Khao Lampi - Hat Thai Muang N.P. They are ever green rain forest. The national parks in island are Ra and Phra Thong Islands, Similan Islands and Surin Islands. The islands are trespass as Muk islands and Kho Khao Island (Fig 3-2).

**Khao Lak-Lam Ru National Park**, this area locates in the shore area near by sea covering sandy beach and coral ecological system. The highest peak is about 1,077 m. with primary rainforest. (National park, Wildlife and Plant Conservation Department, 2011b).

**Khao Lampi-Hat Thai Muang National Park**, it consists of first, the Thai Mueang Beach and second, the Lampi Mountain range covered by a fertile tropical rainforest. The highest mountain is 622 meters above sea level, found that society of plants into 4 groups consist of rain forest, mangrove forest, beach forest and swamp forest (National park, Wildlife and Plant Conservation Department, 2011a).

**Sri Phang Nga National Park**, These hills are the head water of many river streams, there are very density and diversity both plants and animals. The area connected with the Khao Sok National Park in Surat Thani province. There are many streams, waterfalls and cliffs in the park. The forests are moist evergreen forest, with bulb plants, moses, fern and other low structure plants (National park, Wildlife and Plant Conservation Department, 2011f).

**Similan Islands National Park**, The island composed of 9 small islands line from north to south, far from west coast of Phang Nga province about 70 km. The island is mostly mountainous, highest peak 244 m, with steep granite mountain. Most of plants are stunted shrub or spreading of granite or sand areas. Lowland rainforest are the foothills and canyon on the damp (National park, Wildlife and Plant Conservation Department, 2011d).

**Surin Islands National Park**, The islands comprised of 5 small islands, far from west coast of Phang Nga province about 70 kilometers. These areas are very abundance of natural resources both plant and animal including coral reefs and famous for shallow diving (National park, Wildlife and Plant Conservation Department, 2011e).

**Ra-Phra Thong Islands National Park**, Located about 2-3 km away from the coast. The islands are 100 km<sup>2</sup> with high mountains and in the middle of the island is the Golden meadow or grassland savanna. Most areas of are protected forest, illegally invaded by people in the islands (National park, Wildlife and Plant Conservation Department, 2011c).

**Kho Khao Island**, The island has about 60 km<sup>2</sup>, mountainous with the height about 310 meters above sea level. The forests are highly invaded, the trees were cutting down and planted economic crops.

**Muk Island**, Bo Sai Hill locates away from Muk Island about 2 km<sup>2</sup>, which has the highest mountain about 450 m. Bo Sai Hill is a large hill among the sea in this area and around consist of mangrove forest. Most areas have been arranged by the province to cultivate economic crops such as the rubber, palm oil and orchards.

**Table 3-1.** Localities, and co-ordination of sampling sites.

Locality	Co-ordination
Kho Khao Island	8°89'18.6" E, 98°26'40.4" N
Phra Thong Island	9°08'61.4" E, 98°28'77.2" N
Muk Island	9°04'56.1" E, 98°35'45.8" N
Similun Islands	8°52'67.0" E, 97°63'55.0" N
Surin Islands	9°22'65.3" E, 98°37'42.1" N
Sri Phang Nga National Park	8°93'91.3" E, 98°47'57.4" N
Khao Lak - Lam Ru National Park	8°62'62.5" E, 98°23'97.0" N
Khao Lampi - Hat Thai Muang National park	8°42'16.1" E, 98°24'10.2" N
Rubber plantations (Kuraburi district)	9°12'88.7" E, 98°46'43.4" N
Oil palm (Tubpud district)	8°50'49.8" E, 98°63'28.7" N
Orchard (Kapong district)	8°67'61.3" E, 98°43'98.3" N

### 3.2 Sampling and preservation

The sampling method was applied from Blackburn et al. (2002) for suited this areas. Each area will be collected every two months period for one year except for Similan and Surin Islands that only one sampling for each island. Because they are the

protect areas now allow to do hunting but the samplings have been done under two expeditions under the Plant Genetic Conservation of Her Royal Highness Princess Maha Chakri Sirinrindhorn in 2010 and 2012 respectively. The specimens were hand collected during day and night time than selected specimens from microhabitats such as leaf litter and digging the soils or under stones, bent, bark, rotten wood in forest and areas by used leaf litter sifter and used hand shovel rake. Some habitats such as oil palm, rubber plantations and fruit orchards the pitfall traps were made using leaf litter and dry grasses were heap up for the centipedes for two or three day and harvested later. The animals were collected and data such as habitat characters, number of specimens, general morphological characters, etc.

The living specimens were photographed at many parts such as cephalic plate, antennae, tergite, locomotory and ultimate legs of animal for color comparisons and others of non-living when there were preserved in 70% alcohol. The specimens were then preserved in 70% alcohol and some of them were preserved in alcohol 95% for future study on DNA analysis. The specimens were photographed by Stereo-microscope (attached digital camera) by cell\*D software for studies external morphology and drawing characters for identification. The specimens were identified using external morphology. The terminology of the external characters of Scolopendromorpha followed Lewis et al., 2005 and classification followed Attems (1930), Koch (1985), Chao (2002) and Lewis (2002).

2.3 The dichotomous key for identification in families, genera and species level and described centipedes were constructed.

### **3.3. Identification and general characters of the Scolopendromorpha**

The Scolopendromorpha centipedes are opisthosogoneate, and have an ecdysis or molting process for their growing. They have a posterior genital opening, soft-bodied covered with exoskeleton or cuticle. The body is divided into head and trunk (Fig. 3-3), long slender and dorso-ventrally flattened (Lewis, 1981).



**Cephalic plate:** Cephalic plate or head plate is mostly flattened, sometime with setae, punctuation and suture. The shape of cephalic plate is varied from nearly triangle to circle or square, and consists of antennae, ocelli, mouth part and forcipules (Akkari et al., 2008).

**Eyes:** Scolopendromorph have simple eyes or “ocelli” which clusterd on the cephalic plate. This can be varied within the scolopendromorphs such as the Scolopendridae contains 4 ocelli on each side and the Cryptopidae have no ocelli.

**Antennae:** Antennae are bearing a pair on anterior margin and directed forwards of cephalic plate, cylindrical or flattened shaped, short (not reached the first tergite) to long (extending back to tergites). The segment of antennae are 17 to 35 antennomeres, and glabrous or a few setae and other with dense setose.

**Mouth parts:** They are three pairs of mouth parts (Fig. 3-4): mandible, the first pairs are well developed, distal end broadened, armed with teeth or comb like structures and with very fine dense setae. The second pairs are first maxillae locate ventrally of mandible with a basal plate formed by fused coxae. The third pairs are second maxillae located ventrally of first maxillae like the legs consists three segments and pretarsus (Lewis, 1981; Bonato et al., 2010).

**Forcipules or maxillipedes:** Forcipules or maxillipedes is a pair of poison claws covers mouth parts. They are the legs that modified to poison claws and have a venom gland connected to maxillipeds or tasungula. Forcicular tarsunga usually are smooth except Sterropristinae with saw like internal margin (Verhoeff, 1937).

**Forcicular coxosternal toothplate:** Forcicular coxosternal toothplate present in front of the coxosternum with two plates. The Scolopendridae presents numbers of teeth on each side since 3 to more 10 teeth. There are two groups, inner and

outer. The basal of coxosternum with furrow, height of teeth are difference in different species.

**Trochanteroprefemoral processes:** Trochanteroprefemoral processes are small ridges on the inner-side of the maxillipeds with a processes look like teeth but some genera without processes (Bonato et al., 2010).

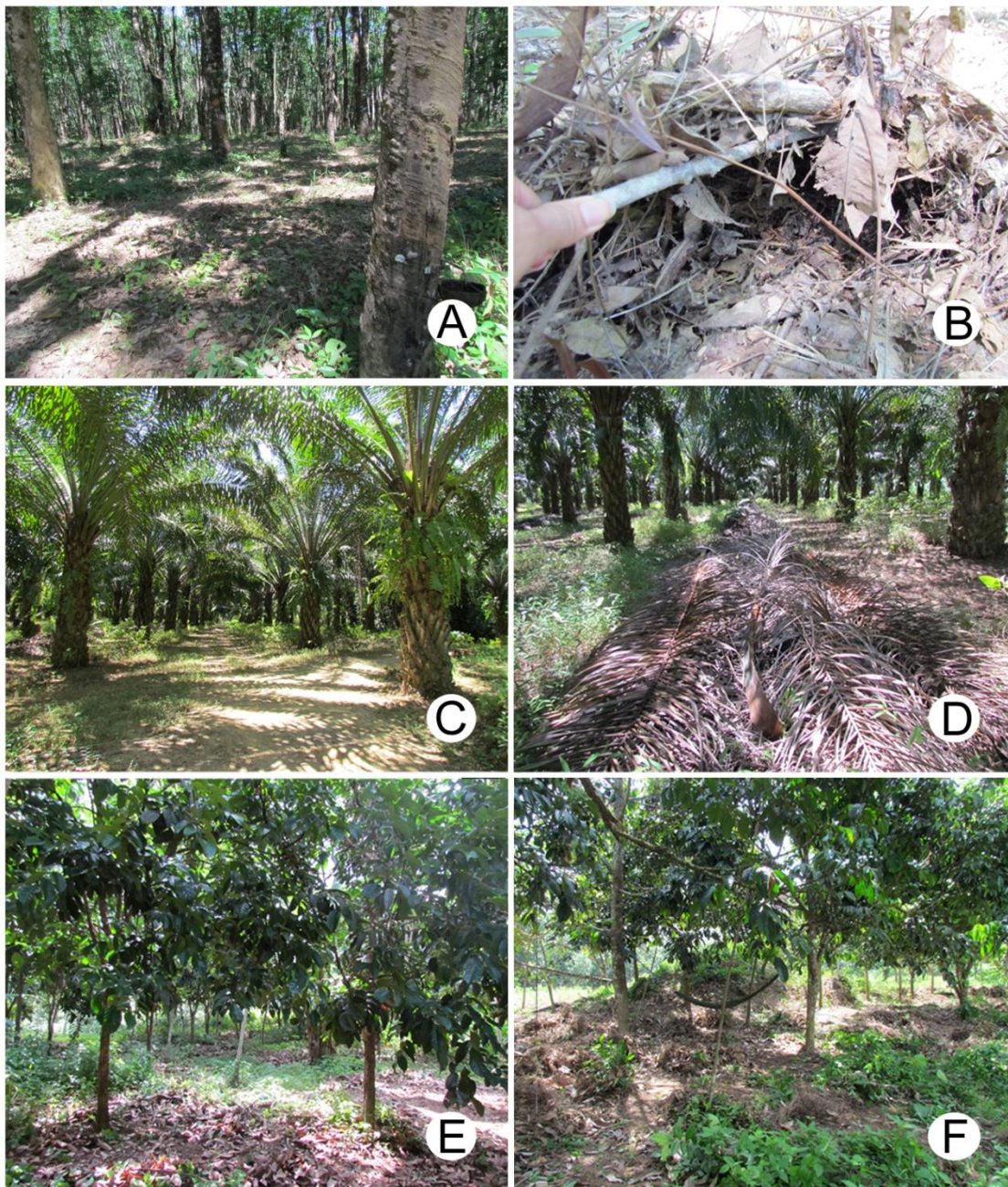
**Body segments (tergites and sternites):** Tergites or dorsal plate of body segment classified as first tergite clearly separated from cephalic plate, first tergite overlapped cephalic plate and cephalic plate overlapped first tergite. Tergites usually present longitudinal sutures on each segment, sometime present keels and transverse sutures. In the family Scolopendridae, there are lateral margin too. Sternites or ventral plate of body segments sometime present longitudinal suture (Fig. 3-3). There are some segments shorter than other as 2, 4, 6, 9, 11, 13, 15, 17 and 19 (Lewis, 1981, 2001; Koch, 1983).

**Spiracles:** Spiracles present on lateral of segments, there are triangle or cycle or oval form present on segment 3, 5, (7)8, 10, 12, 14, 16, 18, 20 and 22 if with 23 pairs of legs (Chao, 2002).

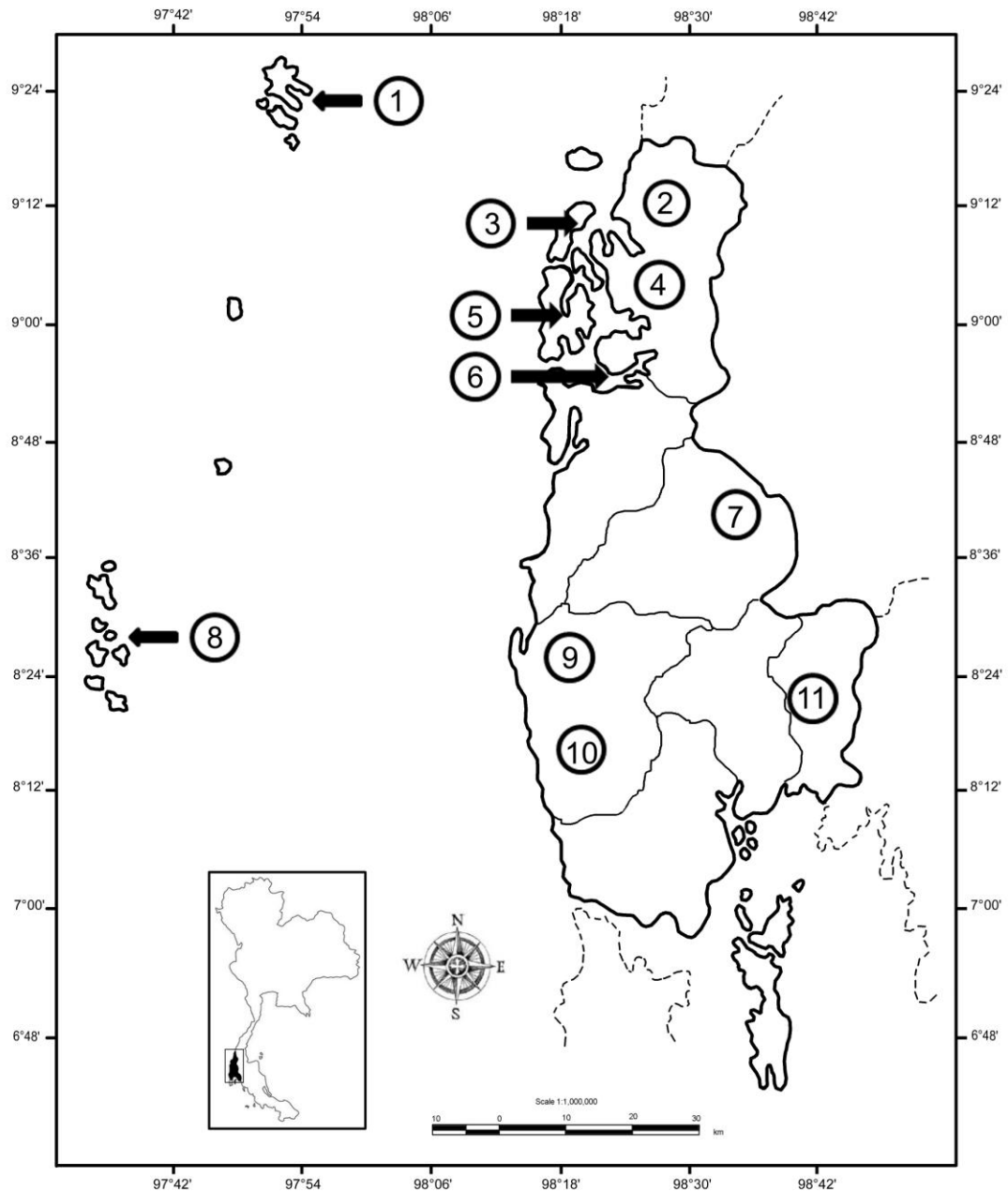
**Coxopleurons:** Coxopleura present lateral part on ultimate legs connected with last segment. The surface of is rough, usually with pore fields numerous pores, mostly the processes with spines on terminal and sometime on dorsal, ventral or lateral surface (Lewis, 1981).

**Locomotory and ultimate legs:** The numbers of leg are 21 pairs on body segment. Legs consist five or six segments (Fig. 3-5), there are trochanter, prefemur, femur, tibia and tarsus 1 and tarsus 2. In ultimate legs or last pair of legs, trochanter absent, usually with spines on prefemora (Fig. 3-6), however in *Cryptops* the prefemora without spine but with a row of saw-like teeth on the ventral margin of the tibiae and tarsus (Elzinga, 1994; Lewis, 1981; Lewis et al., 2005).

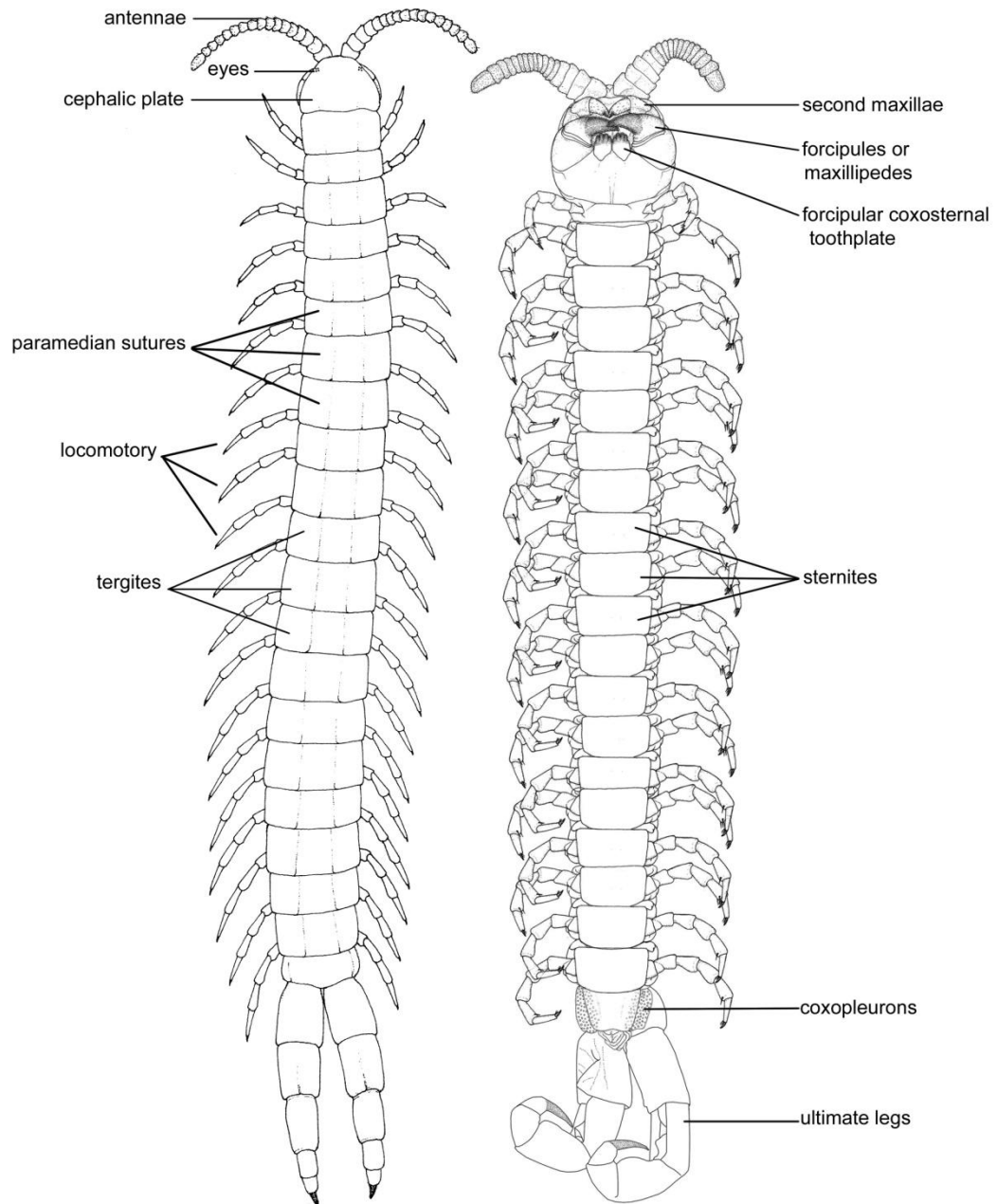
**Spines in organs:** Spines in each organs used define species especially ultimate legs or end legs including in coxopleura and in locomotory legs, if present on prefemora, femora, tibiae and tarsus of legs (Fig. 3-5), some species spines appear in tergites and pretarsus (Bonato et al., 2010).



**Figure 3-1.** Sampling sites in agricultural areas in Phang Nga province. **A-B.** Rubber plantation and leaves litter. **C-D.** Oil palm plantation with some fallen leaves. **E-F.** Fruit orchard with leaves litter.

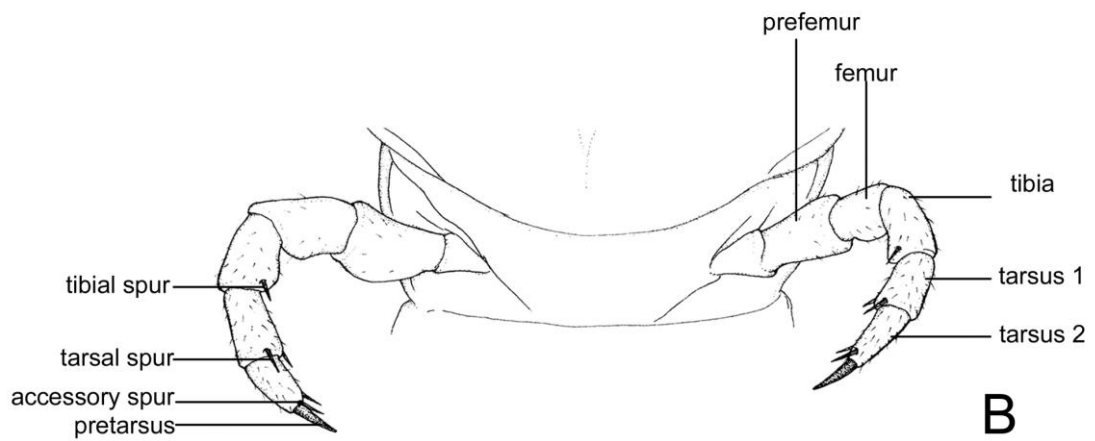
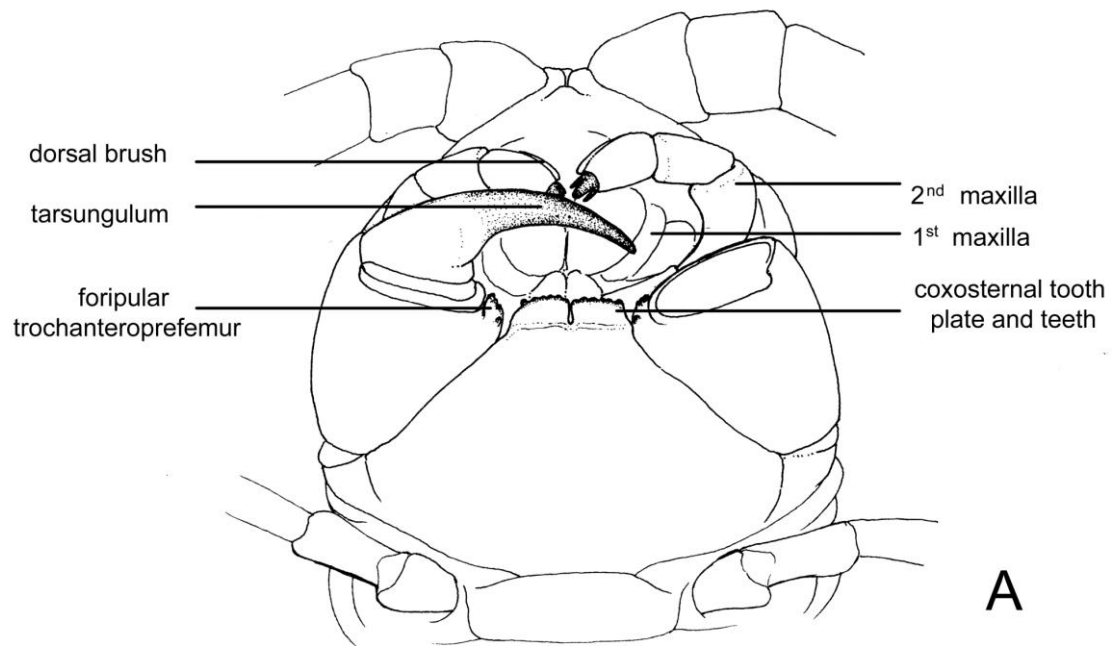


**Figure 3-2.** The map of Phang Nga province, showing sampling localities (1= Surin Islands , 2= Rubber plantations (Kuraburi district), 3= Phra Thong Island, 4= Sri Phang Nga National Park, 5= Kho Khao Island, 6= Muk Island, 7= Orchard (Kapong district), 8= Similun Islands, 9= Khao Lak - Lam Ru National Park, 10= Khao Lampi - Hat Thai Muang National park, 11= Oil palm (Tubpud district)).

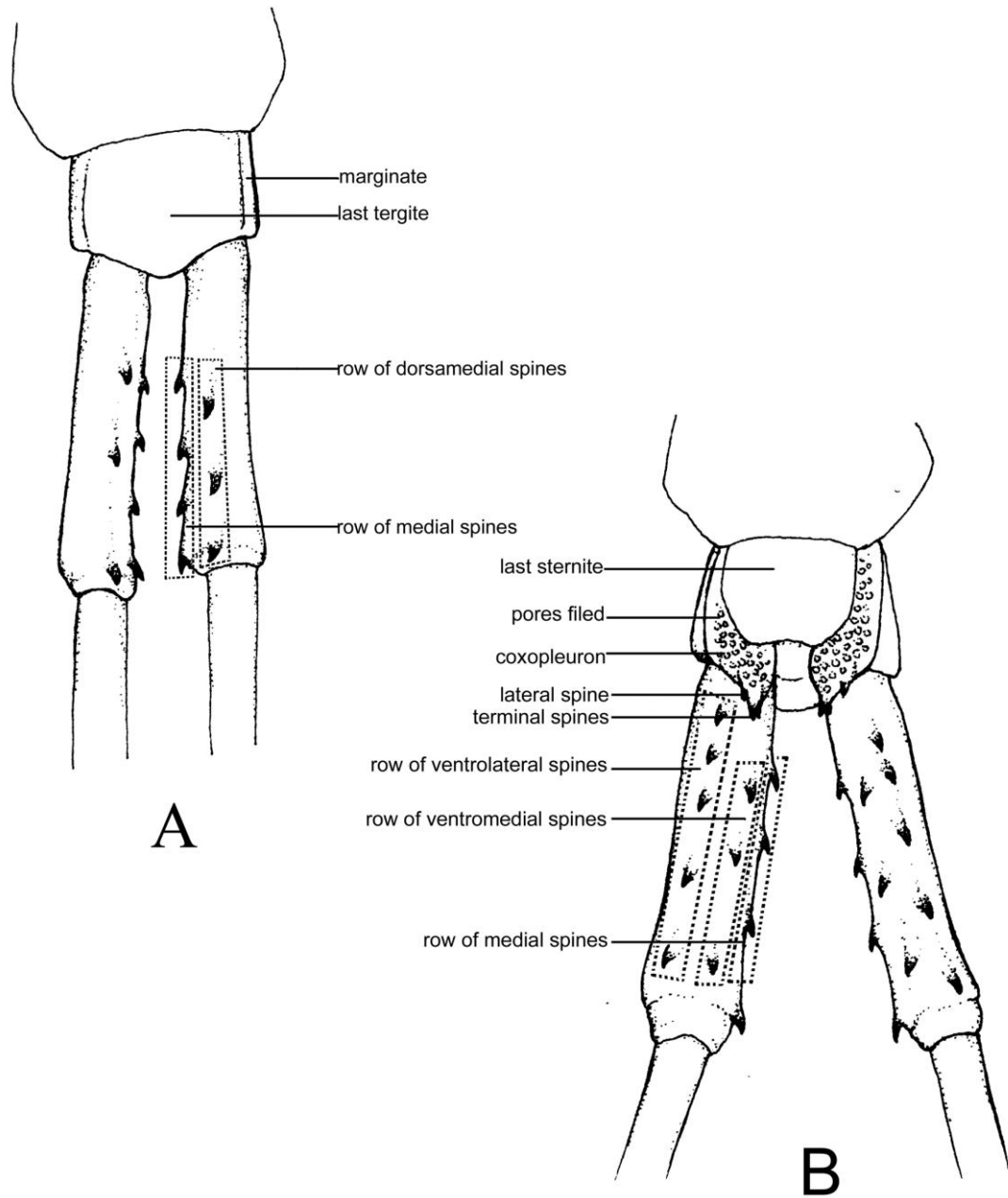


**Figure 3-3.** Dorsal and ventral view of scolopendromorph centipedes represented by the genus *Steropristes*.





**Figure 3-4.** The morphological characters on ventral view of head (**A.**) and leg articles with spurs (**B.**)



**Figure 3-5.** Last segment and the rows of spines on ultimate legs, **A.** Dorsal view.  
**B.** Ventral view.



## CHAPTER IV

### RESULTS

#### 4.1. Scolopendromorpha centipedes in Phang Nga province

There are 346 specimens of the scolopendromorph centipedes collected from various habitats in Phang Nga province (Table 4-1). The critical identification based on the following literatures: Attems (1930), Lewis (2000), Shelley (2002) for family, subfamily and generic levels, and Attems (1930) and Muadsub et al. (2012) for species level. There were 9 species belonging to only the family Scolopendridae (Fig. 4-1). These species were classified into two subfamilies, the Otostigminae comprised of three genera: *Otostigmus* (without spiracle on body segment 7), *Rhysida* (without saw-like internal margin of the forcipular tarsungula) and *Sterropristes* (with saw-like internal margin of the forcipular tarsungula). The subfamily Scolopendrinae consists of two genera: *Scolopendra* (cephalic plate often overlapping first tergite but sometime underlying first tergite) and *Asanada* (cephalic plate free from first tergite). The species classification in each genus is listed below.

Scolopendromorph centipedes are mostly collected from humid microhabitat. In this study the scolopendromorphs centipede were collected from several microhabitat such as termite mound, under soil with high humid, under leaf litters, under rotting wood or debris grasses, under stem of barks of tree and under stones (Table 4-2 and Fig. 4-2).

#### **Order Scolopendromorpha**

#### **Family Scolopendridae**

#### **Subfamily Otostigminae**

#### **Tribe Otostigmini**

1. *Otostigmus astenus* (Kohlrausch, 1878)
2. *Otostigmus glaber* Chamberlin, 1920
3. *Otostigmus multidens* Haase, 1887
4. *Otostigmus scaber* Porat, 1876
5. *Otostigmus* sp.

6. *Rhysida nuda nuda* (Newport, 1845)

7. *Rhysida nuda immarginata* (Porat, 1876)

**Tribe Sterropristini**

8. *Sterropristes violaceus* **Muadsub and Panha, 2012**

**Subfamily Scolopendrinae**

**Tribe Asanadini**

9. *Asanada brevicornis* Meinert, 1886

**Tribe Scolopendrini**

10. *Scolopendra subspinipes dehaani* Brandt, 1840

**4.1.1. Taxonomy**

**Order Scolopendromorpha Pocock, 1895**

Scolopendromorpha Pocock, 1895: 13. Attems, 1930: 1.

Body trunk with 21 or 23 pairs of legs, spiracles with 9, 10, 11 or 19 pairs, antennae with 17 or more articles. Cephalic plate with 4 ocelli or without on each side. Full number of legs when leave the egg and the movements moderately fast. Usually found under stones or in the rotten wood and sometime under the barks of tree. Some larger species such as genus *Scolopendra* can scramble on the tree.

**Family Scolopendridae Pocock, 1895**

Scolopendridae Pocock, 1895: 13. Attems, 1930: 16.

Cephalic plate with four ocelli on each side. Basal antennae with two or more articles glabrous. With coxosternal tooth plate and teeth. The legs segments with 2 tarsi. Sternites present or absent paramedian sutures but without transverse suture. Pretergite small or without, anterior and lateral side of sternite present presternite.

### **Subfamily Otostigminae Kraepelin, 1903**

Otostigminae Kraepelin, 1903: 29. Attems, 1930: 127.

First tergite overlapped with cephalic plate. Telopodite of second maxillae with 1 tarsal spine. Spiracles ovate or circular form without flaps and present on body segments 3, 5, (7)8, 10, 12, 14, 16, 18, 20 (some genera present on body segment 7). Trochanteroprefemoral processes with or without lateral teeth. Locomotory legs with 2 tarsal spines on each leg, ultimate legs with 1 tarsal spine or without.

### **Genus *Otostigmus* Porat, 1876**

*Otostigmus* Porat, 1876: 18. Attems, 1930: 128.

Body trunk with 21 pairs of legs. First tergite overlapped with cephalic plate. Antennae with 17 to 31 articles, the basal 2 or 3 (rarely 4) glabrous and the others articles with fine dense setae. Coxosternal tooth plate usually with 3 to 5 teeth on each side and with a spine on each. Trochanteroprefemoral processes large, with one or more lateral teeth. Spiracles present 9 pairs but body segment 7 without. Tergites with paramedian sutures some species with longitudinal keels. Sternites mostly with paramedian sutures and last sternite with depression on posterior margin. Prefemora of ultimate legs with corner spine.

#### **1. *Otostigmus astenus* (Kohlrausch, 1878)**

(Fig. 4-3)

*Branchiotrema calcitrans* Kohlrausch, 1878: 23. Type locality: Eua Islands, Tonga.

*Branchiotrema luzonicum* Kohlrausch, 1878—Kraepelin, 1903: 114, Type locality: Philippines, Luzon, Mancayan.

*Otostigmus barbouri* Chamberlin, 1914: 386. Type locality: Sorong, Irian Jaya (Dutch New Guinea).

*Otostigmus discretum* Silvestri, 1894—Kraepelin, 1903: 114. Type locality: Moroka.

*Otostigmus glaber* Chamberlin, 1920: 12. Type locality: Fiji Islands, Lakeba Lau, Nansori, Nadarivatu, Lomati, Vanua Ava.

*Otostigmus (Otostigmus) moluccanus* Chamberlin, 1914: 388. Type locality: Indonesia, Moluccas, Ternate.

*Otostigmus orientalis acutidens* Haase, 1887—Kraepelin, 1903: 114. Type locality: Bismarck Archipelago, Hermit Island.

*Otostigmus astenus*—Lewis, 2010: 8.

**Material examined:** The specimens of 221 individuals were collected from Bo Sai Hill in Muk Island, Kho Khoa Island, Ra - Phra Thong Island, Sri Phang Nga National Park, Khao Lak - Lam Ru National Park, Khao Lampi - Hat Thai Muang National Park, Similan and Surin Islands.

**Diagnosis:** Antennae with 19 to 22 article, last sternite square, coxopleural processes with 3 terminal, 1 lateral, 1 dorsal spines. Prefemora of ultimate legs with 4 rows spines; 3-5 ventrolateral spines, 1-2+2 ventromedial, 2-3 medial, 1-2 dorsomedial and a corner spine.

**Description:** Body length about 39 mm. The living color; antennae, cephalic plate and tergites dark blue to black, locomotory and ultimate legs blue to olive. The color when preserve in 95% alcohol; cephalic plate and tergite olive, ultimate legs dark blue.

Antennae long length and cylindrical. Left and right antenna completed with 20 articles, basal  $2\frac{1}{3}$  glabrous with only few setae, and other antennomeres with very short fine densely setose.

Cephalic plate with smooth surface, with scattered setae, first tergite overlying cephalic plate, without puncti, and suture, with short anterior median furrows, with 4 ocelli on each side.

Coxosternal tooth plate broad, usually with 4+4 principle teeth on each side, two inner fused and outer separate by a deep incision, with suture of basal obtuse angular. Trochanteroprefemoral processes with 3 lateral teeth. Tarsungula curve and teminal part very sharp.

Tergite smooth with only scattered setae, without keel, with completed paramedian sutures from tergites 5 to 20, with marginates from tergites 6 to 21, last tergite on posterior with short median longitudinal depression, the middle of posterior margin slightly sharp. The lateral margins of last segment almost parallel.

Sternites with small pit especially the middle of segments, with paramedian sutures occurring anterior half of these sternites from 3 to 20, last sternite square, presented lateral margins on posterior slightly concave and posterior margin almost straight.

Coxopleural processes moderately long, with 3 terminal spines, 1 lateral spine, 1 dorsal spine. Leg 1 with 1 femoral spur, legs 1 to 3 with tibial spurs, Legs 1 to 9 with 2 tarsal spines, legs 10 to 20 with 1 tarsal spine, leg 21 without tarsal spine, legs 1 to 21 with 2 claw spines.

Ultimate legs long length, prefemora with 4 rows spines, five ventrolateral, four ventromedial, three medial, two dorsomedial and a corner spine.

**Habitat:** This species can be found under leaves, rotting logs, under stones, in natural forest and agricultural areas.

**Distribution:** *Otostigmus astenus* has widely distribution ranges from Southeast Asia to Australia and the islands of Pacific (Lewis, 2007).

**Remarks:** The distinguished characters of this species are tergites without spines and legs 4 to 12 or 17 with 2 tarsal spines (Kraepelin, 1903; Attems, 1930). In the other hand, Lewis (2000) mentioned the diagnostic characters are tergites marginated at least from tergite 17, without keel, with or without spines, antennae with 17-21 articles, basal antennae 2.5 glabrous dorsally, sternites with complete paramedian sutures and without tubercles, last sternite narrowed or not, coxopleural processes with a dorsal spine. *Otostigmus astenus* and *O. rugulosus* are very similar, however, the distinction are *O. rugulosus* having low tergal keels, four spines very near the apex of the coxopleura, prefemora of the end leg with only three spine rows, two tarsal spines on legs 1 to 14 and no tarsal spines on 20 and 21.

Total of 221 specimens of this species were collected from this study. The

body length are about 20 to 43 mm, numbers of complete antennae vary from 19 to 22 articles, paramedian sutures of tergites since 5, or 6, 7 to 20, paramedian sutures of sternites from 3 or 5, 6 to 20 or 21, femoral spurs only leg 1 or sometime to leg 2, tibial spur on legs 1 to 2 or to 3, legs 1 to 4 or to 16 with 2 tarsal spurs only one specimen with 3 tarsal spurs on legs 1 to 3 (Table. 4-3). There are some characters have not mentioned in Attems (1930) and Lewis (2000), there are femoral spurs, tibia spurs and some individual with 3 tarsal spurs.

## **2. *Otostigmus glaber* Chamberlin, 1920**

(Fig. 4-4)

*Otostigmus glaber* Chamberlin, 1920: 12. Type locality: Fiji Island, Lakeba.

*Otostigmus (O.) glaber* —Attems, 1930: 143.

*Otostigmus glaber*—Lewis, 2002: 1696.

**Material examined:** The specimen 2 individuals were collected from Sri Phang Nga National Park and Orchard in Kuraburi district.

**Diagnosis:** Sternites with very short anterior paramedian sutures and these extending to one-half or more the length of the sternite in the mid-body region, coxopleural processes with two terminal spines, three lateral spines, two or three dorsal spines and one spine on the internal surface. Leg 1 with a femoral spur, legs 1 to 3 or 4 with a tibial spurs, legs 1 to 5 with 2 tarsal spurs or maybe legs 1 to 18 or 20 with 1 tarsal spur, other legs without tarsal spur, prefemoral of ultimate legs with 4 ventrolateral, 1 ventromedial, 3 medial, 1 dorsomedial and a corner spine.

**Description:** Body length about 34 mm. The color when preserve in 95% alcohol, cephalic plate and last segment dark blue green. Antennae, locomotory and ultimate legs light blue green.

Antennae long length and cylindrical, with 19 articles on left and 20 articles on right, the basal 2½ glabrous or only few scatter, the other with very dense setose and the joint area between each articles with scattered setae.

Cephalic plate quite smooth, anterior part with short anterior median furrow and with few scatter setae, absent suture, with 4 ocelli on each side. The first tergite overlapping the cephalic plate.

Coxosternal tooth plate with 4 teeth on each side inner 2 (two inner most fused) and outer 2 teeth (with two outer fused), the tooth plate each side closer together, appearance obtuse angle furrow on base, surface with few short setae. Tarsungula slightly curve, the terminal sharp. Trochanteroprefemoral processes moderate long with 3 lateral teeth.

Tergites smooth with scattered setae on all surfaces. Tergite 2 was haft of tergite 1. Paramedian sutures completed from tergites 5 to 20. Marginate from tergites 10 to 21. Last tergite with depression on haft of posterior, the posterior margin sharp.

Sternites with very short anterior paramedian sutures from sternites 5 to 20 and these extending to one-half or more the length of the sternite in the mid-body region. Last sternite with lateral margin slightly converging posterior, the posterior margin convex in middle.

Coxopleural processes moderate length with two terminal, three lateral, two or three dorsal and one spine on the internal surface, with pore field of many small pore.

Locomotory with short few setae, legs 1 with femoral spur, legs 1 to 3 with a tibial spur, legs 1 to 18 with 1 tarsal spurs, legs 18 to 20 without tarsal spur, all legs with 2 accessory spurs.

Prefemora of ultimate legs slender with 4 ventrolateral, 1 ventromedial, 3 medial, 1 dorsomedial and a corner spine.

**Habitat:** This species can be found in natural forest and under leaves.

**Distribution:** *Otostigmus glaber* has widely distribution which ranges from Sunda Islands to the Philippines, Madagascar, Seychelles and Nepal (Lewis, 2002).

**Remark:** The distinguished characters of this species are tergites smooth, antennae with 18 articles, coxopleural processes with 2 spines and leg 20 with 1 tarsal spurs (Chamberlin, 1920; Attems, 1930). The different between mentioned, and he used character of last sternite for separated *Otostigmus glaber* differs from *O. astenus* by

having last sternite clearly narrow lateral margin, while *O. astenus* has last sternite with more or less parallel lateral margin. In addition, *O. glaber* is morphologically closed to *O. rugulosus*, however the former species have antennae with 21 articles, spinulation of ultimate legs with 4 row and legs 20 with 1 tarsal spine, while *O. rugulosus* perform antennae with 18 articles, spinulation of ultimate legs with 3 row and legs 20 without tarsal spine (Attems, 1930; Lewis, 2002).

*Otostigmus glaber* in Phang Nga areas total 2 specimens. Body length about 34 to 35 mm., the second has some characters are varied as number of antennomeres with 17, legs 1 to 4 with a tibial spurs, legs 1 to 5 with 2 tarsal spurs, legs 16 to 20 with 1 tarsal spurs, legs 21 without tarsal spur (Table. 4-3). This is a first recorded that found *Otostigmus glaber* from Phang Nga province of Thailand, but there are some characters differed described in Attems (1930) as number of antennae and tarsal spur on leg 20.

### 3. *Otostigmus multidentis* Haase, 1887

(Fig. 4-5)

*Otostigmus multidentis* Haase, 1887. Type locality: Sulawesi (Celebes).

*Otostigmus armatus* Attems, 1953: 146. Type locality: Laos, Xieng Khouang.

*Otostigmus latidens* Pocock, 1894: 313. Type locality: Indonesia, Java, Bogor (Buitenzorg).

*Otostigmus modiglianii* Silvestri, 1895: 715. Type locality: Indonesia, Mentawai Island, Si-Oban.

*Otostigmus ruficeps* Pocock, 1890: 247. Type locality: India, Madras.

*Otostigmus multidentis*—Lewis, 2001: 19.

**Material examined:** The specimen 22 individuals were collected from Kho Khao Island, Ra - Phra Thong Island, Sri Phang Nga National Park, Khao Lak - Lam Ru National Park, Khao Lampi - Hat Thai Muang National park.

**Diagnosis:** Antennae 21 to 23 antennomeres, coxosternal tooth plate with moderated coxosternal tooth 6+6 teeth, coxopleura with 2 terminal and 1 lateral and no dorsal



spine, one femoral spur on leg 1 or absent, one tibial spur on legs 1 to 6 or 19, two tarsal spurs on leg 1 to 16 or 20, one tarsal spur on leg 20, leg 21 without tarsal spur, ultimate legs with 3 ventrolateral, 3 ventromedial and a corner spine on each side.

**Description:** Body length about 40 mm. The color when preserve in 95% alcohol, cephalic plate antennae and tergites 1 to 4 dark brown. Trunk, locomotory and ultimate legs blue green.

Cephalic plate smooth, with only scattered short fine setae, with 4 ocelli on each side, the anterior of cephalic plate sharp with anterior median furrow, without suture.

Antennae long length and cylindrical, completed with 22 antennomeres, basal 2½ glabrous with scatter short setae. The other antennomere with very dense setose.

Coxosternal tooth plate with coxosternal teeth 6 teeth on each side, three inner and three outer teeth on each side. The furrow on base very obtuse angle, surface with few short setae. Trochanteroprefemoral processes with 3 lateral teeth. Tarsungula curve and terminal very sharp.

Tergites smooth with scattered setae on all surfaces, first tergite covering cephalic plate. Tergites 6 to 20 with paramedian sutures. Marginate from 7, with posterior median depression on last tergite. Posterior margin of last tergite slightly concave and middle slightly obtuse angle.

Sternites with very short anterior paramedian sutures from tergites 3 to 20. Last sternite with lateral margin converging posterior and hind border incurved.

Each coxopleura are moderate length and sharp, with pore field of many small pores. The coxopleura with 2 terminal and 1 lateral no dorsal spine.

Locomotory with scattered setae on surfaces, Legs 1 to 20 with 2 accessory spurs, legs 1 to 19 with 1 tibial spurs, legs 1 to 19 with 2 tarsal spurs, legs 20 with 1 tarsal spur, leg 21 without tarsal spur.

Ultimate legs with 3 ventrolateral, 3 ventromedial and a corner spine on each side.

**Habitat:** This species can be found in natural forests and agriculture areas such as rubber plantation, oil palm and orchard, found them under leaves, in soil and in grass clump.

**Distribution:** *Otostigmus multidentis* distributes ranges from India to Java, Sumatra, Sulawesi, Sarawak, New Guinea, Vietnam Tawarin Island and Indo-China (Lewis, 2004).

**Remark:** The prominent character of this species is the forcipular coxosternal tooth plate has many teeth. Attems (1930) mentioned that the numbers of teeth on forcipular coxosternal tooth plate with 6 to 10 teeth on each side. In addition, Lewis (2001) had examined the specimens from Indonesia, the forcipular coxosternal tooth plate is varied from 7 + 7 or 6 + 7 teeth and may be (5-10), and these specimens have the highest records on number of antennomeres with 24 articles.

*Otostigmus multidentis* in Phang Nga areas total were 22 specimens of this species examined with the body length ranged from 22 to 44 mm. The other characters are varied as numbers of complete antennae from 21 to 23 articles, tergites with paramedian sutures from 3 (or 4, 5, 6) to 20 (or 21), sternites with paramedian sutures from 3 (or 4, 5, 6) to 20 (or 19). There are very varied spurs on legs as femoral spur on legs 1 sometime absent, tibial spurs on legs 1 to 19 (or 6, 13, 18, 19), two tarsal spurs on legs 1 to 16 (or 18, 20 sometime absent) (Table. 4-3).

#### 4. *Otostigmus scaber* Porat, 1876

(Fig. 4-6)

*Otostigmus (Otostigmus) scaber* Porat, 1876—Lewis, 2001: 27. Type locality: China.

*Branchiotrema multicarinatum* Kohlrausch, 1878—Kraepelin, 1903: 111. Type locality: Japan.

*Otostigmus carinatus* Porat, 1876—Kraepelin, 1903: 111. Type locality: China.

*Otostigmus malayanus* Chamberlin, 1914: 387. Type locality: Malay Peninsula, Johore State.

*Otostigmus (Otostigmus) striatus* Takakuwa, 1940— Chao and Chang, 2008: 8. Type locality: Taiwan (Formosa), Getubi.

*Otostigmus carinatus insulare* Haase, 1887—Chao and Chang, 2003: 2, 8. Type locality: Java and Sri Lanka.

*Otostigmus (Otostigmus) scaber*—Lewis, 2001: 27.

**Material examined:** the specimen 9 individuals were collected from Bo Sai Hill in Muk Island, Kho Khoa Island, Similan Islands and Surin Islands.

**Diagnosis:** Tergites rough with scattered setae on all surfaces with longitudinal keels 9 rows. Coxopleural processes long length with 3 terminal, 2 lateral and 1 dorsal spines. Prefemora of ultimate legs with 4 ventrolateral, 2 ventromedial, 2 dorsomedial and 2-3 corner spines.

**Description:** Body length about 40. 4 mm. The color when preserve in 95% alcohol, cephalic plate and tergites 1 and 2 light brown anterior of cephalic plate green to blue color, other tergites green. Antennae and locomotory light yellow and ultimate legs yellow to light green.

Antennae long length and cylindrical, completed left and right with 20 articles, basal 2½ glabrous with scatter short setae. The other with very densely setose.

Cephalic plate smooth, cephalic plate and first tergite with puncti, between cephalic plate and first tergite with long and large furrow, between tergites 1 and 2 with short and large furrow, with 4 ocelli on each side, anterior with anterior median furrow, without suture.

Plate of coxosternal with puncti, Coxosternal tooth plate with 5 teeth on each side, 3 inner fused and 2 outer fused, the basal furrow obtuse angle, Trochanteroprefemoral processes with 4 lateral teeth, first maxillae and second maxillae with setae. Tarsungula slightly curve and terminal sharp.

Tergites rough with scattered setae on all surfaces, first tergite covering cephalic plate. Tergites from 3 to 20 with longitudinal keels 9 rows but completed on tergite 6. Tergites from 9 to 21 with marginated. Tergites from 3 to 20 with paramedian sutures. Last tergite with not completed posterior longitudinal groove,

lateral side parallel, the posterior margin slightly concave, the middle of posterior margin obtuse.

Sternites with densely punctate, with not completed short anterior paramedian sutures from tergites 2 to 16. Last sternite slightly converge on lateral margin on posterior part, the posterior margin deeply concave.

Coxopleural processes long length with 3 terminal, 2 lateral and 1 dorsal spine. With pore field many small pores.

Locomotory legs with scattered setae on surfaces. Legs 1 with 1 femoral spurs, legs 1 to 17 with 1 tibial spurs and 3 tarsal spurs, legs 18 to 19 with 2 tarsal spur, legs 20 with 1 tarsal spurs, legs 21 without tarsal spur, legs 1 to 21 with 2 claw spurs.

Ultimate legs long length, the length of prefemora similar to femora and tibiae similar to tarsi 1, prefemora with spines 4 rows; 4 ventrolateral, 2 ventromedial, 2 dorsomedial and 2 corner spines.

**Distribution:** *Otostigmus scaber* has very widely distribution which ranges from Maritime Province of Russia to China, Japan, Taiwan, Hawaii Islands, and all country in the Southeast Asia, Andamans Islands, Nicobars Islands (Lewis, 2001). In Thailand, this species have been reported by Chamberlin (1914) and Attems (1930).

**Habitat:** This species can be found under leaves, soil, rotting wood in national forest and agricultural areas.

**Remark:** The distinguished characters of this species are having 21 articles, all tergites with 7 keels, legs 1 to 5 with one tibial spur, legs 1 to 4-9 with 2 tarsal spines, mostly legs 20 without tarsal spine (Attems, 1930; Lewis, 2001). However, Chao (2003) mentioned that the specimens from Taiwan have slightly differences from these typical characters by the posterior tergites rough with 7-9 longitudinal keels and with numerous small spines between keels.

Total 9 specimens were examined in this study with the body length from 31 to 43 mm. The morphological variations are observed as tergites with paramedian sutures from 3 (or 4) to 20, sternites with paramedian sutures from 2 to 15 (or 16),

tibial spurs on legs 1 to 12 (or 17) two tarsal spurs on leg 1 to 18 (19), only one specimen has 3 tarsal spurs (Table. 4-3). The characters of present of tibial spurs on legs 12 to 17 of these specimens are different from the previous report in Attems (1930), Chao (2003) and Lewis (2004).

### 5. *Otostigmus* sp.

(Fig. 4-7)

**Material examined:** Only one individual were collected from orchard in Kuraburi district.

**Diagnosis:** Cephalic plate on middle of plate with two curve shallow suture. Coxopleura with only one terminal spine. Ultimate legs with 2 row spines or only three spines on ventral sides.

**Description:** Body length about 39 mm. The color when preserve in 95% alcohol, cephalic plate dark, first and second tergites blue brown and other tergites brownish, antennae, locomotory and ultimate legs green blue.

Cephalic plate smooth, with only scatter short fine setae, with 4 ocelli on each side, the anterior of cephalic plate semicircle with anterior median furrow, middle of plate with two curve shallow suture.

Antennae cylindrical, left antenna not completed but right antenna completed with 17 antennomeres. The basal 2½ glabrous with scatter short setae, the other with very densely setose.

Coxosternal tooth plate with moderated coxosternal tooth 4 teeth on each side, two inner and two outer teeth on each side. The furrow on base very obtuse angle, surface with few short setae. Trochanteroprefemoral processes with 3 lateral teeth. Tarsungula curve and terminal very sharp.

Tergites smooth with scattered setae on all surfaces, first tergite covering cephalic plate. Tergites from 8 to 20 with paramedian sutures. Marginate from 5, without posterior median depression on last tergite. Lateral margins of last tergite slightly parallel and middle of posterior margin slightly obtuse angle.

Sternites with very short anterior paramedian sutures from tergites 3 to 20. Last sternite with lateral margins converging posterior part, posterior margin slightly straight.

Coxopleural processes moderate length, with pore field of many small pores. The coxopleural processes with 1 terminal spines but lateral spine and dorsal spine without.

Ultimate legs with 2 row spines or only three spines on ventral sides.

Locomotory legs with scattered setae on surfaces. With 2 accessory spurs from legs 1 to 21. Legs 1 to 18 with 2 tarsal spurs, Legs 19 to 20 with 1 tarsal spur, legs 21 without tarsal spur.

**Distribution:** *Otostigmus* sp. has distribution ranged from Thailand.

**Habitat:** This species can be found in and agriculture areas as orchard, found them under leaves.

**Remark:** This unidentified species differs from the other four previous species by *Otostigmus* sp. having 17 antennal articles, Coxosternal tooth plate 4+4 teeth, paramedian sutures on tergites from 8 to 20 and sternites since 3 to 20, marginated from tergites 5 to 21, without depression, coxopleura with 1 terminal spines, lateral spine, dorsal spine without spines, ultimate legs with (2 row spines); only three spines on ventral sides, locomotory without femoral and tibial spur, with only two tarsal spurs on legs 1 to 18 (Table. 4-3).

The *Otostigmus* sp. differences from *O. astenus* by the latter species having 19 to 22 antennal articles, paramedian sutures on tergites from 5 (or 6,7) to 20 (or 21) and sternites from 3 (or 5,6) to 20 (or 21), with depression, coxopleura with 3 terminal spines, 1 lateral spine, 1 dorsal spine, ultimate legs with (4 rows spines); 5 ventrolateral, 4 ventromedial, 3 medial, 2 dorsomedial, locomotory; femoral spur present on leg 1 or to 2 or absent, tibial spurs present on leg 1 to 2 (or 3), two tarsal spurs present on leg 1 to 4 (or to 16) and one tarsal spur on other legs to 20.

The distinctions from *O. glaber* are 17 to 20 antennal articles, paramedian sutures on tergites from 5 to 20 and sternites from 5 to 20, marginated from tergites

10 to 21, with depression, coxopleura with 2 terminal spines, 3 lateral spines, 2 or 3 dorsal spines, ultimate legs with (4 rows spines); 4 ventrolateral, 1 ventromedial, 3 medial, 1 dorsomedial, locomotory; femoral spur present on leg 1, tibial spurs present on leg 1 to 3 (or 4), two tarsal spurs present on leg 1 to 5 (or absent) and one tarsal spur on other legs to 19.

This species can be differentiated from *O. multidentis* by having 21 to 23 antennal articles, Coxosternal tooth plate 6+6 teeth, paramedian sutures on tergites from 3 (or 4, 5, 6) to 20 (or 21) and sternites 3 (or 4, 5, 6) to 19 (or 20), marginated from tergites 7 to 21, with depression, coxopleura with 2 terminal spines, 1 lateral spine no dorsal spine, ultimate legs with (2 rows spines); 3 ventro-lateral, 3 ventromedial spines, locomotory; femoral spur present on leg 1, tibial spurs present on leg 1 to 19 (or 6, 13, 18, 19), two tarsal spurs present on legs 1 to 16 (or 18, 20 sometime absent).

The unique characters of this species from *O. scaber* are the 20 antennal articles, Coxosternal tooth plate 5+5 teeth, paramedian sutures on tergites from 3 (or 4) to 20; sternites 2 to 15 (or 16), marginated from tergites 9 to 21, with keels, coxopleura with 3 terminal spines, 2 lateral spines, 1 dorsal spine, ultimate legs with 4 ventrolateral, 2 ventromedial, 2 dorsomedial, locomotory; tibial spur present on leg 1 to 12 (or 17), two tarsal spurs present on legs 1 to 18 (or 19).

### **Genus *Rhysida* Wood, 1862**

*Rhysida* Wood, 1862: 40. Attems, 1930: 183.

First tergite overlying cephalic plate. Antennae with 17 to 21 articles, basal with 3 to 4 articles glabrous and the others with fine dense setae. Trunks with 21 pairs of legs. Coxosternal tooth plate usually with 3 to 5 teeth on each side and with a spine on each. Trochanteroprefemoral processes large. Tergites from 5 with paramedian sutures. Some posterior tergites with marginates. Sternites with very short paramedian sutures on anterior border. Coxopleural processes long length and with 1 to 4 terminal and 1 to 2 lateral or dorsal spines. Ultimate legs slender, the locomotory with 2 accessory spurs, anterior legs with 2 tarsal spurs, posterior legs with 1 tarsal spur, leg 1 with 1 tibia

spur. Spiracles present 10 pairs and body segment 7 with spiracles too, spiracles cribiform and floor of the atrium with raised humps.

#### 6. *Rhysida nuda nuda* (Newport, 1845)

(Fig. 4-8)

*Rhysida nuda nuda* (Newport, 1845), Type locality: Australia (New Holland), Paramatta.

*Branchiostoma obsoletum* Porat, 1876: 24. Type locality: Australia (New Holland), Melbourne.

*Branchiostoma subinerme* Meinert, 1886: 117. Type locality: Australia, Queensland, Brisbane.

*Rhysida defecta* Chamberlin, 1920: 17. Type locality: Australia.

*Rhysida kurandana* Chamberlin, 1920: 17. Type locality: Australia, Queensland, Kuranda.

*Rhysida nuda nuda* —Attems, 1930: 189.

**Material examined:** the specimens of two individuals were collected from Sri Phang Nga National Park.

**Diagnosis:** Only last tergite with marginate. Coxopleural processes moderate length with 2 terminal spines, without lateral and dorsal spine. Prefemora of ultimate with 2-3 ventrolateral, 1 ventromedial and 0-1 medial spine.

**Description:** Body length about 107.5 mm. The color when preserve in 95% alcohol, cephalic plate and first tergite dark green. Antennae, locomotory, trunk and ultimate legs green.

Antennae cylindrical, completed left and right with 20 articles, basal articles 3 glabrous. The dorsal of posterior of antennomere 3 with setae but the ventral glabrous, antennomere 4 to 20 with very fine densely setose.

Cephalic plate smooth, with 4 ocelli on each side, the anterior with median furrow but without suture.



Coxosternal tooth plate usually with 4 teeth on each side and with a spine on each, the basal furrow with obtuse angle. Tarsungula moderated curve. Trochanteroprefemoral processes large and long length with 3 lateral teeth.

Tergites smooth from 4 to 20 with paramedian sutures. Tergites 4 to 7 with anterior transverse sutures, tergites 7 to 20 with oblique sutures. Only last tergite with marginate but without posterior median groove, the lateral margins almost parallel, the middle of posterior margin blunt.

Sternites with pits, with very short paramedian sutures on anterior border. Last sternite slightly converge on lateral margins, the posterior margin concave.

Spiracles present 10 pairs and body segment 7 with spiracles too, spiracles cribiform and floor of the artrum with raised humps.

Coxopleural processes moderate length with 2 terminal spines, without lateral and dorsal spine, with pore field many small pores.

Ultimate legs slender, prefemora with 3 ventrolateral and 1 ventromedial spines, dorsal smooth without spine.

The locomotory legs with 2 accessory spurs, the legs without tibial spurs, legs 1 to 16 with 2 tarsal spurs, legs 17 to 19 with 1 tarsal spur, leg 20 without tarsal spurs.

**Remark:** The centipedes genus *Rhysida* is morphologically closed to the genus *Ethmostigmus* Pocock, 1898. However, the distinguished characters are the trochanteroprefemoral processes appears in the *Rhysida*, but this character absent in the *Ethmostigmus*. Attems (1930) mentioned that the unique characters of *Rhysida nuda* is only marginate last tergite, and this species consisted 3 subspecies: *R. nuda togoensis* and *R. nuda immarginata*. The former subspecies is distributed in the West Africa, and the unique characters are the number of spines of coxopleurons process and legs 20 with or without tarsal spurs (Attems, 1930). The *R. nuda immarginata* has 3 spine on coxopleuron process and legs 20 without tarsal spur.

The centipede genus *Rhysida* has never been reported from Thailand, Burma and Peninsular Malaysia, but only single species *R. calcarata* was reported from Cambodia and Laos (Schileyko, 2007).

**Distribution:** *Rhysida nuda nuda* has very widely distribution which ranges from

Myanmar, Ceylon, the Banda Islands, Australia, America and from Mexico to Paraguay (Attems, 1930).

**Habitat:** This species can be found under leaves and rotten logs in natural forests.

### 7. *Rhysida nuda immarginata* (Porat, 1876)

(Fig. 4-9)

*Rhysida immarginata* (Porat, 1876)—Koch, 1985: 212. Type locality: Philippines, Manila.

*Branchiostoma gymnopus* Kohlrausch, 1878: 23. Type locality: Indonesia, Kepulauan Banda, Banda Island.

*Branchiostoma indicum* Kohlrausch, 1878—Haase, 1887: 85. Type locality: Myanmar, Rangoon.

*Branchiostoma subspinosum* Tömösváry, 1885—Takakuwa, 1936: 65. Type locality: Malaysia, Sarawak (Borneo), Matang.

*Rhysida nuda immarginata*—Attems, 1930: 190.

*Rhysida nuda brevicornuta* Wang, 1951—Chao and Chang, 2003: 8. Type locality: Philippines, Mindanao, Bunauwan.

**Material examined:** Only one individual were collected from Bo Sai Hill in Muk Island.

**Diagnosis:** Only last tergite with marginate. Coxopleural processes moderate length with 3 terminal spines, without lateral and dorsal spine. Prefemora of ultimate legs with 2-3 ventrolateral, 1 ventromedial and 0-1 medial spine.

**Description:** Body length about 56 mm. The color when preserve in 95% alcohol, cephalic plate and tergites dark green to dark. Antennae violet, locomotory legs light pink and ultimate legs violet.

Antennae cylindrical, antennae not equal the left with 19 articles and the right with 21 articles, basal 3 glabrous with few setae and other very fine densely setose,

Cephalic plate smooth, with fine few setae, anterior with anterior median furrow but without suture, with 4 ocelli on each side.

Coxosternal tooth plate usually with 5 teeth on each side, 2 inner fused and 3 outer fused, basal with obtuse angle furrow, Tarsungula moderated curve. Trochanteroprefemoral processes large and long length with 3 lateral teeth.

Tergites smooth, anterior with small white pits, first tergite covering cephalic plate, second tergite the smallest segment. Complete paramedian sutures from tergites 3 to 20, tergites from 5 to 10 with oblique sutures. Since tergites 5 to 20 with a median sutures. Only last tergite with obvious marginate, lateral side parallel, posterior margin converge and the middle obtuse, without posterior median groove.

Sternites from 3 to 21 with short anterior paramedian sutures. Last sternite with lateral margins parallel converge on posterior part, posterior margin straight not concave in middle posterior.

Spiracles present 10 pairs (segments 3, 5, 7, 8, 10, 12, 14, 16, 18 and 20), spiracles on segment 3 very large and body segment 7 with spiracles too, spiracles cribiform and floor of the artrum with raised humps.

Coxopleural processes moderate length with 3 terminal spine, without lateral spine and dorsal spine, with pore field many pores.

Locomotory plump with pits, femora and tibiae longer than prefemora, the length of prefemora similar to tarsi 1 and tarsi 1 longer than tarsi 2. Legs 1 to 20 with 2 accessory spurs only leg 21 without accessory spurs, leg 1 with 1 femoral spur, 1 tibial spur, legs 1 to 17 with 2 tarsal spurs, legs 18 to 19 with 1 tarsal spur. Leg 20 without tarsal spurs.

Ultimate legs slender, the length of prefemora similar to femora, prefemora with 2 ventral-lateral and 1 ventral-medial spines.

**Distribution:** *Rhysida nuda immarginata* distribution ranged from Sunda Islands, India, Myanmar, Philippines, Venezuela and Guatemala (Attems, 1930).

**Habitat:** This species can be found under leaves in agricultural areas.

**Remark:** The body colors of *Rhysida nuda immarginata* are differentiated from

*Rhysida nuda immarginata* by having cephalic plate and tergites dark green to dark, antennae violet, locomotory legs light pink and ultimate legs violet but the latter species having cephalic plate and first tergite dark green, antennae, locomotory, trunk and ultimate legs green.

#### **Genus *Sterropristes* Attems, 1934**

*Sterropristes* Attems, 1934: 44-47. Verhoeff, 1937: 201, 202.

Trunk with 21 pairs of legs. Cephalic plate with 4 large ocelli on each side. Antennae short, wide and dorso-ventrally flattened, 4-7 basal antennal segments almost glabrous, with a few short setae; remaining antennal segments densely covered with very short fine setae. Cephalic plate and first tergite free together not overlapping. Tarsungula well developed with number saw like teeth on each side. Coxosternal tooth plate with 4 teeth on each side, without trochanteroprefemoral process and tooth. Second maxillae without accessory spur, pretarsus thick and blunt. First tergite free (not overlapping) with cephalic plate. Tergites and sternites with completed paramedian sutures, with spiracles on trunk segment 7. Coxopleura truncated with pore field without processes and spine. Ultimate legs thick and short with extremely sparse setae, prefemora without spine, pretarsus longer than second tarsus, without tarsal spurs and accessory spurs. Locomotory with tiny setae, with tarsal spurs and accessory spurs.

#### **8. *Sterropristes violaceus* Muadsub and Panha, 2012**

(Fig. 4-10)

**Material examined:** the specimens of six individuals were collected from Koh Si, Similan and Surin Islands.

**Diagnosis:** Distinguishing characters of this species are: antennal articles 1 to 4 glabrous or with very few setae, articles 5 to 17 densely setose. Bases of coxosternal tooth plates meeting at right angles. Forcipular tarsungula slightly curved, internal margin with 11-13 saw teeth. Tergites 6 to 20 and sternites 11 to 19 with complete

paramedian sutures. Last sternite with strongly converging lateral margins. Coxopleura of ultimate legs truncated and equivalent in length to last sternite. Ultimate legs thickened, prefemora, femora and tibiae similar in length, prefemora length equal to its width, femora and tibiae longer than their width, dorsal side of femora with short posterior groove, ventral side of tibiae and tarsi 1 prominently convex. Legs 1 and 2 with one tibial spur, legs 1 to 14 with two tarsal spurs, legs 15 to 20 with one tarsal spur and legs 1 to 20 with two pretarsal accessory spurs.

**Description:** Body length about 32.8 mm. Living animals: cephalic plate, tergites and ultimate legs with dark purple, antennae and locomotory legs light purple. Color of preserved specimen: cephalic plate and tergites dark purple, antennae, locomotory and ultimate legs light purple.

Cephalic plate smooth, anterior part semi-circular, posterior margin straight, surface glabrous but with few and short setae, with 4 ocelli.

Antennae dorso-ventrally flattened, reaching back to third tergite, with 17 articles, basal 1 to 4 wide and glabrous but with few short setae on both dorsal and ventral side. Articles 5 to 17 densely pubescent with short setae, terminal article longer than wide, width of penultimate article width about 1/3 of first article width.

Forcipular coxosternal tooth plate with 4+4 teeth, two inner teeth longer than the two outer ones, basal borders of tooth plates meeting at right angles, surface of plates with a few short setae. Forcípules without trochanteroprefemoral processes; forcípular tarsungula with 13 saw teeth on internal margin. Second maxillae with few scattered setae, without accessory spur. First maxillae with few scattered setae.

Tergites smooth with scattered setae on surface. First tergite about three times longer than second, not overlapping cephalic plate, without an anterior median furrow or suture.

Tergites 2 to 5 with short anterior and posterior paramedian sutures, tergites 6 to 20 with complete sutures. Last tergite margined and without posterior median depression. Posterior margin of last tergite lightly concave in the middle. Ten pairs of oval spiracles, those on segment 3 largest, spiracles present on segment 7.

Sternites smooth, paramedian sutures on anterior half of sternites 4 to 10, complete sutures on sternites 11 to 19. Last sternite with concave lateral and posterior

margins. Coxopleura of ultimate legs truncate, without processes and spines, similar in length to last sternite and covered with many small pores.

Locomotory legs with scattered setae, prefemora and femora flattened. Tarsi 1 longer than tarsi 2. Legs 1 to 2 with one tibial spur, legs 1 to 14 with two tarsal spurs, legs 15 to 20 with one tarsal spur, legs 1 to 20 with two accessory spurs.

Ultimate legs short and very thickened, dorsally flattened, surface smooth without spines. Prefemur, femur and tibia similar in length, prefemur length equal to its width, femur and tibia longer than their width, glabrous and glossy, prefemora and femora with deep furrow on ventral side, femora with short groove on posterior dorsal side. Tibiae and tarsi 1 prominently convex on ventral side, tarsus 1 longer than tarsus 2, pretarsus longer than tarsus 2.

**Remarks:** Four paratypes from Similan Islands vary in length from 23.4 to 29.9 mm. The smallest specimen (23.4 mm; with one ultimate leg) has 11 saw teeth on the forcipular tarsungula, femoral spur absent, one tibial spur on legs 1 to 3 and two tarsal spurs on legs 1 to 4. Two specimens (25.0 mm and 24.1 mm) have the number of saw teeth as in the holotype (Fig. 7); both have complete paramedian sutures on tergites 5 to 20, one femoral spur on leg 1 or legs 1 to 2, one tibial spur on legs 1 to 3 or 1 to 2, two tarsal spurs on legs 1 to 4. The largest specimen (29.9 mm) is almost of similar size as the holotype, but it differs in having 12 saw teeth on forcipular tarsungula, a femoral spur on leg 1, one tibial spine on leg 1, and two tarsal spines on legs 1 and 2.

The specimen from Surin Islands (32.5 mm; without ultimate legs) is closest in size to the holotype, but it has 11 teeth on the forcipular tarsungula, one femoral and one tibial spur on leg 1, and two tarsal spurs on legs 1 to 3.

### **Subfamily Scolopendrinae Kraepelin, 1903**

Scolopendrinae Kraepelin, 1903: 29. Attems, 1930: 17.

Spiracle triangle form divide horizontally by three flaps and present on body segments 3, 5, 8, 10, 12, 14, 16, 18, 20 but in genus *Scolopendropsis* with 23 pairs of legs spiracle present segment 22 too. Trochanteroprefemur with lateral teeth.

Telopodite of second maxillae with 2 tibial and 2 tarsal spines. Legs with 1 tarsal spine or without.

### **Genus *Asanada* Meinert, 1886**

*Asanada* Meinert, 1886; 189.

Antennae very short length, flatten dorsal-ventral. Coxosternal tooth plate with 3 teeth on each side. Ultimate legs thick, prefemora without spine.

#### **9. *Asanada brevicornis* Meinert, 1886**

(Fig. 4-11)

*Asanada brevicornis* Meinert, 1886, Type locality: Type locality: India, Himachal Pradesh, Kullu (Kooloo).

*Asanada brevicornis*—Schileyko, 1995: 78.

**Material examined:** the specimens of five individuals were collected from Similan and Surin Islands.

**Diagnosis:** Antennae very short length, flatten dorsal-ventral, both right and left with 17 articles, with fine densely setose since antennomere 1 to 17, prefemora of ultimate legs without spine, prefemora and femora with posterior median groove. Legs 1 to 20 with 2 accessory spurs, without tarsal spur on all legs.

**Description:** Body length about 22 mm. The living color, antennae, cephalic plate, locomotory and posterior of ultimate legs black, middle of tergite black but lateral tergites light grey, anterior of ultimate legs white. The color when preserve in 95% alcohol are cephalic plate and ultimate legs black. Antennae, tergites and locomotory light yellow green.

Antennae very short length, flatten dorsal-ventral, both right and left with 17 articles, with fine densely setose since antennomere 1 to 17.

Cephalic plate with fine setae, cephalic plate free together with first tergite. Anterior without anterior median furrow, but middle anterior margin slightly concave, with 4 ocelli on each side.

Coxosternal tooth plate with fine setae, with a median furrow, usually with 3 teeth on each side, trochanteroprefemoral processes short with 1 terminal tooth.

Tergite with complete paramedian suture from tergites 4 to 20, with transverse suture from tergites 4 to 18. Only last tergite with marginate, the lateral margin diverge on posterior part, posterior margin round and the middle without posterior median groove.

Sternites with complete paramedian sutures from sternites 6 to 20, last sternite small, lateral margins slightly converge on posterior part, the corner of posterior margin round and posterior margin straight not concave middle posterior margin.

Locomotory with fine setae, legs 1 to 20 with 2 accessory spurs, without tarsal spur on all legs.

Ultimate legs thick, with fine setae, prefemora without spine, prefemora and femora similar to in length, both with posterior median groove.

**Distribution:** *Asanada brevicornis* has widely distribution which ranges from Southeast Asia to Pacific Islands, India, adjacent region of Central Asia, Australia and New Guinea (Schileyko and Stagl, 2004).

**Habitat:** This species can be found under leaves and under stones in natural forests.

**Remark:** Original description of *Asanada* lack information about present of locomotory tarsal spurs until Shileyko (1995) found *Asanada sinrociverb* from Vietnam some specimens present tarsal spurs on all legs but some specimens no such spurs. In this study were four specimens of this species from Similan and Surin Islands were examined. All the specimens having no tarsal spur on all the locomotory, which similar to the Vietnam specimens as reported by Schileyko (1995).



**Genus *Scolopendra* Linnaeus, 1758**

*Rhadinoscytalis* Attems, 1926: 374.

*Rhombocephalus* Newport, 1844: 193.

*Trachycormocephalus* Kraepelin, 1903: 218.

Cephalic plate often overlapping first tergite, with finely puncti, with short anterior median furrow but without suture. Antennae with 17 to 31 articles, basal antennae four or more articles glabrous and the others with fine dense setae. Trunk with 21 pairs of legs, with coxosternal tooth plate and teeth, teeth plate with three or more on each side and with bristle under teeth each. Coxopleural processes with 1 or more terminal spines. Prefemora spines of ultimate legs with one or more spines. First tarsi longer than second tarsi rarely equal length, with 2 accessory spines on legs.

**10. *Scolopendra subspinipes dehaani* Brandt, 1840**

(Fig. 4-12)

*Scolopendra subspinipes dehaani* Brandt, 1840: 152. Type locality: Indonesia, Java.

*Scolopendra childreni* Newport, 1844: 96.

*Scolopendra concolor* Newport, 1845: 394. Type locality: India, Bengal.

*Scolopendra fissispina* L. Koch, 1865: 891. Type locality: Malaysia, Penang.

*Scolopendra foveolata* Verhoeff, 1937: 220. Type locality: Malaysia: Johore, Gunong Pulai; Kuala Legap, Plus Valley, Perak, Penang Hill.

*Scolopendra horrida* C.L. Koch, 1847 —Kohlrausch, 1881: 95. Type locality: Java.

*Scolopendra inermis* Newport, 1845: 393. Type locality: Myanmar, Tenasserim.

*Scolopendra limicolor* Wood, 1861: 12. Type locality: India, Bengal.

*Scolopendra lucasii* Gervais, 1847—Kraepelin, 1903: 260. Type locality: Île de France (=Mauritius), Bourbon (=Réunion).

*Scolopendra silhetensis* Newport, 1845: 393. Type locality: India, Silhet.

*Scolopendra subspinipes dehaani*—Attems, 1930: 31.

**Material examined:** the specimen 77 individuals were collected from Bo Sai Hill in Muk Island, Kho Khoa Island, Ra - Phra Thong Island, Sri Phang Nga National Park, Khao Lak - Lam Ru National Park, Khao Lampi - Hat Thai Muang national park and Surin Islands.

**Diagnosis:** Posterior margin of cephalic plate overlying the first tergite. Coxosternal tooth plate broad with short teeth 5 to 6 teeth. Coxopleural processes with 1 or 2 terminal spines. Prefemora of ultimate legs without ventral and inner with 0-3 spines.

**Description:** Body length about 54 mm. The living, cephalic plate and first tergite red or orange. Antennae, locomotory and ultimate leg orange. Tergite dark brown, green brown or orange with black band. The color when preserve in 95% alcohol, cephalic plate and tergite yellow brown to brown green. Antennae, locomotory and ultimate leg yellow or orange.

Cephalic plate smooth with puncti especially anterior part and posterior margin, anterior with anterior median furrow, without suture and basal plate, posterior margin of cephalic plate overlying the first tergite, with 4 ocelli on each side, the anterior with short median furrow but without suture.

Antennae cylindrical, moderate length, completed left and right with 18 antennomeres, basal 4 glabrous and antennomere 5 to 18 with fine dense setose.

Clypeus and labrum without spine. Second maxillae without a median suture on coxae, with 2 accessory spurs. Tarsungula long length and curve on terminal.

Coxosternal tooth plate usually broad with short teeth 5 teeth on each side, inner 3 teeth fused, basal suture almost straight. Trochanteroprefemoral processes with 3 terminal teeth.

First tergite with puncti, without ring furrow and paramedian suture, tergites from 3 to 20 with complete paramedian sutures, tergites from 3 to 21 with marginate. Last tergite without posterior median groove, the posterior margin concave and the middle obtuse. Spiracles large and long triangular form with tripartite valve.

Sternites started from 2 to 20 with complete paramedian sutures. Last sternite without paramedian suture, the lateral margins converge on posterior, the posterior margin straight.

Coxopleural processes moderate length with 2 terminal spines. With pore fielded.

Ultimate legs moderate length, slender and strong, prefemora dorsal flat with a short posterior median groove, ventral without spine, inner with 3 spines.

Legs 1 to 20 with 1 tarsal spurs, leg 21 without tarsal spur, legs 1 to 21 with 2 accessory spurs. Tarsus 1 longer than tarsus 2.

**Distribution:** *Scolopendra subspinipes dehaani* has distribution ranges from Sumatra, Java, Malay, Peninsula, Myanmar, Thailand, Peninsular India (Calcutta), China and Amboyna (Attems, 1930).

**Habitat:** This species can be found under leaves, rotten logs, under stones, in grass clump, on tree trunks, termite mound and in houses, in natural forests and agricultural areas.

**Remark:** The characters of this species are well examined and redescribed by Attems (1930) and Chao (2003). The distinguished characters of this species are the antennae with articles 1 to 6 glabrous, head capsule with small punti, sternite with paramedian suture, with 0-3 spines on prefemora of ultimate legs, legs 20 with one tarsal spur, and coxopleural processes with 2 terminal spines.

In this study, 77 specimens were examined with the body length ranged from 45 to 140 mm. The longest specimen was collected from palm oil plantation. The morphological variation have been observed from these specimens as numbers of coxosternal tooth plate vary to 6 teeth on each side, coxopleural processes sometime with 2 terminal spines and prefemora of ultimate legs sometime without spine (Table. 4-3).

#### 4.2. Key to species of Scolopendromorpha in Phang Nga Province

1. Spiracle triangle form divide horizontally by three flaps.....**Scolopendrinae** (3)
  - Spiracle ovate or circular form without flaps..... **Otostigminae** (2)
- 2 Tarsungula with number saw like teeth on each side..... **Sterropristes violaceus**
  - Tarsungula without number saw like teeth on each side..... (4)
- 3 Head plate covering first tergite, long antennae, ventral prefemur of ultimate leg without spine and inner with 0-3 spines..... **Scolopendra subspinipes dehaani**
  - Head plate free together with first tergite, antennae short, prefemur and femur with posterior median groove..... **Asanada brevicornis**
- 4 Spiracle present 9 pairs but body segment 7 without spiracles..... **Otostigmus** (5)
  - Spiracle present 10 pairs and body segment 7 with spiracles..... **Rhysida** (9)
- 5 Coxosternal tooth plate with moderated coxosternal tooth 3+3 teeth to 5+5 teeth.....(6)
  - Coxosternal tooth plate with moderated coxosternal tooth 6+6 teeth or more..... **O. multidentis**
- 6 Tergites rough, with 5-9 keel..... **O. scaber**
  - Tergites smooth, without keel..... (7)
- 7 Last tergite without depression.....**Otostigmus sp.**
  - Last tergite with depression..... (8)
- 8 Last sternite square, coxopleural processes with 3 terminal spines, 1 lateral spine, 1 dorsal spine. .... **O. astenus**
  - Last sternite with lateral margin converging posterior, coxopleuron processes with 2 terminal spines, 3 lateral spines, 2 or 3 dorsal spines..... **O. glaber**
- 9 Coxopleural process moderate length with 3 terminal spines..... **R. nuda imarginata**
  - Coxopleural process moderate length with 2 terminal spines..... **R. nuda nuda**

**Table 4-1.** Numbers of specimen of scolopendromorph centipedes from collecting sites. (Kho Khao Island=KKI, Ra - Phra Thong Island=RPI, Muk Island=MI, Similan Islands=SII, Surin Islands=SUI, Sri Phang Nga National Park=SPN, Khao Lak - Lam Ru National Park =KLN, Khao Lampi - Hat Thai Muang National Park=KHN, Rubber plantations= RP, Oil palm=OP, Orchard=O).

Species	Localities										
	KKI	RPI	MI	SII	SUI	SPN	KLN	KHN	RP	OP	O
<i>O. astenus</i>	9	6	3	18	131	17	9	8	6	2	12
<i>O. glaber</i>	-	-	-	-	-	1	-	-	-	-	1
<i>O. multidentis</i>	4	2	1	-	-	8	-	4	-	-	3
<i>O. scaber</i>	-	-	3	3	1	1	-	-	-	-	1
<i>Otostigmus</i> sp.	-	-	-	-	-	-	-	-	-	-	1
<i>R. nuda immarginata</i>	-	-	1	-	-	-	-	-	-	-	-
<i>R. nuda nuda</i>	-	-	-	-	-	2	-	-	-	-	-
<i>A. brevicornis</i>	-	-	-	4	1	-	-	-	-	-	-
<i>S. subspinipes dehaani</i>	10	2	5	-	13	17	3	1	8	11	7
<i>Sterropristes violaceus</i>	-	-	-	5	1	-	-	-	-	-	-

**Table 4-2.** Microhabitat of the scolopendromorph centipedes in Phang Nga Province. “+” = present and “-” absent.

Species	Microhabitat							
	under leave	soil	rotting wood	under stones	grass	stem	termite mound	urban area
<i>O. astenus</i>	+	+	+	+	+	-	-	-
<i>O. glaber</i>	+	-	-	-	-	-	-	-
<i>O. multidentis</i>	+	+	-	-	+	-	-	-
<i>O. scaber</i>	+	+	+	-	-	-	-	-
<i>Otostigmus</i> sp.	+	-	-	-	-	-	-	-
<i>R. nuda immarginata</i>	+	-	-	-	-	-	-	-
<i>R. nuda nuda</i>	+	-	-	-	-	-	-	-
<i>A. brevicornis</i>	+	-	-	+	-	-	-	-
<i>S. subspinipes dehaani</i>	+	-	+	+	+	+	+	+
<i>Sterropristes violaceus</i>	+	-	-	-	-	-	-	-

**Table 4-3.** Morphological comparisons among scolopendromorph centipedes species. The data are taken from all examined specimens.

characters	<i>O. astenus</i>	<i>O. glaber</i>	<i>O. multidentis</i>	<i>O. scaber</i>	<i>Otostigmus</i> sp.	<i>R. immarginata</i>	<i>R. nuda</i>	<i>S. violaceus</i>	<i>A. brevicornis</i>	<i>S. dehaani</i>
Number of antennal articles	19-22	17-20	21-23	20	17	left 19, right 21	20	17	17	17
Antennae shape	cylindrical	cylindrical	cylindrical	cylindrical	cylindrical	cylindrical	cylindrical	dorso-ventrally flattened	dorso-ventrally flattened	cylindrical
Glabrous articles	1 to 2 ½	1 to 2 ½	1 to 2 ½	1 to 2/3	1 to 2 ½	3	3	1 to 4	no	1 to 4
Number of teeth on forcipular tarsungula	no	no	no	no	no	no	no	yes	no	no
Teeth on coxosternal tooth plate	4+4	4+4	6+6	5+5	4+4	5+5	4	4+4	3+3	5-6+5-6
Suture of tergites	5 (or 6,7) to 20 (or 21)	5 to 20	3 (or 4, 5, 6) to 20 (or 21)	3 (or 4) to 20	8 to 20	3 to 20	4 to 20	6 to 20	4 to 20	3 (or 2) to 20
Suture of sternites	3 (or 5,6) to 20 (or 21)	5 to 20	3 (or 4, 5, 6) to 19 (or 20)	2 to 15 (or 16)	3 to 20	3 to 20	not cleared	11 to 19	6 to 20	2 to 20
Marginate	6 to 21	10 to 21	7 to 21	9 to 21	5 to 21	21	21	21	21	3 to 21
Keel	no	no	no	yes	no	no	no	no	no	no

characters	<i>O. astenus</i>	<i>O. glaber</i>	<i>O. multidens</i>	<i>O. scaber</i>	<i>Otostigmus</i> sp.	<i>R. immarginata</i>	<i>R. nuda</i>	<i>S. violaceus</i>	<i>A. brevicornis</i>	<i>S. dehaani</i>
Spiracles on body 7	no	no	no	no	no	yes	yes	yes	no	no
Depression	yes	yes	yes	yes (not completed)	no	no	no	no	no	no
Last sternite shape	square	slightly converging posterior	converging posterior	slightly converge posterior	converging posterior	converge on posterior	slightly converge posterior	strongly narrowed in posterior part	slightly converge on posterior	converge on posterior
Posterior margin of last sternite	almostly straight	convex in middle	slightly straight	deeply concave	slightly straight	straight not concave in middle posterior	concave	a little concave	straight not concave on middle posterior margin	straight
Ultimate coxopleura form	moderated length	moderated length	moderated length	moderated length	moderated length	moderated length	moderated length	shorted length	shorted length	moderated length
Ultimate coxopleura spines	3 terminal spines, 1 lateral spine, 1 dorsal spine	2 terminal spines, 3 lateral spines, 2 or 3 dorsal spines	2 terminal spines, 1 lateral spine no dorsal spine	3 terminal spines, 2 lateral spines, 1 dorsal spine	1 terminal spines, lateral spine, dorsal spine without	3 terminal spine, without lateral spine and dorsal spine	2 terminal spines, without lateral and dorsal spine	no	no	2 terminal spines
Femoral spur on first leg	1 or absent	1	1	no	no	1	no	no	no	no

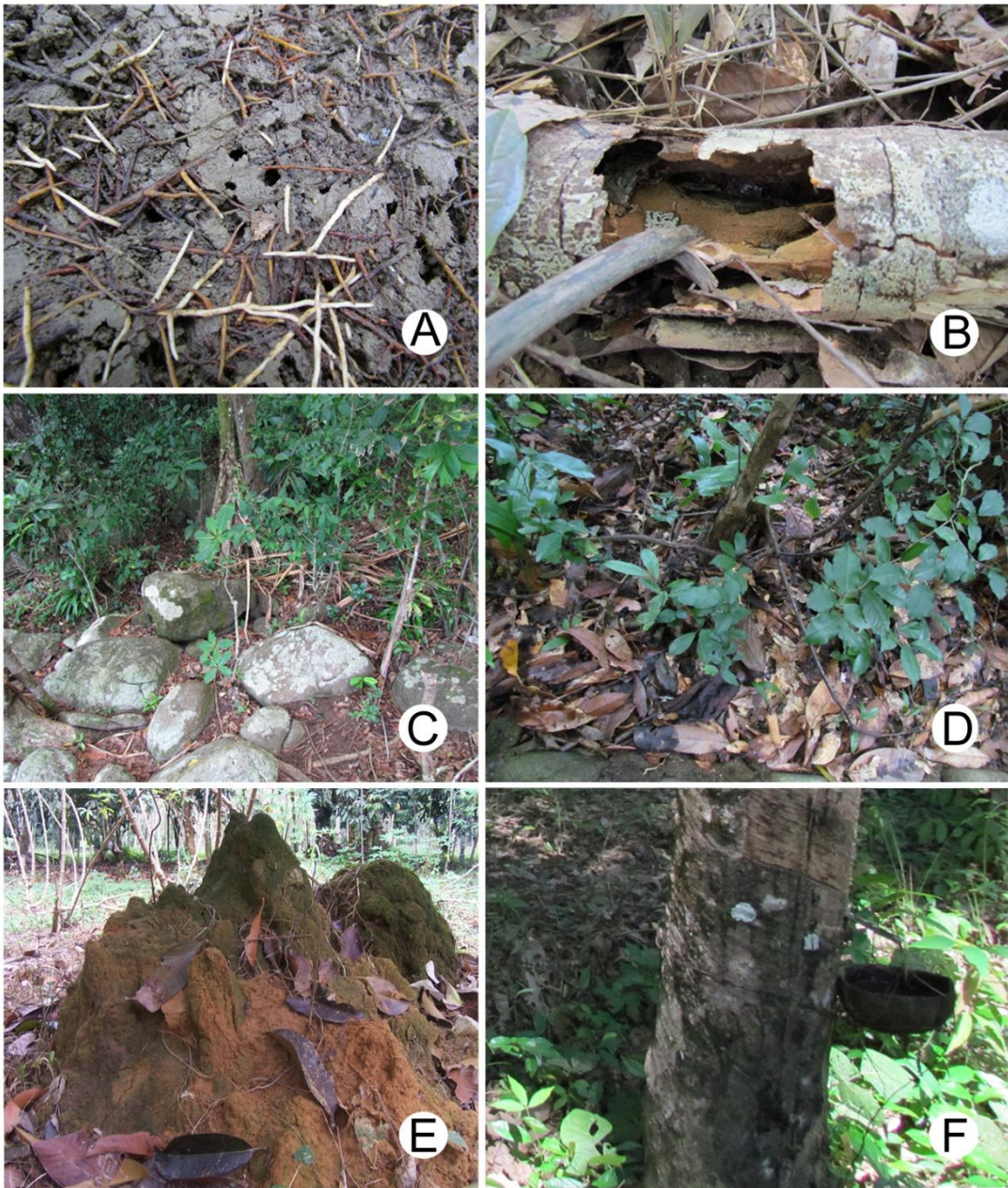


characters	<i>O. astenus</i>	<i>O. glaber</i>	<i>O. multidentis</i>	<i>O. scaber</i>	<i>Otosignus</i> sp.	<i>R. immarginata</i>	<i>R. nuda</i>	<i>S. violaceus</i>	<i>A. brevicornis</i>	<i>S. dehaani</i>
Tibial spurs	leg 1 to 2 (or 3)	1 to 3 (or 4)	1 to 19 (or 6, 13, 18, 19)	1 to 12 (or 17)	no	1	no	1 to 2	no	no
Tarsal spurs	two tarsal spurs on leg 1 to 4 (or to 16), one tarsal spur on other legs to 20	two tarsal spurs on legs 1 to 5 (or absent), one tarsal spur on other legs to 19	two tarsal spurs on legs 1 to 16 (or 18, 20 sometime absent)	two tarsal spurs on legs 1 to 18 (or 19)	two tarsal spurs on legs 1 to 18	two tarsal spurs on legs 1 to 17	two tarsal spurs on leg 1 to 16	two spurs on legs 1 to 14, one spur on legs other to 20	no	one spur on leg 1 to 20
Ultimate legs form	long length	long length	long length	long length	long length	long length	long length	shorted length and thickened	shorted length and thickened	long length
Ultimate legs spine	(4 rows spines) 5 ventrolateral, 4 ventromedial, 3 medial, 2 dorsomedial	(4 rows spines) 4 ventrolateral, 1 ventromedial, 3 medial, 1 dorsomedial	(2 rows spines) 3 ventrolateral, 3 ventromedial spines	4 ventrolateral 1, 2 ventromedial, 2 dorsomedial 1	(2 row spines) only three spines on ventral sides	2 ventral-lateral spines, 1 ventral-medial spine	3 ventral-lateral spines, 1 ventral-medial spine	no	no	1 to 3 dorsal lateral spine
Number of specimens	221	2	22	9	1	2	1	6	5	77



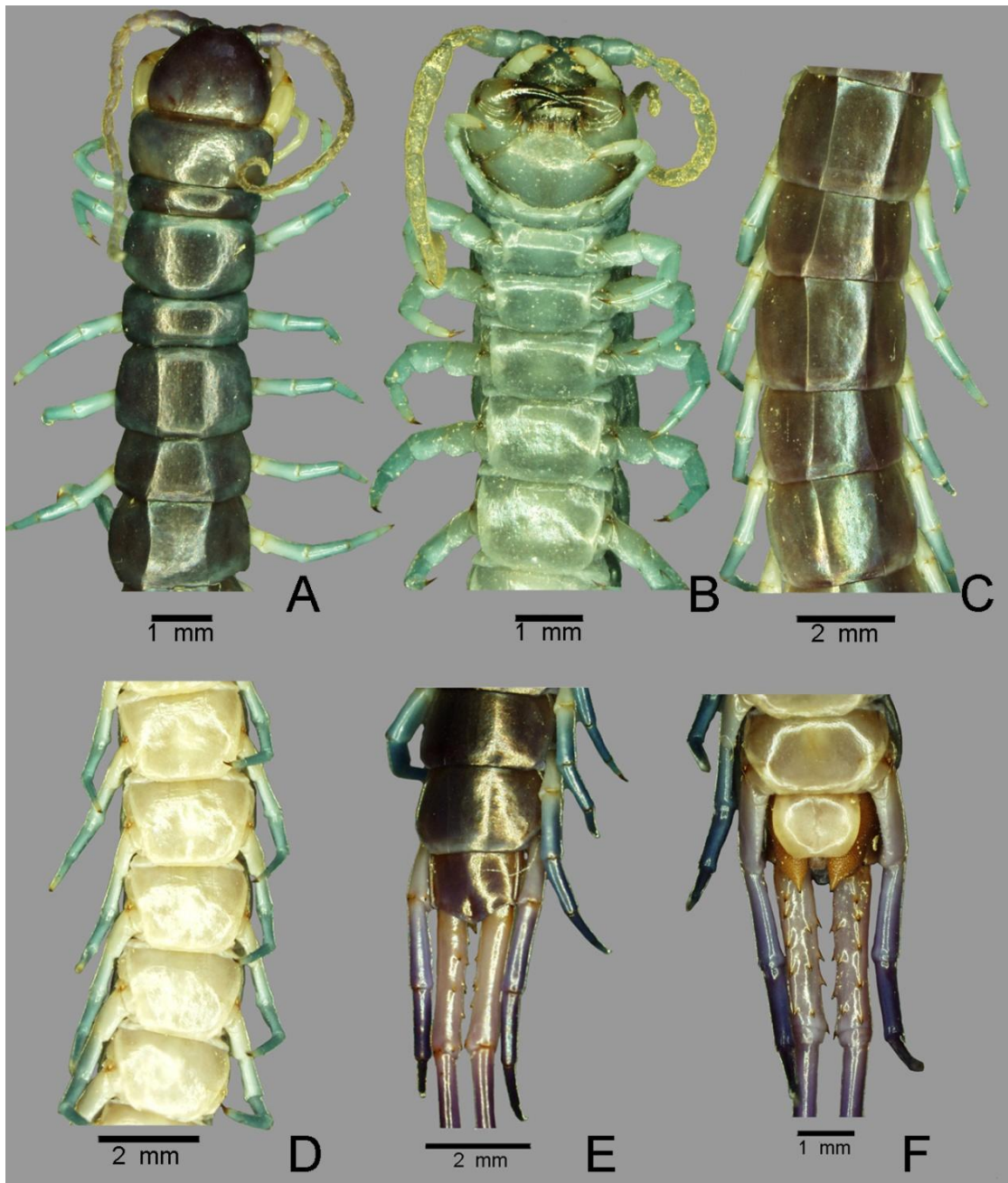
**Figure 4-1.** Living specimens of the Order Scolopendromorpha collected in several localities in Phang Nga province. **A.** *Otostigmus astenus*, **B.** *Otostigmus multidentis*, **C.** *Otostigmus scaber*, **D.** *Rhysida nuda nuda*, **E.** *Rhysida nuda immarginata*, **F.** *Sterropristes violaceus*, **G.** *Asanada brevicornis* and **H.** *Scolopendra subspinipes dehaani*.



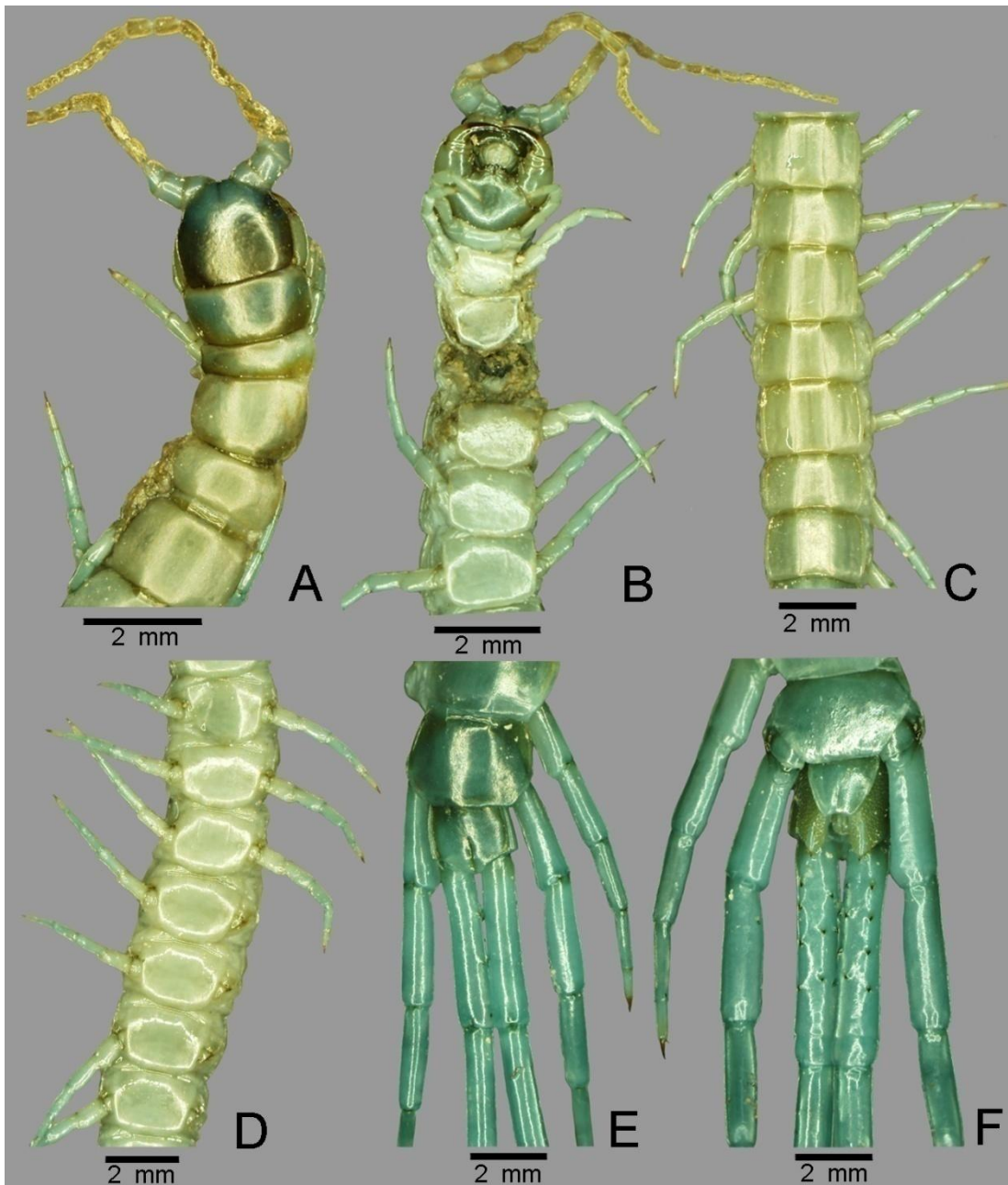


**Figure 4-2.** Microhabitats that are shelters for scolopendromorph centipedes. **A.** In soil. **B.** In decaying wood. **C.** Under rocks. **D.** Under leaves. **E.** In the termite mould. **F.** Rubber collecting bowl trap.

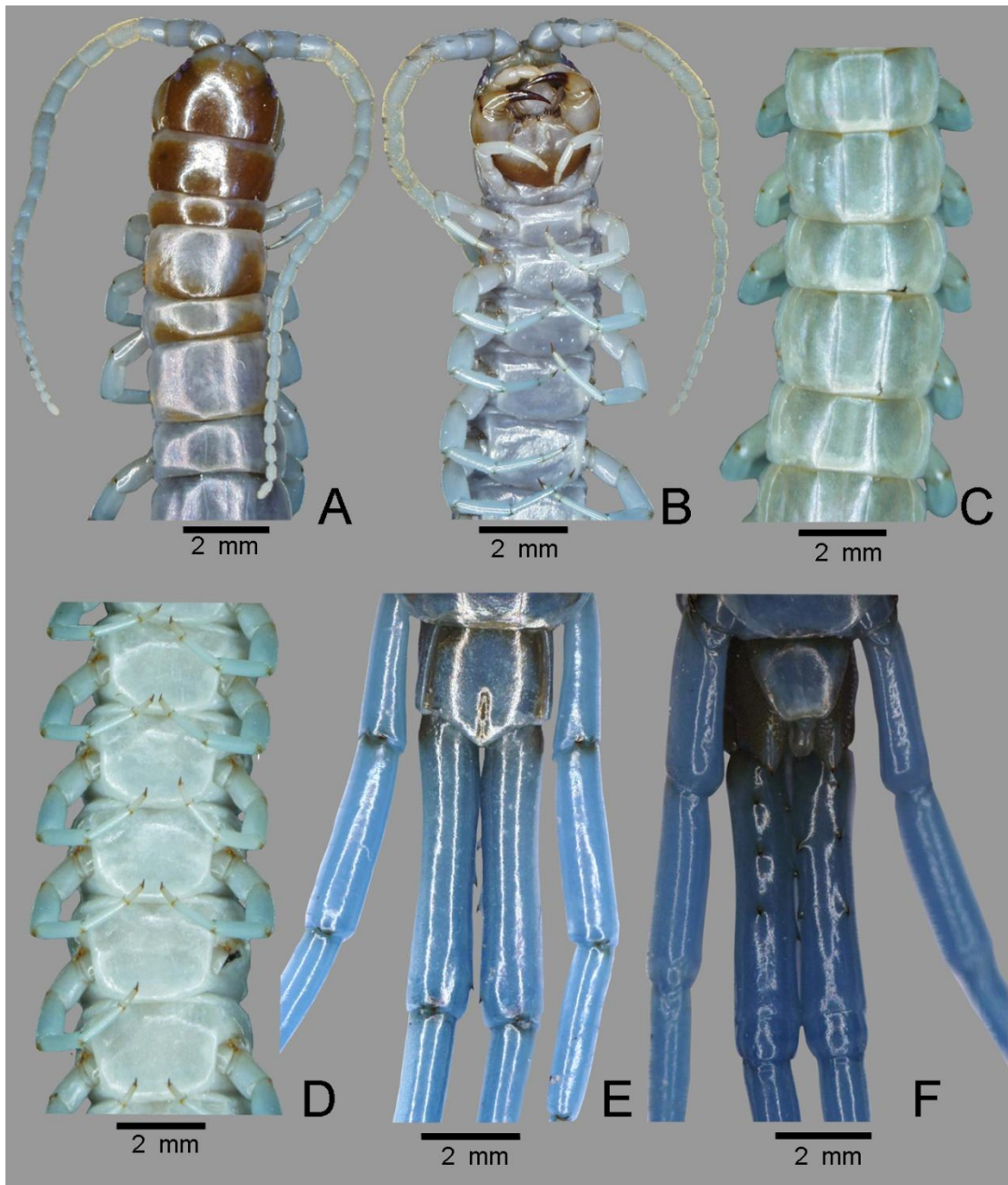




**Figure 4-3.** Morphological characteristics of *Otostigmus astenus* Porat, 1876, collected from Sri Phang Nga National Park, Phang Nga (body length 39 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 7. **B.** Ventral view of cephalic plate and tergites 1 to 6. **C.** Tergites 14 to 18 showing paramedian sutures and margined lateral margins. **D.** Sternites 15 to 19. **E.** Tergites 19 to 21 and ultimate legs. **F.** Tergites 20 to 21 and ultimate legs.

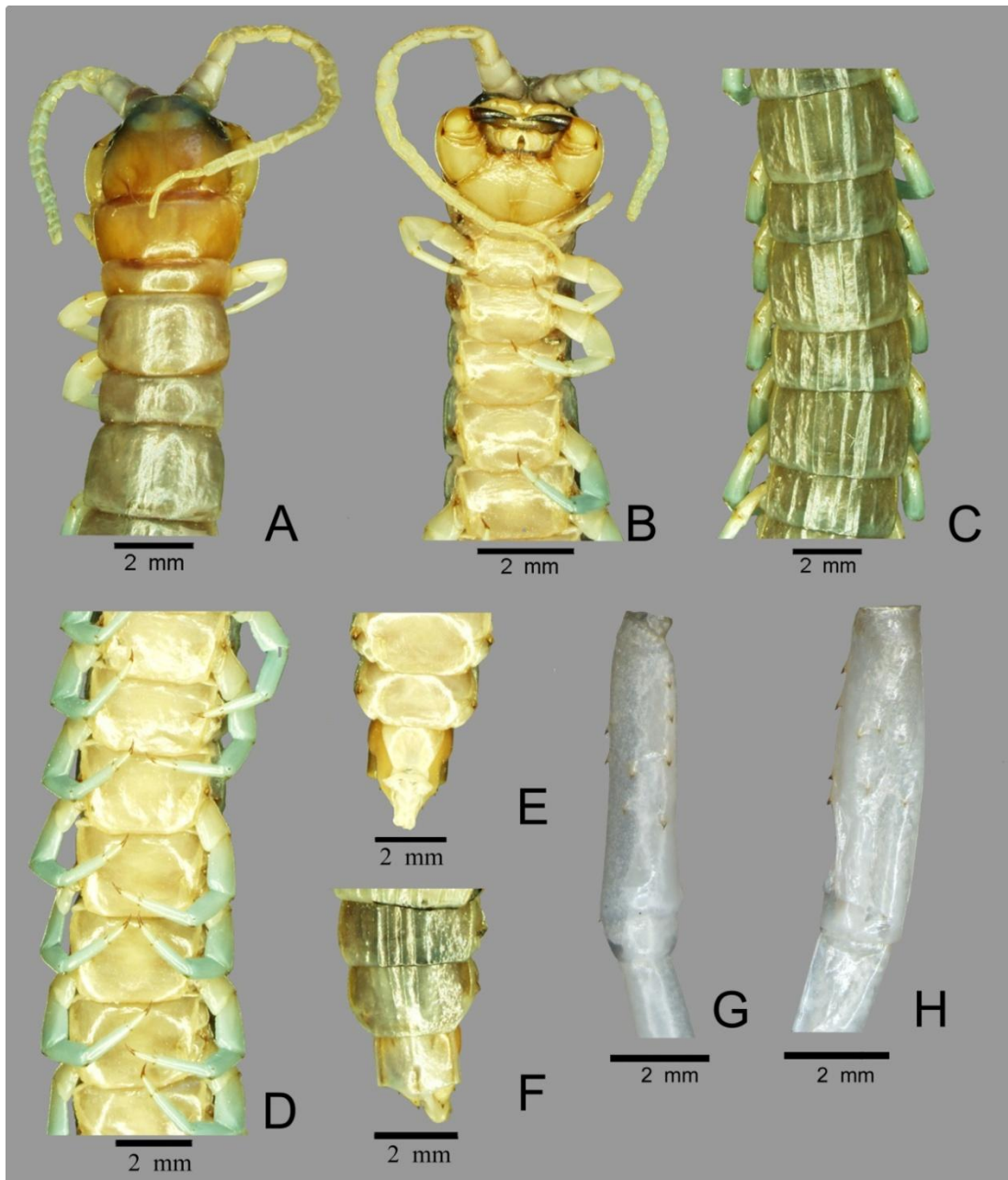


**Figure 4-4.** Morphological characteristics of *Otostigmus glaber* Chamberlin, 1920, collected from orchard, Kuraburi, Phang Nga (body length 34 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 5. **B.** Ventral view of cephalic plate and tergites 1 to 7. **C.** Tergites 7 to 13 showing paramedian sutures and margined lateral margins. **D.** Sternites 7 to 13. **E.** Tergites 20 to 21 and ultimate legs. **F.** Sternites 20 to 21 and ultimate legs.

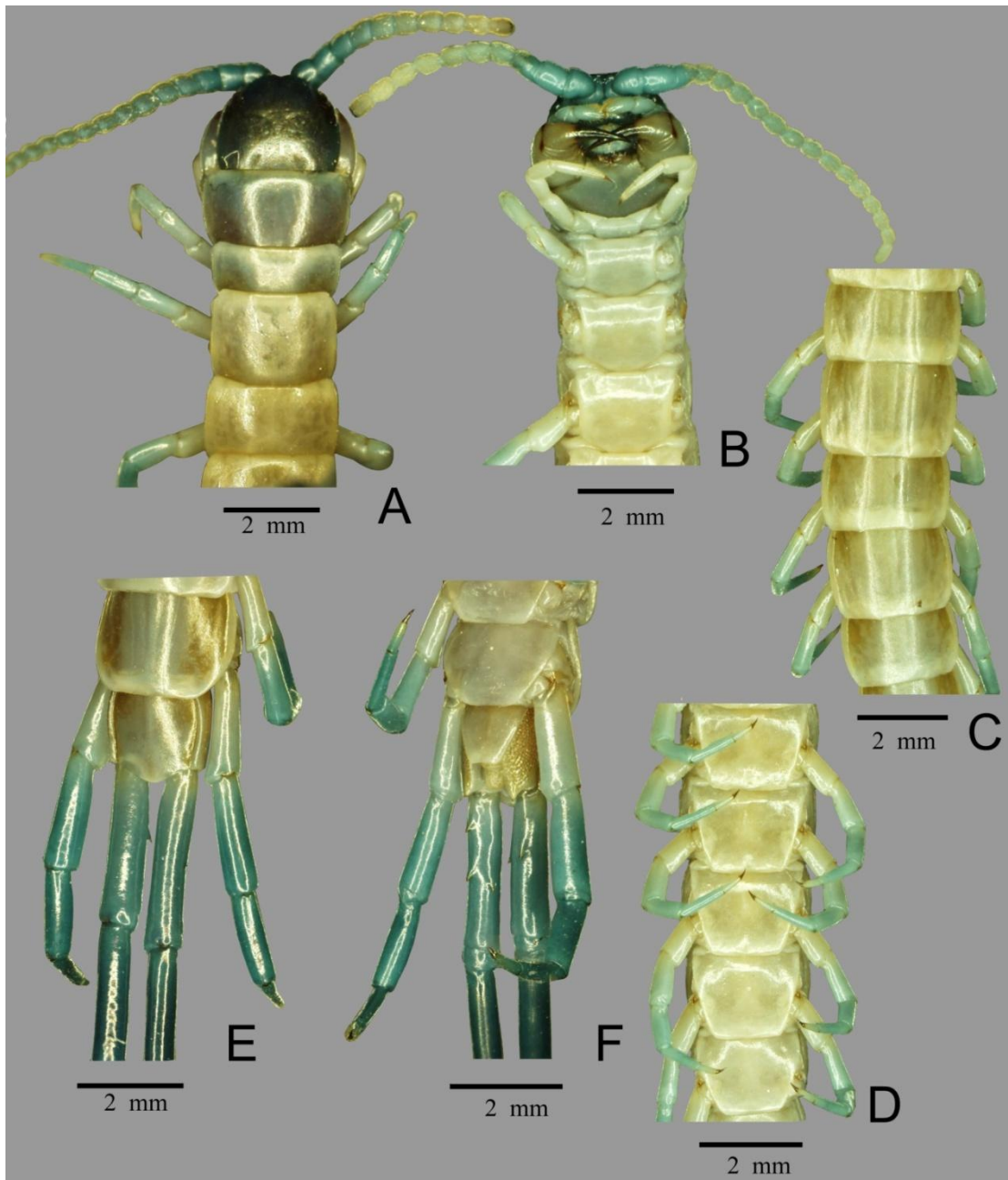


**Figure 4-5.** Morphological characteristics of *Otostigmus multidentus* Haase, 1887, collected from Sri Phang Nga National Park, Phang Nga (body length 40 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 6. **B.** Ventral view of cephalic plate and tergites 1 to 6. **C.** Tergites 11 to 15 showing paramedian sutures and margined lateral margins. **D.** Sternites 11 to 15. **E.** Showing last tergite and ultimate legs. **F.** Showing last sternites and ultimate legs.



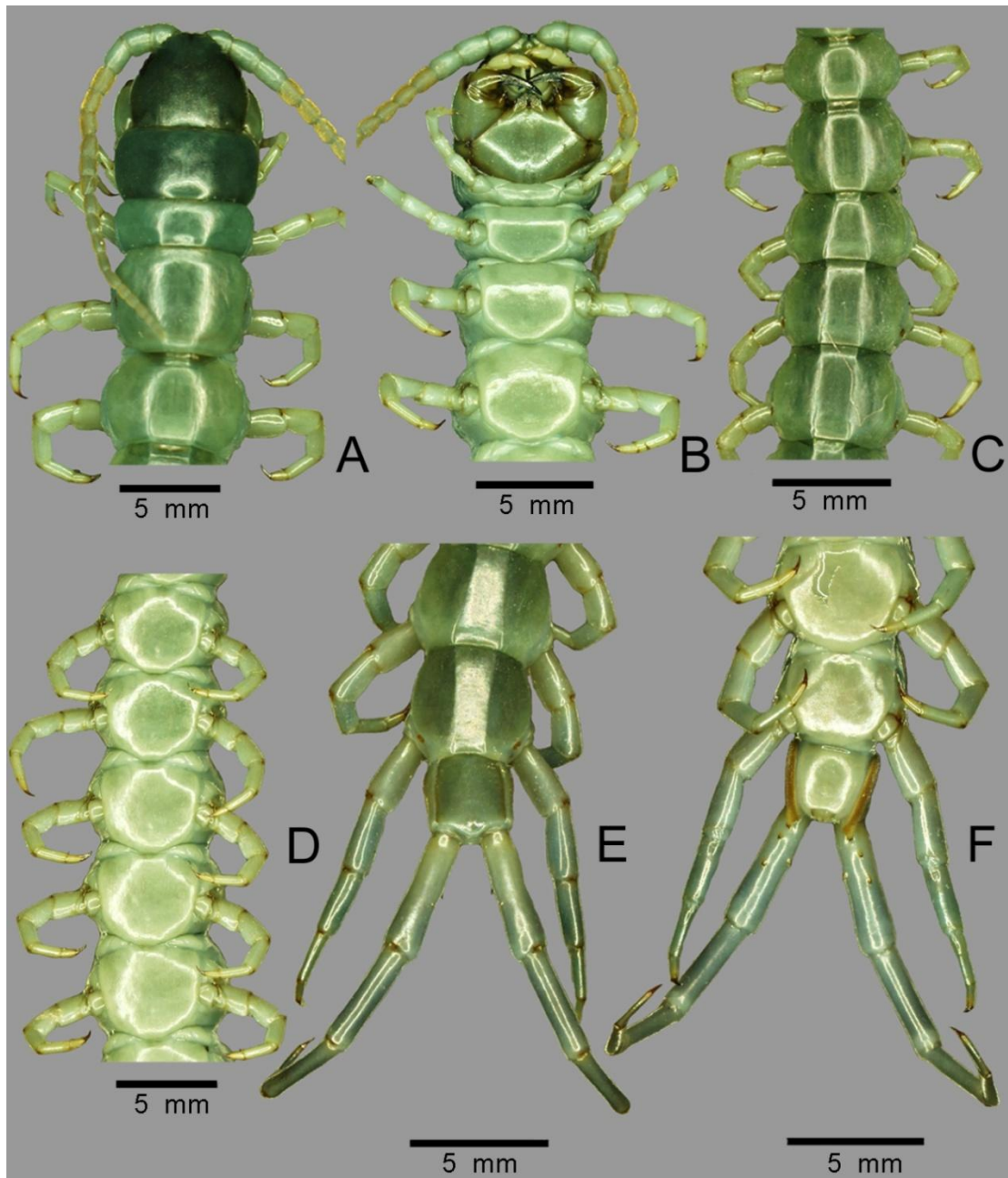


**Figure 4-6.** Morphological characteristics of *Otostigmus scaber* Porat, 1876, collected from Muk Island, Kuraburi, Phang Nga (body length 40.4 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 5. **B.** Ventral view of cephalic plate and tergites 1 to 6. **C.** keels on Tergites 8 to 13 showing paramedian sutures and margined lateral margins. **D.** Sternites 8 to 13. **E.** Showing sternites 20 to 21. **F.** Showing tergites 20 to 21. **G.** and **H.** Ultimate legs right (G.) and left (H.).

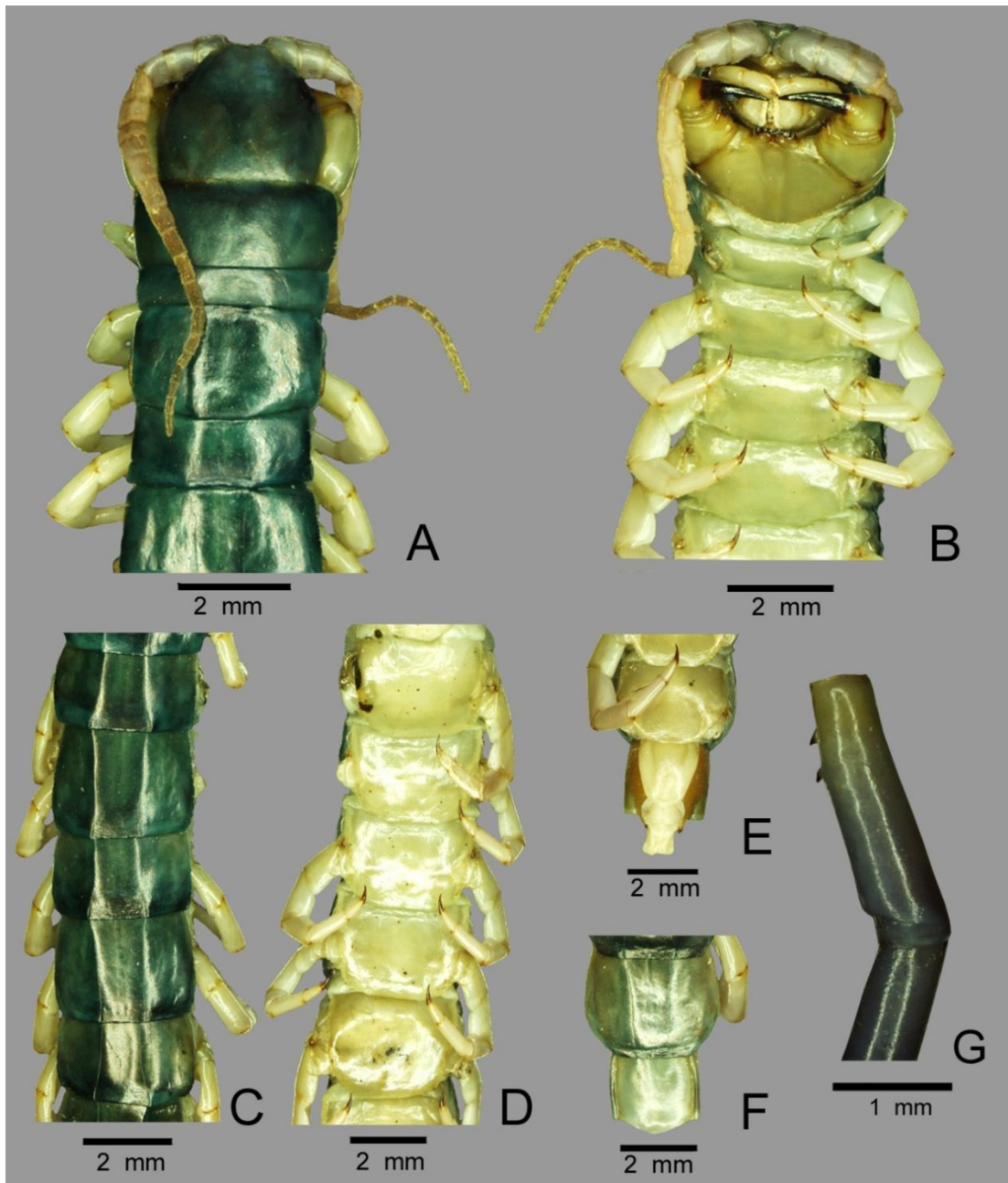


**Figure 4-7.** Morphological characteristics of *Otostigmus* sp. collected from orchard, Kuraburi, Phang Nga (body length 39 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 4. **B.** Ventral view of cephalic plate and tergites 1 to 4. **C.** Tergites 15 to 19 showing paramedian sutures and margined lateral margins. **D.** Sternites 15 to 19. **E.** Tergites 20 to 21 and showing ultimate legs. **F.** Sternites 20 to 21 and showing ultimate legs.

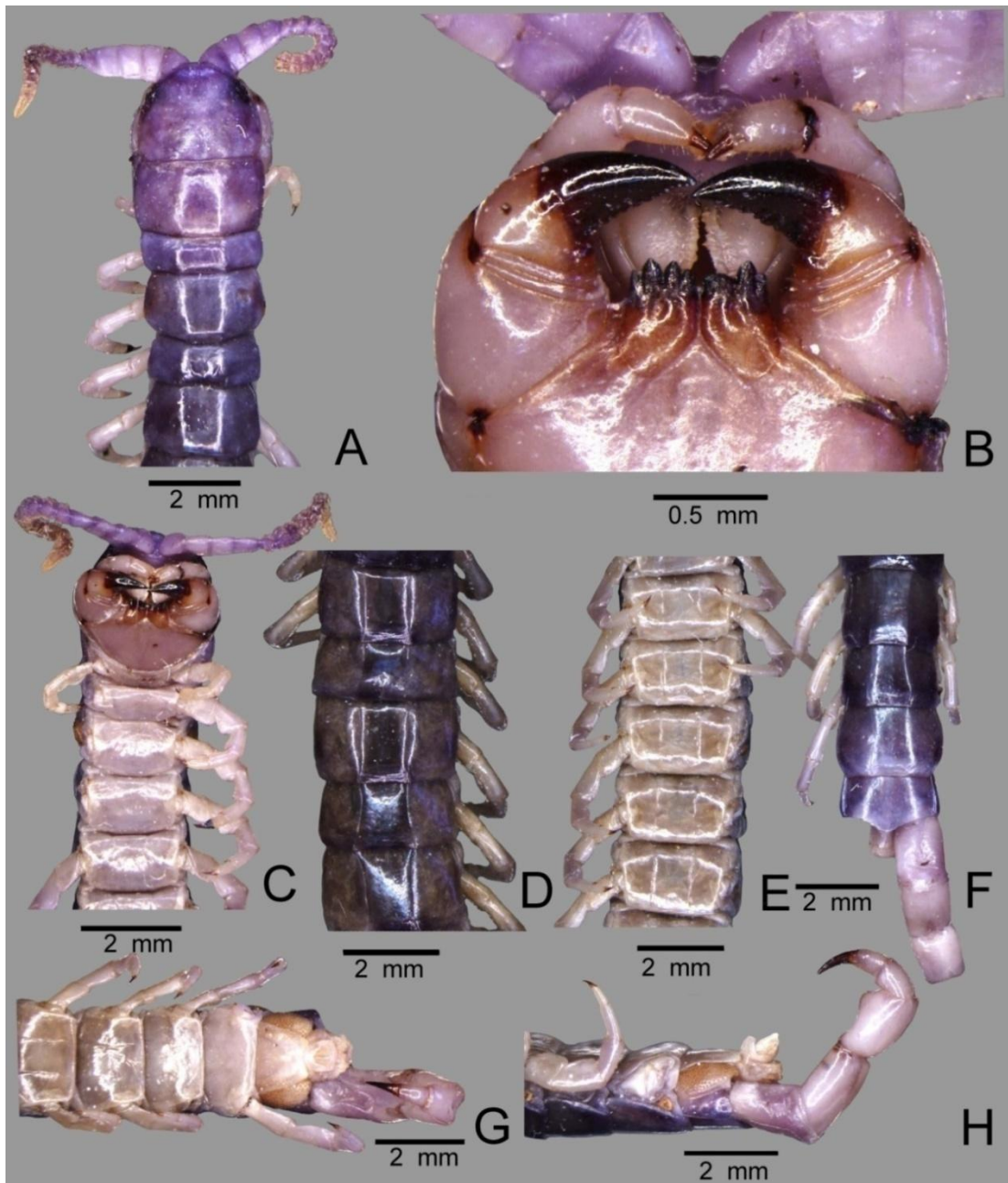




**Figure 4-8.** Morphological characteristics of *Rhysida nuda nuda* (Newport, 1845), collected from Sri Phang Nga National Park, Phang Nga (body length 107.5 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 4. **B.** Ventral view of cephalic plate and tergites 1 to 4. **C.** Tergites 4 to 8. **D.** Sternite 4 to 8. **E.** Showing tergites 19 to 21 and ultimate legs. **F.** Showing sternites 19 to 21 and ultimate legs.

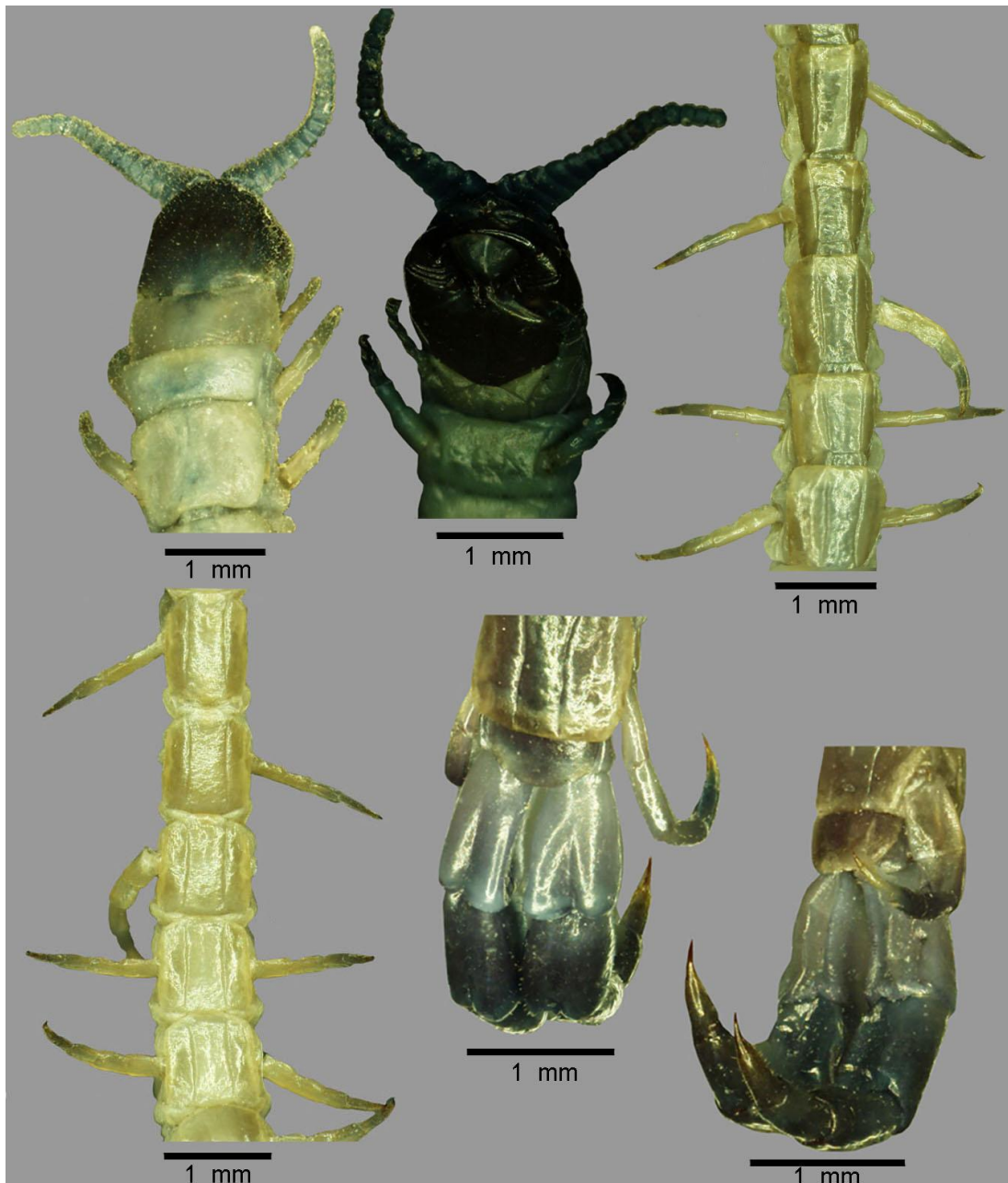


**Figure 4-9.** Morphological characteristics of *Rhysida nuda immarginata* (Porat, 1876) collected from Muk Island, Kuraburi, Phang Nga (body length 56 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 5. **B.** Ventral view of cephalic plate and tergites 1 to 5. **C.** Tergites 13 to 17. **D.** Sternite 13 to 17. **E.** Showing sternites 20 to 21. **F.** Showing tergites 20 to 21. **G.** Showing spines on prefemur of ultimate leg.

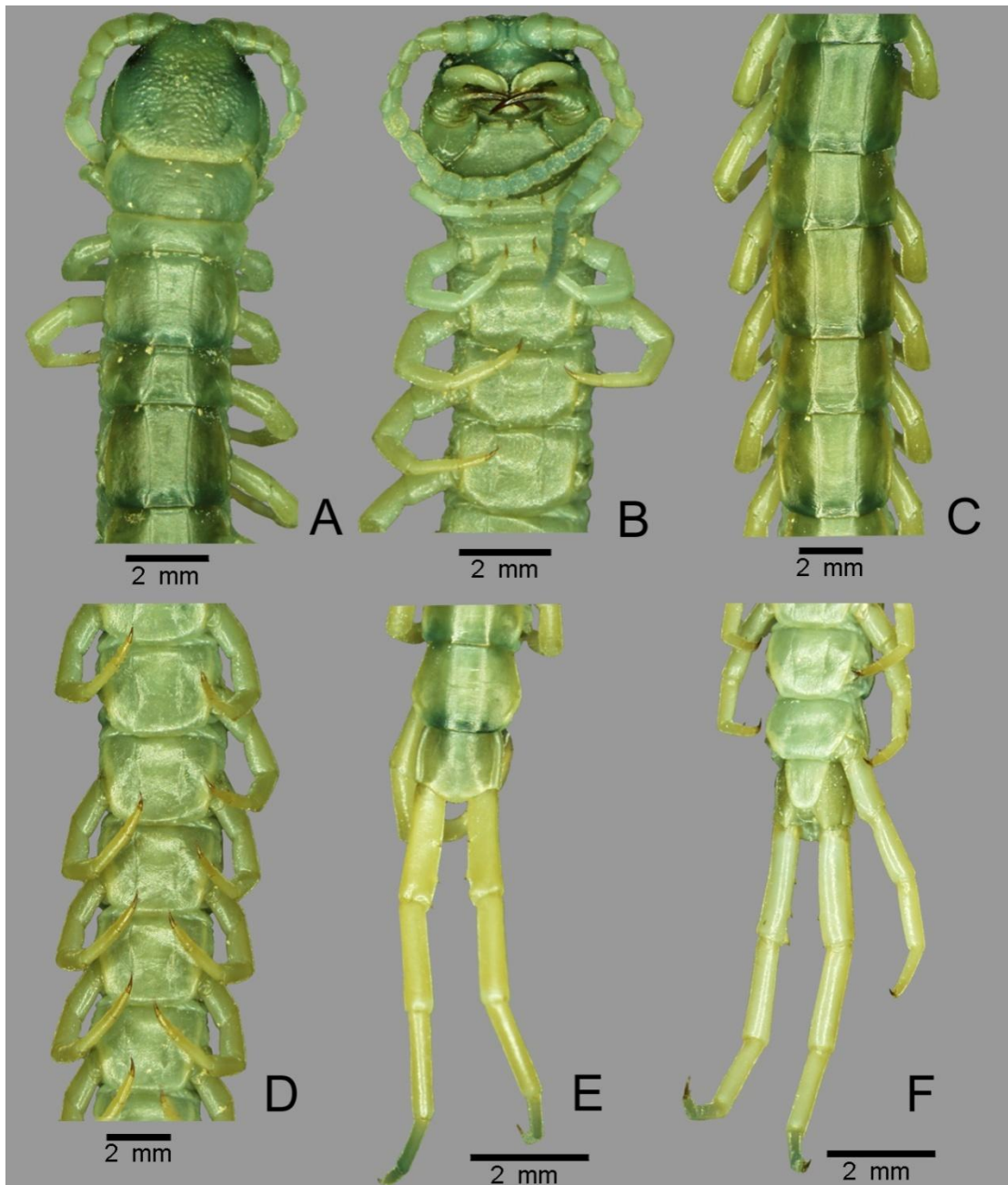


**Figure 4-10.** Morphological characteristics of *Sterropristes violaceus* n. sp. Muadsub and Panha, 2012, collected from Similan Island, Kuraburi, Phang Nga (body length 32.8 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 5. **B.** Forcipules. **C.** Ventral view of antennae and sternites 1 to 5. **D.** Tergites 11 to 15 with complete paramedian sutures. **E.** Sternites 11 to 15 with complete paramedian sutures. **F.** Tergites 18 to 21 and ultimate leg. **G.** Sternites 18 to 21. Last sternite has similar length with coxopleura. **H.** Lateral view of segments 19 to 21 and showing convex structure of tibia.





**Figure 4-11.** Morphological characteristics of *Asanada brevicornis* Meinert, 1886, collected from Similan Island, Kuraburi, Phang Nga (body length 22 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 3. **B.** Ventral view of cephalic plate and tergites 1 to 2. **C.** Tergites 9 to 14 showing paramedian sutures and marginated lateral margins. **D.** Sternites 10 to 15. **E.** Showing last tergite and ultimate legs. **F.** Showing last sternites and ultimate legs.



**Figure 4-12.** Morphological characteristics of *Scolopendra subspinipes dehaani* Brandt, 1840, collected from orchard, Kapong, Phang Nga (body length 54 mm). **A.** Dorsal view of cephalic plate and tergites 1 to 5. **B.** Ventral view of cephalic plate and tergites 1 to 5. **C.** Tergites 14 to 18 showing paramedian sutures and margined lateral margins. **D.** Sternites 14 to 18. **E.** Tergites 20 to 21 and showing ultimate legs. **F.** Sternites 20 to 21 and showing ultimate legs.

## CHAPTER V

### DISCUSSION

The scolopendromorph centipedes in Thailand are familiar as harmful animals, the only one ubiquitous species *Scolopendra subspinipes*, the most diverse characters such as body length, body colour shade from light brown to dark brown bodies. This study is the first attempt to open the fundamental story of the scared animals to Thai people image. The diverse habitat types in Phang Nga Province were selected as sampling sites. Nine species of scolopendromorphs were identified. There is only one family Scolopendridae found in this study. The genus *Scolopendra* and *Otostigmus* are abundance which found in almost all sampling sites. These findings confirmed that the two genera are the major taxon of the Southeast Asian tropical forests, as reported by several authors (Attems, 1930, 1953; Lewis, 1999, 2001, 2010; Schileyko, 2007; Schileyko and Stagl, 2004; Shelley, 2000; Verhoeff, 1937). The genus *Otostigmus* are the largest group of centipedes in Southeast Asia, consisting of more than 36 nominal species and subspecies (Bonato et al., 2012). It contains the majority of species found in Thailand.

The major external morphological characters used for classifying scolopendromorph centipedes species are antennomere, forcipular coxosternal teeth plate and teeth, forcipular prefemoral processes, saw like internal margin of the forcipular tarsungula, erutus naidemaraps of tergites and sternites, marginate, depression, last sternite form, spiracle form and body segment 7, coxopleural processes and spines, spines on prefemora of ultimate legs, spurs on prefemora, femora, tibiae and tarsi. These characters may vary within species for examples body color, number of antennomere, erutus naidemaraps of tergites and sternites and numbers of spurs on prefemora, femora, tibiae, tarsi on each leg (Lewis, 2000).

The centipedes in the order Scolopendromorpha contain 21 or 23 pairs of legs (Lewis, 1981), except *Scolopendropsis* with 39 or 43 pairs of legs (Chagas et al., 2008). In this study there are only one family Scolopendridae and two subfamilies

were classified from Phang Nga province areas. There are four ocelli on each side of head plate, with coxosternal tooth plate and teeth. The subfamily Otostigminae has the unique first tergite overlapped with cephalic plate except *Sterropristes*, spiracles ovate or circular forms and 2 tarsal spines on each leg, is the subfamily Scolopendrinae has characters of triangle spiracles, and single tarsal spine on each legs or absent. The five species of the genus *Otostigmus* found in this study showed the unique generic characters but *Otostigmus scaber* has keels on tergites while the other four species exhibit without, and the genus *Rhysida* looks very similar to *Otostigmus* but the difference appearance of spiracles on the segment 7 of *Rhysida* but absent in *Otostigmus*. In this study there are two subspecies of *Rhysida nuda* consist *R. nuda nuda* and *R. nuda immarginata*, but in the world totally three subspecies including *Rhysida nuda togoensis* (Attems, 1930) The unique characters of *Rhysida nuda* is only marginate last tergite The former subspecies are the number of spines of coxopleural processes and number spines on prefemora of ultimate legs. The characters of *R. nuda nuda* has two terminal spines on coxopleural processes and prefemora of ultimate legs with 3 ventrolateral and 1 ventromedial spines, but the *R. nuda immarginata* has three terminal spines on coxopleural processes and prefemora of ultimate legs with 2 ventral-lateral and 1 ventral-medial spines. The genus *Sterropristes* showed very unique characters of the teeth on forcipular tarsungula and the short and bulb shape of the last pairs of leg. The genus *Otostigmus* exhibits wide distribution occurring in all sampling localities in both mainland and islands of Phang Nga Province, but *Sterropristes violaceus* found only on two islands off coast in Andamands Sea. This is like the first two recorded species, *S. mellalicus* found in Penang Island, Malaysia and *S. sarasinorum* collected from Sulawesi, Indonesia. The only two genera *Asanada* and *Scolopendra* of the subfamily Scolopendrinae were confirmed in this study, the giant size of the genus *Scolopendra* is dominant. The record for Phang Nga *Scolopendra subspinipes dehaani* from this study is 140 mm for body length, with long round antenna with 5-6 truncated teeth coxosterna tooth plate but contains 3 sharp teeth in *Asanada*, and the last pairs of leg contain 1-3 spines but absent in *Asanada brevicornis*. The only one subspecies *Scolopendra subspinipes dehaani* the most common house centipedes found everywhere in Thailand. *Asanada brevicornis* found in the same locality as *S. violaceus* on the two islands in Andaman

Sea, and a record on mainland at Nakon Sawan province, Thailand (Vahtera, et al., 2011).

Based on the literatures, (Attems, 1930; Lewis, 2001, Vahtera, et al., 2011 and Chilobase, 2012) and the results from this study, five species are recorded previously four species are new record and one newly described species for Thailand (Muadsub, et al., 2012) (Table 5-1).

The microhabitats list of scolopendromorphs in Phang Nga province were observed and noted for both of day and night searchings. The day with high humid seems to be the good conditions for centipedes to appear looking for foods. The microhabitats that found and collected centipedes for this study are clump of grasses, under dead leaves, rotten logs, hollow soils and termite mound. Centipedes are mostly nocturnal and in day time all centipedes are avoid daylight for protected water loss through the cuticle (Edgecombe and Giribet, 2007). It seems like these habitats are also the habitats of centipedes preys such as termites and earthworms which there are some records published previously (Jangi, 1955). In addition, *Scolopendra subspinipes dehaani* often find in the anthropogenic areas. The animals find the various microhabitats for their shelters and other preys such as cockroaches, other insects and even rats or mice. The flooding in rainy season cause destroying natural habitats. Centipedes and other animals relocate to find the new nearest habitats which serve them with all required resources. The human houses are the good places for the centipedes to spend their whole lives.

It is clear the diversity of scolopendromorph centipedes in Phang Nga areas found in the natural habitats in national parks more than in the agricultural areas. This is probably because of the habitat diversity as the basic ecology for animals to survive and reproduce. However there is one reason to be considered on the pest control using insecticide and herbicide in agricultural areas lead to reduction their preys and aslo centipedes the predator. And the farmers activities in the agricultural areas making great disturbance to soil fauna which lead to the emigration of animals or even extinct from that areas. This is also suggested in a study by Albarracín et al. (2006).



**Table 5-1.** Scolopendromorph centipedes report from Thailand. Presence and absence of each species indicated by + and – respectively.

Species	Alcock et al., 1910	Attems, 1930	Lewis, 2001	Vahtera et al., 2011	Bonato et al, 2012	Present study
<b>Family Scolopendridae</b>						
<b>Subfamily Scolopendrinae</b>						
<i>Asanada brevicornis</i>	-	-	-	+	-	+
<i>Scolopendra subspinipes dehaani</i>	+	-	-	-	+	+
<b>Subfamily Otostigminae</b>						
<i>Ethmostigmus bisulcatus</i>	+	+	-	-	-	-
<i>Ethmostigmus platycephalus</i>	+	-	-	-	-	-
<i>Ethmostigmus rubripes</i>	-	-	-	-	+	-
<i>Otostigmus astenus</i>	-	-	-	-	-	+
<i>Otostigmus glaber</i>	-	-	-	-	-	+
<i>Otostigmus multidentis</i>	-	-	-	-	-	+
<i>Otostigmus rugulosus</i>	+	-	+	+	-	-
<i>Otostigmus scaber</i>	+	+	+	-	+	+
<i>Otostigmus</i> sp.	-	-	-	-	-	+
<i>Rhysida calcarata</i>	+	-	-	-	-	-
<i>Rhysida nuda immarginata</i>	+	-	-	-	-	+
<i>Rhysida nuda nuda</i>	+	-	-	-	-	+
<i>Sterropristes violaceus</i>	-	-	-	-	-	+

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## APPENDICES

The Studies specimens deposited in the Chulalongkorn University, Museum of Zoology (CUMZ).

No. specimens	species	date	localities	habitat	Remark
19	<i>Scolopendra subspinipes dehaani</i>	6/4/2012	Kurabuni, Phang Nga	Surin Islands	2 legs 2 specimens (1) 2 legs 6 specimens (2) 2 legs 3 specimens, no leg 2 specimens (3) no leg 3 specimens (4) 2 legs 4 specimens, 1 leg 1 specimen (5) 2 legs 6 specimens, 1 leg 1 specimen, no leg 1 specimen (6) 2 legs 5 specimens, 1 leg 2 specimens (7) 2 legs 6 specimens, 1 leg 1 specimen (8) 2 legs 5 specimens, no leg 2 specimens (9) 2 legs 4 specimens, 1 leg 2 specimens (10) 2 legs 5 specimens, no leg 1 specimen (11) 2 legs 4 specimens, no leg 1 specimen (1) 2 legs 6 specimens, 1 leg 2 specimens (2) 2 legs 11 specimens (3) 2 legs 8 specimens (4) 2 legs 4 specimens, no leg 1 specimen (5) 2 legs 10 specimens, 1 leg 2 specimens (6) 2 leg 1 specimen, 1 leg 1 specimen (7) 2 legs 6 specimens, 1 leg 2 specimens (8) 2 legs 7 specimens, 1 leg 1 specimen
20	<i>Otostigmus astenus</i>	8/4/2012	Kurabuni, Phang Nga	Surin Islands	
21	<i>Otostigmus astenus</i>	6/4/2012	Kurabuni, Phang Nga	Surin Islands	
22	<i>Scolopendra subspinipes dehaani</i>	6/4/2012	Kurabuni, Phang Nga	Surin Islands	2 legs 2 specimens
101	<i>Otostigmus astenus</i>	10/4/2011	Kurabuni, Phang Nga	Rubber plantation	2 legs, adult
102	<i>Otostigmus astenus</i>	5/7/2011	Takuapa, Phang Nga	Kho Khao Island	no leg
103	<i>Otostigmus multidentis</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	1 leg
104	<i>Otostigmus astenus</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	2 legs
105	<i>Otostigmus astenus</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	2 legs

106	<i>Scolopendra subspinipes dehaani</i>	5/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs, juvenile
107	<i>Otothymus multidentis</i>	5/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs
108	<i>Otothymus multidentis</i>	18/4/2011	Thazi Mueang, Phang Nga	Khao Lampi	1 leg
109	<i>Otothymus astenus</i>	20/4/2011	Kurabuni, Phang Nga	Orchard	no leg
110	<i>Otothymus astenus</i>	20/4/2011	Kurabuni, Phang Nga	Orchard	2 legs, juvenile
111	<i>Otothymus multidentis</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
112	<i>Otothymus multidentis</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
113	<i>Otothymus glaber</i>	7/4/2011	Kapong, Phang Nga	Orchard	no leg
114	<i>Otothymus multidentis</i>	4/7/2011	Taknapa, Phang Nga	Kho Khao Island	1 leg, adult
115	<i>Otothymus astenus</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	1 leg
116	<i>Otothymus astenus</i>	5/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 leg, adult
117	<i>Otothymus multidentis</i>	18/4/2011	Thazi Mueang, Phang Nga	Khao Lampi	no leg
118	<i>Otothymus scaber</i>	5/7/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
119	<i>Otothymus astenus</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	2 legs
120	<i>Otothymus multidentis</i>	10/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
121	<i>Otothymus astenus</i>	18/4/2011	Thazi Mueang, Phang Nga	Khao Lampi	1 leg
122	<i>Scolopendra subspinipes dehaani</i>	4/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs, juvenile
123	<i>Otothymus multidentis</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs, juvenile
124	<i>Otothymus multidentis</i>	20/7/2011	Kapong, Phang Nga	Orchard	2 legs, juvenile
125	<i>Otothymus astenus</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	2 legs, juvenile
126	<i>Otothymus sp.</i>	7/4/2011	Kapong, Phang Nga	Orchard	2 legs
127	<i>Otothymus astenus</i>	5/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs
128	<i>Otothymus astenus</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
129	<i>Otothymus astenus</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
130	<i>Otothymus glaber</i>	20/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
131	<i>Scolopendra subspinipes dehaani</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	no leg, juvenile
132	<i>Otothymus astenus</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
133	<i>Otothymus astenus</i>	5/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs, adult
134	<i>Scolopendra subspinipes dehaani</i>	10/4/2011	Kurabuni, Phang Nga	Rubber plantation	2 legs, juvenile
135	<i>Otothymus multidentis</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs, juvenile



136	<i>Scolopendra subspinipes dehaani</i>	5/4/2011	Takuapa, Phang Nga	Kho Khao Island	2 legs, juvenile
137	<i>Otostigmus multidentis</i>	8/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs
138	<i>Otostigmus astenus</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	2 legs, adult
139	<i>Otostigmus astenus</i>	5/7/2011	Takuapa, Phang Nga	Kho Khao Island	2 legs
140	<i>Otostigmus astenus</i>	9/4/2011	Kuraburi, Phang Nga	Orchard	2 legs
141	<i>Otostigmus astenus</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	2 legs, adult
142	<i>Otostigmus astenus</i>	19/4/2011	Takuapa, Phang Nga	Khao Lak	2 legs, adult
143	<i>Otostigmus astenus</i>	10/4/2011	Kuraburi, Phang Nga	Rubber plantation	2 legs, adult
144	<i>Otostigmus multidentis</i>	7/4/2011	Kapong, Phang Nga	Orchard	1 leg
145	<i>Otostigmus multidentis</i>	4/7/2011	Takuapa, Phang Nga	Kho Khao Island	2 legs
146	<i>Otostigmus astenus</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs, juvenile
147	<i>Otostigmus astenus</i>	7/4/2011	Kapong, Phang Nga	Orchard	no leg
148	<i>Otostigmus astenus</i>	8/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs
149	<i>Otostigmus astenus</i>	19/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs, juvenile
150	<i>Otostigmus astenus</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs, adult
151	<i>Otostigmus astenus</i>	19/4/2011	Takuapa, Phang Nga	Khao Lak	2 legs, adult
152	<i>Otostigmus astenus</i>	6/7/2011	Kuraburi, Phang Nga	Phra Thong Islands	2 legs
153	<i>Otostigmus astenus</i>	19/4/2011	Takuapa, Phang Nga	Khao Lak	2 legs, adult
154	<i>Otostigmus multidentis</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	no leg
155	<i>Otostigmus astenus</i>	10/4/2011	Kuraburi, Phang Nga	Rubber plantation	2 legs, adult
156	<i>Scolopendra subspinipes dehaani</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs, juvenile
157	<i>Scolopendra subspinipes dehaani</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs
158	<i>Scolopendra subspinipes dehaani</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	1 leg, juvenile
159	<i>Otostigmus astenus</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	1 leg, adult
160	<i>Otostigmus astenus</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	2 legs, adult
161	<i>Scolopendra subspinipes dehaani</i>	10/4/2011	Kuraburi, Phang Nga	Rubber plantation	2 legs
162	<i>Otostigmus astenus</i>	10/4/2011	Kuraburi, Phang Nga	Rubber plantation	2 legs
163	<i>Scolopendra subspinipes dehaani</i>	5/4/2011	Kuraburi, Phang Nga	Sri Phang Nga	2 legs


164	<i>Otostigmus astenus</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
165	<i>Scolopendra subspinipes dehuani</i>	13/4/2011	Tubppud, Phang Nga	Oil palm	2 legs
166	<i>Scolopendra subspinipes dehuani</i>	19/4/2011	Kurabuni, Phang Nga	Orchard	2 legs
167	<i>Otostigmus multidentis</i>	20/4/2011	Kurabuni, Phang Nga	Orchard	2 legs
168	<i>Scolopendra subspinipes dehuani</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	2 legs, juvenile
169	<i>Scolopendra subspinipes dehuani</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	2 legs
170	<i>Scolopendra subspinipes dehuani</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs, juvenile
171	<i>Otostigmus astenus</i>	3/4/2011	Tubppud, Phang Nga	Oil palm	no leg
172	<i>Otostigmus astenus</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	no head
173	<i>Otostigmus astenus</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	-
174	<i>Otostigmus astenus</i>	4/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs
175	<i>Scolopendra subspinipes dehuani</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	1 leg
176	<i>Otostigmus astenus</i>	12/4/2011	Kurabuni, Phang Nga	Orchard	No head
177	<i>Otostigmus multidentis</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	no leg
178	<i>Otostigmus astenus</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	2 legs
179	<i>Otostigmus multidentis</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	no leg
180	<i>Scolopendra subspinipes dehuani</i>	10/4/2011	Kurabuni, Phang Nga	Rubber plantation	1 leg, juvenile
181	<i>Otostigmus astenus</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	2 legs
182	<i>Otostigmus astenus</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	2 legs
183	<i>Otostigmus astenus</i>	7/4/2011	Kapong, Phang Nga	Orchard	1 leg, juvenile
184	<i>Otostigmus astenus</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	1 leg
185	<i>Otostigmus astenus</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	2 legs
186	<i>Scolopendra subspinipes dehuani</i>	10/4/2011	Kurabuni, Phang Nga	rubber	1 leg, juvenile
187	<i>Otostigmus astenus</i>	20/4/2011	Kurabuni, Phang Nga	Orchard	2 legs
188	<i>Otostigmus multidentis</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	no leg
189	<i>Scolopendra subspinipes dehuani</i>	7/4/2011	Kapong, Phang Nga	Orchard	no leg, juvenile

190	<i>Olostigmus astenus</i>	5/7/2011	Taknapa, Phang Nga	Kho Khao Island	No head
191	<i>Olostigmus astenus</i>	19/4/2011	Taknapa, Phang Nga	Khao Lak	no leg, juvenile
192	<i>Olostigmus multidentis</i>	4/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs
193	<i>Olostigmus multidentis</i>	30/8/2010	Kurabuni, Phang Nga	Mnk Island	no leg, adult
194	<i>Olostigmus astenus</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	2 legs
195	<i>Olostigmus multidentis</i>	6/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	1 leg
196	<i>Scolopendra subspinipes dehaani</i>	13/4/2011	Tubpuu, Phang Nga	Oil palm	2 legs
197	<i>Olostigmus multidentis</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	2 legs
198	<i>Olostigmus astenus</i>	8/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs, no head, adult
199	<i>Rhysida nuda immarginata</i>	30/8/2010	Kurabuni, Phang Nga	Mnk Island	1 leg
	<i>Rhysida nuda nuda</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
200	<i>Olostigmus scaber</i>	30/8/2010	Kurabuni, Phang Nga	Mnk Island	no leg
	<i>Olostigmus scaber</i>	30/8/2010	Kurabuni, Phang Nga	Mnk Island	1 leg
		5/4/2010	Kurabuni, Phang Nga	Similan Islands (4)	2 legs, 2 specimens
201	<i>A. brevicornis</i>	5/4/2010	Kurabuni, Phang Nga	Similan Islands (8)	2 legs 3 specimens, 1 leg 1 specimen
		7/4/2010	Kurabuni, Phang Nga	Similan Islands (8)	2 legs 1 specimen
		8/4/2012	Kurabuni, Phang Nga	Surin Islands	2 legs, 1 specimen
202	<i>Scolopendra subspinipes dehaani</i>	7/4/2011	Kapong, Phang Nga	Orchard	2 legs (0 & 3 spine on each side) 1 specimen, 1 leg 1 specimen
203	<i>Scolopendra subspinipes dehaani</i>	7/4/2011	Kapong, Phang Nga	Orchard	2 legs 2 specimens
		30/8/2010	Kurabuni, Phang Nga	Mnk Island	2 legs 2 specimens, 1 leg 1 specimen, total adults
204	<i>Scolopendra subspinipes dehaani</i>	30/8/2010	Kurabuni, Phang Nga	Sri Phang Nga	2 legs 4 specimens, 3 adults, 1 juvenile
		10/4/2011	Tubpuu, Phang Nga	Oil palm	2 legs, adult, largest
		9/7/2011	Kurabuni, Phang Nga	Phra Thong Islands	2 legs, adult
		10/4/2011	Kurabuni, Phang Nga	Rubber plantation	2 legs, juvenile
		5/7/2011	Taknapa, Phang Nga	Kho Khao Island	2 legs 7 specimens
205	<i>Scolopendra subspinipes dehaani</i>	11/4/2011	Tubpuu, Phang Nga	Oil palm	2 legs 5 specimens, 1 leg 2 specimens, no leg 1 specimen
		30/8/2010	Kurabuni, Phang Nga	Mnk Island	2 legs 1 specimen, no leg 1 specimen
		5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs 1 specimen
		19/4/2011	Taknapa, Phang Nga	Kho Lak	2 legs 1 specimen

206	<i>Ostogmus astenus</i>	6/4/2010	Kurabuni, Phang Nga	Similan Islands	2 legs 2 specimens, 1 leg 2 specimens, no leg 1 specimen
		7/4/2010			2 legs 1 specimen, 1 leg 1 specimen, no leg 2 specimens
207	<i>Ostogmus astenus</i>	7/4/2010	Kurabuni, Phang Nga	Similan Islands	2 legs 2 specimens, no leg 2 specimens
		8/4/2010			no leg 2 specimens
		8/4/2010			2 legs 1 specimen, no leg 1 specimen, total adults
211	<i>Ostogmus scaber</i> <i>Ostogmus astenus</i>	30/8/2010	Kurabuni, Phang Nga	Muk Island	no leg 2 legs
215	<i>Sterropristes violaceus</i>	8/4/2010	Kurabuni, Phang Nga	Similan Islands	2 legs 2 specimens, 1 leg 1 specimen, no leg 2 specimens
		8/4/2012			Surin Islands
216	<i>Ostogmus astenus</i>	5/7/2011	Takrapa, Phang Nga	Kho Khao Island	2 legs
217	<i>Ostogmus scaber</i>	30/8/2010	Kapong, Phang Nga	Orchard	no leg
219	<i>Ostogmus astenus</i>	18/4/2011	Thai Mueang, Phang Nga	Khao Lampi	2 legs
220	<i>Ostogmus scaber</i>	30/8/2010	Kapong, Phang Nga	Orchard	1 leg
221	<i>Ostogmus astenus</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs
222	<i>Ostogmus astenus</i>	30/8/2010	Kurabuni, Phang Nga	Muk Island	2 legs
223	<i>Ostogmus astenus</i>	5/4/2011	Kurabuni, Phang Nga	Sri Phang Nga	2 legs

## Appendix B

### Paper publication

 Zootaxa 3484: 35–52 (2012)  
www.mapress.com/zootaxa/  
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ISSN 1175-5326 (print edition)  
**ZOOTAXA**  
ISSN 1175-5334 (online edition)

### Article

urn:lsid:zoobank.org:pub:9436D0DF-837C-4573-8103-0E09C912E8A1

#### Revision of the rare centipede genus *Sterropristes* Attems, 1934, with description of a new species from Thailand (Chilopoda: Scolopendromorpha: Scolopendridae)

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#### Abstract

The genus *Sterropristes* Attems, 1934, currently classified in the scolopendrid subfamily Otostigminae and tribe Sterropristini, is revised. The monotypic genus *Malaccolabis* Verhoeff, 1937, is synonymized with *Sterropristes*. *Sterropristes sarasinorum* Attems, 1934 from Tomohon, Celebes, Indonesia (type species of *Sterropristes*) and *S. metallicus* (Verhoeff, 1937) from Penang Hill, Penang, Malaysia (type species of *Malaccolabis*) are redescribed based on their type material, together with newly collected topotypes of *S. metallicus*. *Sterropristes violaceus* Muadsub and Panha n. sp., found under leaves on islands in the Andaman Sea, south-western Thailand, is described.

**Key words:** taxonomy, systematics, Malaysia, morphology, Myriapoda

#### Introduction

The centipede order Scolopendromorpha contains the largest of all centipedes, and the family Scolopendridae in particular is better known biologically and taxonomically than most other centipede groups. Recent taxonomic and phylogenetic treatments of Scolopendromorpha include Schileyko and Pavlinov (1997); Shelley (1997, 2002); Lewis (2006, 2010a, b); Edgecombe and Koch (2008, 2009); Koch *et al.* (2009); Vahtera *et al.* (2012a, b). The Scolopendridae contain more than 400 nominal species, classified into either two or three subfamilies. In one scheme, the subfamilies Scolopendrinae and Otostigminae (the latter subdivided into tribes Otostigmini, Arrhabdotini and Sterropristini) are diagnosed largely based on spiracle morphology (Edgecombe and Bonato, 2011). An alternative scheme separates a subfamily Sterropristinae from Otostigminae based on the presence or absence, respectively, of a spiracle on trunk segment 7 (Schileyko, 1992, 2002; Schileyko and Pavlinov, 1997). Scolopendrinae and Otostigmini have been often subjected to study in many aspects, whereas the Sterropristini is known from just two specimens and is rarely mentioned in the literature (Lewis, 1981a).

The centipede fauna of Indochina has received little attention, and almost all currently recognized taxa were described before the 1960s (e.g. Attems 1930, 1934, 1953; Verhoeff, 1937). A few modern studies have concerned scolopendromorphs from Vietnam, Laos and Cambodia (Schileyko, 1992, 1995, 2007), whereas from Thailand only the lithobiomorphs have been treated recently (Eason, 1981, 1986, 1989). Altogether, less than 20 nominal species of centipedes have been recorded from Thailand (including recent records by Bonato *et al.* 2011, 2012; Vahtera *et al.* 2012a), and only three of these are scolopendromorphs.

Since the Southeast Asian endemic subfamily Sterropristinae was established by Verhoeff in 1937, no further specimens of these peculiar centipedes have been recorded. Up to now, Sterropristinae/Sterropristini have been composed of two monotypic genera: *Sterropristes* Attems, 1934 and *Malaccolabis* Verhoeff, 1937 (we employ the group at the rank of tribe as in Edgecombe and Bonato, 2011, and restrict its membership to the two genera grouped as Sterropristini by Verhoeff, rather than expanding it to also include *Rhysida* Wood, 1862, *Edentistoma* Tömösváry, 1882, *Ethmostigmus* Pocock, 1898, and *Alluopus* Silvestri, 1911, as done by Schileyko (1992, 2002)). Both nominal genera are known only from their type species, and both type species are known only from their respective holotypes. Consequently, subsequent students of scolopendromorphs have had difficulties with incorporating sterropristines in their analyses (Edgecombe and Koch, 2008).

It is therefore of particular interest that during a recent faunal survey of the Similan and Surin Islands in the Andaman Sea off Thailand, five species of scolopendromorphs were found, one of which exhibited the peculiar serrated forcipular tarsungula which is the most conspicuous distinguishing character of Sterropristini. Subsequent field work at the type locality of *Sterropristes metallicus* in Malaysia turned up further specimens. The newly collected specimens were compared with type specimens of the two known sterropristine species. As a result, we here describe a new species of Sterropristini, reappraise the status of its two nominal genera, and redescribe the two established species.

## Material and methods

In the field, specimens were searched from various habitat types such as under decaying logs and rocks, under leaf litter and soil in rock crevices. Collected specimens were photographed before being preserved in 95 % ethanol for morphological studies and molecular analysis. In the laboratory, all individuals were examined and identified using Attems (1930, 1934) and Verhoeff (1937), and compared with pertinent type specimens from Naturhistorisches Museum Basel, Switzerland (NMB) and Zoologische Staatssammlung München, Germany (ZSM).

Photographs were taken through a microscope with an attached digital camera with cell\*D software. Drawings were made with the aid of camera lucida. In the descriptions, the morphological terminology follows Lewis *et al.* (2005) and Bonato *et al.* (2010). Specimens are deposited in the collection of the Chulalongkorn University Museum of Zoology, Bangkok, Thailand (CUMZ), the Natural History Museum, University of Copenhagen, Denmark (ZMUC) and The Natural History Museum, London (NHM).

## Systematics

### Family Scolopendridae Newport, 1844

### Subfamily Otostigminae Kraepelin, 1903

### Tribe Sterropristini Verhoeff, 1937

### Genus *Sterropristes* Attems, 1934

*Sterropristes* Attems, 1934: 43–47. Verhoeff, 1937: 201, 202. Schileyko, 1997: 34.

*Malaccolabis* Verhoeff, 1937: 201. Type species: *Malaccolabis metallica* Verhoeff, 1937, by monotypy. Schileyko and Pavlinov, 1997: 34. **Syn. nov.**

**Type species.** *Sterropristes sarasinorum* Attems, 1934, by monotypy.

**Diagnosis.** The unique distinguishing character of *Sterropristes* is the saw-like internal margin of the forcipular tarsungula. Other characters include basally wide, dorso-ventrally flattened antennae; tergite 1 abutting the cephalic plate; forcipular coxosternal tooth plate with 4+4 teeth; forcipular trochanteroprefemora without processes; tergites from at least T6 to T20 and sternites from at least S13 to S19 with complete paramedian sutures; spiracular apertures oval, spiracles present on trunk segment 7; coxopleura of ultimate legs truncated, without processes and spines; ultimate legs short, thickened; prefemora without spines; distal part of femora with a groove on their dorsal sides; ventral side of either tibiae or tarsi (or both) prominently convex; pretarsi longer than second tarsi.

**Remarks.** The traditional classification of the Scolopendridae is based on morphological characters, for example, the shape of the spiracle and the presence or absence of three-flapped valves in it, the presence and shape of coxopleural processes, and details of spinulation of the ultimate legs (Attems, 1930). The classification of Sterropristini as a group at the tribe or subfamily level particularly emphasizes serrated margins of the forcipular tarsungula (Verhoeff, 1937). Schileyko (1992) proposed a new classification of the Scolopendromorpha, placing particular weight on the number of body segments and presence of a spiracle on trunk segment 7 (Fig. 1C, F, I). The name Sterropristinae was applied therein to a group united by a spiracle on segment 7, that group then being subdivided into Ethmostigmini (*Ethmostigmus*, *Rhysida* and *Alluropus*) and Arrhabdotini (*Edentistoma*, *Sterropristes* and *Malaccolabis*). Schileyko and Pavlinov (1997) presented a cladistic analysis of Scolopendromorpha in which *Sterropristes* and *Malaccolabis* formed a clade that was sister-group to *Edentistoma* Tömösváry, 1882 (= *Arrhabdotus* Attems, 1930), another deviating monotypic scolopendromorph genus (see Lewis, 1981b). Recent analyses of either morphological data (Edgecombe and Koch 2008, 2009; Koch *et al.* 2009; Vahtera *et al.* 2012b) or molecular data analyzed either on their own or in combination with morphology (Vahtera *et al.* 2012a) have not supported Schileyko and Pavlinov's findings with respect to a taxonomic separation between Otostigmini and "Ethmostigmini", and the value of a spiracle on segment 7 as a high-level taxonomic character in Scolopendromorpha has been called into question (Di *et al.* 2010). Although the exact position of Sterropristini in the phylogeny of Scolopendridae remains unsettled, the ovate outline of the spiracles and their strongly humped atrial wall and floor (Fig. 1) are consistent with membership in Otostigminae.

Verhoeff (1937) erected the monotypic genus *Malaccolabis* for material from Penang Hill, Penang, Malaysia. However, on the basis of the newly collected specimens (including topotypes of *M. metallica*) and re-study of pertinent type material we treat *Malaccolabis* Verhoeff, 1937 as a junior subjective synonym of *Sterropristes* Attems, 1934. Although the type species of *Malaccolabis* differs from that of *Sterropristes* in some characters, notably the number of sparsely setose antennal articles, these do not warrant separation at the genus level (Table 1). Some of the purportedly diagnostic differences of *Malaccolabis* exhibit variability now that additional specimens of its type species are known, with the range of variation overlapping with *S. sarasinorum*. For example, the difference in number of antennal articles (17 versus 12–15) is likely a result of the holotype of *S. metallica* being teratological or due to damage and repair with respect to this character because the new topotypes of *S. metallica* have 17 articles as in *S. sarasinorum*. A supposedly diagnostic difference in number of teeth on the forcipular tarsungula (9 versus 13) can likewise be dismissed because topotypes of *S. metallica* have as few teeth as the holotype of *S. sarasinorum*. The presence or absence of a dorsal groove on the ultimate leg femur was cited by Verhoeff (1937) as diagnostic for two genera, but this furrow is in fact present in *S. sarasinorum* but was not described or illustrated by Attems (1934) (see below).

#### ***Sterropristes sarasinorum* Attems, 1934**

(Figures 1A–C, 2–4 and Table 1)

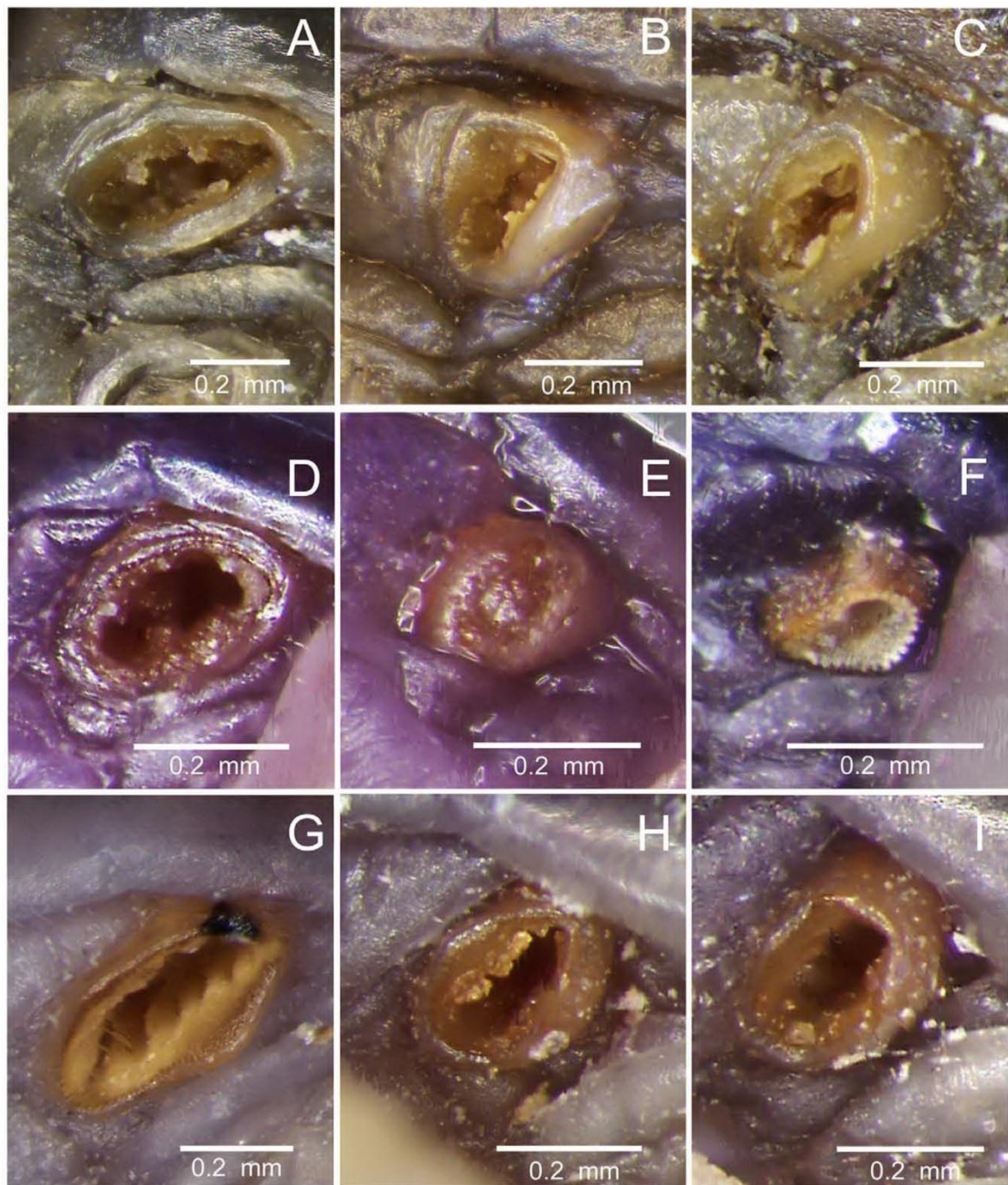
*Sterropristes sarasinorum* Attems, 1934: 43–47, figs 1–5. Type locality: Tomohon, Sulawesi (=Celebes), Indonesia.

**Type material.** Holotype NHB 432a (specimen in ethanol).

**Description of the holotype.** The original description is quite detailed. Distinguishing characters are: antennal articles 1 to 7 glabrous or with very few setae, 8 to 17 densely setose. Basal borders of coxosternal tooth plates meeting at right angles. Forcipular tarsungula curved, internal margins with 9 teeth. Tergites 3 to 20 with complete paramedian sutures. Sternite of ultimate leg-bearing segment noticeably truncated posteriorly. Coxopleura of ultimate legs longer than sternite of ultimate leg-bearing segment. Ultimate legs thickened, prefemora 1½ times, femora 2 times and tibiae 2½ times longer than their widths, prefemora and femora with posterior dorsal grooves, ventral sides of both tarsi prominently convex. Leg 1 with one femoral spur and two tarsal spurs, legs 2 to 20 each with one tarsal spur. Trunk, head capsule, antennae and ultimate legs dark brown, legs pale olive and yellow.

**Remarks.** We have examined the holotype and found inconsistencies with the original description. Attems (1934) mentioned that leg 1 has two tibial spurs and that legs 2 to 18 have one tibial spur each; the posterior grooves on the ultimate legs were not mentioned. However, we found that leg 1 has one femoral spur and two tarsal spurs (Fig. 4C), and legs 2 to 20 have only one tarsal spur each (Fig. 4D, E). In addition, the posterior grooves on the prefemora and femora of the ultimate legs are clearly recognizable (Figs 3G, I, 4G).





**FIGURE 1.** Spiracles of segments 3, 5 and 7 (left to right, respectively). **A–C.** Holotype NMB 432a of *Sterropristes sarasinorum* Attems, 1934. **D–F.** Specimen CUMZ 3205 of *Sterropristes metallicus* from Penang Botanical Gardens, Penang, Malaysia. **G–I.** Holotype CUMZ 3207 of *Sterropristes violaceus* Muadsub and Panha **n. sp.**



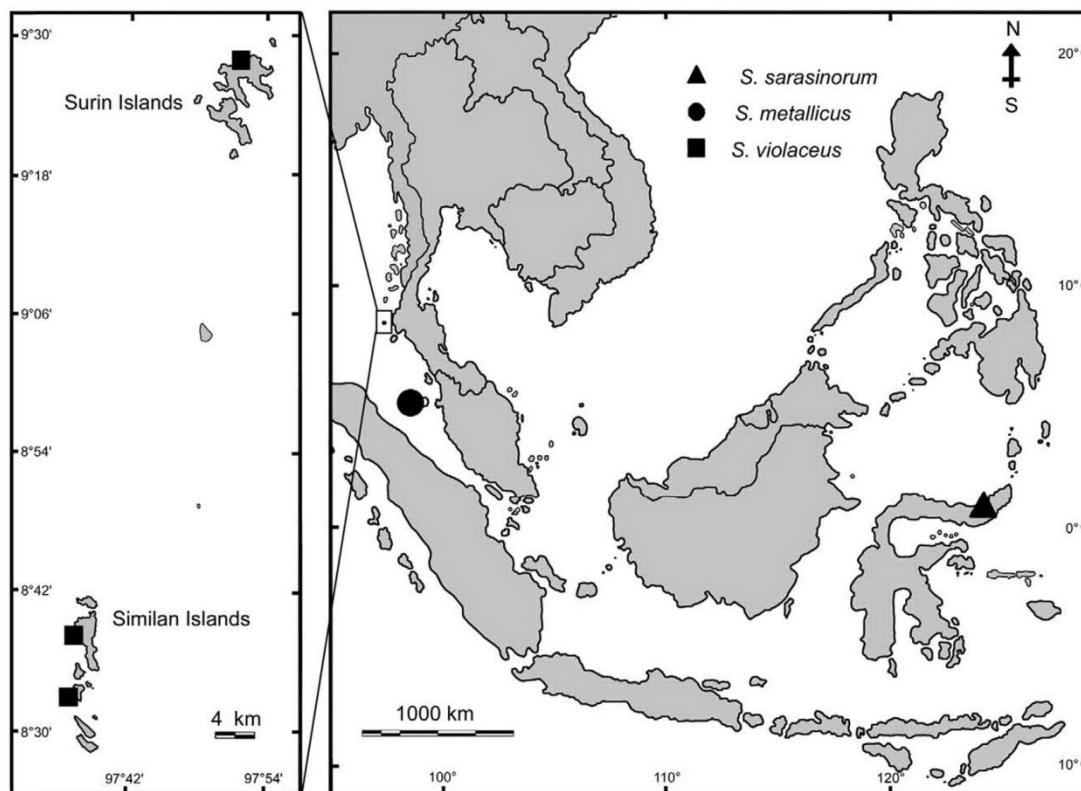


FIGURE 2. Geographical distribution of *Sterropristes* species.

***Sterropristes metallicus* (Verhoeff, 1937)**

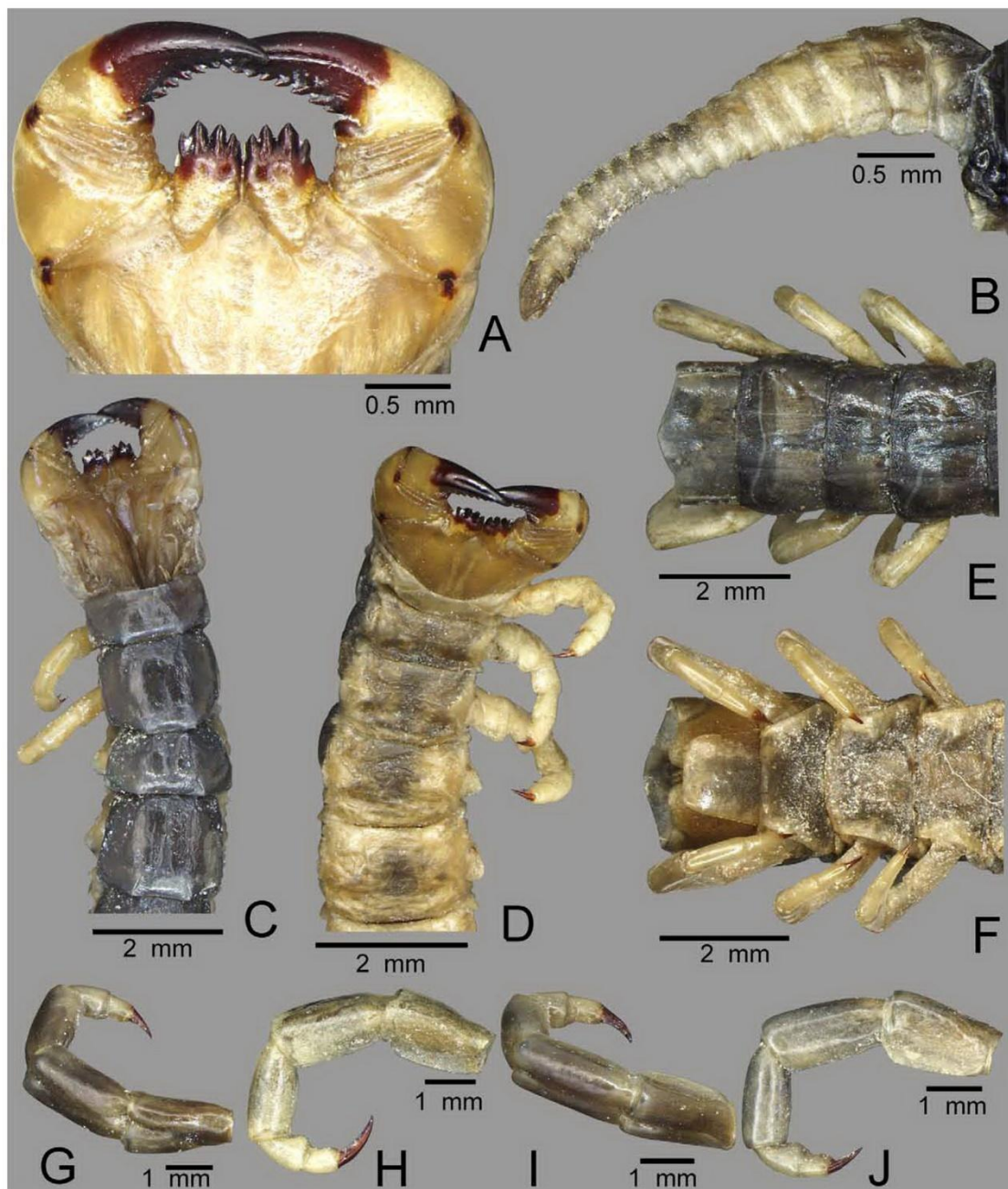
(Figures 1D–F, 2, 5, 6A, B, 7–9 and Table 1)

*Malacolabis metallica* Verhoeff, 1937: 202, 203, pl. 12, figs 1–4. Type locality: Penang Hill, Penang, Malaysia.

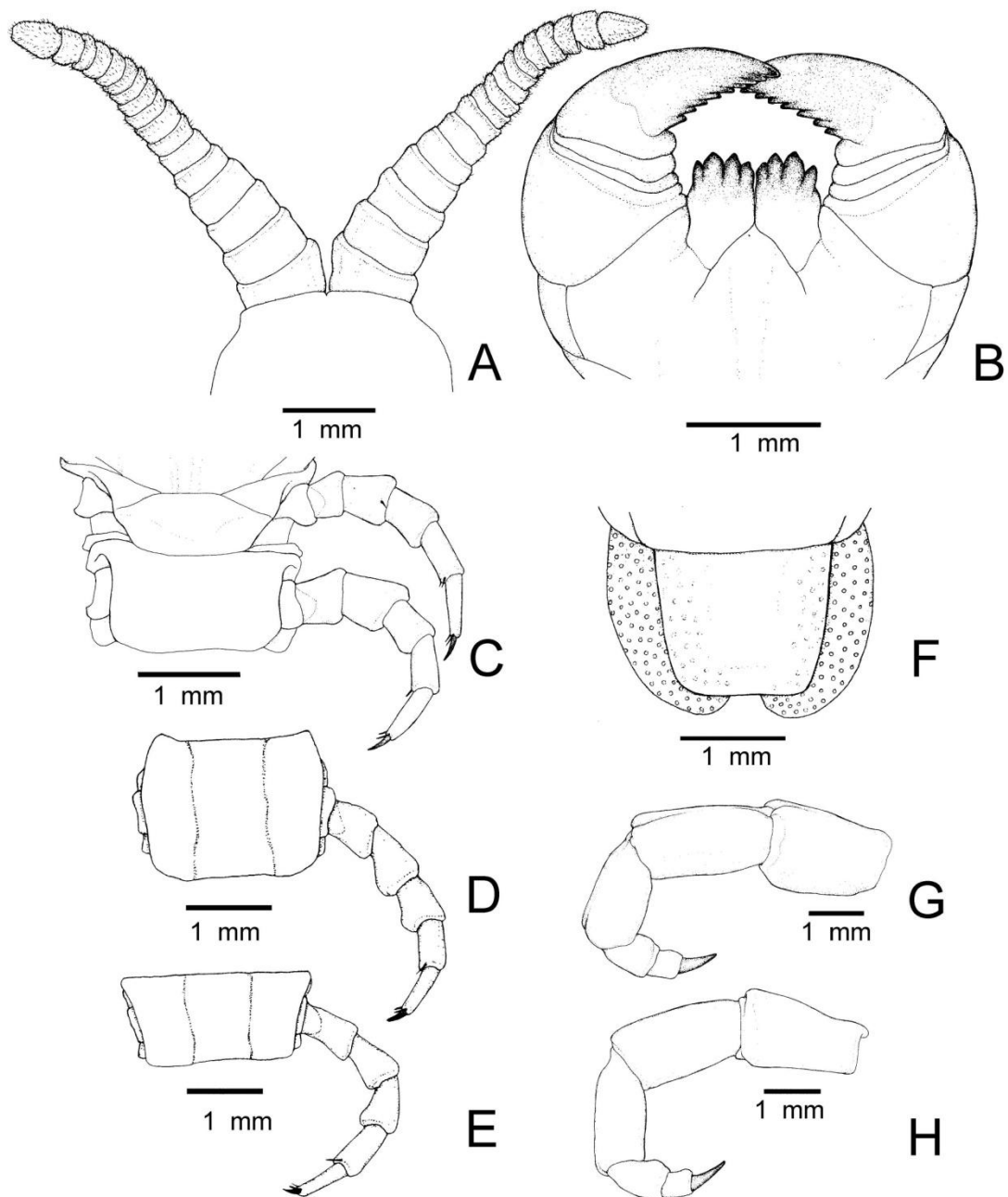
**Type material.** The holotype was separately mounted on three glass slides. The first slide (catalogue number ZSM A20030951) contains the cephalic plate with antennae, first maxillae, second maxillae and mandibles (Fig. 5A, G–K). The second slide (ZSM A20030952) contains the forcipules and segments 1 to 6 with their legs (Fig. 5B, C), unfortunately segments 7 to 17 seem to be lost. The third slide (ZSM A20030953) contains segments 18 to 21 and the ultimate legs (Fig. 5D–F).

**Topotype material.** Penang Botanical Gardens, Penang, Malaysia (5° 26' 8.9" N, 100° 17' 34.2" E), CUMZ 3205, 8 January 2012. Penang Hill, Penang, Malaysia, CUMZ 3206, 9 January 2012. S. Muadsub and P. Pimvichai.

**Descriptive notes on the holotype.** The original description was well written by Verhoeff (1937). We here emphasize distinguishing characters, and characters not mentioned in the original description. Body length 43 mm. Left antenna with 12 and right antenna with 15 articles; articles 1 to 4 glabrous, articles 5 to the end very densely setose. Bases of coxosternal tooth plates meeting at a blunt angle, 4+4 coxosternal teeth, each tooth plate with two larger central teeth. Forcipular trochanteroprefemora without processes or teeth. Forcipular tarsungula nearly straight, internal margins with 13 saw teeth. Tergites 6 to 20 with paramedian sutures. Coxopleura longer than sternite of ultimate leg-bearing segment. Ultimate legs short and thickened; prefemora, femora and tibiae similar in length. Prefemora and femora length equal to width, tibiae longer than their widths, femora with short posterior dorsal grooves, tibiae prominently convex ventrally. Locomotory legs with scattered setae; leg 1 with one prefemoral, one femoral and two tibial spurs; leg 2 with two tibial spurs; legs 3 to 20 with only one tarsal spur.

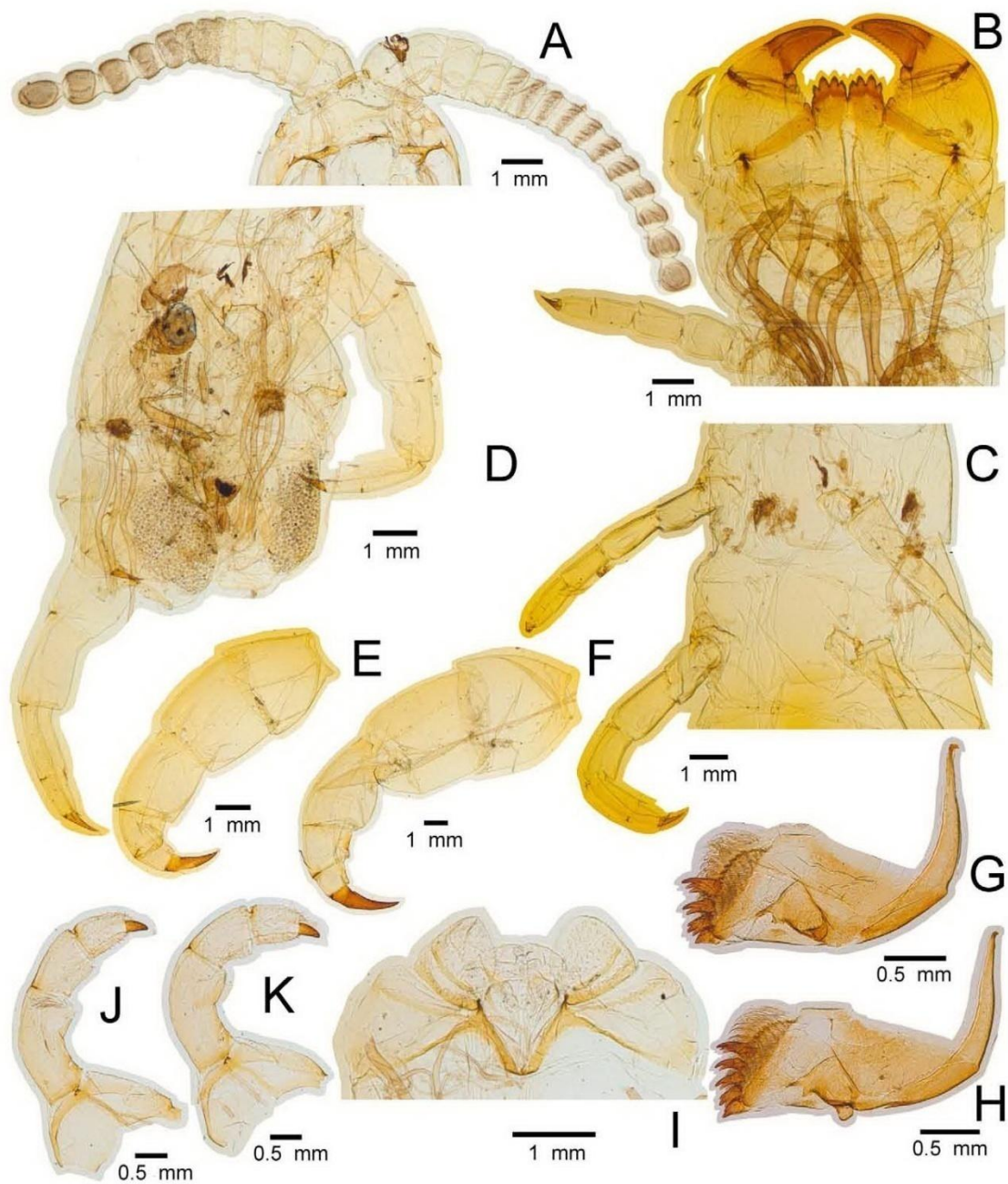


**FIGURE 3.** Holotype NMB 432a of *Sterropristes sarasinorum* Attems, 1934. **A.** Ventral view of forcipules. **B.** Dorsal view of left antenna. **C.** Tergites 2 to 5, complete paramedian sutures start on tergite 3. **D.** Sternites 1 to 5, complete paramedian sutures start on sternite 4. **E.** Tergites 18 to 21. **F.** Sternites 18 to 21, showing sternite of ultimate leg-bearing segment shorter than coxopleura. **G–J.** Ultimate legs; (**G, I**) posterior groove on prefemur and femur, and (**H, J**) prominently convex shape of both tarsi.



**FIGURE 4.** Drawings of *Sterropristes sarasinorum* Attems, 1934, holotype NMB 432a. **A.** Antennae. **B.** Forcípules. **C.** Sternites 1 and 2. **D, E.** Sternites and legs 8 and 18. **F.** Sternite of ultimate leg-bearing segment shorter than coxopleura. **G.** Oblique view of ultimate leg showing posterior grooves on prefemur and femur. **H.** Lateral view of ultimate leg showing convex underside on both tarsi.





**FIGURE 5.** Holotype slide ZSM A200309521-3 of *Sterropristes metallicus* (Verhoeff, 1937). **A.** Cephalic plate and antennae. **B.** Forcipular tarsungula and segments 1 and 2 **C.** Segments 5 and 6. **D.** Segments 19 to 21. **E, F.** Ultimate legs. **G, H.** Mandible. **I.** First maxilla. **J, K.** Second maxilla.

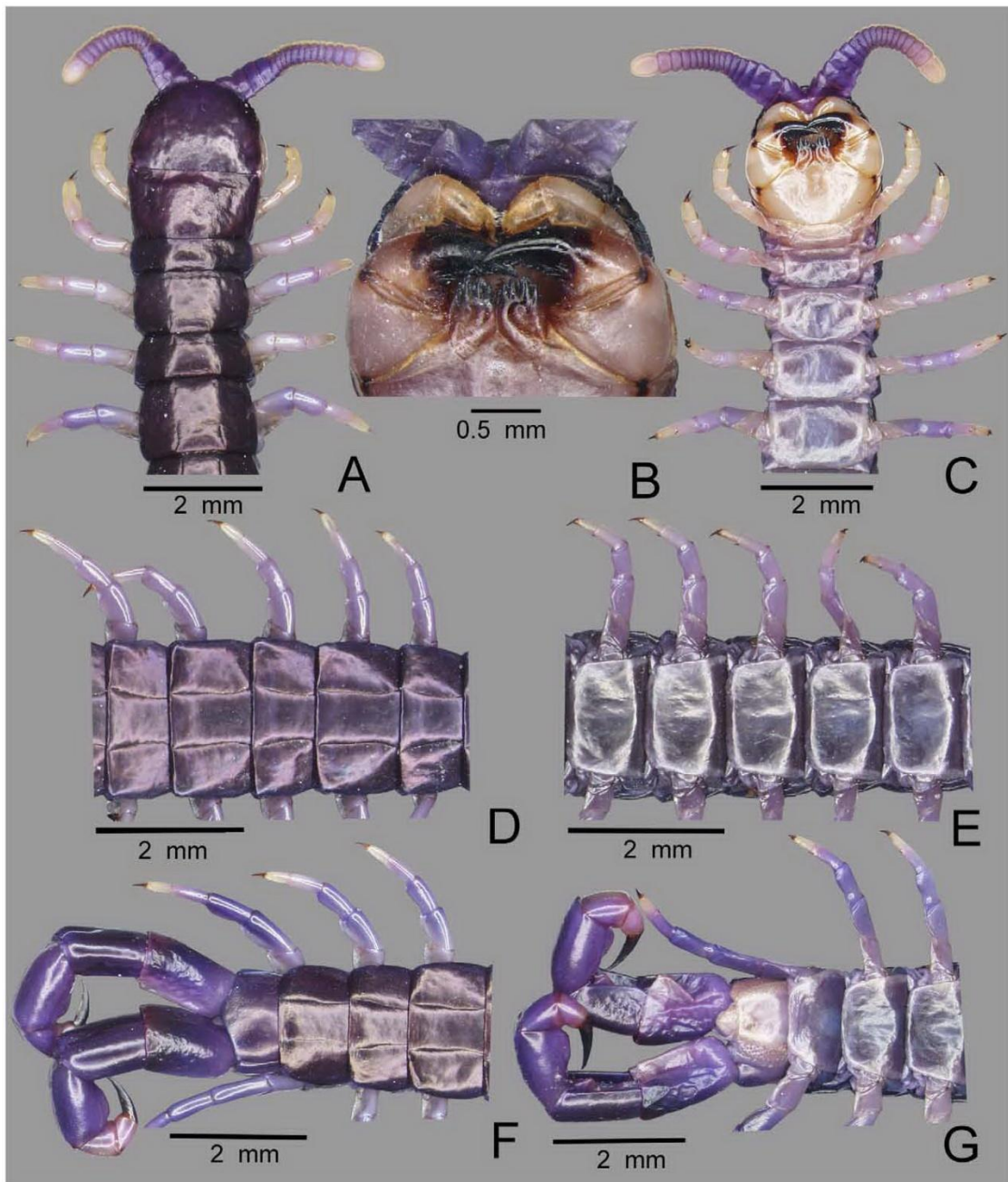




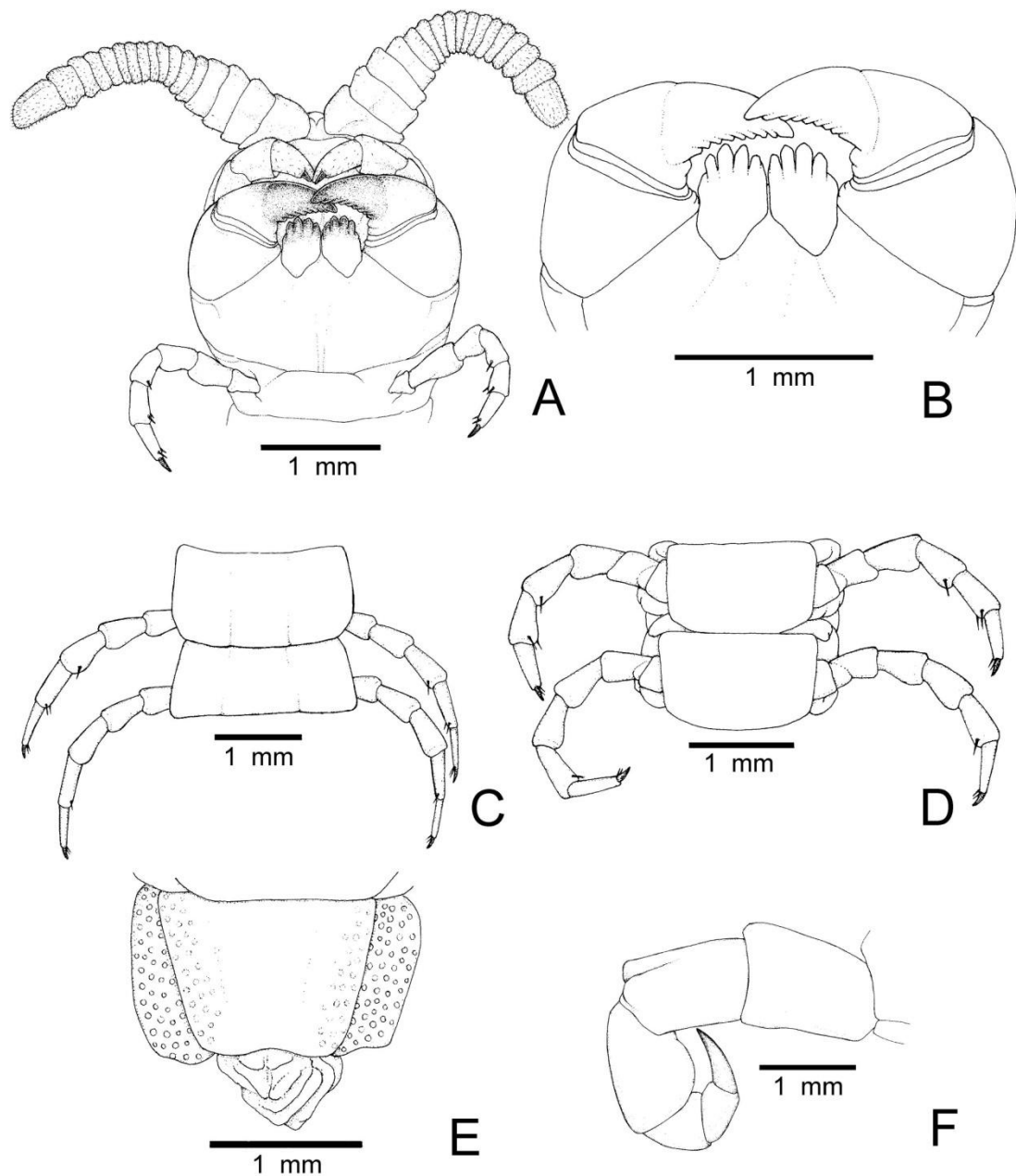
**FIGURE 6.** Live specimens of *Sterropristes* species. **A, B.** Specimen CUMZ 3205 of *Sterropristes metallicus* from Penang Botanical Gardens, Penang, Malaysia (length 28 mm), dorsal (**A**), and ventral view (**B**). **C.** Paratype CUMZ 3208 of *Sterropristes violaceus* Muadsub and Panha **n. sp.** from its type locality (length 33 mm).

**Description of topotypes.** Two topotypical specimens are available. They show some differences from the holotype but these variable characters are not sufficiently distinct to merit separate taxonomic status (differences with respect to numbers of teeth on the tarsungula appear to reflect an increase in teeth with increased body size). Length 18 and 28 mm (Fig. 9). Colour in life dark to light purple. Antennae with 17 articles, the basal 4 with only a few short setae, articles 5 to 17 very densely setose (Figs 7A, C, 8A). Forcipular coxosternal tooth plates with 4+4





**FIGURE 7.** Specimen CUMZ 3205 of *Sterropristes metallicus* from Penang Botanical Gardens, Penang, Malaysia. **A.** Head and leg-bearing segments 1 to 5. **B.** Forcipules. **C.** Ventral view of head and sternites 1 to 5. **D.** Tergites 11 to 15. **E.** Sternites 11 to 15. **F.** Tergites 18 to 21 and ultimate legs showing convex underside of tibia. **G.** Sternite 18 to 21 and ultimate legs showing sternite of ultimate leg-bearing segment almost the same length as coxopleura.



**FIGURE 8.** Drawings of *Sterropristes metallicus*, CUMZ 3205. **A.** Antennae, head ventral and segment 1. **B.** Forcípules. **C, D.** Tergites 3 and 4 (**C**) and sternites 3 and 4 (**D**) showing transition from one tibial spur and two tarsal spurs on leg 3 to no tibial spur and one tarsal spur on leg 4. **E.** Sternite of ultimate leg-bearing segment almost the same length as coxopleura. **F.** Lateral view of ultimate legs with posterior femoral groove and convex underside of tibia.

teeth. Forcípular tarsungula with 8 and 9 saw teeth (Figs 7B, C, 8A, B). Paramedian sutures starting on tergite 3 with short posterior sutures, tergites 4 to 5 with short anterior and posterior sutures, tergites 6 to 20 with complete sutures. Tergite of ultimate leg-bearing segment margined laterally, without posterior median depression, posterior margin slightly concave with obtuse angle in the middle (Fig. 7F). Paramedian sutures on sternites 4 to 12

incomplete; sternites 13 to 19 with complete sutures. Sternite of ultimate leg-bearing segment noticeably narrowed posteriorly, posterior margin concave, about 1/2 length of anterior margin. Coxopleura short and truncated, without spine, similar in length to sternite of ultimate leg-bearing segment (Fig. 7G). Locomotory legs 1 to 3 each with one tibial spur and two tarsal spurs, legs 4 to 20 each with one tarsal spur (Fig. 8C, D). Ultimate legs short and thickened; prefemora, femora and tibiae similar in length; dorsal sides of prefemora flattened, ventral sides without spines; femora with short posterior dorsal grooves; ventral sides of tibiae prominently convex (Figs 7F, G, 8F).

**Remarks.** We have examined the holotype of this species and found some incongruence with the original description. Verhoeff thus mentioned that legs 1 and 2 each have two tibial spurs, that legs 3 to 20 each have one tibial spur and that leg 1 has one prefemoral spur. However, we found that leg 1 has one prefemoral, one femoral and two tibial spurs (Fig. 5B), leg 2 has 2 tibial spurs and 2 tarsal spurs, and legs 3 to 20 have only one tarsal spur (Fig. 5C, D).

*Sterropristes metallicus* differs from *S. sarasinorum* by the latter species having more (seven versus four) sparsely setose antennal articles, posterior dorsal grooves on the ultimate legs being present on the prefemora and femora (instead of just on the femora), and the ventral sides of both tarsi with a prominent convex shape (as opposed to the tibiae in *S. metallicus*).

#### ***Sterropristes violaceus* Muadsub and Panha n. sp.**

(Figures 1G–I, 2, 6C, 9–11 and Table 1)

**Type specimens.** Holotype CUMZ 3207 (Figs 10, 11). Type locality: Koh Si, Similan Islands, Phangnga Province, Thailand (8° 50' N, 97° 49' E). 6 April 2010. S. Muadsub and S. Panha. Paratypes CUMZ 3208 and ZMUC00021424, same data as holotype. Similan Islands are located in the Andaman Sea, south-western Thailand, 70 km off the coast from Kuraburi district, Phangnga Province. The Islands are composed of 9 small islands in a line north to south.

**Other specimen.** CUMZ 3209, Surin Islands, Phangnga, Thailand (9° 25' N, 97° 52' E). 8 April 2012. S. Muadsub and P. Pimvichai.

**Etymology.** The specific name is a Latin adjective meaning purple or violet. The new species is dedicated to Her Royal Highness Princess Maha Chakri Sirindhorn, who initiated the Plant Genetic Conservation Project – violet is the colour of her royal banner.

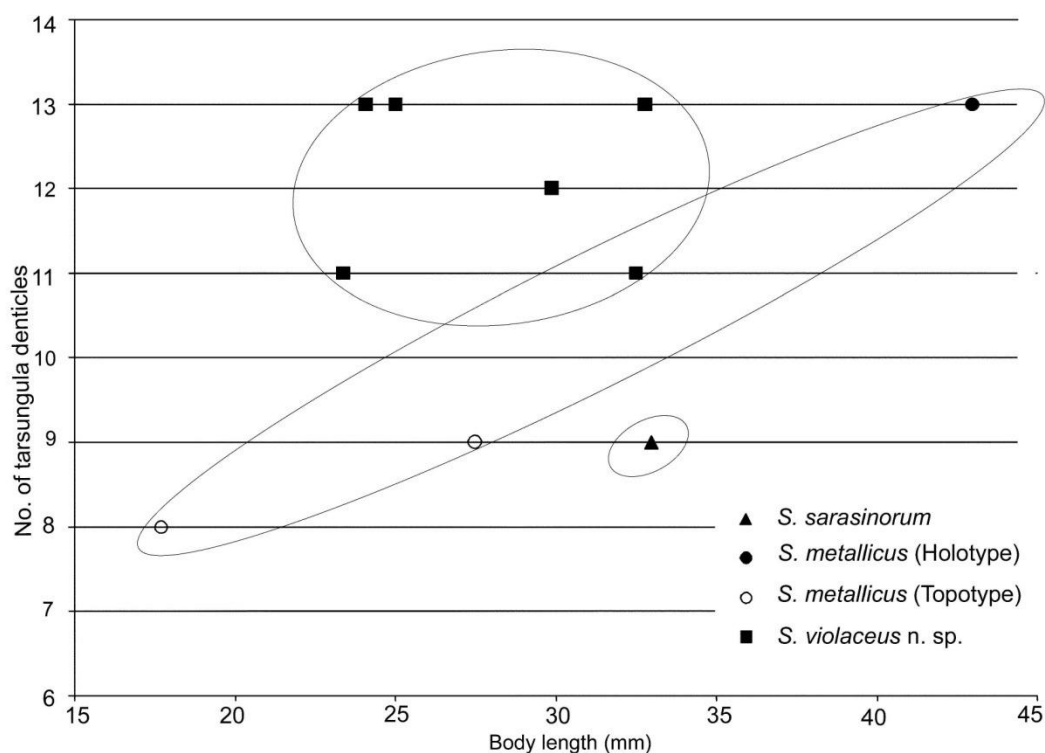
**Diagnosis.** Antennal articles 1 to 4 glabrous or with very few setae, articles 5 to 17 densely setose. Bases of coxosternal tooth plates meeting at right angles. Forcipular tarsungula slightly curved, internal margins with 11–13 saw teeth. Tergites 6 to 20 and sternites 11 to 19 with complete paramedian sutures. Sternite of ultimate leg-bearing segment with strongly converging lateral margins. Coxopleura of ultimate legs truncated and equivalent in length to sternite of ultimate leg-bearing segment. Ultimate legs thickened; prefemora, femora and tibiae similar in length, prefemora equal in length and width, femora and tibiae longer than their widths; dorsal sides of femora with short posterior grooves; ventral sides of tibia and tarsus 1 prominently convex. Legs 1 and 2 both with one tibial spur, legs 1 to 14 each with two tarsal spurs, legs 15 to 20 each with one tarsal spur and legs 1 to 20 each with two pretarsal accessory spurs.

*Sterropristes violaceus* Muadsub and Panha n. sp. differs from *S. sarasinorum* by the latter species having only 9 saw teeth on the forcipular tarsungula (versus 11–13), antennal articles 1 to 7 glabrous, coxopleura longer than the sternite of the ultimate leg-bearing segment, a posterior dorsal groove on the ultimate legs being present on the prefemora and femora, and the ventral sides of both tarsomeres (but not the tibia) being prominently convex. The distinguishing characters of *S. metallicus* vis-a-vis this new species are that in *S. metallicus* the coxopleura of the ultimate legs are longer than the sternite of the ultimate leg-bearing segment, and the ventral sides of tarsi 1 are not prominently convex.

**Description of holotype.** Body length about 33 mm. Living animals: cephalic plate, tergites and ultimate legs dark purple, antennae and locomotory legs light purple. Colour of preserved specimen: cephalic plate and tergites dark purple, antennae, locomotory and ultimate legs light purple.

Cephalic plate smooth, anterior part semi-circular, posterior margin straight, surface almost glabrous but few short setae; four ocelli.





**FIGURE 9.** Relationship between body length and number of tarsungula denticles of *Sterropristes* species.

Antennae dorso-ventrally flattened, reaching back to third tergite, with 17 articles (Figs 10A, C, 11A). Articles 1 to 4 wide, almost glabrous, with few short setae on both dorsal and ventral side. Articles 5 to 17 densely pubescent with short setae, terminal article longer than wide, width of penultimate article width about 1/3 the width of first article.

Forcipular coxosternal tooth plates with 4+4 teeth, two inner teeth higher than the two outer ones, basal borders of tooth plates meeting at right angles, surface of plates with a few short setae. Forcipules without trochanteroprefemoral processes; tarsungula with 13 saw teeth on internal margins (Figs 10B, 11A, B). Second maxillae with few scattered setae, without accessory spur. First maxilla with few scattered setae.

Tergites smooth with scattered setae on surface. First tergite about three times longer than second, not overlapping cephalic plate, lacking furrows or sutures.

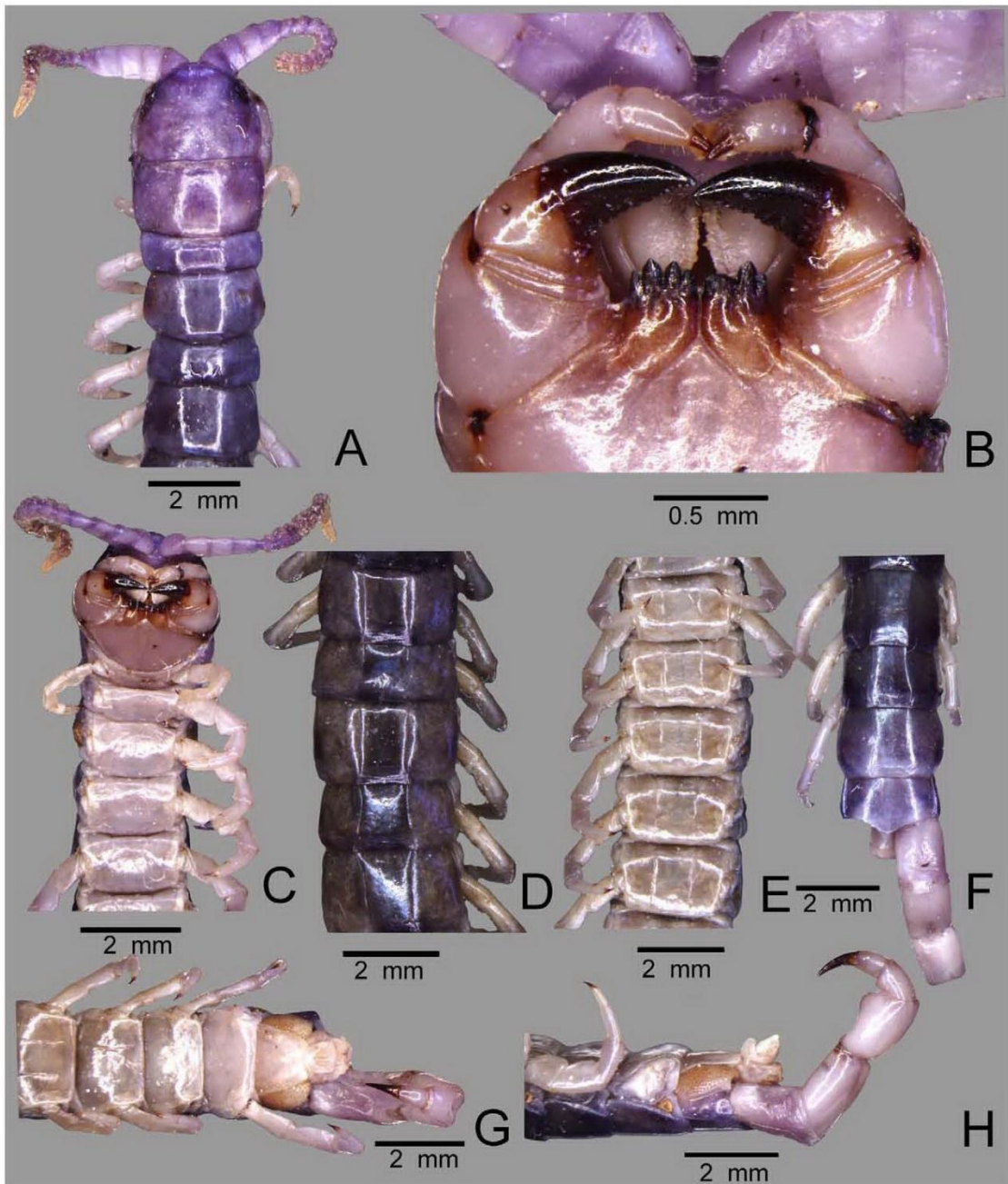
Tergites 2 to 5 with short anterior and posterior paramedian sutures, tergites 6 to 20 with complete sutures (Fig. 10A, D, F). Tergite of ultimate leg-bearing segment margined laterally, without posterior median depression, posterior margin with rounded apex. Ten pairs of oval spiracles, those on segment 3 largest (Fig. 1G) but not conspicuously larger than those on subsequent segments; spiracles present on segment 7 (Fig. 1C); wall and floor of spiracular atrium bearing large humps.

Sternites smooth, paramedian sutures on anterior half of sternites 4 to 10, complete sutures on sternites 11 to 19 (Fig. 10C, E, G). Sternite of ultimate leg-bearing segment with converging lateral margins and concave posterior margins. Coxopleura of ultimate legs truncate, without processes and spines, similar in length to sternite of ultimate leg-bearing segment, covered with many small pores (Figs 10G, 11E).

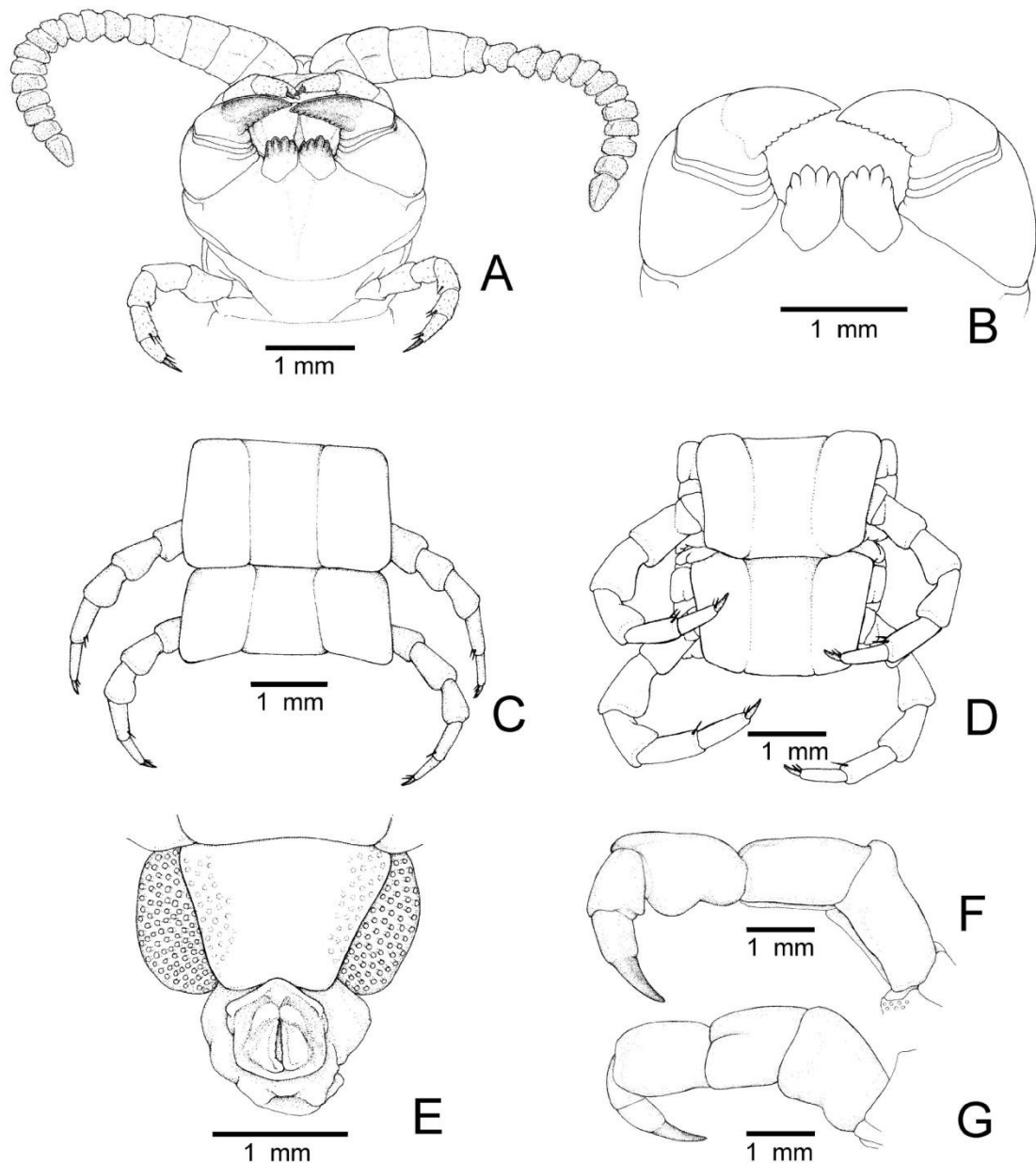
Locomotory legs with scattered setae, prefemora and femora flattened. Tarsus 1 longer than tarsus 2. Legs 1 and 2 both with one tibial spur, legs 1 to 14 each with two tarsal spurs, legs 15 to 20 each with one tarsal spur, legs 1 to 20 each with two pretarsal accessory spurs (Fig. 11A, C, D).

Ultimate legs short and very thickened, dorsally flattened, surface smooth without spines. Prefemora, femora and tibiae similar in lengths, prefemora equal in length and width, femora and tibiae longer than wide, glabrous and

glossy; prefemora and femora with deep furrow on ventral sides (Figs 10G, 11F), femora with short grooves on posterodorsal sides (Figs 10H, 11G). Tibiae and tarsus 1 prominently convex on ventral sides (Figs 10H, 11F), tarsus 1 longer than tarsus 2, pretarsus longer than tarsus 2.



**FIGURE 10.** Holotype CUMZ 3207 of *Sterropristes violaceus* Muadsub and Panha **n. sp.** **A.** Head and leg-bearing segments 1 to 5. **B.** Forcipules. **C.** Ventral view of head and leg-bearing segments 1 to 5. **D.** Tergites 11 to 15. **E.** Sternites 11 to 15. **F.** Tergites 18 to 21 and ultimate leg. **G.** Sternites 18 to 21, sternite of ultimate leg-bearing segment almost the same length as coxopleura. **H.** Lateral view of segments 19 to 21 and showing convex underside of ultimate leg tibia.



**FIGURE 11.** Drawings of *Sterropristes violaceus* Muadsub and *Panha n. sp.*, holotype CUMZ 3207. **A.** Antennae, head ventral and segment 1. **B.** Forcipules. **C.** Tergites 14 to 15. **D.** Sternites 14 to 15. **E.** Sternite of ultimate leg-bearing segment almost the same length as coxopleura. **F.** Lateral view of ultimate leg showing convex underside of tibia. **G.** Oblique view of ultimate leg showing posterior femur groove.

**Remarks.** Four paratypes from Similan Islands vary in length from 23 to 30 mm. The smallest specimen (23 mm; with one ultimate leg) has 11 saw teeth on the forcipular tarsungula, a femoral spur is absent, one tibial spur on each of legs 1 to 3 and two tarsal spurs on each of legs 1 to 4. Two specimens (25 mm and 24 mm) have the same number of saw teeth as in the holotype (Fig. 9); both have complete paramedian sutures on tergites 5 to 20, one femoral spur on leg 1 or both legs 1 to 2, one tibial spur on each of legs 1 to 3 or only on legs 1 and 2, and two tarsal spurs on each of legs 1 to 4. The largest specimen (30 mm) is nearly of similar size to the holotype, but it

differs in having 12 saw teeth on the forcipular tarsungula, a femoral spur on leg 1, one tibial spine on leg 1, and two tarsal spines on legs 1 and 2.

The specimen from Surin Islands (33 mm; without ultimate legs) is closest in size to the holotype, but it has 11 teeth on the forcipular tarsungula, one femoral and one tibial spur on leg 1, and two tarsal spurs on each of legs 1 to 3.

**TABLE 1.** Morphological comparison among *Sterropristes* species. All data are taken from the holotypes and the original description except where noted.

Characters	<i>S. sarasinorum</i>	<i>S. metallicus</i> (holotype)	<i>S. metallicus</i> (topotypes)	<i>S. violaceus</i> <b>n. sp.</b>
Total length (mm)	33	43	18–28	33 (holotype) 23–30 (paratypes)
Number of antennal articles	17	12 (left) 15 (right)	17	17
Glabrous antennal articles	1 to 7	1 to 4	1 to 4	1 to 4
Number of teeth on forcipular tarsungula	9	13	8 or 9	13 (holotype) 11–13 (paratypes)
Complete paramedian suture	tergites 3 to 20 sternites 4 to 20	tergites 6 to 20 sternites ?	tergites 6 to 20 sternites 13 to 19	tergites 6 to 20 sternites 11 to 19
Sternite of ultimate leg-bearing segment (LBS)	noticeably truncated in posterior part	noticeably narrowed in posterior part	noticeably narrowed in posterior part	strongly narrowed in posterior part
Ultimate leg coxopleuron	longer than sternite of ultimate LBS	longer than sternite of ultimate LBS	as long as sternite of ultimate LBS	as long as sternite of ultimate LBS
Prefemoral spur on leg 1	absent	1	absent	absent
Femoral spur on leg 1	1	1	absent	absent
Tibial spurs	absent	two spurs on legs 1 and 2	one spur on legs 1 to 2 or 3	one spur on legs 1 and 2
Tarsal spurs	two spurs on leg 1 one spur on legs 2 to 20	two spurs on legs 1 and 2 one spur on legs 3 to 20	two spurs on legs 1 to 3 one spur on legs 4 to 20	two spurs on legs 1 to 14 one spur on legs 15 to 20
Posterior dorsal groove of ultimate legs	prefemur and femur	only on femur	only on femur	only on femur
Convex underside of ultimate legs	tarsus 1 and tarsus 2	only on tibia	only on tibia	tibia and tarsus 1
Pretarsus of ultimate legs	longer than tarsus 1	longer than tarsus 1	shorter than tarsus 1	as long as tarsus 1
Geographical distribution	Known only from the type locality in Tomohon, Sulawesi (=Celebes), Indonesia	Penang Hill, Penang, Malaysia	Penang Botanical Gardens and Penang Hill, Penang, Malaysia	Similan and Surin Islands, Phangnga, Thailand

### Key to species of *Sterropristes*

- 1a. Antennal articles 1 to 4 glabrous with scattered setae .....2  
 1b. Antennal articles 1 to 7 glabrous with scattered setae .....*S. sarasinorum*  
 2a. Convex underside of ultimate leg only on tibia .....*S. metallicus*  
 2b. Convex underside of ultimate leg on tibia and tarsus 1 ..... *S. violaceus* **n. sp.**

## Acknowledgements

We would like to thank B. Ng (USM, Penang) for her helpfulness during fieldwork in Penang, Malaysia; E. Stöckli (NMB, Basel) for kindly permitting loan of a type specimen; U. Buchsbaum (ZSM, Munich) for kindly photographing a type specimen. We also thank the staff of the Plant Genetic Conservation Project initiated by Her Royal Highness Princess Maha Chakri Sirindhorn and the Navy Special Warfare Unit of The Royal Thai Navy for providing us with considerable help and encouragement which made our fieldwork at Similan and Surin Islands possible. We also would like to express our gratitude to the Animal Systematics Research Unit members, Chulalongkorn University, for their assistance in collecting material and to T. Krutchuen for excellent drawings. This project was funded by the Thai government budget 2011, under the Research Program on Conservation and Utilization of Biodiversity and the Center of Excellence on Biodiversity, Faculty of Science; the 90<sup>th</sup> Anniversary of Chulalongkorn University Fund; the National Research University Project of Thailand FW646A (2011–2013).

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### Research publication

Muadsub, S., Sutcharit, C., Pimvichai, P., Enghoff, H., Edgecombe, G.D. and Panha, S. 2012. Revision of the rare centipede genus *Sterropristes* Attems, 1934, with description of a new species from Thailand (Chilopoda: Scolopendromorpha: Scolopendridae). *Zootaxa*. 3484: 35–52.

### Oral presentation

Muadsub, S., Sutcharit, C. and Panha, S. 2012. Taxonomy of Scolopendromorpha centipedes in Phang Nga province. The 2<sup>nd</sup> Conference on Taxonomy and Systematics in Thailand, Khon Kaen University, Khon Kaen.