Taxonomy and Biogeography of the Family Macrochelidae (Acari: Mesostigmata) Associated with Dung Beetles (Coleoptera: Scarabaeidae) in Kalimantan, Indonesia

(インドネシア・カリマンタンにおける食糞性コガネムシ科甲虫に便乗するハエダニ科（ダニ亜綱：トゲダニ目）の分類および生物地理学的研究)

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Contents

Abstract

As a result of faunal survey on macrochelid mites in Kalimantan, Indonesia, 35 species of four genera belonging to the family Macrochelidae (Acari: Mesostigmata) associated with dung beetles (Scarabaeidae) were recorded and described. Three new species were described for the first time in the present thesis (*Macrocheles lumbiensis*, *M. lorensis*, and *Neopodocinum murungensis*), three species were already described and published by author during the study (*M. dayaci*, *M. riparius*, and *M. wainensis*), 16 species have already known previously, and 13 species recorded from Kalimantan for the first time. A key to 35 species (female) of the family in Kalimantan was provided.

Based on morphological characters, especially dorsal and sternal characters, three species of the genus *Holostaspella* were classified into 3 species groups (*bifoliata*, *mirabilis*, and *sculpta* species group). Nineteen species of the genus *Macrocheles* maybe classified to the four species groups (*glaber* species group, *muscaedomesticae* group, *subbadius* group, and *krantzi* group) and seven species complexes. Five complexes are belonging to *glaber* group, i.e., *glaber* complex (including *Macrocheles* sp. aff. *glaber* (Müller, 1860), *M. oigru* Walter and Krantz, 1986, and *M. dayaci* Dwibadra and Takaku, 2014), *kraepelini* complex (including *M. kraepelini* (Berlese, 1905) and *M. hallidayi* Walter and Krantz, 1986), *scutatus* complex (*M. dispar* (Berlese, 1910), *M. entetiensis* Hartini and Takaku, 2005, *M. jabarensis* Hartini and Takaku, 2003, *M. nidus* Hartini and Takaku, 2013, and *M. persimilis* Hartini, Dwibadra and Takaku, 2007), *pumilus* complex (including *M. pumilus* Hartini, Dwibadra and Takaku, 2009 and *M. riparius* Dwibadra and Takaku, 2014), *baramensis* complex (including *M. baramensis*, *M. kalimantanensis*, and *M. lumbiensis*). One species complex, *merdarius* complex, is included in *subbadius* group. The *krantzi* species group and *pumilus* and *baramensis*

complexes belonging to *glaber* species group were established and their diagnoses were defined here.

Macrochelids of Kalimantan (including Malaysian part) were found to be phoretic on 9 genera of scarab beetles *Aphodius*, *Caccobius*, *Catharsius*, *Copris*, *Onitis*, *Oniticellus*, *Onthophagus*, *Paragymnopleurus*, and *Sisyphus* (Coleoptera: Scarabaeidae), one genus of geotrupid beetle *Bolbochromus* (Geotrupidae), and one genus of scavenger scarabaeid beetle *Phaeocroops* (Hybosoridae). Twenty two species of mites were collected from the genus *Catharsius*, 19 spp. from *Onthophagus* and 13 spp. from *Paragymnopleurus*. These results suggest that larger sized genus or diversified genus of beetle tend to harbor large number of species of macrochelid mites. Most of macrochelid mites were associated with several genera of beetles (e.g., *Macrocheles hallidayi* were found on 5 genera of beetles, *M. kalimantanensis* on 7 genera of beetles), and macrochelids associated with dung beetles in Kalimantan did not show preference to particular species of dung beetles.

In this study, five groups of geographical region based on the similarity of macrochelid fauna of Borneo and surrounding areas are presented, i.e.: 1) Sumatra, Borneo, and mainland of South East Asia; 2) Java; 3) Sulawesi and Lesser Sunda; 4) The Philippines; and 5) New Guinea. Macrochelid fauna of Borneo is very similar to that of mainland of South East Asia rather than Sumatra, and it is dissimilar to that of Philippines. These data may be consistent with geological history in Oriental Region. Geological data suggest that Borneo had been connected with mainland of South East Asia by land for long geological time, while it had not been connected with the Philippines except for Palawan Island.

Distribution data of Indonesian macrochelid species indicated that there were a

few cosmopolitan species, and distributions of most species were restricted in Oriental and Australian Regions. Macrochelid fauna in Indonesia showed peculiarity due to high endemic species rate of macrochelids exceeding 50%. As a result of analysis of distributional pattern of mites in Indonesia, species with disjunct distribution or wide distribution tended to have association with a variety of beetles genera, and the associations appeared to increase opportunity of dispersal.

PREFACE

The family Macrochelidae contains a very large number of species of mites, approximately 400 species of the family have been described to date, and number of extant species will be found to exceed 2000 (Krantz, 1998). Macrochelid mites are found wherever organic matter is decomposing, especially in dung and carrion, compost and litter. In these habitats they prey not only on small arthropods, especially the eggs and larvae of flies, but also able to feed on other prey such as nematodes and oligochaetes. The flies that breed in these habitats are sometimes pests of humans and their livestock, and the observation that macrochelids prey on these species has been the motivation for much of the biological and taxonomic work that has been done on the family (Halliday, 2000). Most species of the family are associated with insects, especially dung scarabaeid beetles, and they utilize the beetles as vehicles for appropriate habitat. Therefore, I expect that plenty of number and species of mite will be collected from such beetles, and samples will include several species new to science.

The Borneo island covers more than 746,000 km^2 and it make the island as the third largest island in the world and the largest land mass in the Sunda region. Borneo is divided into three political territories, i.e. Kalimantan (the Indonesian territory), Sarawak (Malaysian territory), and the independent sultanate of Brunei Darussalam. Kalimantan is the largest area of this island, covers almost 73% of the island. The climate of Borneo is characterized by frequent rainfall and high temperatures throughout the year. Up to 1950s almost the whole island was covered by tropical evergreen rain forest. Other types rainforest also exist in this island, such as ‘Kerangas’, carbon-rich peat swamp forest, freshwater swamps and mangrove forests which are

grow next to the shore line and cover coastal plains. With the high diversity of habitat condition, Borneo provides a fascinating area for various sort of biological studies. However, small invertebrates like mites and ticks including macrochelid mites are still poorly investigated taxonomically. Moreover, the condition is worsen by the fact that all natural ecosystem in this island are under pressure by over-exploitation and fire (Langner, 2007; MacKinnon *et al*., 1996).Therefore, in the present thesis, I will make a taxonomic study of the group that has been poorly studied, the mites of the family Macrochelidae.

Indonesia consists of three zoogeographic divisions, i.e., Oriental Region, Australian Region, and transitional zone (*Wallacea*), and the biodiversity in Indonesia has been fascinating many taxonomists and biogeogaphers. Taxonomic study on macrochelid mites in Indonesia was started by Oudemans (1903), and has been continued for more than 100 years by several acarologists in various islands in Indonesia (e.g., Berlese, 1905; Vitzthum, 1925; Krantz, 1965; Hartini and Takaku, 2003a–c). However, there was no comprehensive study on macrochelids in Kalimantan, and information of the fauna in Kalimantan is invaluable for elucidation of Indonesian macrochelid fauna and biogeography of the mites.

The present thesis comprises two parts. Part I contains records and descriptions of all the species of macrochelid mites from Kalimantan, Indonesia, including some newly described species and those recorded from Kalimantan for the first time. Part II contains the biogeography and distribution of Macrochelidae in Kalimantan and surrounding areas.

I. Description of Phoretic Macrochelidae Associated with Dung Beetles in Kalimantan, Indonesia

I. 1. Introduction

Studies of macrochelid mites in Indonesia were started by Berlese (1905, 1910, 1911, 1921), then followed by Vitzthum (1925, 1926). The family of Macrochelidae itself was established by Vitzthum (1930). The work on this family then continued by Oudemans (1931), Krantz (1965, 1967a, b), Walter and Krantz (1986a, b), Hartini and Aziz (1992), Takaku (1998, 2001), Takaku and Hartini (2001), Hartini and Takaku (2003a, b, c, 2004, 2006a, b, 2010, 2012), Hartini *et al*. (2003, 2005, 2007, 2009, 2012, 2013), Hartini and Dwibadra (2011), Dwibadra (2010), and Dwibadra *et al*. (2008, 2014).

Several taxonomic studies on macrochelid mites have been carried out in Sumatra and Java in the Greater Sunda Islands (*e.g.*, Vitzthum, 1925; Takaku, 2001; Hartini and Takaku, 2003a, b, c; Hartini *et al*., 2009), where more than 30 species have been recorded, but there has been no comprehensive study of macrochelids in Kalimantan, that is Indonesian territory of Borneo. To date, 16 species of macrochelids have been recorded from Kalimantan by Hartini and Takaku (2003b, 2004) and Hartini *et al*. (2003), all collected from scarabaeinae dung beetles. These species belong to three genera: *Macrocheles* (10 species), *Neopodocinum* (5 species), and *Holostaspella* (1 species). Although most of the species were collected from East Kalimantan, *Macrocheles hallidayi* Walter and Krantz, 1986, *M. kraepelini* (Berlese, 1905), and *M.* sp. aff. *glaber* (Müller, 1860) were also collected from Central Kalimantan.

In this thesis, I record and describe 35 species of macrochelid mites, including 3

new species of the genus *Macrocheles*, 16 species already described previously, and 16 species recorded from Kalimantan for the first time.

I. 2. Materials and Methods

Mites were collected at 26 sites in Kalimantan (Fig. 1). Host beetles were collected using pitfall traps baited with fresh human dung or fish fillet which were set in several kinds of habitat. All scarab beetle specimens were fixed in 70% ethyl alcohol in the field. Collected specimens from one trap were kept in the same vial. Some mites were collected from the ventral surface of the scarab beetles, and others detached from beetles were collected from residue in the vials in which the scarabs had been fixed and preserved.

All mite specimens were preserved in 70% ethyl alcohol. Some were dissected under a stereoscopic microscope after clearing in lactic acid 60% for few days. The specimen was dissected following to the method of Krantz (1978): dorsal and ventral shields were separated by minute pins and chelicerae were removed from gnathosoma. As a result, there are three parts of dissected specimens, i.e., dorsal shield, ventral body with gnathosoma, and chelicerae.

Each body part was mounted on a slide in PVA (polyvinyl alcohol-lactic acid mixture) medium. Observations were made with phase contrast and differential interference contrast microscopes. Illustrations were prepared with the aid of a drawing tube.

All measurements are given in micrometres (μm). Dorsal chaetotaxy follows Halliday (1987) and other terminology follows Walter and Krantz (1986b).

The holotype specimen of each new species will be deposited in the collection of the Museum Zoologicum Bogoriense, Cibinong, Bogor, Indonesia (MZB), and the remaining specimens will be divided between the MZB and The Hokkaido University Museum, Sapporo, Japan.

I. 3. General Morphology and Terminology

The family Macrochelidae belongs to the superfamily Eviphidoidea, subcohort Dermanyssiae, Cohort Gamasina, suborder Monogynaspida, order Mesostigmata (Krantz and Walter, 2009).

In the present thesis, terminology for morphological study use terminology by Evans and Till (1979) which had been modified by Krantz (1981). In 1964, van der Hammen started detailed study of Macrochelidae with *Glyptholaspis confusa* (Foà), then followed by Evans and Till (1979) by publishing an extensive morphological study of Mesostigmata in Britain and Ireland. Krantz modified the terminology of Evans and Till in 1981 and now this modified terminology have been used generally (Hallidayi, 1986a, 1988, 2000; Hyatt and Emberson, 1988; Walter and Krantz, 1986a, b; Takaku, 1998, 2001).

The body of Acari is consisted of two major body divisions, an anterior gnathosoma (Fig. 3A) and the posterior idiosoma. Gnathosoma carries the primary organs of food gathering, preoral digestion and sensory organs, whereas idiosoma carries organs for locomotion (four pairs of legs in adult and three pairs of legs in larvae), postoral digestion, reproduction, respiration, and secretion (Alberti and Coons, 1999; Krantz and Walter, 2009).

1) Adults

Idiosoma

Dorsum (Fig. 2B)

The dorsal surface of macrochelid mites is covered by dorsal shield, which is

ornamented with various degrees of reticulation and/or punctures and bears a number of dorsal setae (Fig. 2C). In the present thesis, dorsal chaetotaxy of Halliday (1987) is used. Dorsal chaetotaxy (Fig. 4) was developed by Linquist and Evans (1965) for the family Ascidae, and now has been applied to other groups of the cohort Gamasina (Hyatt and Emberson, 1988), and reviewed on the family Macrochelidae by Halliday (1986c, 1987). There are four pairs of longitudinal series of setae on the dorsal shield. The series of setae are designated from the center to the margin as j–J series, z–Z series, s–S series, and r–R series. The dorsal hexagon formed by setae j5, z5, and j6, is located at the central region of dorsal shield, and it has been used to define the posterior limit of the dorsal anterior half. The number and shape of dorsal setae on the dorsal shield and ornamentation of the ventral shield are mainly used as the generic and specific characters.

Venter (Fig. 2A)

The ventral surface of female specimen is covered with three main shields, i.e. sternal shield, epigynial shield, and ventrianal shield while in the male, one (holoventral) or two (sternoventral and ventrianal) shields are present. The shape and ornamentation of the shields are important for taxonomic study because it differ from species to species or from genus to genus. Female sternal ornamentation is particularly important for defining genus and species, and the pattern of lines on the shields established by Berlese (1918) have been used to taxonomic studies of Macrochelidae.

The setation of the ventrianal shield is variable in the family or in each genus. In the female, three to five pairs of preanal setae are usually present on the shield. In some cases, the most anterior pair of preanal setae is located on the integument. In the male, three to five pairs of preanal setae are present on the shield.

Metasternal shield and metapdal shield are usually small, and free from or fused to other shields. Posterior extremities of peritreme bend antero-ventrally.

In female *Holostaspella katakurai* Hartini and Takaku, 2003, two pairs of small platelet are present in between epigynial and ventrianal shield.

Legs

Idiosoma bears four pairs of legs which comprise seven primary segments, i.e., coxa, trochanter, femur, genu, tibia, tarsus, and ambulacrum. Tarsi II to IV have claws and ambulacra, whereas tarsus I lacks these structures (Fig. 2E), except that in the genus.

The chaetotaxy of each leg was expressed by the chaetotactic formula proposed by Krantz (1978) who followed Evans (1963). The setae on the antero-lateral and postero-lateral surfaces were designated antero-lateral (al) and postero-lateral (pl) setae, respectively. The dorsal surface of segment was divided into anterior and posterior regions, so the setae on each region were designated antero-dorsal (ad) and postero-dorsal (pd) setae. Those on the anterior and posterior regions of the ventral side were designated antero-ventral (av) and postero-ventral (pv) setae. The chaetotaxy of the leg segments was expressed by the following formula: al, ad/av, pd/pv, pl. For example, the formula 2, 3/1, 2/1, 2 indicates that the segment has 2 antero-lateral, 3 antero-dorsal, 1 antero-ventral, 2 postero-dorsal, 1 postero-ventral, and 2 postero-lateral setae. Macrochelid mites have a fairly constant pattern of leg chaetotaxy, and typical leg chaetotaxy of the family Macrochelidae is given below in Table 1.

Although most of the macrochelid mites have this pattern of leg chaetotaxy, there are some exceptions. For example, in some species of the genus *Macrocheles* genu

IV has seven setae and genus *Neopodocinum* has only four setae on trochanter III. The difference of leg chaetotaxy is taxonomically important at generic or species group or species level.

Table 1. Pattern of leg chaetotaxy of the adult Macrochelidae.

	coxa	trochanter	femur	genu	tibia
Leg I	0,0/1,0/1,0	1,0/1,0/2,1	2,3/1,2/3,2	2,3/1,2/1,2	2,3/2,2/1,2
Leg II	0,0/1,0/1,0	1,0/1,0/2,1	2,3/1,2/2,1	2,3/1,2/1,2	2,2/1,2/1,1
Leg III	0,0/1,0/1,0	1,1/1,0/1,1	1,2/1,1/0,1	1,2/1,2/0,1	1,1/1,2/1,1
Leg IV	0,0/0,0/1,0	1,1/2,0/1,0	1,2/1,1/0,1	1,2/1,1/0,0	1,1/1,2/1,1

Michael's organ (Sacculus foemineus)

Michael's organ is a spermathecal complex in the female which has been described for a number of macrochelid mites (Petrova, 1960; Costa, 1966, 1967; Krantz, 1981) and used as taxonomic characters at the generic or species group or species level (Evans and Till, 1979; Hyatt and Emberson, 1988). This structure consists of a pair of tubulus annulatus, ramus, cornu, and a pair of sacculi. Tubulus annulatus start from the base of coxa III, are connected by a ramus to a pair of sacculi. The sacculi are broadly fused or divided, and are distally connected to a cornu. The surfaces of sacculi are wrinkled or smooth or ornamented with processes. A sperm duct starts from the distal tip of the cornu, and terminates at the spermatheca.

Gnathosoma

Palpal and cheliceral segments belong to gnathosoma. The chaetotaxy of the palp in macrochelidae was investigated by Evans (1964), who showed the chaetotaxy of the trochanter, femur, genu, tibia, and tarsus as 2-5-6-14-15. The setae of the distal segments, particularly the tarsus, however, are often hard to observe. The tarsus of the

palp has a trifid apotele. The fixed digit and the movable digit of the chelicerae have smooth teeth. In the male, the movable digit has a sperm transfer organ called spermatodactyl. The numbers of the teeth, length of the cheliceral arthrodial processes, and shape of the spermatodactyl are taxonomically important at the generic or species group level.

Ventral surface of gnathosoma has three pairs of hypostomatic setae, a pair of palcoxal setae, and a deutosternal groove with some rows of denticles. Dorsal surface of gnathosoma has a process termed tectum which is important to distinguish between genera or between species groups. Most all stage of Macrochelidae, hypostomatic setae are similar in shape.

2) Deutonymph

Idiosoma

Dorsum

The dorsal shield of idiosoma is laterally incised at the level of dorsal setae z6 and ornamented with various degrees of reticulation and punctures. The shield of *Macrocheles* in Indonesia has 28–29 pairs of setae, while some of the genus *Neopodocinum* have unpaired setae (Krantz, 1965). The number and ornamentation of the setae are taxonomically important at the species level. Dorsal chaetotaxy of deutonymph is same as that of adults.

Venter

The ventral surface has an oblong sternoventral shield and an oval anal shield. The sclerotizations of these shields are weaker than that of adults. The sternoventral shield has four pairs of setae and three pairs of pores. The anal shield has a pair of

paranal setae and a postanal seta.

Legs

Legs of deutonymph is the same as in adults, tarsus I lacks claws and ambulacra, and tarsi II to IV have claws and ambulacra, except for some species of the genus *Neopodocinum* which has small but distinct claws on tarsus I. The leg chaetotaxy of deutonymph is the same as that of adults.

Gnathosoma

The chaetotaxy of the palp in deutonymph are also similar to those of adults, except for *N. bosschai* with thick conical internal posterior hypostomal setae.

3) Protonymph

Idiosoma

Dorsum

The dorsal shield is divided into anterior (podonotal shield) and posterior shield (podonotal shield). Podonotal shield has usually 11 pairs of setae, and opisthonotal shield has usually 8 setae. The dorsal chaetotaxy is as in Fig. 4A. The ornamentation and sclerotization of the dorsal shield are weaker than those of deutonymphs and adults.

Venter

Venter is covered with sternoventral and anal shield which have weak ornamentation. Sternoventral shield has three pairs of setae and two pairs of pores, and anal shield has a pair of paranal setae and a postanal seta.

Legs

Legs of deutonymph is also the same as in adults and deutonymphs. There is no

claws and ambulacra on tarsus I, and tarsi II to IV have claws and ambulacra (exceptionally, in some species of the genus *Neopodocinum* the protonymphs have small claws on tarsus I). The leg chaetotaxy of the protonymph is given below.

Table 2. Leg chaetotaxy of the protonymph of Macrochelidae.

	coxa	trochanter	femur	genu	tibia
Leg I	0,0/1,0/1,0	1,0/1,0/1,1	2,2/1,2/1,2	2,2/0,2/1,1	2,2/1,2/1,1
Leg II	0,0/1,0/1,0	1,0/1,0/1,1	2,2/1,2/1,1	2,2/0,2/0,1	1,1/1,2/1,1
Leg III	0,0/1,0/1,0	1,0/1,0/1,1	1,2/1,1/0,1	1,2/1,2/0,1	1,1/1,2/1,1
Leg IV	0,0/0,0/1,0	1,1/2,0/0,0	1,2/0,1/0,0	1,2/0,2/0,0	1,1/1,2/1,1

As in adults and deutonymphs, there are some exceptions. For example, in some species of the genus *Macrocheles*, genu IV has six setae.

Gnathosoma

The chaetotaxy of the palp in protonymphs is 1-4-5-12-15. Other gnathosomal characters of the deutonymphs are similar to those adults, but the shape of tectum is more simple; for example, lateral processes of tectum are absent in protonymph, whereas they are present in deutonymphs and adults.

4) Larva

Idiosoma

Dorsum

There is no distinct dorsal shield in larva. In the genus *Holostaspella*, the podonotal shield is present, but sclerotization is weak. Some of posterior dorsal setae are present on the ventral side.

Venter

Ventral shield has three pairs of intercoxal setae inserted in integument. Anal

opening is distinct but anal shield is absent. Stigma and peritreme are undeveloped.

Legs

The larva has three pairs of legs. As in other ontogenic stages, there is no claw and ambulacra on tarsus I, and tarsus II and III have claws and ambulacra, except in some species of the genus *Neopodocinum* in which the larva have small claws also on tarsus I. The leg chaetotaxy of the larva is in Table 3.

Table 3. The leg chaetotaxy of the larva in family Macrochelidae.

	coxa	trochanter	femur	genu	tibia
Leg I	0,0/1,0/1,0	1,0/1,0/1,1	2,2/1,2/1,2	1,2/0,2/1,1	1,2/1,2/1,1
Leg II	0,0/1,0/1,0	1,0/1,0/1,1	1,2/1,2/0,1	1,2/0,2/0,1	1,1/1,2/1,1
Leg III	0,0/1,0/1,0	1,0/1,0/1,1	1,2/1,1/0,0	1,2/0,2/0,1	1,1/1,2/1,1

Gnathosoma

The chaetotaxy of the palp in larva is larva is 0-4-5-12-11. The chelicerae are blunt, teeth are poorly developed, and arthrodial processes are absent or very weak. The apotele is bifid or trifid. The shape of tectum is unipartite. On ventral side, only two pairs of hypostomatic setae are present.

I. 4. Remarks on the Description

Description of Material

The description of the female of each species was based on more than one specimen if available, and included all kinds of morphological variations observed. The male and immature stages were also described for some species of the genus *Neopodocinum*, though the numbers of samples obtained were small in some species.

Scientific name of the host beetles followed Balthasar (1963a, b, 1964).

Abbreviations

The following abbreviations were used in the figures and descriptions. Abbreviations used in description are given below:

Abbreviations used for female sternal shield (Fig. 3B):

st. 1: sternal setae 1; most anterior paired setae of three pairs on the sternal shield.

st. 2: sternal setae 2; second pairs of three pairs on the sternal shield.

st. 3: sternal setae 2; most posterior paired setae of three pairs on the sternal shield.

a. pf.: area punctiformes; median punctate field posterior to l.m.t.

a. p. l.: area punctatae laterales; punctate field lateral to sternal pore 2

a. p. p.: area punctatae posteriores; punctate field posterior to l.m.t. and along l.o.p.

l. ang.: linea angulata; anterior convergent line starting from sternal pore 1

l. arc.: linea arcuata; short medial transverse line in anterior half

l. m. t.: linea media transversa; transverse line connecting st.2

l. o. a.: linea oblique anteriores; anterolateral line between sternal pore 1 and st.2

l. o. p.: linea oblique posteriores; posterolateral line between l.m.t. and st.3

Abbreviations of the localities used in the descriptions:

BBG: Balikpapan Botanical Garden

BHP Biliton: name of company mining natural resources

CA: Cagar Alam (Natural Reserve)

km. 12 to km. 38: points 12–38 km away from Balikpapan on the road from Balikpapan to Samarinda

SWPF: Sungai Wain Protection Forest (= Hutan Lindung Sungai Wain)

Tahura: Taman Hutan Raya (Forest Park)

TWA: Taman Wisata Alam (Natural Tourism Park)

Type-depository

Holotypes and paratypes of species described as new to science will be deposited in the Museum Zoologicum Bogoriense (MZB) in Zoology Division, Research Center for Biology-LIPI, Indonesia, and a part of paratypes in Hokkaido University Museum, Japan.

I. 5. Description and Remarks

Family **Macrochelidae** Vitzthum, 1930

Macrochelidae Vitzthum, 1930: 300.

Diagnosis: Female. Dorsal shield ornamented with lines and punctures; the shield bearing 27–31 pairs of setae. Tritosternum well-developed. Presternal shield absent. Sternal shield with 3 pairs of setae and 2 pairs of pores, a pair of lateral sclerite present; ventrianal shield or anal shield present; peritreme on lateral side of the body, forming hook or U-shape posteriorly, joining to stigma at the end. Gnathosoma with developed corniculi, tripartite or unipartite tectum; palpapotele three-tined; movable digit of chelicerae with 1 or 2 arthrodial processes on the base. Lack of claws on the first tarsi; tarsi II–IV with developed ambulacra and claws; each of tibia and genu I with 2 anterolateral setae; genu IV with 6–8 setae. Sacculus foeminus internally located.

Male. Ventral side with holoventral shield or sternoventral and vetrianal shield; genital orifice at the center of anterior margin of sternoventral or holoventral shield; movable digit of chelicerae with short thick or long sinuous spermatodactyl; leg II, and leg IV in some species, with various modified spurs.

Free living in various habitats, found in soil, leaf litter, beachside debris, poultry manure, dung, or phoretic on insect and mammals.

Five genera have been recorded in Indonesia: *Geholaspis* Berlese, 1918; *Glyptholaspis* Filipponi and Pegazzano, 1960; *Holostaspella* Berlese, 1903; *Macrocheles* Latreille, 1829; and *Neopodocinum* Oudemans, 1902. Four of them, except *Geholaspis*, were found in Kalimantan.

Genus ***Glyptholaspis*** Filipponi and Pegazzano, 1960

Glyptholaspis Filipponi and Pegazzano, 1960: 136.
Nothrholaspis Berlese, 1918: 169 (*partim*).
Macrocheles: Evans and Browning, 1956: 10 (*partim*).
Type species: *Nothrholaspis fimicola* Sellnick, 1931 (=*Gamasus tardus* Berlese, 1882).

Diagnosis: Female. Dorsal shield sclerotized and distinct reticulation present; lateral and posterior margin crenulate; dorsal shield with 28 or 29 pairs of setae or with additional unpaired

seta; dorsal setae strongly plumose, pilose or simple; insetion of j1 separated. Sternal shield with polygonal ornamentation; sternal shield extended posteriorly to posterior margin of coxa III. Metasternal shield adjacent to posterior margin of sternal shield. Ventrianal shield expanded laterally. Gnathosoma well developed; median process of tectum bifurcated distally. Leg I without claws and ambulacra.

Male. Venter of the male with holoventral shield which ornamented with polygonal pattern; genital orifice at center of anterior margin of the shield. Spermatodactyl present at movable digit. Spurs present on Leg II, III, and IV.

Free living or phoretic on insect or mammals.

Glyptholaspis asperrima (Berlese, 1905)

(Fig. 5A, B)

Holostaspis asperrimus Berlese, 1905: 163, fig. 25.

Macrocheles (*Macrocheles*) *asperrimus*: Berlese, 1918: 172.

Glyptholaspis asperrima: Filipponi and Pegazzano, 1960: 166, fig. 9, tav. XI; 1962: 202; Krantz, 1967c: 150–152; Roy, 1989b: 346–348, figs 10–14; Takaku *et al*., 2012: 102, figs 10, 31, 52; Hartini *et al*., 2013: 51.

Diagnosis: Female. Dorsal length less than 1,100 μ m; dorsal setae J5 as long as Z5; posterior margin of dorsal shield with regularly spaced small teeth between setae Z5. Sternal shield fused with metasternal shield and ornamented with distinct polygonal ornamentation.

Material examined: **East Kalimantan**: 1 female, *Acacia mangium* Willd plantation, km. 18, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *A. mangium* plantation, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex Onthophagus semicupreus* Harold, 1877; 3 females, km. 23, Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *A. mangium* plantation, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, km.. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; **West Kalimantan**: 2 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp. and *Catharsius* sp.; 1 female, Ranao Teluk, Tayan Hilir,

Sanggau, 24 October 2012, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, *ex Catharsius* sp.

Habitat: This species has been collected from the scarab beetle genera *Aphodius*, *Catharsius*, *Copris*, *Onitis*, and *Onthophagus*; otherwise it has been collected from cow dung, compost, manure, etc.

Distribution: Indonesia [Bali, Sulawesi, Flores, Java, Kalimantan (new record)], Philippines, China, India, England, Iceland, Italy, Greece, South Africa, Congo, and North America.

Glyptholaspis confusa (Foà, 1900)

(Fig. 5C, D)

Holostaspis confusus Foà, 1900: 137, figs 5, 5 bis, 6.

Macrocheles (*Macrocheles*) *vagabundus* var. *neotropicus* Berlese, 1918: 173 [partim].

Macrocheles plumiventris Evans and Browning, 1956: 36; Filipponi and Seganti, 1957: 27; Balogh, 1958: 253, figs 26–30.

Macrocheles (*Macrocheles*) *confusus*: Filipponi and Ilardi, 1958: 118.

Glyptholaspis confusa: Filipponi and Pegazzano, 1960: 154, figs 5, 6, tav. VII, VIII; Krantz, 1972: 270; Halliday, 1986b: 73; Hyatt and Emberson, 1988: 116; Mašán, 2003: 122, figs 124–125; Takaku *et al*., 2012: 104.

Diagnosis: Female. Dorsal shield large, oval, with punctate-reticulate pattern; posterior margin of dorsal shield between setae Z5 with 5 large denticles and numerous microdenticles; most dorsal setae brush-shaped and densely plumose; setae j5 brush-shaped and longer than z6; setae j6, z5, and 1 unpaired median seta between j6 and J2 pilose; setae z6 and J2 pilose distally; network meshes of sternal and ventrianal shield mostly micropunctured; ventrianal shield with truncate anterior margin; preanal setae short and brush-like.

Material examined: **East Kalimantan**: 1 female, *Acacia mangium* plantation, km. 22, Balikpapan, 23 December 2006, D. Dwibadra leg., *ex* residue in vial; 3 females, 4–9 December 2008, *ex* residue in vial, BBG, Balikpapan.

Habitat: This species has been found from the scarab beetle genera *Aphodius*, *Euoniticellus*, *Liatongus*, and *Onthophagus*. This was also collected from cadavers and in compost heaps, decaying fodder, silage, and bird nests.

Distribution: Indonesia (Kalimantan; new record), Philippines, Japan, Israel, Turkmenistan, Uzbekistan, Australia, New Zealand, British Isles, Germany, Switzerland, Austria, Slovakia, Italy, Bulgaria, Greece, Russia, Caucasus, and Argentina.

Genus ***Holostaspella*** Berlese, 1903

Holostaspella Berlese, 1903: 241.
Holostaspella (*Prholaspina*) Berlese, 1918: 175.
Areolaspis Trägårdh, 1952: 61.
Aethiolaspis Van Driel and Loots, 1975: 587.
Type species: *Holostaspella* (*Holostaspella*) *sculpta* Berlese, 1903.

Diagnosis: Female. Dorsal shield with sclerotization and ridges or punctures ornamentation; bearing 28 or 29 pairs of setae; j1 expanded, short, pilose, and inserted on anterior projection (with exception in some species). Sternal shield with ridges or punctures ornamentation. Metasternal shield small and free from sternal shield or large and adjacent to sternal shield. Epigynial and ventrianal shield with punctures, ridges, and lines ornamentation. Gnathosoma with tripartite tectum and lateral processes separated. Leg I without claws and ambulacra; leg II with spur (with exception in some species); mid-ventral seta of tarsus II developed into strong spine.

Male. Venter with holoventral or sternoventral and ventrianal shield separately; genital orifice at center of anterior margin of the shield. Spermatodactyl present at movable digit. Spurs present on Leg II.

Free living or phoretic on insect or mammals.

bifoliata species group

Diagnosis: Female. Dorsal shield with 28 pairs of setae; j1 expanded, short, pilose, inserted on anterior projection. Sternal shield without anterior ridge formed by l. ang., and without distinct posterior punctate ridge; shield with posterior arch formed by l. o. p. and l. m. t. Metasternal free from sternal shield. Ventrianal shield expanded in lateral side, strong sclerotization, and with 3 pairs of preanal setae; leg II with spur.

Male. Holoventral shield with weak sclerotization. Other characters typical for the genus.

Free living in various habitats, i.e., leaf litter, compost, soil, phoretic on sung beetles and small mammals.

Species group members: *Holostaspella bifoliata* (Trägårdh, 1952) and *H. polytrema* Krantz, 1967.

Holostaspella bifoliata (Trägårdh, 1952)

(Fig. 6A, B)

Aerolaspis bifoliata Trägårdh, 1952: 61–63, figs 23–29.

Holostaspella bifoliata: Krantz, 1967b: 113–118, figs 23–31, 77, 82, 86; Filipponi and Pegazzano, 1967: 243–248, fig. 15, pls 23–4, 24–5, 26; Ishikawa, 1968: 201; Halliday, 1988: 151, fig. 2; Roy, 1989a: 337–339, figs 24–25; Hartini *et al*., 2005: 202; Hartini and Takaku, 2010: 108; Takaku *et al*., 2012: 99.

Diagnosis: Female. Dorsal shield with punctate pattern, laterally with a series of punctate rounded depressions; most dorsal setae short and simple; j1 broadly plumose, inserted on anterior protuberance of the shield; J5 pectinate. Sternal shield strongly punctate, posterior half with distinctive arched pattern; ventrianal shield large, rounded, slightly wider than long, and ornamented with punctate-reticulate pattern. Femur II with spurs ventrally; mv on tarsus II spinose.

Material examined: **West Kalimantan**: 1 female, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius*; 1 female, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius*;

South Kalimantan: 2 females, Tahura Sultan Adam, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.

Habitat: This species has been collected from scarab beetles *Dichotomius carolinus*, *Onitis alexis*, *Oni*. *aygulus*, *Oni*. sp., *Onthophagus australis*, *Ont*. *gazella*, *Ont*. *granulatus*, *Ont*. *laminatus*, *Ont*. *viduus*, *Taurocopris mimas*, and *Phanaeus corythus*. This species was recorded from *Trox tuberculatus*, *T. suberosa*, *T*. sp. (Coleoptera: Trogidae), *Peromycus leucopus* (Mammalia: Rodentia) and also taken in litter, bark, soil, compost heap, decaying bark heap, vegetable debris, decaying grasses, cattle dung, and soil under weeds.

Distribution: Indonesia [Java, Flores, and Kalimantan (new record)], the Philippines, Singapore, Japan, India, Papua New Guinea, Australia, Israel, Italy, Costa Rica, Peru, Tahiti, USA, and South Africa.

mirabilis species group

Diagnosis: Dorsal shield of the female has 28 pairs of setae; ventrianal shield reduced with 2 or 3 pairs of preanal setae; sternal shield without sculptured ornamentation.

Species group members: *Holostaspella mirabilis* Petrova and Tskaeva, 1964 and *H. katakurai* Hartini and Takaku, 2003.

Holostaspella katakurai Hartini and Takaku, 2003
(Fig. 6C, D)

Holostaspella katakurai Hartini and Takaku, 2003b: 348–350, figs 1–8.
Holostaspella katakurai: Hartini and Takaku, 2010: 109.

Diagnosis: Female. Dorsal shield strongly punctate and ornamented; setae j5, j6, z5, and J2 small and pectinate; z5 smaller than other setae and located at level anterior to j5; other dorsal setae pectinate and long; marginal setae long and reaching to insertions of setae behind them. Sternal shield ornamented with punctations except for smooth posteromedial area; ventrianal shield reduced, oval, longer than wide, and with 3 pairs of preanal setae. Femur II with a small spur ventarlly; mv of tarsus II spinose.

Material examined: **North Kalimantan**: 1 female, Lumbis, Tau lumbis, Tau Lumbis, Nunukan E 116°13' 05.4" N 04°18'18.8", 7 July 2009, A. H. Prasetyo leg., *ex* Scarabaeidae; 1 female, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae

Habitat: This species has been collected from scarab beetles *Catharsius molossus*, *Onthophagus blumei*, *O*. sp., and *Paragymnopleurus maurus*.

Distribution: Indonesia (Kalimantan, Java, and Sumatra).

sculpta species group

Diagnosis: Female. Dorsal shield with strong sculptured ornamentation and sclerotization; robust; body size generally large (>800 μm). Sternal shield with perpendicular line or ridge dividing a. p. p.; metasternal shield long (more than two times the width); ventrianal shield broader than long, with 3 or 4 pairs of preanal setae; tarsus II with spinose seta, not spur.

Species group members: *Holostaspella sculpta* Berlese, 1904, *H. ornata* (Berlese, 1904), *H. moderata* Berlese, 1921, *H. subornata* Bregetova and Koroleva, 1960, *H. ainscoughi* Krantz, 1967, *H. anchylothrix* Krantz, 1967, *H. aplodontiae* Krantz, 1967, *H. berlesei* Krantz, 1967, *H. crenulata* Krantz, 1967, *H. parornata* Bhattacharyya, 1972, and *H. similiornata* Roy, 1989.

Holostaspella moderata Berlese, 1921

(Fig. 7A, B)

Holostaspella moderata Berlese, 1921: 188.

Holostaspella (*Holostaspella*) *egregia* Vitzthum, 1925: 16.

Holostaspella moderata: Krantz, 1967b: 130, figs 52, 54.; Filipponi and Pegazzano, 1967: figs III, IV, tav. XIX, 3–4, tav. XX, 2; Roy, 1989a: 334–335, figs 11–18; Takaku *et al*., 2012: 100.

Diagnosis: Female. Dorsal shield punctate, j1 plumose, on anterior projection of shield; z1 longer than j1; dorsal setae weakly or strongly pectinate; sternal shield typical for *sculpta* species group; st1 plumose, st2–3 short, smooth or pectinate; ventrianal shield broader than long

with 3 pairs of long preanal setae; Jv2 and Zv2 smooth or pectinate, Jv3 distally pectinate; paranal and postanal setae short and smooth.

Material examined: **East Kalimantan**: 1 female, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial.

Habitat: This species has been collected from banana plantation litter, grassy soil, leaf litter, and a refuse dump.

Distribution: Indonesia [Sumatra, Java, Kalimantan (new record)], Philippines, Japan, India, and Australia.

Genus ***Macrocheles*** Latreille, 1829

Macrocheles Latreille, 1829: 282.
Coprhrolaspis Berlese, 1918: 146.
Nothrholaspis Berlese, 1918: 169 (*partim*).
Manoplites Hull, 1925: 215.
Macrholaspis Oudemans, 1931: 272.
Andrholaspis Turk, 1948: 103.
Type species: *Acarus marginatus* Hermann, 1804 (=*Acarus muscae domesticate* Scopoli, 1772).

Diagnosis: Female. Dorsal shield with sclerotization, ornamented with reticulation and punctures; margin smooth or serrate; bearing 28 to 30 pairs of setae. Sternal shield with 3 pairs of setae. Metasternal shield free or adjacent to sternal shield, with a seta. Ventrianal shield with 0 to 3 pairs of setae, a pair of paranal setae and a postanal seta. A few pairs of platelet sometimes located between epigynial and ventrianal shield. Gnathosoma well developed with tripartite or unipartite tectum; lateral processes free or fused basally or reduced; movable digit with arthrodial process. Leg I without claws and ambulacra. Genu IV with 6 or 7 setae.

Male. Venter with sternoventral and ventrianal shield separately; genital orifice at center of anterior margin of the sternoventral shield. Spermatodactyl present at movable digit. Ventrianal shield with 3 to 5 pairs of preanal setae; cribrum with paranal extensions. Spurs present on Leg II and IV in some species.

Free living or phoretic on insect or mammals.

glaber species group

Diagnosis: Female. Dorsal shield with well-developed procurved line; dorsal setae j1 pilose distally; J5 serrate entirely; other dorsal setae simple or pilose slightly to strongly or distally to entirely. Sternal shield with ornamented with lines and punctations; l. ang. convergent medially; anterior half of shield with 1 or 2 transverse lines l. arc.; l. o. a. poorly developed; l. m. t. connecting second pair of sternal setae (st 2); l. o. p. bifrurcate, joining l. m. t. or not bifurcate and disjunct from l. m. t.; posterior area of l. o. p. punctate slightly to strongly to make a. p. p. and a. pf. Ventrianal shield pentagonal or subtriangular, sometime expanded laterally; cribrum limited to posterior to postanal seta. Genu IV with usually 6 setae, but rarely 7 setae.

baramensis species complex

Diagnosis: Female. Dorsal shield oval, attenuate posteriorly, covered with fine reticulations and bearing 28 pairs of setae; j1 pilose or plumose in their distal halves, dorsal setae mostly pilose or bipectinate, except simple j5, j6, z5, z6, and J2 (in some cases these slightly pilose). Sternal shield granular with faint linear ornamentation; l. ang., l. arc., l. m. t., and l. o. p. present with or without punctations along lines. Ventrianal shield longer than wide with lines ornamentation.

Macrocheles baramensis Evans and Hyatt, 1963
(Fig. 8A, B)

Macrocheles baramensis Evans and Hyatt, 1963: 335–337, figs 15–17.
Macrocheles baramensis: Hartini *et al*., 2003: 307–308.

Diagnosis: Female. Dorsal shield granular, covered with fine reticulations and bearing 28 pairs of setae; j1 pilose in their distal halves, dorsal setae bipectinate in their distal halves, except simple j5, j6, z5, z6, and J2 (in some cases these slightly pilose). Sternal shield granular with faint linear ornamentation.

Material examined: **East Kalimantan**: 3 females, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex Paragymnopleurus maurus* Sharp, 1875; 6 females,

SWPF, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex P. maurus*; 1 female, SWPF, Balikpapan, 11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, km. 15, Balikpapan, 19 December 2007, *ex* Scarabaeinae; 2 females, km. 15, Balikpapan, 11 December 2008, D. Dwibadra and A. Ueda leg., *ex P. maurus*; 2 females, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 3 females, km. 24, Balikpapan, 14–19 December 2008, D. Dwibadra and A. Ueda leg., *ex P. maurus*; 1 female, burned valleys, km. 24, Balikpapan, 5–10 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 5 females, km. 12, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex* Scarabaeinae; **North Kalimantan**: 35 females, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg., *ex Paragymnopleurus* sp., *Onthophagus* sp., *Sisyphus* sp., and *Catharsius* sp.; 15 females, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **West Kalimantan**: 8 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Paragymnopleurus* sp.; **Central Kalimantan**: 99 females, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; **South Kalimantan**: 1 female, Tahura Sultan Adam, Karang intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex* residue in vial.

Habitat: This species has been collected from the scarab beetle genera *Catharsius*, *Onthophagus*, and *Paragymnopleurus*.

Distribution: Indonesia (Kalimantan) and Malaysia (Sarawak).

Macrocheles kalimantanensis Hartini and Takaku, 2003
(Fig. 8C, D)

Macrocheles kalimantanensis Hartini and Takaku, 2003 in Hartini *et al*. 2003: 310–312, figs 1–2.

Diagnosis: Female. Dorsal shield oval, attenuate posteriorly; j1 plumose in distal half; z1 simple; j5 and z5 slightly pilose or simple; j6 simple; z6 and J2 simple but in some cases slightly pilose; other dorsal setae pilose; l. ang., l. arc., l. m. t., and l. o. p. with punctations along lines.

Material examined: **East Kalimantan**: 25 females, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex Sisyphus thoracicus* Sharp, 1875, *Onthophagus pasificus*, *O. borneensis*, and residue in vials; 19 females, SWPF, Balikpapan, 17 December 2006, D.

Dwibadra and A. Ueda leg., *ex O. semicupreus*, *O. schwaneri*, *O. borneensis*, *Onthophagus* sp., and residue in vials; 7 females, SWPF, Balikpapan, 18 December 2006, D. Dwibadra and A. Ueda leg., *ex S. thoracicus*, *O. waterstradti*, and *O. pastillatus*; 27 females, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex O. obscurior*, *O. cervicapra*, *Paragymnopleurus maurus*, *Catharsius dayacus*, and residue in vials; 38 females, SWPF, Balikpapan, 14 December 2007, D. Dwibadra and A. Ueda leg., *ex O. waterstradti*, *O. incisus*, *O. schwaneri*, *O. cervicapra*, *O. vulpes*, *O. semicupreus*, *C. dayacus*, *P. maurus*, and residue in vials; 16 females, SWPF, Balikpapan, 15 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *P. maurus*, and *O. schwaneri*; 5 females, SWPF, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex Copris* sp.; 4 females, SWPF, Balikpapan, 20–25 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 48 females, SWPF, Balikpapan, 11 December 2008, *ex O. borneensis* and residue in vials; 20 females, SWPF, Balikpapan, 12 December 2008, D. Dwibadra and A. Ueda leg., *ex O. obscurior*, *O. borneensis*, *O. pastillatus*, *S. thoracicus*, *P. maurus*, *O. semicupreus*, and *O. bonorae* Zunino, 1976; 6 females, SWPF, Balikpapan, 5 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 1 female, SWPF, Balikpapan, 7 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 10 females, SWPF, Balikpapan, 10 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials, 8 females, secondary forest, km. 12, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*; 1 female, *Imperata cylindrica* grassland, km. 23, Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *Acacia mangium* plantation, km. 23, Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *A. mangium* plantation, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex Caccobius unicornis* (Fabricius, 1798); 21 females, burned secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. dux*, *P. maurus*, and residue in vial; 16 females, secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*, *O. aurifex*, *O. vulpes*, *C. dayacus*, and residue in vial; 12 females, natural forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*, *C. dayacus*, and residue in vial; 10 females, burned secondary forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 6 females, *I. cylindrica* grassland, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 32 females, *A. mangium* plantation, km. 24, Balikpapan, 26

December 2006, D. Dwibadra and A. Ueda leg., *ex O. limbatus* and residue in vials; 14 females, natural forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex O. cervicapra*, *O. schwaneri*, *O. rudis*, and residue in vials; 18 females, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *P. maurus*, *O. schwaneri*, and residue in vials; 5 females, burned ridges, km. 24, Balikpapan, 19–24 December 2007, *ex* residue in vials; 16 females, burned ridges, km. 24, Balikpapan, 6–11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 20 females, *A. mangium* plantation, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani* and residue in vials; 3 females, *I. cylindrica* grassland, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 51 females, km. 29, Balikpapan, km. 24, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri, O. cervicapra*, *C. renaudpauliani*, and residue in vials; 3 females, km. 38, Balikpapan, 16–21 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 22 females, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex Catharsius* sp., *O. semiaureus*, *O. incisus*, *P. maurus*, *Sisyphus thoracicus*, and residue in vials.; **North Kalimantan**: 31 females, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg., *ex Paragymnopleurus* sp. and *Onthophagus* sp.; 27 females, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **West Kalimantan**: 4 females, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex* residue in vials; 1 female, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg.; 32 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and *Onthophagus* sp.; 6 females, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp. and residue in vials; **Central Kalimantan**: 81 females, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; **South Kalimantan**: 8 females, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg., *ex Onthophagus* sp.; 1 female, rubber tree plantation, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.; 1 female, Tahura Sultan Adam, Karang intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Sisyphus* sp.

Additional specimens examined, deposited in MZB: **Sumatra**: 1 female, 350 m alt., Mt. Leuser, Ketambe National Park, Nanggroe Aceh Darussalam, 4 September 1989, Habley and D. C. Darling leg., *ex Onthophagus diabolicus* Harold, 1877; 9 females, Biology Research Forest, Andalas University, Padang, West Sumatra, 3–7 November 2001, S. Hartini and G. Takaku leg., *ex Catharsius* sp. and *Onthophagus* sp. **Bali**: 1 female, Pancasari, Sukasada, Buleleng, 3 December 1999, S. Hartini and G. Takaku leg., *ex Catharsius* sp. **Sulawesi**: 1 female, Tountimomoro, North Sulawesi, 27 November 1999, S. Hartini and G. Takaku leg., *ex Copris* sp.

Habitat: This species has been collected from the scarab beetle genera *Catharsius*, *Copris*, *Microcopris*, *Onthophagus*, *Paragymnopleurus*, and *Sisyphus*.

Distribution: Indonesia [Kalimantan; Sumatra, Bali, and Sulawesi (new records)].

Macrocheles lumbiensis sp. nov.

(Fig. 9A–E)

Description: Female. Length of dorsal shield 916.7 (885.1– 931.7), width at level of coxae II 546.4 (513.9– 611.1) (n=5). Specimens reddish brown in color.

Dorsum (Fig. 9A). Dorsal shield , surface of shield covered with lines; lateral margin of shield smooth; shield bearing 28 pairs of dorsal setae and 22 pairs of pores; seta j1 pilose distally; z1, j5, j6, z5, z6, and J2 simple; other setae pilose in distal 2/3; J5 pilose entirely.

Venter (Fig. 9B). Sternal shield ornamented with lines; length 172.2 (167.3– 178.6), width at level of coxae II 177.9 (173.4– 181.9) (n=5); shield with 3 pairs of simple setae and 2 pairs of pores; l. ang. and l. m. t. present; l. arc. and l. ang. present as distinct line and join with l.o.a.; l. o. p connected to l. m. t.; a. p. p. with some punctures;. metasternal shields almost triangular shape and free; each shield with 1 simple seta and anterior pore.

Width of epigynial shield 273.8 (270–275) (n=5); shield ornamented with punctations, with pair of simple setae on the posterior corner.

Ventrianal shield longer than wide, length 311.1 (290– 319), width 226.6 (207.1–256.9) (n=5); shield ornamented with distinct lines; 3 pairs of preanal setae, 1 pair of paranal setae, and 1 postanal seta present; all setae simple; cribrum located posterior to postanal seta.

Gnathosoma (Fig. 9C). Well developed and sclerotized. Deutosternal groove with 6 rows of denticles, anteriormost row divided; 3 pairs of simple hypostomal setae and 1 pair of simple

palpcoxal setae present. Epistome (Fig. 9D) with median process and pair of lateral elements; median process bifurcate distally, and lacking minute spicules; basal margin serrate. Fixed digit of chelicera (Fig. 9E) with simple dorsal seta, robust median tooth, small distal tooth, *pilus dentilis*, and terminal hook; movable digit with robust bidentate median tooth, small distal tooth, and terminal hook; length of fixed digit 236.1 (228.6–246.1) and movable digit 86.8 (84.9–92) (n=5).

Legs. Most leg segments with simple and pilose setae except for coxae I–IV; trochanter I–III and tarsus I with only simple setae. Leg chaetotaxy typical for this genus. Genu IV with 6 pilose setae. Leg length (excluding ambulacrum, n=5); leg I, 634.5 (620.5–652.6); leg II, 644.2 (631–660.5); leg III, 630.8 (615.9–653.8); leg IV, 875.3 (857.7–899.4).

Sacculus foemineus. Not observed.

Male and other stages. Unknown.

Type series: Holotype (MZB. Acar. 8864.4): female, 212 m asl, Kabunglor, Lumbis, Nunukan, North Kalimantan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae. Paratypes: 3 females, data same as in holotype; 1 female, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, Central Kalimantan, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae.

Etymology: The specific name is derived from locality record (Kampung Lumbis).

Distribution: Indonesia (Kalimantan).

Remarks: Sternal and ventrianal shield ornamentation of this species is similar to those of *Macrocheles baramensis*, but they are different in the shape of dorsal shield and setae. Dorsal setae of the present species are mostly pilose distally but shorter than dorsal setae of *M. baramensis*. For example, seta j5 of *M. lumbiensis* is 37. 5 μm (n = 2), less than half length of that of *M. baramensis* (79. 8 μm; n = 2). The dorsal shield of *M. lumbiensis* is more rounded and wider compared to *M. baramensis*.

glaber species complex

Diagnosis: Female. Dorsal setae simple or distally pilose. Sternal ornamentation distinct and typical for the *glaber* species group; l. ang. not strongly convergent medially. Ventrianal shield pentagonal or subtriangular. Other characters typical for the species groups.

The species of the complex were found in various habitats, i.e., soil, compost, manure, nest of small mammals, and phoretic on insect or mammals.

The species of the complex were distributed worldwide except for Neotropical Region.

In Kalimantan, three species are included in *glaber* species complex: *Macrocheles dayaci* Dwibadra and Takaku, 2014; *M. oigru* Walter and Krantz, 1986, and *M.* sp.aff. *glaber* (Müller, 1860).

Macrocheles dayaci Dwibadra and Takaku, 2014

(Fig. 10A–E)

Macrocheles dayaci Dwibadra and Takaku, 2014 in Dwibadra *et al*., 2014: 49, fig 1.

Description: Female. Length of dorsal shield 1035 (1020–1050), width at level of coxae II 627.5 (600–660) (n=4). Specimens reddish brown in color.

Dorsum (Fig. 10A). Dorsal shield broadly rounded posteriorly with procurved outline, surface of shield covered with strong punctations and reticulation; lateral margin of shield smooth; shield bearing 28 pairs of dorsal setae and 22 pairs of pores; seta j1 pilose distally; z1 simple; other setae pilose distally.

Venter (Fig. 10B). Sternal shield wider than long; length 178.8 (175–180), width at level of coxae II 207.5 (200–210) (n=4); shield with 3 pairs of simple setae and 2 pairs of pores; l. ang. and l. m. t. present; l.o.a. with faint punctation; two punctate l. arc. distinct; l. o. p. present as distinct line, with punctations, connected to l. m. t.; a. p. p. with strong and coarse punctations. Metasternal shields oval and free; each shield with 1 simple seta and anterior pore.

Width of epigynial shield 273.8 (270–275) (n=4); shield ornamented with punctations, with pair of simple setae on the posterior corner.

Ventrianal shield longer than wide, length 411.3 (400–420), width 317.5 (295–340) (n=4); shield with strong, dimpled reticulation and punctations; 3 pairs of preanal setae, 1 pair of paranal setae, and 1 postanal seta present; postanal seta pilose, other setae simple; cribrum located posterior to postanal seta.

Gnathosoma (Fig. 10C). Well developed and sclerotized. Deutosternal groove with 6 rows of denticles, anteriormost row divided; 3 pairs of simple hypostomal setae and 1 pair of simple palpcoxal setae present. Epistome (Fig. 1E) with median process and pair of lateral

elements; median process bifurcate distally, and lacking minute spicules; basal margin serrate. Fixed digit of chelicera (Fig. 10D) with simple dorsal seta, robust median tooth, small distal tooth, *pilus dentilis*, and terminal hookm.ovable digit with robust bidentate median tooth, small distal tooth, and terminal hook; length of fixed digit 220 (200–230) and movable digit 96.9 (95–100) (n=4).

Legs. Most leg segments with simple and pilose setae except for coxae I–IV; trochanter I–III and tarsus I with only simple setae. Leg chaetotaxy typical for this genus. Genu IV with 6 pilose setae. Leg length (excluding ambulacrum, n=4); leg I, 758.8 (720–830); leg II, 715.6 (647.5– 765); leg III, 702.5 (660–760); leg IV, 1007.5 (945–1045).

Sacculus foemineus. Not observed.

Male and other stages. Unknown.

Type series: Holotype (MZB. Acar. 7559.2): female, Hutan Lindung Sungai Wain, Balikpapan, East Kalimantan, 20 December 2006, *ex Catharsius dayacus*, A. Ueda and D. Dwibadra leg. Paratypes: 1 female, data same as in holotype; 2 females, km. 24, Balikpapan, East Kalimantan, 26 December 2006, *ex* residue in vial.

Etymology: The specific name is derived from the specific epithet of the phoretic host, the scarab beetle *Catharsius dayacus*.

Remarks: *M. dayaci* is a member of the *glaber* species group and is similar to *M. witcoskyanus* Walter and Krantz, 1986 (Walter and Krantz 1986b) in the shape of dorsal setae and shield sternal ornamentation. However, *M. dayaci* is distinguishable from *M. witcoskyanus* by the following characters (corresponding conditions of *M. witcoskyanus* in parentheses): 1) j4 and j5 pilose distally (simple); 2) z5 and j6 in some cases slightly pilose (simple); and 3) ventrianal shield not expanded, longer than wide (expanded laterally, wider than long).

Macrocheles oigru Walter and Krantz, 1986

(Fig. 11A, B)

Macrocheles oigru Walter and Krantz, 1986b: 281–282, figs 4, 5.

Macrocheles oigru: Takaku, 2001: 500, figs 1, 7; Takaku and Hartini, 2001: 324; Hartini and Takaku, 2003c: 1265.

Diagnosis: Female. Dorsal setae simple, elongate, surpassing insertions of setae behind them, except for j1, j4, Z5, and S5 pilose distally; sternal ornamentation developed; l. o. p. bifurcate and reaching to l. m. t.

Material examined: **South Kalimantan**: 1 female, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg., *ex* residue in vial.

Habitat: This species were found to be phoretic on coprophagous beetles genera *Aphodius*, *Catharsius*, *Copris*, *Gymnopleurus*, *Oniticellus*, *Onitis*, *Onthophagus* (Scarabaeidae), and *Pachylister* (Histeridae).

Distribution: Indonesia [Java, Madura, Sumatra, Bali, Lombok, Sumbawa, Sumba, Flores, Sulawesi, and Kalimantan (new record)] and India.

Macrocheles sp. aff. ***glaber*** (Müller, 1860)

(Fig. 11C, D)

Diagnosis: The shape of dorsal setae and ornamentation of sternal shield similar to *Macrocheles glaber* (Müller, 1860): Female. Dorsal setae j1, j4, Z4, and S5 pilose distally, other setae simple, not reaching insertions of the next setae; sternal ornamentation distinct, l.o.p bifurcated and reaching to l.m.t; ventrianal shield not greatly expanded, without strongly dimpled reticulations. However, according to Halliday (1986a), we need to observe male and/or immature stages for accurate identification and those specimens could not be obtained in this present study.

Material examined: **West Kalimantan**: 1 female, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.

Habitat: This species has been collected from *Catharsius molossus*, *Copris*, *Onitis* and *Onthophagus*.

kraepelini species complex

Diagnosis: Female. Dorsal shield broadly rounded posteriorly; most of dorsal setae enlarged and pilose, except for simple setae j6, z5, z6, and J2; seta z1 occasionally pilose. Sternal shield with distinct ornamentation; l. ang. with many punctations; posterior l. arc. concave; l. o. p. bifurcated; a.p.p. with strong punctations. Genu IV with 6 pectinate setae.

The species of the complex were found in leaf littet, compost, cow dung and phoretic on insect or small mammals.

The species of the complex were distributed Oriental, Australian, and Oceanian Region.

In Kalimantan, two species are included in this species complex: *Macrocheles hallidayi* Walter and Krantz, 1986 and *M. kraepelini* (Berlese, 1904).

Macrocheles hallidayi Walter and Krantz, 1986

(Fig. 12A, B)

Macrocheles hallidayi Walter and Krantz, 1986a: 214–216, figs 12, 13.

Macrocheles hallidayi: Walter and Krantz, 1986b: 289, fig. 1b; Takaku, 1998: 30–36, figs 1–14; 2001: 501, figs 3, 9; Takaku and Hartini, 2001: 325; Hartini and Takaku, 2003c: 1264; Hartini *et al*., 2003: 308; 2005: 202; 2007: 75; 2009: 420; Takaku *et al*., 2012: 105–106; Hartini *et al*., 2013: 53.

Diagnosis: Female. Dorsal shield ornamented with punctate-reticulate pattern and with well developed procurved line; dorsal setae j1 pilose; z1 shorter than j1 and not reaching insertions of j2; j5, j6, z5, z6, and J2 simple; J5 serrate; other dorsal setae sparsely to strongly bipectinate. Sternal shield with strongly punctate margin along l. ang. and with two deeply punctate l. arc., well developed l. m. t., l. o. p., and l. ang.; l. o. p. bifurcate, with distinct a. p. p. and a. pf. Genu IV with 7 pectinate setae.

Material examined: **East Kalimantan**: 1 female, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, SWPF, Balikpapan, 15 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus schwaneri* and *Catharsius dayacus* Lansberge, 1886; 1 female, SWPF, Balikpapan, 17 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, SWPF, Balikpapan, 5 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, km. 12, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*; 39 females, km. 18, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*, *O. liliputanus* Lansberge, 1883, *Onthophagus* sp., and residue in vials; 2 females, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 5 females, *Imperata cylindrica* grassland, km. 23,

Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 8 females, *Acacia mangium* plantation, km. 23, Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex Catharsius renaudpauliani* Ochi and Kon, 1996 and *O. obscurior* Boucomont, 1914; 29 females, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, residue in vials; 7 females, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex O. limbatus*, residue in vials; 2 females, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex O. schwaneri* and *Paragymnopleurus maurus*; 4 females, burned ridge, km. 24, Balikpapan, 6–11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 16 females, *A. mangium* plantation, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 4 females, *I. cylindrica* grassland, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 24 females, km. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex O. cervicapra*, *O. schwaneri*, *C. renaudpauliani*, and residue in vials; 1 female, secondary forest, km. 38. Balikpapan,16–21 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus* sp.; 3 females, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *O. schwaneri*, and residue in vial; **North Kalimantan**: 3 females, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg., *ex Paragymnopleurus* sp. and *Onthophagus* sp.; **West Kalimantan**: 2 females, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and *Onthophagus* sp.; 2 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 8 females, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp. and residue in vial; **South Kalimantan**: 17 females, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg., *ex Catharsius* sp., *Onthophagus* sp., and residue in vials; 1 female, CA Gunung Kentawan, Loksado, Hulu Sungai Selatan, 5 November 2012, D. Dwibadra leg., *ex Sisyphus* sp.; 1 female, rubber tree plantation, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.

Habitat: This species has been collected from the scarab beetle genera *Aphodius*, *Catharsius*, *Copris*, *Heliocopris*, *Microcopris*, *Oniticellus*, *Onitis*, *Onthophagus*, and *Paragymnopleurus*.

Distribution: Indonesia (Java, Madura, Sumatra, Kalimantan, Bali, Sulawesi, Lombok, Sumbawa, Flores, and Sumba), Malaysia (Sarawak), Thailand, Cambodia, Philippines, and India.

Macrocheles kraepelini (Berlese, 1904)

(Fig. 12C, D)

Holostaspis kraepelini Berlese, 1904: 164, fig. 26.

Macrocheles (*Cophrolaspis*) *kraepelini*: Berlese, 1918: 146; Vitzthum, 1926: 34–35.

Macrocheles (*Cophrolaspis*) *multihamatus* Vitzthum, 1926: 29–34, figs 20–22.

Macrocheles kraepelini: Krantz and Filipponi, 1964: 40–42, figs 3–5, tav. II figs 1, 2; Halliday, 1986a: 743, figs 2, 33–39; Wallace, 1986: 8–9, fig. 2F, pl. 1(3); Walter and Krantz, 1986a: 212–213, figs 1–3; 1986b: 289; Halliday, 2000: 298–299; Takaku, 2001: 500–501, figs 2, 8; Hartini and Takaku, 2003c: 1264; Hartini *et al*., 2005: 203; 2007: 76; Takaku *et al*., 2012: 106; Hartini *et al.*, 2013: 53.

Diagnosis: Female. Dorsal shield broadly rounded posteriorly; most of dorsal setae enlarged and pilose, except for simple setae j6, z5, z6, and J2; seta z1 occasionally pilose. Sternal shield with distinct ornamentation; l. ang. with many punctations; posterior l. arc. concave; l. o. p. bifurcate; a.p.p. with strong punctations. Genu IV with 6 pectinate setae.

Material examined: **East Kalimantan**: 1 female, SWPF, Balikpapan,15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex Copris* sp.; 1 female, SWPF, Balikpapan, 7 December 2008, *ex* residue in vial; 1 female, SWPF, Balikpapan,13 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *Acacia mangium* plantation, km. 18, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *A. mangium* plantation, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, *A. mangium* plantation, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 4 females, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus dux*, *O. schwaneri*, and residue in vials; 1 female, burned valley, km. 24, Balikpapan, 5–10 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *Imperata cylindrica* grassland, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, km. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 6 females, secondary forest,

km. 38, Balikpapan, 16–21 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vials; **North Kalimantan**: 1 female, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg., *ex Paragymnopleurus* sp.; 6 females, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **West Kalimantan**: 3 females, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 22 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and *Onthophagus* sp.; 6 females, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.; **Central Kalimantan**: 4 females, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; **South Kalimantan**: 1 female, Tahura Sultan Adam, Karang intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.; 1 female, Batu Bini, Padang Batung, Hulu Sungai Selatan, 9 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.

Habitat: This species has been collected from the scarab beetle genera *Catharsius*, *Microcopris*, *Onthophagus*, and *Paragymnopleurus*.

Distribution: Indonesia (Java, Kalimantan, and Sumatra), Malaysia, Philippines, Singapore, Thailand, Vietnam, India, Pakistan, Australia, Caroline Islands, Fiji, and Samoa.

***pumilus* species complex**

Diagnosis: Female. Dorsal setae j1 pilose distally; j4 simple; some anterolateral setae r2, r3 and posterior setae Z4, Z5, S4, J5 pilose distally or entirely; sternal shield ornamented with lines and punctations; l. arc. present as irregular punctate lines; l. m. t. punctate; l. o. p. present as transverse punctate line, and disjunct from l. m. t.

Macrocheles pumilus Hartini, Dwibadra and Takaku, 2009

(Fig. 13A, B)

Macrocheles pumilus Hartini, Dwibadra and Takaku, 2009: 424, figs 13–17.

Diagnosis: Female. Dorsal shield bearing 28 pairs of dorsal setae; j1 pilose in distal two thirds; r2 and r3 pilose in distal half or simple; Z4, Z5 and S4 pilose in distal two thirds or simple; J5 entirely pilose; other setae simple. Sternal shield longer than wide, with 3 pairs of simple setae; l. ang. complete with punctuations, l. o. a. punctate, l. arc. present as irregular punctate line; l. m. t. undulate and punctate; l. o. p. present as transverse line, with punctations, not reaching to l. m. t. Genu IV with 6 pilose setae.

Material examined: **North Kalimantan**: 1 female, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05.4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg.

Habitat: This species has been collected from *Onthophagus* (*Onthophagus*) *javensis* and *Onthophagus* sp.

Distribution: Indonesia [Java and Kalimantan (new record)].

Macrocheles riparius Dwibadra and Takaku, 2014

(Fig. 14A–F)

Macrocheles riparius Dwibadra and Takaku, 2014 in Dwibadra *et al*. 2014: 51, fig. 2.

Description: Female. Length of dorsal shield 731.5 (680–770), width at level of coxae II 467.5 (410–510) (n=10). Specimens yellowish brown in color.

Dorsum (Fig. 14A). Dorsal shield with distinct punctations and reticulation; lateral margin of shield smooth; shield bearing 28 pairs of dorsal setae and 22 pairs of pores; seta j1 and Z5 pilose distally; J5 entirely pilose, r2 simple but sometimes slightly pilose; other setae simple.

Venter (Fig. 14B). Sternal shield wider than long; length 144 (130–150), width at level of coxae II 154.5 (150–160) (n=10); shield with 3 pairs of simple setae and 2 pairs of pores; l. ang. with punctation, disjunct from l. arc.; l. o. a. punctate; two l. arc. present as irregular punctate lines; l. m. t. punctate; l. o. p. present as paired transverse lines, with punctations, not connected to l. m. t.; two a. p. l. present. Metasternal shields oval and free; each shield with 1 simple seta and an anterior pore.

Width of epigynial shield 184.5 (160–200) (n=10); shield ornamented with punctations and pair of simple setae.

Ventrianal shield longer than wide; length 260 (235–280), width 221 (195–245) (n=10); shield ornamented with reticulation and punctations; 3 pairs of preanal setae, 1 pair of paranal

setae, and 1 postanal seta present; postanal seta pilose, other setae simple; cribrum located posterior to postanal seta.

Gnathosoma (Fig. 14C). Well developed and sclerotized, differing from that of *Macrocheles dayaci* only in median process of epistome (Fig. 14E) bearing many small spicules. Chelicera (Fig. 14D) same as in *M. dayaci*; length of fixed digit 217.5 (210–220) and movable digit 69.8 (67.5–72.5) (n=10).

Legs. Most leg segments with simple and pilose setae except for coxae I–IV, trochanters I–III and tarsus I with only simple setae. Leg chaetotaxy typical for this genus. Genu IV with 6 pilose setae. Leg length (excluding ambulacrum, n=10); leg I, 638.5 (610–665); leg II, 615 (585–680); leg III, 573.5 (525–625); leg IV, 847.5 (815–930).

Sacculus foemineus (Fig. 14F). Pair of sacculi present; cornu distinct, small and rounded distally; spermatheca oval.

Male and other stages. Unknown.

Type series: Holotype (MZB. Acar. 7566): female, Hutan Lindung Sungai Wain, Balikpapan, East Kalimantan, 20 December 2006, *ex* residue in vial, A. Ueda and D. Dwibadra leg. Paratypes: **SWPF**: 5 females, 17 December 2006, *ex Onthophagus semicupreus*, *O. waterstradti*, and residue in vials; 2 females, 20 December 2006, *ex* residue in vial; 1 female, 12 December 2008, *ex* residue in vial, other data same as holotype. **Km. 24**: 2 females, Balikpapan, East Kalimantan, 21 December 2006, ex *O. schwaneri* and residue in vial.

Additional specimens: **East Kalimantan**: 1 female, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex Bolbochromus catenatus*.

Etymology: This specific name alludes to its occurrence around the Wain River.

Remarks: The sternal punctate ornamentation of the present species is similar in pattern to that of *Macrocheles adenostictus* Krantz and Whitaker, 1988 (Krantz and Whitaker, 1988) recorded from the USA. However, *M. riparius* is distinguishable by the following characters (corresponding conditions of *M. adenostictus* in parentheses): 1) most dorsal setae, including setae of z-Z and s-S series, simple (all z-Z and s-S series setae strongly pilose distally); and 2) ophisthogastric setae simple (weakly pilose distally).

scutatus species complex

Diagnosis: Female. Dorsal setae simple or distally pilose; setae j4 distally pilose. Sternal ornamentation reduced; l. ang. weakly produced, l. arc. with minute punctations, l. o. p. often disjunct from l. m. t., a. p. p. and a. pf. reduced to scattered punctations. Ventrianal shield pentagonal or subtriangular. Five species of *Macrocheles* in Kalimantan are included in this species complex: *M. dispar* (Berlese, 1910), *M. entetiensis* Hartini *et al*., 2005, *M. jabarensis* Hartini and Takaku, 2003, *M. nidus* Hartini and Takaku, 2013, *M. persimilis* Hartini *et al*., 2007.

Macrocheles dispar (Berlese, 1910)

(Fig. 15A, B)

Holostaspis dispar Berlese, 1910: 251.

Macrocheles (*Coprholaspis*) *dispar*: Berlese, 1918: 151.

Macrocheles dispar: Walter and Krantz, 1992: 244, fig. 1D; Hartini and Takaku, 2003c: 1262–1263, figs 1–6; Hartini *et al*., 2003: 308; Takaku *et al*., 2012: 105; Hartini *et al*., 2013: 52.

Diagnosis: Female. Dorsal setae j1 plumose distally; j4, z2, z4, r2–4, J5, Z5, and S5 pilose distally; j2, j3, and s2 simple but in some cases pilose distally; other setae simple. Sternal shield ornamented with lines and punctation; l. ang., l. m. t., l. o. p. with distinct punctations; l. m. t. complete; l. o. p. disjunct from l. m. t. and not bifurcate; center of posterior half of shield with small punctations.

Material examined: **East Kalimantan**: 2 females, SWPF, Balikpapan, 14 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus vulpes* Harold, 1877 and *O. cervicapra* Boucomont, 1914; 1 female, SWPF, Balikpapan, 11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial. 1 female, km. 12, Balikpapan, 15–20 December 2007, *ex O. schwaneri* Vollenhoven, 1864; 1 female, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex Paragymnopleurus maurus*; 2 females, km. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*; 5 females, km. 38, Balikpapan, 16–21 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus* sp., residue in vial; 3 females, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., ex *O.*

semiaureus, *O. schwaneri*; **West Kalimantan**: 11 females, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp., *Phaeocroops* sp., and residue in vials; 5 females, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and *Onthophagus* sp.; 1 female, Sebadu, Mandor, Landak, 21 October 2012, D. Dwibadra and S. Hartini leg., *ex Aphodius* sp.; 40 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., ex *Catharsius* sp. and *Onthophagus* sp.; **North Kalimantan**: 2 females, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg.; 2 females, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **Central Kalimantan**: 1 female, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., ex Scarabaeidae; **South Kalimantan**: 153 females, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg. *ex Catharsius* sp., *Onthophagus* sp., and residue in vials; 7 females, CA Gunung Kentawan, Loksado, Hulu Sungai Selatan, 5 November 2012, D. Dwibadra leg., *ex Catharsius* sp., *Onthophagus* sp., and residue in vials; 1 female, rubber tree plantation, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.

Habitat: This species has been collected from the scarab beetle genera *Aphodius*, *Catharsius*, *Copris*, *Enoplotrupes*, *Onthophagus*, and *Paragymnopleurus*.

Distribution: Indonesia (Java, Sumatra, Kalimantan, Lombok, and Sulawesi), Viet Nam, Philippines, China (Szechuan), and Taiwan.

Macrocheles entetiensis Hartini and Takaku, 2005
(Fig. 15C, D)

Macrocheles entetiensis Hartini and Takaku, 2005 in Hartini *et al*. 2005: 204–206, figs 1–5.
Macrocheles entetiensis: Dwibadra *et al*., 2014: 45.

Diagnosis: Female. Dorsal setae j1 pilose distally; j3 and z4 thickened and pilose distally; j5, j6, z5, z6, and J2 simple; other dorsal setae pilose distally or pilose in distal half. Sternal shield with distinct l. ang., l. arc., l. m. t., and l. o. p.; l. o. p. disjunct from l. m. t. and not bifurcate.

Material examined: **East Kalimantan**: 5 females, km. 18, Balikpapan, 23 December 2006, *ex Onthophagus schwaneri*, D. Dwibadra and A. Ueda leg., residue in vial; 8 females, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 4 females, km. 23, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex O. limbatus* Herbs, 1789; 8 females, *Imperata cylindrical* (L.) grassland, km. 23, Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex O. uedai* Ochi and Kon, 2006 and residue in vials; 33 females, km. 24, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex O. limbatus* and residue in vials; **West Kalimantan**: 1 female, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.; 1 female, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg.

Habitat: This species has been collected from the scarab beetle genera *Aphodius*, *Catharsius*, and *Onthophagus*.

Distribution: Indonesia [Timor, Sumba, Flores, Sumbawa, Java, and Kalimantan (new record)].

Macrocheles jabarensis Hartini and Takaku, 2003

(Fig. 16A, B)

Macrocheles jabarensis Hartini and Takaku, 2003a: 1266, figs 7–12.
Macrocheles jabarensis: Hartini *et al*. 2003: 308.

Diagnosis: Female. Dorsal setae j1 plumose distally; S5 and Z5 pilose in distal half; J5 entirely pilose; other setae simple (in some cases j4 pilose distally). Ornamentation of sternal shield distinct; l. ang., l. m. t., and l. o. p. distinct; l. o. p. disjunct from l. m. t. and not bifurcate.

Material examined: **East Kalimantan**: 32 females, SWPF, Balikpapan,16 December 2006, D. Dwibadra and A. Ueda leg., *ex Onthophagus semicupreus*, *O. vulpes*, *O. obscurior*, *O. cervicapra, O. borneensis* Harold, 1877, *O. pasificus* Lansberge, 1885, *Catharsius dayacus*, and residue in vials; 14 females, 17 December 2006, *ex O. waterstradti* Boucomont, 1914, *O. schwaneri*, *O. borneensis*, and *Onthophagus* sp.; 14 females, SWPF, Balikpapan,18 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*; 30 females, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex O. obscurior, O. pastillatus* Boucomont, 1919, *O. cervicapra, C. dayacus*, and residue in vials; 53 females, SWPF, Balikpapan, 14 December

2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *O. schwaneri*, *O. waterstradti*, *O. incisus* Harold, 1877, *O. vulpes*, *Paragymnopleurus maurus*, and residue in vials; 3 females, SWPF, Balikpapan, 12 December 2008, D. Dwibadra and A. Ueda leg., *ex O. borneensis*; 4 females, SWPF, Balikpapan, 5 December 2008, *ex* residue in vials; 6 females, SWPF, Balikpapan, 11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 6 females, *Acacia mangium* plantation, km. 18, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 6 females, *A. mangium* plantation, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani* and residue in vials; 1 female, *Imperata cylindrica* grassland, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. papulatus* Boucomont, 1914; 5 females, burned secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 19 females, secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. aurifex* Harold, 1877, *O. schwaneri*, *O. dux* Sharp, 1875, *C. dayacus*, and residue in vials; 16 females, natural forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri* and residue in vials; 2 females, burned secondary forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 4 females, *I. cylindrica* grassland, km.. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 40 females, *A. mangium* plantation, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 4 females, natural forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*, *O. rudis* Sharp, 1875, and residue in vial; 3 females, burned ridges, km. 24, Balikpapan, 6–11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 2 females, *A. mangium* plantations, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 8 females, *I. cylindrica* grassland, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 165 females, km.. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri, O. cervicapra*, *O. obscurior*, *C. renaudpauliani*, and residue in vials; 10 females, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex Catharsius* sp., *O. vulpes*, *Sisyphus thoracicus*, and residue in vials; **North Kalimantan**: 26 females, Lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg., *ex Paragymnopleurus* sp., *Onthophagus* sp, and *Catharsius* sp.; 45 females, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg.,

ex Scarabaeidae; **West Kalimantan**: 11 females, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp., *Onthophagus* sp., and *Phaeocroops* sp.; 2 females, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 18 females, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and *Onthophagus* sp.; 1 female, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg.; **Central Kalimantan**: 15 females, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; **South Kalimantan**: 7 females, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg., *ex Catharsius* sp., *Onthophagus* sp., and residue in vials; 5 females, CA Gunung Kentawan, Loksado, Hulu Sungai Selatan, 5 November 2012, D. Dwibadra leg., *ex Catharsius* sp. and *Onthophagus* sp; 1 female, rubber tree plantation, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 9 females, Tahura Sultan Adam, Karang intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp., *Catharsius* sp., and residue on vial; 2 females, Batu Bini, Padang Batung, Hulu Sungai Selatan, 9 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.; 3 females, Tahura Sultan Adam, Karang intan, Banjar, 9 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.

Habitat: This species has been collected from the scarab beetle genera *Catharsius*, *Microcopris*, *Onthophagus*, and *Paragymnopleurus*.

Distribution: Indonesia (Java, Kalimantan, Sumatra, Lombok, and Sumbawa).

Macrocheles nidus Hartini and Takaku, 2013

(Fig. 16C, D)

Macrocheles nidus Hartini and Takaku, 2013 in Hartini *et al.*, 2013: 48–50, figs 1–5.

Diagnosis: Dorsal shield broadly rounded posteriorly with punctate and reticulate ornamentation; lateral margin smooth; dorsal shield with 28 pairs of setae; j1 pilose distally; j2 slightly pilose; z1, j5, j6, z5, z6, and J2 simple; J5 pilose entirely; other dorsal setae pilose in their distal halves, or distal 2/3. Sternal shield with two l. arc.; l. o. p. with punctations in posterior 2/3 and disjunct from or connected to l. m. t.

Material examined: **East Kalimantan**: 9 females, *Acacia* pantation, km. 23, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, burned ridges, km. 24, Balikpapan, 5–10 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, burned ridges, km. 24, Balikpapan, 6–11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *Acacia* plantation, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *I. cylindrica* grassland, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial.

Habitats: This species has been collected from nest of honey bee *Apis dorsata dorsata* and dung trap.

Distribution: Indonesia [West Java and Kalimantan (new record)].

Macrocheles persimilis Hartini, Dwibadra and Takaku, 2007

(Fig. 17)

Macrocheles persimilis Hartini, Dwibadra and Takaku, 2007: 82–83, 85, fig. 3.

Diagnosis: Dorsal shield oval, attenuate posteriorly; surface ornamented with distinct reticulations and punctations; lateral margin smooth; dorsal shield with 28 pairs of setae; j1–4 pilose distally; j5, j6, z1, z5, z6, and J2 simple; other dorsal setae pilose; sternal shield with one or two l. arc.

Material examined: **East Kalimantan**: 1 female, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, km. 24, Balikpapan, 26. December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; **West Kalimantan**: 1 female, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 2 females, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.

Habitat: This species has been collected from the scarab beetle genus *Onthophagus.*

Distribution: Indonesia [Sulawesi and Kalimantan (new record)].

krantzi species group

Diagnosis: Female. Most dorsal setae short and simple; j1, Z4, Z5, and S5 simple or pilose distally; ornamentation of sternal shield very faint, and ornamentation lack in center of shield. The species of this species group have been collected from dung beetles. Two species in Kalimantan are included in this group: *Macrocheles krantzi* Evans and Hyatt, 1963 and *M. sumbaensis* Hartini and Takaku, 2005.

Macrocheles krantzi Evans and Hyatt, 1963

(Fig. 18A, B)

Macrocheles krantzi Evans and Hyatt, 1963: 351, figs 58–61.

Macrocheles krantzi: Krantz and Filipponi, 1964: 44, tav. IV, figs 13, 14.

Macrocheles krantzi: Wallace, 1986: 12, fig. 2E, pl. 2(9); Halliday, 2000: 299; Takaku and Hartini, 2001: 326.

Diagnosis: Female. Dorsal shield with 28 pairs short, slender, simple setae; sternal shield granular, l. o. p short and punctate; genu IV with six simple setae.

Material examined: **West Kalimantan**: 1 female, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex* residue in vial.

Habitat: This species has been collected from scarab beetle genera *Scarabaeus* and *Onthophagus*.

Distribution: Indonesia [Bali and Kalimantan (new record)], India, Sri Lanka, and Australia.

Macrocheles sumbaensis Hartini and Takaku, 2005

(Fig. 18C, D)

Macrocheles sumbaensis Hartini and Takaku, 2005 in Hartini *et al*., 2005: 206–207, figs 6–11.

Diagnosis: Dorsal shield oval, surface ornamented with distinct reticulation and punctations; 28 dorsal setae; setae j1, Z4, Z5, and S5 pilose distally; J5 entirely pilose; other setae

simple. Sternal shield with granular ornamentation, short lines and punctation in edges of shields; epygynial shield ornamented with punctate reticulation.

Material examined: **East Kalimantan**: 1 female, *Acacia mangium* plantation, km. 23, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial.

Habitat: This species has been collected from scarab beetles of the genus *Aphodius* and from the histerid beetle *Pachylister lutarius* (Erichson, 1834).

Distribution: Indonesia [Sumba and Kalimantan (new record)].

muscaedomesticae species group

Diagnosis: Female. Dorsal setae simple or pillose distally; sternal shield ornamented with lines and large or fine punctations; transverse line connecting st.2; a band of strongly ornamented area located in posterior half; ventrianal shield usually wider than long. In Kalimantan, only one species, i.e. *Macrocheles muscaedomesticae* (Scopoli, 1772), is member of this group.

Macrocheles muscaedomesticae (Scopoli, 1772)

(Fig. 19A, B)

Acarus muscaedomesticae Scopoli, 1772: 125, 157.
Macrocheles muscaedomesticae: Pereira and de Castro, 1945: 161 –178, figs 1–22.

Diagnosis: Dorsal shield ornamented with reticulate pattern; j1 plumose in distal third; j5, j6, J2, z1, z5, and z6 simple; other dorsal setae pilose in their distal third; sternal shield with punctures and ridges.

Material examined: **East Kalimantan**: 1 female, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex Catharsius dayacus*; 1 female, 20 December 2006, *ex* residue in vial; 1 female, SWPF, Balikpapan, 14 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus schwaneri*; 1 female, burned secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex O. waterstradti*; 1 female, km. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial.

Habitat: This species has been collected from various kinds of animals, e.g., beetles, flies, moths, rodents, birds, etc., and various habitats, e.g., litter, rotting seaweed, bumble bee nests, compost, poultry manure, etc.

Distribution: Cosmopolitan. In Indonesia, this species is known from Java and Kalimantan (new record).

subbadius species group

Diagnosis: Most dorsal setae simple; J5 simple or short and spinose; Z4, Z5, and S5 simple or pilose distally; sternal shield with lines and punctations; l. o. a. connected by transverse punctate lines; genu IV with 6 or 7 setae.

merdarius species complex

Diagnosis: Most dorsal setae simple; J5 simple or short and spinose; Z4, Z5, and S5 simple or pilose distally; l. o. a. of sternal shield connected by transverse lines; lines with small, fine punctures. In Kalimantan, only one species, i.e. *Macrocheles merdarius* (Berlese, 1889) has been recorded as a member of the complex.

Macrocheles merdarius (Berlese, 1889)

(Fig. 19C, D)

Holostaspis merdarius Berlese, 1889: fasc. 52(1), fig. 103.

Macrocheles merdarius: Filipponi and Pegazzano, 1963: 83–88, figs V, VI, tav. XXIV; Takaku and Hartini, 2001: 326–327; Hartini and Takaku, 2003c: 1265; Hartini *et al*., 2003: 309; Hartini *et al*., 2005: 204; Hartini and Takaku, 2006a: 32.

Diagnosis: Female. All dorsal setae simple. L. o. a. of sternal shield connected by transverse lines; punctations very faint. Genu IV with 6 setae.

Material examined: **East Kalimantan**: 4 females, *Imperata cylindrica* grassland, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, *Acacia mangium* plantation, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda

leg., *ex* residue in vial; **South Kalimantan**: 1 female, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg., *ex Onthophagus* sp.

Habitat: This species has been collected from the scarab beetle genera *Aphodius*, *Catharsius*, *Copris*, *Coptodactyla*, *Euoniticellus*, *Lepanus*, *Liatongus*, *Notopedana*, *Onthophagus*, *Pentodon*, *Coptodactyhanaeus*, and *Synapsidis*, the geotropid beetle genus *Geotrupes*, the histerid beetle genus *Pachylister*, and from beetles of other families including Lucanidae, Silphidae, and Trogidae. It has also been recorded from rodents, soil, leaf litter, cow dung, compost, manure, etc.

Distribution: Cosmopolitan. In Indonesia, this species is known from Java, Kalimantan, Sulawesi, Bali, Lombok, Flores, Sumbawa, Sumba, and West Papua.

Non group species

Macrocheles mammifer Berlese, 1918

(Fig. 20A, B)

Macrocheles mammifer Berlese, 1918: 146, 162, 171.

Holostaspis polyornata Turk, 1948: 105.

Macrocheles pavlovskii Bregetova and Koroleva, 1960: 83; Karg, 1971: 140.

Macrocheles postneri Krauss, 1970: 28.

Macrocheles tridentatus: Delfinado and Baker, 1975: 53, not Pearse and Wharton, 1936 in Pearse *et al*., 1936: 473 (misidentification).

Macrocheles mammifer: Bregetova, 1977: 363; Wallace, 1986: 11; Krantz and Whitaker, 1988: 236.

Diagnosis: Dorsal shield widely rounded, reticulate and micropunctured; lateral and marginal dorsal setae plumose distally except for s2, s6, and r4; 8 pairs of dorsocentral and mediolateral dorsal setae (j2, j5, j6, J2, J5, z1, z5, and z6) smooth and needle-like; j1 brush-like, z2 pilose distally; ventral shield sculptured; sternal shield sparsely and irregularly punctured; sculptural lines absent; surface of epigynal and ventrianal shield reticulate; ventrianal shield wider than long, with micropunctation in lateral areas.

Material examined: **East Kalimantan**: 1 female, km. 22, Balikpapan, *Imperata cylindrica* grassland, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial.

Habitat: This species has been collected from scarab beetles and decaying substrates.

Distribution: Indonesia (Kalimantan; new record), Malaysia, Singapore, Philippines, Israel, Australia, Micronesia, Spain, Germany, Poland, Slovakia, Russia, USA, Trinidad, Cuba, and Argentina.

Macrocheles plumosus Evans and Hyatt, 1963
(Fig. 20C, D)

Macrocheles plumosus Evans and Hyatt, 1963: 364–365, figs 94–98.
Macrocheles plumosus: Hartini *et al*., 2003: 309.

Diagnosis: Female. Dorsal shield with a very characteristic areolate pattern and with 28 pairs of setae; vertical setae j1 extremely short and palmate, z1 pilose or simple; most of the dorsal setae long and strongly bipectinate. Sternal shield entirely covered by conspicuous reticulation.

Material examined: **South Kalimantan**: 1 female, CA Gunung Kentawan, Loksado, Hulu Sungai Selatan, 5 November 2012, D. Dwibadra leg., *ex Onthophagus* sp.

Habitat: This species has been collected from *Catharsius molossus*.

Distribution: Indonesia (Kalimantan) and Malaysia (Sarawak).

Macrocheles sukaramiensis Takaku, 2001
(Fig. 21A–B)

Macrocheles sukaramiensis Takaku, 2001: 502–504, figs 13–18.
Macrocheles sukaramiensis: Hartini and Takaku, 2003c: 1265–1266; Hartini *et al*., 2003: 309.

Diagnosis: Female. Dorsal shield attenuated posteriorly, most of dorsal setae sparsely pilose in the distal, simple setae for j5, j6, z5, z6, J2, Z1, and Z3. L. ang., l. m. t., and l. o. p present with l. m. t. slightly concave; symmetric weak reticulate pattern between l. ang. and l. m. t., punctuations present along the line of l. ang.

Material examined: **North Kalimantan**: 30 females, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18", 4 July 2009, A. H. Prasetyo leg., *ex Paragymnopleurus* sp. And residue in vial; 2 females, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23.7" E 116°10'44.2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **South Kalimantan**: 1 female, CA Gunung Kentawan, Loksado, Hulu Sungai Selatan, 5 November 2012, D. Dwibadra leg., *ex Catharsius* sp.

Habitat: This species has been collected from *Catharsius molossus*, *Copris doriae*, *Copris* sp., and *Paragymnopleurus maurus*.

Distribution: Indonesia (Sumatra, Java, and Kalimantan).

Macrocheles wainensis Dwibadra and Takaku, 2014

(Fig. 22A–F)

Macrocheles wainensis Dwibadra and Takaku, 2014 in Dwibadra *et al*., 2014: 43–57, fig. 3.

Description: Female. Length of dorsal shield 674 (640 – 740), width at level of coxae II 417.5 (400–460) (n=10). Specimens yellowish brown in color.

Dorsum (Fig. 22A). Dorsal shield oval, attenuate posteriorly, strongly punctate laterally; punctation and reticulation indistinct in center of anterior half; lateral margin of shield smooth; shield bearing 28 pairs of dorsal setae and 22 pairs of pores; seta j1 pilose distally; z1 simple and reaching to insertion of j2; j5, j6, z5, z6, and J2 simple; other setae pilose entirely or in distal 2/3; some podonotal setae (e.g., z4–6) inserted on tubercles.

Venter (Fig. 22B). Sternal shield wider than long; length 139.5 (130–150), width at level of coxae II 154 (150–160) (n=10); shield with 3 pairs of simple setae and 2 pairs of pores; l. ang present; l. arc. and l. m. t. present as punctate transverse line; paired a. p. l. present; l. o. p. present as punctate line; a. p. p. producing scattered punctations and not reaching to l. m. t. Metasternal shields oval and free; each shield with 1 simple seta and anterior pore.

Width of epigynial shield 171.5 (160–185) (n=10); shield ornamented with punctuations and one pair of simple setae on the posterior corner.

Ventrianal shield longer than wide, length 234.5 (220–245), width 200.5 (185–220) (n=10); shield ornamented with semiconcentric lines and reticulation; 3 pairs of preanal setae, 1 pair of paranal setae, and 1 postanal seta present; postanal seta pilose and other setae simple; cribrum located posterior to postanal seta.

Gnathosoma (Fig. 22C). Well developed and sclerotized. Features of gnathosoma, epistome (Fig. 22E), and chelicerae (Fig. 22D) similar to those of *Macrocheles riparius*. Length of fixed digit 198.5 (190–205) and that of movable digit 65.5 (63.8–67.5) (n=10).

Legs. Most leg segments with simple and pilose setae except for coxae I, III, and IV; trochanter I and tarsus I with only simple setae. Leg chaetotaxy typical for this genus. Genu IV with 6 pilose setae. Leg length (excluding ambulacrum, n=10); leg I, 521.5 (490–550); leg II, 518 (490–560); leg III, 476.8 (450–500); leg IV, 691.5 (620–770).

Sacculus foemineus (Fig. 22F). Very similar to that of *Macrocheles riparius*.

Male and other stages. Unknown.

Type series: Holotype (MZB. Acar. 7562): female, Hutan Lindung Sungai Wain, Balikpapan, East Kalimantan, 20 December 2006, *ex O. semicupreus*, A. Ueda and D. Dwibadra leg. Paratypes: SWPF: 1 female, 16 December 2006, ex residue in vial; 1 female, 17 December 2006, *ex O. semicupreus*; 1 female, 18 December 2006, *ex O. semicupreus*; 2 females, 20 December 2006, *ex O. semicupreus* and *Phaeocroops* sp.; km. 24: 1 female, 21 December 2006, *ex O. dux*; 2 females, 26 December 2006, *ex O. rudis* and residue in vial; 1 female, 5–10 December 2008, *ex* residue in vial.

Additional specimens: **East Kalimantan**: 4 females, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex Catharsius dayacus, O. semiaureus*, and *O. schwaneri*; **West Kalimantan**: 5 females, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Phaeocroops* sp., and residu in vial; 1 female, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.

Etymology: This specific name is derived from the type locality.

Remarks: *M. wainensis* is a member of the *glaber* species group. The pattern of sternal ornamentation in *M. wainensis* is similar to that of *M. nataliae* Bregetova and Koroleva, 1960 from Slovakia, as illustrated by Mašán (2003). Most of the dorsal setae are more or less pilose in *M. wainensis* whereas setae j1, r2 – r4, J5, Z4, Z5, and S5 are pilose and the other setae are

simple in *M. nataliae*. There is some variation in the distribution of pilose setae in *M. nataliae*, as was noted in the drawing and description by Bregetova and Koroleva (1960), and as has been discussed by Hyatt and Emberson (1988). Also the pilose setae of specimens from Kalimantan are stronger in pilosity and mostly inserted in the tubercles. The dorsal setae in the present species are similar in shape to those of *M. sukabumiensis* Hartini and Takaku, 2003 (Hartini and Takaku, 2003c), but the shapes of j5, j6, z5, z6, and J2 differ. Those setae are simple in *M. wainensis*, but pilose in *M. sukabumiensis*.

Macrocheles lorensis sp. nov.

(Fig. 23)

Description: Female. Length of dorsal shield 582.3, width at level of coxae II 314.3 (n=1). Specimens yellowish brown in color.

Dorsum (Fig. 23A). Dorsal shield oval, attenuate posteriorly, ornamented with strong punctations; lateral margin of shield smooth; shield bearing 28 pairs of dorsal setae and 22 pairs of pores; seta j1short and pilose distally; z1 short and simple; J5 pilose entirely; Z5 and S5 pilose in distal 2/3; other setae long and simple.

Venter (Fig. 23B). Sternal shield wider than long; length 108.7, width at level of coxae II 122.8 (n=1); shield covered with conspicuous reticulation with some distinct punctation in antero- and posterolateral of the shield; the structural lines as part of the ornamentation; 3 pairs of simple setae and 2 pairs of pores present; metasternal shields oval and free; each shield with 1 simple seta and anterior pore.

Width of epigynial shield (n=1); shield ornamented with punctations and one pair of simple setae on the posterior corner.

Ventrianal shield pear shaped and longer than wide, length 188.9, width 164.6 (n=1); shield ornamented with line of punctations; 3 pairs of preanal setae, 1 pair of paranal setae, and 1 postanal seta present; postanal seta pilose and other setae simple; cribrum located posterior to postanal seta.

Gnathosoma (Fig. 23C). Well developed and sclerotized. Deutosternal groove with 6 rows of denticles, anteriormost row divided; 3 pairs of simple hypostomal setae and 1 pair of simple palpcoxal setae present. Epistome (Fig. 23D) with median process and pair of lateral

elements; median process bifurcate distally, and lacking minute spicules; basal margin serrate. Fixed digit of chelicera (Fig. 23E) with simple dorsal seta, robust median tooth, small distal tooth, *pilus dentilis*, and terminal hookm.ovable digit with robust bidentate median tooth, small distal tooth, and terminal hook; length of fixed digit 141.2 and that of movable digit 56 (n=1).

Legs. Most leg segments with simple and pilose setae except for coxae I, III, and IV; trochanter I and tarsus I with only simple setae. Leg chaetotaxy typical for the genus. Genu IV with 6 pilose setae. Leg length (excluding ambulacrum, n=1); leg I, 431.3; leg II, 419.6; leg III, 374.5; leg IV, 508.5.

Sacculus foemineus. Not observed.

Male and other stages. Unknown.

Type series: Holotype (MZB. Acar. 8866): female, 212 m asl, Kabunglor, Lumbis, Nunukan, North Kalimantan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae.

Etymology: This specific name is derived from part of the name of the type locality, *lor*, which means “north” in Javanese.

Remarks: The sternal pattern of *M. lorensis* is similar to that of *M. plumosus* Evans and Hyatt, 1963. The present species is different from the latter on posterior areolate pattern of sternal shield and the shape of dorsal setae. The areolate pattern of *M. plumosus* is more distinct in a. p. p region, while it is less in *M. lorensis*. Most of dorsal setae of *M. plumosus* are strongly bipectinate, while long and simple in *M. lorensis*.

Genus ***Neopodocinum*** Oudemans, 1902

Neopodocinum Oudemans, 1902: 204.
Coprolaelaps Berlese, 1908: 13.
Cosmiphis Vitzthum, 1926: 88.
Type species: *Laelaps jaspersi* Oudemans, 1900.

Diagnosis: Female. Dorsal shield with 28–31 pairs of setae and in some species unpaired additional seta (Jx) appear on posteromedial part; anal shield rarely expanded laterally; peritreme extremities looped or straight; tectum unipartite. Tarsus I without claws but in some species, ambulacra and remnant claw present; trochanter III with 4 setae; genu IV with 7 or 8 setae.

Male. Venter with sternoventral and ventrianal shield separately; genital orifice at center of anterior margin of the sternoventral shield. Spermatodactyl present at movable digit. Large spurs present on femur II and leg IV with various modified spurs.

Mostly phoretic on dung beetles or mammals.

Neopodocinum bosschai (Oudemans, 1901)

(Fig. 24A, B)

Emeus bosschai Oudemans, 1901: 290–291, pl. VIII, figs 16–18.

Cosmiphis bosschai: Vitzthum, 1925: 33–36; 1926: 88–92, figs 55–57; Krantz, 1965: 206; Hartini and Takaku, 2004: 78–86, figs 1–21.

Diagnosis: Dorsal shield of female oval, attenuate posteriorly; insertions of most pairs of dorsal setae connected by transverse ridges; shield with more than 40 pairs of dorsal setae, podonatal setae pilose in their distal half or 2/3; opisthonotal setae broadened and pectinate; l. m. t. in sternal shield complete.

Material examined: **East Kalimantan**: 4 males, 7 deutonymphs, 5 protonymphs, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex Catharsius dayacus*, residue in vials; 1 female, 2 males, 2 deutonymphs, 3 protonymphs, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex Paragymnopleurus maurus* and residue in vials; 6 males, 3 deutonymphs, 6 protonymphs, SWPF, Balikpapan,14 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus, Onthophagus schwaneri, O. waterstradti* and residue in vial; 1 male, 1 deutonymph, SWPF, Balikpapan,15 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*; 2 males, SWPF, Balikpapan,15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 male, 4 deutonymphs, SWPF, Balikpapan, 20–25 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 protonymph, km. 15, Balikpapan, 19 December 2007, D. Dwibadra and A. Ueda leg., *ex* Scarabaeinae; 1 deutonymph, *Acacia mangium* plantation, km. 18, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 12 females, 2 deutonymphs, 1 protonymph, *A. mangium* plantation, km. 22, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri, C. renaudpauliani*, and residue in vials; 1 female, 1 male, km. 23, Balikpapan, 23 December 2006, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani*; 5 females, 4 males, 3 deutonymphs, 1 protonymph, km. 23, Balikpapan, 17–22

December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 4 females, 2 males, 4 deutonymphs, *A. mangium* plantation, km. 23, Balikpapan, 17–22 December 2007, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani*, *O. obscurior*, and residue in vial; 1 male, *A. mangium* plantation, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 3 females, 1 protonymph, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani*; 1 female, 1 deutonymph, burned secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*; 1 female, 2 males, 1 deutonymph, 2 protonymphs, secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *S. thoracicus*, and residue in vials; 1 male, 1 deutonymph, natural forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, 1 male, *Imperata cylindrica* grassland, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani* and residue in vial; 12 females, 6 males, 9 deutonymphs, 7 protonymphs, *A. mangium* plantation, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani*, *O. schwaneri*, *O. limbatus*, and residue in vial; 2 females, 1 male, 3 deutonymphs, 4 protonymphs, natural forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *O. vulpes*, and residue in vials; 2 females, 1 male, 1 deutonymph, 1 protonymph, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *O. schwaneri*, *O. dux*, and *P. maurus*; 1 male, 1 deutonymph, 1 protonymph, burned ridge, km. 24, Balikpapan, 19–20 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 deutonymphs, km. 24, Balikpapan, 6–11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, 2 males, 3 deutonymphs, 1 protonymph, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani* and residue in vials; 1 female, 1 male, *I. cylindrica* grassland, km. 24, Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 19 females, 7 males, 4 deutonymphs, 5 protonymphs, km. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*, *O. cervicapra*, *C. renaudpauliani*, and residue in vials; 2 females, 3 males, 4 deutonymphs, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., ex *C. dayacus*, *C. renaudpauliani*, *O. vulpes*, *O. schwaneri*, and *P. maurus*; **North Kalimantan**: 1 male, 4 protonymphs, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23.7" E 116°10'44.2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **West Kalimantan**: 11 females, 5 males, 5 deutonymphs, 1 protonymphs, Gua

Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and *Onthophagus* sp.; 23 females, 8 males, 13 deutonymphs, 6 protonymphs, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., ex *Catharsius* sp. and residue in vials; 2 females, 1 protonymph, Benuang, Toho, Pontianak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 1 female, Sebadu, Mandor, Landak, 21 October 2012, D. Dwibadra and S. Hartini leg., *ex Aphodius* sp.; 45 females, 16 males, 17 deutonymphs, 7 protonymphs, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 5 females, 1 male, 1 protonymph, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp. and residue in vial; 1 male, 1 deutonymph, Sepatah, Aur Sampuk, Sengah Temila, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; **Central Kalimantan**: 40 males, 42 deutonymphs, 26 protonymphs, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; **South Kalimantan**: 6 females, 6 males, 3 deutonymphs, 4 protonymphs, Padang Panjang, Karang Intan, Banjar, 3 November 2012, D. Dwibadra leg., *ex Catharsius* sp. and residue in vials; 1 female, 1 male, rubber tree plantation, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 6 females, 5 males, 4 deutonymphs, 1 protonymphs, Tahura Sultan Adam, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 3 females, 2 males, 3 deutonymphs, 1 protonymph, Tahura Sultan Adam, Karang Intan, Banjar, 9 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp. and residue in vial.

Habitat: This species has previously been collected from *Heliocopris* sp., *Onthophagus schwaneri*, *Catharsius molossus* (Linnaeus, 1758), *Paragymnopleurus maurus*, and decaying leaves.

Distribution: Indonesia (Sumatra and Kalimantan).

Neopodocinum halimunense Hartini and Takaku, 2003

(Fig. 24C, D)

Neopodocinum halimunensis Hartini and Takaku, 2003a: 49–56, figs 1–25, 53–55.
Neopodocinum halimunense: Hartini and Takaku, 2004: 86.

Diagnosis: Female. Dorsal shield oval, attenuated posteriorly, strong punctation in lateral part, with anterior ridges and flaps over setal insertions; lateral margin smooth; 28 pairs dorsal setae; unpaired seta Jx present; j1 broad and plumose; z1 short; j2, s2, r2, S1–5, and Z3–5 pilose, other setae simple; anal shield expand with 2 pairs of preanal setae.

Material examined: There is no specimen collected in this present study.

Habitat: This species has been collected from *Chatarsius molossus*, *Onthophagus diabolicus*, and *Onthophagus* sp.

Distribution: Indonesia (Java, Sumatra, and Kalimantan).

Neopodocinum kalimantanense Hartini and Takaku, 2004

(Fig. 25A, B)

Neopodocinum kalimantanense Hartini and Takaku, 2004: 87–89, figs 22–26.

Diagnosis: Females. Dorsal shield oval, bearing more than 50 pairs of dorsal setae and 22 pores; insertions of most dorsal setae away from midline and connected by short transverse ridges; lateral margin smooth; most podonotal setae pilose; medial setae from J5 to posteromarginal setae simple and short; lateral and marginal setae pectinate. Sternal shield with complete l. m. t.; all sternal setae simple and long, surpassing insertions of setae behind them.

Material examined: **East Kalimantan**: 5 females, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex Catharsius dayacus* and residue in vials; 9 females, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *Paragymnopleurus maurus*, and residue in vials; 7 females, SWPF, Balikpapan, 14 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *O. schwaneri*, and residue in vial; 1 female, SWPF, Balikpapan, 10 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, SWPF, Balikpapan, 15 December 2007, D. Dwibadra and A. Ueda leg., D. Dwibadra and A. Ueda leg., *ex C. dayacus*; 4 females, SWPF, Balikpapan, 20–25 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 7 females, secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*, *Sisyphus thoracicus*, and residue in vials; 1 female, natural forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*; 1 female, *Acacia mangium* plantation, km. 24,

Balikpapan, 7–12 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex P. maurus* and residue in vial; **North Kalimantan**: 1 female, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **West Kalimantan**: 1 female, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; **Central Kalimantan**: 47 females, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae.

Habitat: This species has been collected from *Catharsius molossus*.

Distribution: Indonesia (Kalimantan).

Neopodocinum maius Berlese, 1911

(Fig. 25C, D)

Neopodocinum maius Berlese, 1911: 431.
Neopodocinum cophrophilum Vitzthum, 1925: 20–21; 1926: 40–52, figs 25–34.
Neopodocinum maius: Krantz, 1965: 185–187, figs 47–48; Hartini and Takaku, 2004: 78.

Diagnosis: Female. Dorsal shield oval, bearing 28 pairs of setae; j1 and z1 plumose distally; unpaired seta Jx absent. Sternal shield broader than long; l. m. t. complete; anal shield expanded laterally, subtriangular, without preanal setae; ophisthogastric setae pectinate or smooth.

Material examined: **East Kalimantan**: 3 females, 4 males, 4 protonymphs, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex Catharsius dayacus* and residue in vials; 3 females, 4 males, 1 protonymph, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex Onthophagus borneensis*, *Paragymnopleurus maurus* and residue in vials; 1 female, 2 protonymphs, SWPF, Balikpapan, 20 December 2006, *ex* 4 females, 3 males, 1 deutonymph, 1 protonymph, SWPF, Balikpapan, 14 December 2007, D. Dwibadra and A. Ueda leg., *ex O. schwaneri* and *C. dayacus*; 1 deutonymph, 3 protonymphs, SWPF, Balikpapan, 15 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus*; 1 male, 1 deutonymph, SWPF, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 5 females, SWPF, Balikpapan, 20–25 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female,

burned secondary forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus*; 2 females, 1 protonymph, natural forest, km. 24, Balikpapan,21 December 2006, D. Dwibadra and A. Ueda leg., *ex* residue in vials; 1 female, 1 deutonymph, natural forest, km. 24, Balikpapan, 26 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus* and residue in vials; 1 protonymph, burned ridge, km. 24, Balikpapan, 14–19 December 2007, D. Dwibadra and A. Ueda leg., *ex P. maurus*; 1 deutonymph, burned ridge, km. 24, Balikpapan, 19–24 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 2 females, 1 protonymph, burned ridge, km. 24, Balikpapan, 6–11 December 2008, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 protonymph, km. 29, Balikpapan, 22 December 2006, D. Dwibadra and A. Ueda leg., *ex C. renaudpauliani*; 1 female, 2 males, 3 protonymphs, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., ex *C. dayacus, O. schwaneri*, and *P. maurus*; **North Kalimantan**: 1 male, 1 deutonymphs, 6 protonymphs, 212 m asl, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2", 1–2 August 2010, M. Irham leg., *ex* Scarabaeidae; **West Kalimantan**: 12 females, 2 males, 26 deutonymphs, 34 protonymphs, Gua Maria Anjungan, Kepayang, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 22 females, 12 males, 22 deutonymphs, 8 protonymphs, Singkong, Simpangkasturi, Anjungan, Landak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 2 females, 4 protonymphs, Benuang, Toho, Pontianak, 20 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 2 females, Sebadu, Mandor, Landak, 21 October 2012, D. Dwibadra and S. Hartini leg., *ex Aphodius* sp.; 52 females, 17 males, 28 deutonymphs, 65 protonymphs, Pasir Panjang, Mandor, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 2 females, 2 deutonymphs, 2 protonymphs, Sepatah, Aur Sampuk, Sengah Temila, Landak, 22 October 2012, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 1 female, 2 deutonymphs, 2 protonymphs, Ranao Teluk, Tayan Hilir, Sanggau, 24 October 2012, D. Dwibadra and S. Hartini leg., *ex* residue in vial; **Central Kalimantan**: 45 females, 17 males, 40 deutonymphs, 73 protonymphs, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; **South Kalimantan**: 1 female, 1 deutonymph, rubber tree plantation, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 7 females, 6 males, 3 deutonymphs, 7 protonymphs, Tahura Sultan Adam, Karang Intan, Banjar, 8 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.; 6 females, 5 males, 1 deutonymph, 2 protonymphs, Tahura Sultan

Adam, Karang Intan, Banjar, 9 December 2013, D. Dwibadra and S. Hartini leg., *ex Catharsius* sp.

Habitat: This species has previously been collected from *Heliocopris* sp., *Catharsius molossus*, and *Onthophagus* sp.

Distribution: Indonesia (Sumatra and Kalimantan).

Neopodocinum subjaspersi Hartini and Takaku, 2003

(Fig. 26A, B)

Neopodocinum subjaspersi Hartini and Takaku, 2003a: 56–64, figs 26–29, 32–52, 56.
Neopodocinum subjaspersi: Hartini and Takaku 2004: 86.

Diagnosis: Female. Dorsal shield oval, attenuate posteriorly; surface strongly punctate posteriorly; lateral margin smooth; shield bearing 28 pairs of setae and 22 pairs of pores; unpaired seta Jx present; setae j1 broad and plumose; setae z1 short and plumose; setae j2, s2, s6, r2, J2, S1–5 pilose, other setae simple.

Material examined: **East Kalimantan**: 4 females, 1 male, 1 deutonymph, 6 protonymphs, SWPF, Balikpapan, 16 December 2006, D. Dwibadra and A. Ueda leg., *ex Onthophagus* sp., and residue in vials; 1 male, 1 protonymph, SWPF, Balikpapan, 20 December 2006, D. Dwibadra and A. Ueda leg., *ex Onthophagus* sp. and residue in vial; 7 females, 8 males, 10 deutonymphs, 19 protonymphs, SWPF, Balikpapan, 14 December 2007, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*, *O. borneensis*, *O. incisus*, *O. vulpes*, *O. semicupreus*, *Catharsius dayacus*, and residue in vial; 2 females, SWPF, Balikpapan, 15 December 2007, D. Dwibadra and A. Ueda leg., *ex C. dayacus* and residue in vial; 1 female, 1 deutonymph, 1 protonymph, SWPF, Balikpapan, 15–20 December 2007, D. Dwibadra and A. Ueda leg., *ex Copris* sp. and residue in vial; 1 female, SWPF, Balikpapan, 20–25 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, 1 deutonymph, natural forest, km. 24, Balikpapan, 21 December 2006, D. Dwibadra and A. Ueda leg., *ex C. dayacus* and residue in vial; 1 female, 1 male, burned ridge, km. 24, Balikpapan, 19–24 December 2007, D. Dwibadra and A. Ueda leg., *ex* residue in vial; 1 female, km. 29, Balikpapan,22 December 2006, D. Dwibadra and A. Ueda leg., *ex O. schwaneri*; 4 females, 1 male, TWA Bukit Bangkirai, Kutai Kartanegara, 13–18 December 2007, D. Dwibadra and A. Ueda leg., *ex Onthophagus* sp. and residue in vial; **West Kalimantan**: 1 male, CA

Gunung Kentawan, Loksado, Hulu Sungai Selatan, 5 November 2012, D. Dwibadra leg., *ex Onthophagus* sp.; **Central Kalimantan**: 2 females, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, 15 March 2009, O. Efendi leg., *ex* Scarabaeidae; South Kalimantan: 8 females, 1 male, Batu Bini, Padang Batung, Hulu Sungai Selatan, 9 December 2013, D. Dwibadra and S. Hartini leg., *ex Onthophagus* sp.

Habitat: This species has previously been collected from *Onthophagus* sp. and *C. molossus*.

Distribution: Indonesia (Java, Sumatra, and Kalimantan).

Neopodocinum murungensis sp. nov

(Figs 27–30)

Description: Female. Length of dorsal shield 965.2 (924.4– 1007.2), width at level of coxae II 680.8 (667.1– 689.7) (n=3). Specimens brown in color.

Dorsal shield (Fig. 27A). Dorsal shield broad and round, slightly attenuate on the base of j1, between j4 and r2 ornamented with lines and punctuations; lateral margin of shield smooth; shield bearing 28 pairs of dorsal setae and 1 unpaired jx seta; j1 palmate, short, board, and pilose distally; dorsal setae pectinate except short and simple for j6, z6, s5, unpaired jx, S4, J5, and Z5.

Venter (Fig. 27B). Sternal shield wider than long; length 72.3 (64.8– 77.7), width at level of coxae II 257.3 (248.2– 274.9) (n=3); shield with 3 pairs of pilose setae and 2 pairs of pores; spine-like ornamentations in the end of l. m. t. before reaching to st. 2. Metasternal shields oval and free; each shield with 1 pilose seta and anterior pore.

Width of epigynial shield 186.7 (171.7–203.4) (n=3); shield ornamented with punctations and 1 pilose seta on each lateral side.

Anal shield oval, length 140.9 (137.2–146.7), width 85.2 (78.3–88.9) (n=3); shield with 1 pair of paranal setae and 1 postanal seta present; all setae simple.

Gnathosoma (Fig. 27C). Well developed and sclerotized. Deutosternal groove with 5 rows of denticles; 3 pairs of hypostomal setae and a pair of palpcoxal setae; external posterior hypostomal setae long and pilose distally, other setae simple but first internal posterior hypostomal setae longer than 2 other setae; epistome (Fig. 27E) unipartite with small spine laterally and dorsally; base serrate laterally. Fixed digit of chelicerae (Fig. 27D) with simple

dorsal setae, robust median tooth, small distall tooth, *pilus dentilis*, and terminal hook; movable digit with median bidentate tooth, small distal tooth, and terminal hook; arthrodial process strongly pilose; length of fixed digit 209.8 (199.9–219.7) and that of movable digit 106.7 (105–110) (n=3).

Legs. Tarsus I without ambulacrum; tarsi II–IV with well ambulacra and claws. Most leg segments with thick pilose and simple setae. Leg length (excluding ambulacrum, n=2 (leg I and II), n=3 (leg III and leg IV)): leg I, 455.2 (419.5–490.8); leg II, 635.4 (622.8–647.9); leg III, 530.6 (503.2–546); leg IV, 632.6 (564.9–680.5).

Sacculus foemineus. Not observable.

Male. Length of dorsal shield 1000, width at level of coxae II 660 (n=1). Specimens brown in color.

Dorsal shield (Fig. 28A). Dorsal shield as in female with 28 pairs of dorsal setae and 1 unpaired seta Jx; setae j1 palmate, short, board, and plumose distally; j2–j4, z1, z2, r2, S5, and Z4 plumose, other setae simple or slightly pilose distally.

Venter (Fig. 28B). Tritosternum well developed and with pilose laciniae. Sternal shield longer than wide; length 262.8, width at level of coxae II 253.2 (n=1); shield with 5 pairs of strongly pilose setae and 3 pairs of pores; l. m. t. present.

Anal shield oval, length 129.7, width 74.6 (n=1); shield with 1 pair of paranal setae and 1 postanal seta present; all setae simple.

Gnathosoma (Fig. 28C). Gnathosoma as in female; epistome (Fig. 28D) unipartite with small spine laterally and dorsally; base serrate laterally. Fixed digit of chelicerae (Fig. 28E) with simple dorsal setae, robust median tooth, small distall tooth, *pilus dentilis*, and terminal hook; movable digit with median bidentate tooth, spermatodactyl, and terminal hook; arthrodial process pilose; length of fixed digit 227.7 and that of movable digit 102.9 (n=1).

Legs. Tarsus I without ambulacrum; tarsi II–IV with well ambulacra and claws. Most leg segments with thick pilose and simple setae; femur II with large spur; genu and tibia II with spur and ridge Leg length (excluding ambulacrum, n=1): leg I, 471.5; leg II, 669.9; leg III, 551.8; leg IV, 716.9.

Deutonymph. Length of dorsal shield 713.5, width at level of coxae II 577.3 (n=1). Specimen yellowish brown in color.

Dorsal shield (Fig. 29A). Dorsal shield attenuate anteriorly, punctations and lines present between j4–s2 and j4–s5, lateral incisions present behind dorsal seta s6; bearing 28 pairs of dorsal setae and 1 unpaired seta Jx; setae j1 palmate, short, board, and plumose distally; j5, j6, z5, Jx, J2, Z3, Z5, and Z5 simple; Z4 and S5 very long and slightly pilose; other setae strongly pilose.

Venter (Fig. 29B). Tritosternum well developed and with pilose laciniae. Sternal shield longer than wide; length 186.2, width at level of coxae II 177 (n=1); shield with 5 pairs of strongly pilose setae and 3 pairs of pores; st4 longer than other sternoventral setae.

Anal shield oval, length 104.2, width 50.5 (n=1); shield with 1 pair of paranal setae and 1 postanal seta present; all setae simple, postanal seta thick.

Gnathosoma (Fig. 29C). Gnathosoma as in female; epistome (Fig. 29D) unipartite with small spine laterally and dorsally; base serrate laterally. Fixed digit of chelicerae (Fig. 28E) with simple dorsal setae, robust median tooth, small distall tooth, *pilus dentilis*, and terminal hook; movable digit with median bidentate tooth, small distal tooth, and terminal hook; arthrodial process pilose; length of fixed digit 178.7 and that of movable digit 84 (n=1).

Legs. Tarsus I without ambulacrum; tarsi II–IV with well ambulacra and claws. Most leg segments with thick pilose and simple setae. Leg length (excluding ambulacrum, n=1): leg I, 364.8; leg II, 477.4; leg III, 424.4; leg IV, 515.4.

Protonymph. Length of podonotal shield 373, width at level of coxae II 318.4. Length of opisthonotal shield 108.9, width at level of coxae II 297.5 (n=1). Specimen yellowish brown in color.

Dorsal shield (Fig. 30A). Podonotal shield convex posteriorly, some anterior podonotal setae connected by lines, bearing 11 pairs of podonotal setae, setae very long and plumose, setae j6 shorter than the other podonotal setae. Opisthonotal shield concave anteriorly, bearing 8 pairs of opisthonotal setae, setae very long and pilose except short and pilose for setae J2 and Z5, setae Z5 surpassing the margin of posterior opisthonotal shield.

Venter (Fig. 30B). Tritosternum as in deutonymph. The length of sternoventral shield almost equal to the width; length 156.9, width at level of coxae II 154.4 (n=1); shield with 3 pairs of pilose setae and 2 pairs of pores.

Anal shield oval, length 92.4, width 43.6 (n=1); shield with 1 pair of paranal setae and 1 postanal seta present; all setae simple and postanal seta thick.

Gnathosoma (Fig. 30C). Gnathosoma well developed and sclerotized. Deutosternal groove with 5 rows of denticles; 3 pairs of hypostomal setae and a pair of palpcoxal setae; external posterior hypostomal setae thick, pilose distally, and longer than 3 other setae, other setae simple; epistome (Fig. 30E) unipartite with small spine laterally and dorsally; base serrate laterally. Fixed digit of chelicerae (Fig. 30D) with simple dorsal setae, robust median tooth, small distall tooth, *pilus dentilis*, and terminal hook; movable digit with median bidentate tooth, small distal tooth, and terminal hook; arthrodial process strongly pilose; length of fixed digit 141.1 and that of movable digit 68.7 (n=1).

Legs. Tarsus I without ambulacrum; tarsi II–IV with well ambulacra and claws. Most leg segments with thick pilose and simple setae. Leg length (excluding ambulacrum, n=1): leg I, 266.2; leg II, 371; leg III, 336.8; leg IV, 389.3.

Type series: Holotype (NIR. Acar. 9400.1): female, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya, Central Kalimantan, 15 March 2009, O. Efendi *leg*., *ex* Scarabaeidae. Paratypes: 2 females, 1 male, 1 deutonymph, 2 protonymphs, same data as for holotype.

Etymology: This specific name is derived from the part name of type locality (Murung Raya).

Remarks: The broad and palmate shape of dorsal setae j1 and the spine shape in the ends of l. m. t. in female *Neopodocinum murungensis* definitely differentiate it from other species of *Neopodocinum*. This broad and palmate seta also appears on femur II. Dorsal setae of the present species in female resembles to those of *N. bartkei* Micherdzinski, 1964 from North Viet Nam. Posterodorsal setae of both species short and smooth while anterodorsal setae longer and pectinate. One unpaired seta Jx also appears in both species. The difference between these two *Neopodocinum* is *N. murungensis* has 28 pairs of dorsal setae while *N. bartkei* has 29 pairs of dorsal setae.

I. 6. Key to the species (female) of Macrochelidae in Kalimantan

1. Tectum unipartite; trochanter III with 4 setae (Genus *Neopodocinum*) 4
-. Tectum tripartite; trochanter III with 5 setae 2
2. Metasternal shield adjacent to sternal shield; sternal shield ornamented with polygonal crenulate ridges (Genus *Glyptholaspis*) 9
-. Metasternal shield free from sternal shield 3
3. Spur present in femur II; dorsal seta j1 inserted on anterior projection (Genus *Holostaspella*) 10
-. Spur absent in femur II; dorsal seta j1 not inserted on anterior projection (Genus *Macrocheles*) 12
4. Anal shield expanded, triangular 5
-. Anal shield rounded 6
5. Anal shield with 2 pairs of preanal setae (Fig. 24D) .....
.....***Neopodocinum halimunense*** Hartini and Takaku, 2003
-. Anal shield without preanal setae (Fig. 25D).....
.....***Neopodocinum maius*** Berlese, 1911
6. Unpaired dorsal seta Jx present ……..7
-. Unpaired dorsal seta Jx absent 8
7. Sternal shield without spine-like ornamentation at lateral side of l.m.t.; sternal setae long and simple (Fig. 26D).....
.....…… ***Neopodocinum subjaspersi*** Hartini and Takaku, 2003
-. Sternal shield with spine-like ornamentation at lateral side of l.m.t.; sternal setae st. 1 short and pilose (Fig. 27B)..... ***Neopodocinum murungensis*** sp. nov.

8. Dorsal setae j5 to J5 simple (Fig. 25A) .....
.....***Neopodocinum kalimantanense*** Hartini and Takaku, 2004

-. Dorsal setae j5 to J5 pectinate (Fig. 24A) .....
..... ***Neopodocinum bosschai*** (Oudemans, 1901)

9. Dorsal shield with 28 pairs of dorsal setae; j5 long and pilose; J5 long, pilose, as long as Z5 (Fig. 5A) .....***Glyptholaspis asperrima*** (Berlese, 1905)

-. Dorsal shield with 28 pairs of dorsal setae and 1 unpaired median seta between j6 and J2; j5 thick and plumose; J5 shorter than Z5 and not reaching posterior margin of dorsal shield (Fig. 5C) .....***Glyptholaspis confusa*** (Foà, 1900)

10. Ventrianal shield broader than long 11

-. Ventrianal shield oval; dorsal setae j5, j6, z5, and J2 small and pectinate; z5 smaller than other setae and located at level anterior to j5; other dorsal setae pectinate and long; marginal setae long and reaching to insertions of setae behind them (Fig. 6D).
.....***Holostaspella katakurai*** Hartini and Takaku, 2003

11. Dorsal setae short and simple except pilose J5; sternal setae and postanal seta simple (Fig. 6A) ..... ***Holostaspella bifoliata*** (Trägårdh, 1952)

-. Dorsal setae pectinate; sternal setae thick and plumose; preanal setae long and simple; postanal seta plumose (Fig. 7A) .....
.....***Holostaspella moderata*** Berlese, 1921

12. All or most dorsal setae simple, short, and pointed, except J5 (usually pilose) 13

-. Some dorsal setae pilose, plumose or pectinate 15

13. Dorsal setae simple except Z4, Z5, and S5 which pilose distally (Fig. 18C) .....
..... ***Macrocheles sumbaensis*** Hartini and Takaku, 2005

-. All dorsal setae simple..... 14

14. L. o. a. of sternal shield connected by lines, form a semicircular line in anterior half (Fig. 19D) ..... ***Macrocheles merdarius*** (Berlese, 1889)

-. L. o. a. absent and not connected by lines, appear as a pair of punctate lines around the second pair of pores (Fig. 18B) ..... ***Macrocheles krantzi*** Evans and Hyatt, 1963

15. Sternal shield ornamented with dense or coarse punctations and ridges or reticulations (Fig. 19B, 20B, 20D, 23B) 16

-. Sternal shield ornamented with lines and punctations; l. ang. convergent medially; anterior half of shield with 1 or 2 transverse lines l. arc.; l. o. a. poorly developed; l. m. t. connecting second pair of sternal setae (st. 2); l. o. p. bifrurcate, joining l. m. t. or not bifurcate and disjunct from l. m. t.; posterior area of l. o. p. punctate slightly to strongly to make a. p. p. and a. pf.....19

16. Sternal shield ornamented with distinct reticulation and punctations 17

-. Sternal shield ornamented with punctations..... 18

17. Dorsal setae j1 palmate and all dorsal setae pilose (Fig. 20C)..... .....***Macrocheles plumosus*** Evans and Hyatt, 1963

-. Dorsal setae j1 short and pilose distally, and most of dorsal setae simple and long (Fig. 23) ..... ***Macrocheles lorensis*** sp. nov.

18. Sternal shield ornamented with coarse punctations and ridges ....***Macrocheles muscaedomesticae*** (Scopoli, 1772)

-. Sternal shield ornamented with fine and dense punctations ....***Macrocheles mammifer*** Berlese, 1918

19. Some dorsal setae pilose or pectinate entirely.....20

-. Dorsal setae simple, pilose or pectinate distally, except for J5 which pilose entirely

.....24

20. Genu IV with 6 setae 21

-. Genu IV with 7 setae .....***Macrocheles hallidayi*** Walter and Krantz, 1986

21. Setae j1 pilose in most length; ventrianal shield wider than long (Fig. 12C, D).....

..... ***Macrocheles kraepelini*** (Berlese, 1904)

-. Setae j1 pilose or plumose in distal halves; ventrianal shield longer than wide .....

.....22

22. L. m. t. complete with punctations along the line (Fig. 8D).....

.....***Macrocheles kalimantanensis*** Hartini and Takaku, 2003

-. L. m. t. complete without punctations along the line 23

23. Dorsal setae mostly pilose distally and short (Fig. 9).....

..... ***Macrocheles lumbiensis*** sp. nov

-. Dorsal setae pilose in distal halves and long (Fig. 8A) .....

..... ***Macrocheles baramensis*** Evans and Hyatt, 1963

24. Sternal ornamentations with reduced sclerotization 25

-. Sternal ornamentation developed 32

25. Most of dorsal setae pilose distally 26

-. Most of dorsal setae simple 30

26. Sternal shield with faint reticulate ornamentation in anterior half (Fig. 21).....

.....***Macrocheles sukaramiensis*** Takaku, 2001

-. Sternal shield with lines and/or punctations in anterior half 27

27. Genu IV with only pilose setae 28

-. Genu IV with only simple and pilose setae .....***Macrocheles dispar*** (Berlese, 1910)

28. Sternal shield with two l. arc. and punctations 29

-. Sternal shield with one l. arc. without punctations (Fig. 15D) .....

.....***Macrocheles entetiensis*** Hartini and Takaku, 2005

29. Dorsal shield oval, attenuated posteriorly; j2 pilose distally (Fig. 17A).....

..... ***Macrocheles persimilis*** Hartini, Dwibadra and Takaku, 2007

-. Dorsal shield rounded posteriorly; j2 slightly pilose (Fig. 16C).....

.....***Macrocheles nidus*** Hartini and Takaku, 2013

30. Sternal shield ornamented with lines and punctations (Fig. 16A) .....

..... ***Macrocheles jabarensis*** Hartini and Takaku, 2003

-. Sternal shield with punctations 31

31. Sternal shield longer than wide (Fig. 13B) .....

.....***Macrocheles pumilus*** Hartini, Dwibadra and Takaku, 2009

-. Sternal shield wider than long (Fig. 14) .....

..... ***Macrocheles riparius*** Dwibadra and Takaku, 2014

32. Most of dorsal setae pilose distally.....33

-. Most of dorsal setae simple 34

33. Dorsal setae pilose distally, except z1 simple; a. p. p. with strong and coarse punctuations (Fig. 10).....***Macrocheles dayaci*** Dwibadra and Takaku, 2014

-. Dorsal setae pilose entirely or in distal 2/3, z1simple, some podonotal setae inserted on tubercles; a. p. p. appear as scattered punctations (Fig. 22) .....

..... ***Macrocheles wainensis*** Dwibadra and Takaku, 2014

34. Some dorsal setae reaching or surpassing insertion of setae behind them (Fig. 11) ...

.....***Macrocheles oigru*** Walter and Krantz, 1986

-. Dorsal setae not reaching insertion of the next setae (Fig. 12) .....

.....***Macrocheles*** sp. aff. ***glaber*** (Müller, 1860)

I. 7. Phoretic Association between Macrochelidae and Dung Beetles

Relationships with invertebrates, especially arthropods, abound in Mesostigmata (Walter and Proctor, 2013). Hunter and Rosario (1988) reviewed mite-insect associations, and noted that 25 of 44 monogynaspid (56%) and 20 of 24 trigynaspid families (83%) have species associated with arthropods, 95% of them with insects. Of insects, the dung- and wood-dwelling beetle families Scarabaeidae, Scolytidae, and Passalidae are used as host by many species of Mesostigmata (Walter and Proctor, 2013). Mite-insect associations may range from opportunistic to parasitic or mutualistic. For example, in the association between *Poecilochirus* mites (family Parasitidae) and *Nicrophorus* beetles (family Silphidae), mites have neither positive nor negative effects on host fitness, but sometimes have positive effects (mutualistic association), and rarely negative (parasitic association) (Wilson and Knollenberg, 1987). However, the relationships of mites and their carrier insects are not yet clear in many cases. It is generally accepted that the most common type of association would be phoresy.

Although detail interaction between phoretic mesostigmatid mites and carrier dung beetles has not been investigated yet, Costa (1963, 1966, 1969) and Krantz and Mellott (1968, 1972) reported the species-specific phoretic association of mites with dung beetles. In Japan, Takaku *et al*. (1994) examined the relationships between mesostigmatid mites and various groups of beetles. They mentioned that macrochelids were exclusively found on dung beetles of the families Scarabaeidae and Geotrupidae. Most *Macrocheles* species were generalist and were found on various species of scarabaeid beetles, except one species of the genus *Holostaspella* which was found only

on *Copris* dung beetle (Takaku *et al*., 1994). In their study, most of mite species of families showed definite preference for particular group of beetles, and they suggested phylogenetic constraint and ecological factor could affect the carrier specificity, since beetle groups differ phylogenetically and ecologically (Takaku *et al*., 1994; Takaku, 2007).

The knowledge of association between macrochelid mites and scarabaeid dung beetles is also limited in Indonesia. However, Hartini (2005) gave some information and discussed on the association of Indonesian macrochelid mites with dung beetles. The results of the present study will provide additional data of associations of Indonesian macrochelids with dung beetles, and discuss on characteristics of and specificity to carrier beetles.

1. Phoresy: Definition and Phenomenon

Fossil record of phoresy is for a small astigmatid mites associated with a spider preserved in 44–49 million years old (Eocene) amber (Dunlop *et al*., 2012; Walter and Proctor, 2013). As for the Mesostigmata, oldest records are uropodid mites attached to bark beetles in Dominican amber laid down to 40–20 million years ago (Hunter and Rosario, 1988). However, Lindquit (1975) speculated that such associations have probably existed since late Mesozoic era.

Many definition of the term “phoresy” have been proposed and none has yet been accepted by all acarologists (Walter and Proctor, 2013). However, the definition generalized by Farish and Axtell (1971) is widely accepted (Brown and Wilson, 1994), and is applicable well to the macrochelid mites associated with dung beetles. The definition is as follows:

"Phoresy is a phenomenon in which one animal actively seeks out and attaches to the outer surface of another animal for limited time during which the attached animal (termed the phoretic) ceases both feeding and ontogenesis, such attachment presumably resulting in dispersal from areas unsuited for further development, either of the individual or its progeny".

Macrochelid mites attach to the outer surface (especially on the ventral side) of carrier dung beetles for a limited time, and are transported from dung to dung. On the dung, the mites may feed on nematodes or small insects, and may mate (Hartini, 2005). The mites will have the following benefits of dispersal and migration by phoresy: escape from physically deteriorating habitats, emigration from overcrowded natal sites, transport to new sources of food, prevention of inbreeding, and access to new areas for colonization (Walter and Proctor, 2013). On the other hand, carrier beetles will have neither negative nor positive effect from phoretic mites. Hence, the phoresy is one type of "commensalisms". However, it is often difficult to know whether a mite truly commensal or if its beneficial or harmful effects on the host simply have not been determined (Walter and Proctor, 2013). Many cases of associations previously reported as mere phoresy have been shown as more complex associations, as above-mentioned *Poecilochirus* mites associated with burying beetles. The association between the mite *Dendrolaelaps neodisetus* (Digamasellidae) and the bark beetle *Dendroctonus frontalis* was also mutualistic, the mite increasing the fitness of the bark beetle by lowering the density of nematodes parasitic on the beetle (Kinn, 1980).

In Acari, the phoretic stage may be specifically modified for transport on the host. Deutonymphs of families in the Uropodina usually attach to their carrier arthropods by s stalk secreted from the anus (Fig. 31A). Phoretic deutonymphs of

Astigmata, termed “hypopus”, have flattened body with reduced legs and caudoventral sucker (Fig. 31B). Macrochelid mites, usually the adult female, are phoretic on beetles by grasping a seta or a fold of integument of their carriers by means of their robust chelicerae (Fig. 31C). And deutonymphs of parasitid mites generally have neither robust chelicera nor sucker attachment, and the mites instead hanging on by their ambulacral claws (Fig. 31D).

2. Association between Indonesian species of macrochelid mites and scarabaeid dung beetles

Takaku *et al*. (1994) reported that Japanese species of macrochelid mites showed an intense preference to scarabaeid and geotrupid dung beetles, being exclusively found on these beetles, while many species of mites were generalist and used various species of dung beetles. A result of research by Hartini (2005) was consistent with abovementioned results, i.e., macrochelids were very common on scarabaeid dung beetles also in Indonesia, and many mites were associated with multiple carrier beetles, e.g., *Macrocheles oigru* was most common and associated with seven genera of dung beetles, followed by *M*. *kraepelini* and *M*. sp. aff. *glaber* that were associated with six genera of dung beetles, respectively. The association between macrochelid mites and carrier dung beetles confirmed by the present studies was summarized in Table 5. In total 3,351 specimens of mites were collected in Kalimantan, and the mites were found to be phoretic on 9 genera of scarab beetles *Aphodius*, *Caccobius, Catharsius, Copris, Onitis, Oniticellus, Onthophagus, Paragymnopleurus*, and *Sisyphus* (Scarabaeidae), one genus of geotrupid beetle *Bolbochromus* (Geotrupidae), and one genus of scavenger scarab beetle *Phaeocroops* (Hybosoridae).

Most of macrochelid mites were associated with dung beetles, especially the family Scarabaeidae.

1) Host specificity. As mentioned in Takaku *et al.* (1994) and Hartini (2005), it seemed that most of mite species are generalists with respect to the carrier beetles. *Macrocheles kalimantanensis* was most common and associated with seven genera of dung beetles, followed by *M. baramensis* and *M. jabarensis* with six genera. Thus, species of the genus *Macrocheles* seemed to use several genera of dung beetles. Largest genus *Macrocheles* did not show preference to particular taxonomic groups or species of dung beetles. On the other hand, as in Hartini (2005), *Neopodocinum* species appeared to adopt certain beetle genera, e.g. *Catharsius*, *Onthophagus*, *Paragymopleurus*, and *Sisyphus* in the present study (Table 5, Fig. 32). However, these four genera are tunneler (they bury the dung wherever they find it) or roller (they roll dung into round balls, which are used as a food source or brooding chambers) in nesting type, and small to large in body size (Table 6). So, it seems that there are no uniformity of nesting type and body size in carrier beetle of *Neopodocinum* mites. Of course, since difference of life history between dung beetles species may affect the difference in the carrier specificity between *Macrocheles* and *Neopodocinum*, detail study on ecology of beetles and mites will be necessary in future.

2) Preference to nesting type, size, and species diversity of beetle genera. Of the 9 genera of scarab beetles, genus *Catharsius* was the most commonly utilized species and carried 22 species of macrochelid mites, *Onthophagus* did 19 species of mites, *Paragymnopleurus* did 13 species of mites, *Copris* and *Sisyphus* harbored 7 mite species (Table 5). Of above mentioned four beetle genera carrying many mite species, three, i.e., *Catharsius*, *Paragymnopleurus*, and *Copris*, are larger sized genera (Table 6).

Larger sized genera of beetle (*Catharsius*, *Copris*, *Onitis*, and *Paragymnopleurus*) associate with 10.8 mite species in average, whereas smaller sized genera with 6.4. *Poecilochirus* mites associated with burying discriminate adult male of *Nicrophorus* based on body size, lager beetles attracted more mites (Grossman and Smith, 2008). Larger body size is associated with greater flying ability, and larger burying beetles are more successful in defending a carcass from conspecific and congeneric competitors (Grossman and Smith, 2008). Although the discrimination of body size by mites is case of male in one burying beetle species, it may be able to apply to macrochelid mites associated dung beetles, and mites may choose larger sized dung beetles which possibly have greater flying ability and competitive ability. As for the smaller sized beetles, Bajerlein and Przewoźny (2012) mentioned that beetle infestation by nonspecific phoretic mites is strongly influenced by beetle body size, and smaller sized beetle did not carry mites or had a very low mite burden. *Caccobius*, one of the smallest genus in the family Scarabaeidae, harbor only one species (*M. kalimantanensis*) of macrochelid mite (Tables 5, 6). On the contrary, smaller sized genera *Aphodius* and *Sisyphus* harbor 3 and 7 species of mites respectively. Bajerlein and Przewoźny (2012) reported hydrophilid beetles (Coleoptera: Hydrophilidae) with body length below 2.32 mm did not carry phoretic deutonymph of *Uropoda orbicularis* (Acari: Mesostigmata: Uropodidae). The body size of genera *Aphodius* and *Sisyphus* vary 2 to 15 mm and 4 to 12 mm, respectively (Table 6). In order to elucidate relationship between beetle size and number of mite species and to know whether there is lower limit of body length of beetles for phoretic mites, more detail data will be necessary.

In the meanwhile, genus *Onthophagus*, harboring second largest number of species of mites, is megadiverse group in the family Scarabaeidae, and it consists of

more than 500 species (Balthasar, 1963b; according to Tarasov and Kabakov (2010), it includes about 2,000 spp.). Diversified beetle genera (including more than 100 spp.: genera *Aphodius* and *Onthophagus*) associate with 11 mite species in average, while undiversified genera (including less than 100 spp.) with 7.6. Species diversity of the genus *Onthophagus* in Kalimantan is unknown, but many species may be included in dung community because of high diversity of the genus in Oriental Region (Tarasov and Kabakov, 2010). The phoretic macrochelid mites may tend to ride on the beetles which are abundant in species number and number of individuals in dung community. The genus *Aphodius* is also including more than 600 species, but it harbors only 3 species of mites. Although the difference between *Onthophagus* and *Aphodius* may be affected by nesting type, i.e., dweller (consume the dung pat and deposit eggs in the dung) and tunneler (Table 6), relationship between nesting type of beetles and phoretic mite diversity is unknown.

I. 8. Summary

Thirtyfive species of four genera belonging to the family Macrochelidae (Acari: Mesostigmata) associated with dung beetles (Scarabaeidae) were recorded and described in Kalimantan, Indonesia. Three new species were described for the first time in the present thesis (*Macrocheles lumbiensis*, *M. lorensis*, and *Neopodocinum murungensis*), 19 species have already known previously, and 13 species recorded from Kalimantan for the first time. A key to the 35 species (female) of mites was provided.

Based on morphological characters, especially dorsal and sternal characters, three species of the genus *Holostaspella* were classified into 3 species groups (*bifoliata*, *mirabilis*, and *sculpta* species group). Nineteen species of the genus *Macrocheles* classified to the four species group (*glaber* species group, *muscaedomesticae* group, *subbadius* group, and *krantzi* group) and seven species complexes. Five complexes are belonging to *glaber* group, i. e., *glaber* complex (including *Macrocheles* sp. aff. *glaber* (Müller, 1860), *M. oigru* Walter and Krantz, 1986, and *M. dayaci* Dwibadra and Takaku, 2014), *kraepelini* complex (including *M. kraepelini* (Berlese, 1905) and *M. hallidayi* Walter and Krantz, 1986), *scutatus* complex (*M. dispar* (Berlese, 1910), *M. entetiensis* Hartini and Takaku, 2005, *M. jabarensis* Hartini and Takaku, 2003, *M. nidus* Hartini and Takaku, 2013, and *M. persimilis* Hartini, Dwibadra and Takaku, 2007), *pumilus* complex (including *M. pumilus* Hartini, Dwibadra and Takaku, 2009 and *M. riparius* Dwibadra and Takaku, 2014), *baramensis* complex (including *M. baramensis*, *M. kalimantanensis*, and *M. lumbiensis*). One species complex, *merdarius* complex, is included in *subbadius* group.

Macrochelids of Kalimantan were associated with 11 genera of beetles, i. e., *Aphodius*, *Caccobius*, *Catharsius*, *Copris*, *Onitis*, *Oniticellus*, *Onthophagus*,

Paragymnopleurus, and *Sisyphus* (Scarabaeidae), *Bolbochromus* (Geotrupidae), and *Phaeocroops* (Hybosoridae). It seemed that most of mite species are generalists with respect to the carrier beetles. Genus *Catharsius* was the most commonly utilized species and carried 22 species of macrochelid mites, followed by *Onthophagus* and *Paragymnopleurus* with 19 and 13 mite species respectively.

Macrocheles kalimantanensis was most common and associated with seven genera of dung beetles, followed by *M. jabarensis* and *M. baramensis* with 6 genera of dung beetles.

Beetle with large body size (*Catharsius*, *Copris*, *Onitis*, and *Paragymnopleurus*) associate with 10.8 mite species in average, more than smaller body sized genera with 6.4. *Caccobius*, one of the smallest genus in the family Scarabaeidae, harbor only one species (*M. kalimantanensis*) of macrochelid mite.

The phoretic macrochelid mites may tend to ride on the beetles which are abundant in species number and number of individuals in dung community. Diversified beetle genera (genera *Aphodius* and *Onthophagus*) associate with 11 mite species in average, while undiversified genera with 7.6.

II. Biogeography of the Macrochelid Mites in Borneo and Surrounding Areas

II. 1. Introduction

Wallace (1876) divided South East Asia into the Indochinese (Indo-China), Sundaic, Philippine and Wallacean zoogeographic subregions. The island of Borneo itself, along with Sulawesi is playing important role for biogeography of this region because of bordering Wallace's faunal divide as western boundary of Wallacea, a transitional area between Asiatic and Australian biotas, where organisms show a high degree of endemism (Whitten *et al*., 1987; Moss and Wilson, 1998; Woodruff, 2010).

Borneo has a variety of habitats, such as high mountainous areas, lower rolling topography and flat coastal plains. Complex factors, including physical differences in environment, variation of climate as well as regional geological evolution may all influence the nature and diversity of organism found on Borneo (Whitten and Whitten, 1992).

Based on previous investigation on mammal and bird, the biota of Borneo is similar to mainland South East Asia and other islands on Sunda Shelf. The mammal of Borneo, represented by 222 species of land animals identical at family level. The highest number of species of primates in South East Asia is in Borneo. Not only for the land animal, but Borneo also has high diversity for fresh water fish and birds (MacKinnon *et al*., 1996; Kottelat *et al*., 1993).

Even though invertebrate species are extremely abundant on Borneo, accurate figures are not available for less known groups (Moss and Wilson, 1998). Here I tried to analyze zoogeographic characteristics of Bornean Macrochelidae and compared it to those in surrounding areas. Besides, I tried to analyze distribution of Indonesian macrochelids in the world to clarify characteristics of distribution of Indonesian mites,

and discussed on the relationship between distributional pattern and diversity of carrier beetles.

II. 2. Material and Methods

II. 2. 1. Macrochelid fauna and the faunal similarity between islands

Thirty five species of macrochelid mites have been reported and described from Borneo (including Kalimantan and Malaysian part) as shown in part I of this thesis. In order to understand the faunal characteristics of the Macrochelidae in Borneo and surrounding areas, some analysis were conducted.

Macrochelid mites faunas between islands in Borneo and surrounding areas were compared by using Sørensen's coefficient index (Cs) as a measure of similarity (Sørensen, 1948) (Tables 7, 8).

$$Cs= 2j/(a+b)$$

j= number of species common to two areas in question

a= total number of mite species occurring on area 1

b= total number of mite species occurring on area 2

The similarity matrix resulting from pairwise comparison was subjected to cluster analysis by using UPGMA (Unweighted Pair Group Method with Arithmetic mean) in NTSYS Ver.2.1 (Exeter Software). The number of macrochelid species on Borneo was based on the present study. Those on surrounding areas (islands of Indonesia, New Guinea, mainland of Southeast Asia (Indo-China and Malay Peninsula), and Philippines) were taken from previous publications and Hagiwara (2014) and Takaku (unpublished data).

II. 2. 2. Distribution of macrochelid mites in Indonesia and the world

In total, 79 species, including the result of the present study, have been recorded from Indonesia. I tried to research on the locality data of these species based

on description and record of each species (data of the present study; Takaku, unpublished data), and divided the distribution into six zoogeographic regions, i.e., Australian Region (including Wallacea and New Guinea), Ethiopian Region, Nearctic Region, Neotropical Region, Oriental Region, and Palaearctic Region.

To elucidate endemism of Indonesian macrochelids, I investigated macrochelid mite fauna in Indonesia and surrounding areas, and calculated endemic rate in each island of Indonesia and surrounding area. Besides, endemic species rate in four genera, *Glyptholaspis*, *Holostaspella*, *Macrocheles*, and *Neopodocinum*, and in Indonesian macrochelids were also calculated.

As for the Indonesian 79 species, I researched distribution of each species in Indonesia based on the present study and previous studies by Hartini (e.g. Hartini, 2005; Hartini and Takaku, 2003 a, b, c, 2004, and so on). Distributional pattern of mites were divided into six categories, i.e., DJ (disjunct distribution: distribution in two or more islands where are not adjacent), ED (endemic to one island or area: distribution limited to one island or area), NG (endemic to New Guinea: distribution limited in New Guinea, Australian Region), OR (Oriental Region: distribution limited to mainland of South East Asia and/or Greater Sunda islands excluding Sulawesi), WA (endemic to Wallacea: distribution restricted to Lesser Sunda islands and/or Sulawesi), and WD (wide distribution: wide distribution from Oriental Region Greater Sunda islands excluding Sulawesi) to Australian Region (Wallacea, New Guinea). Based on the data of number of carrier beetle genera associated with each mite species in Borneo (Table 5), I calculated average number of beetle genera in each distributional pattern of macrochelid mites in Indonesia. The average number was used as indicator of diversity of carrier

beetles, although each beetle genus has so different number of species that it is difficult to simply apply the number of genera to the indicator of diversity of carrier beetles.

II.3. Results

II. 3. 1. Macrochelid fauna and the faunal similarity between islands.

Macrochelid fauna of Borneo and surrounding areas are shown in Table 7. From this table, the species that was found only once on an island is counted as endemic species.

A dendogram based on the similarity of macrochelid mites faunas in Borneo and surrounding areas is shown in Fig. 33. Macrochelid fauna in this study first divided into two large clusters, New Guinea and others. The latter big cluster then divided further into Philippines and other islands. In that dendogram clearly show that Sulawesi, Bali and Lesser Sunda are separated from Sundaland (Sumatra, Borneo, mainland South East Asia, and Java). The distribution ranges of the groups based on UPGMA were shown in the map in Fig. 34.

II. 3. 2. Distribution of macrochelid mites in Indonesia and the world

The distribution of each macochelid mites recorded from Indonesia is appeared in Table 9. Endemic species in Indonesia are indicated in red color in the table. In 79 species, only 6 species (*Glyptholaspis confusa*, *Holostaspella bifoliata*, *Macrocheles glaber*, *M. mammifer*, *M. medarius*, and *M. muscaedomesticae*) are almost cosmopolitan, and most of other species are recorded from Australian Region, mainly Wallacea and New Guinea, and/or Oriental Region.

Endemic rate in each island in Indonesia and surrounding areas are shown in Table 10, and endemic species rate in each genus of Macrochelidae and in Indonesian species are shown in Table 11. Endemic rate in fauna of island is higher in New Guinea (50%), Sulawesi (21.1%), and Java (18.6%), and lower in Bali and Lesser Sunda islands

(0%) and mainland of SE Asia (9.1%), Sumatra (9.5%) . Endemic rate in Borneo (11.4%) is higher than that of Sumatra or SE Asia, but lower than that of the Philippines (17.4%) or Sulawesi. Endemic species rate of each genus is high in two genera *Macrocheles* (64%) and *Neopodocinum* (63.6%), and more than half of the species recorded from Indonesia are endemic to Indonesia.

Distributional pattern of macrochelid mites in Indonesia are summarized in Table 12. Eight species have disjunct distribution, 22 species are endemic to one island, 13 species are endemic to New Guinea, 17 species are restricted in Oriental Region, 5 species are endemic to Lesser Sunda or Sulawesi, and 14 species are widely distributed in Indonesia. Species indicating disjunct distribution and wide distribution tend to have large number of genera of carrier beetles: 3.50 in the species of disjunct distribution and 2.73 in the species of wide distribution, while 1.67 in endemic species and 1.79 in the species restricted in Oriental Region.

II. 4. Discussion

Characteristic of macrochelid mites in Borneo and surrounding areas.

On the basis of the similarity of the macrochelid mite fauna, Borneo and surrounding areas are divided into five groups, 1) Sumatra, Borneo, and mainland of South East Asia; 2) Java; 3) Sulawesi and Lesser Sunda; 4) The Philippines; and 5) New Guinea (Figs. 33, 34).

The first group includes Sumatra, Borneo and mainland of South East Asia. The three areas are grouped into one cluster can be interpreted as reflecting the geological history of these islands/areas. During the past 50 million years a part of South East Asia (Peninsular Malaysia, Kalimantan, Sumatra, and Java) were united in the formation of Sundaland or Sunda Shelf (Hall, 1998). In this cluster Borneo has highest percentage of endemism (11.4%) (Table 10).

The second group is Java. The endemism in Java is quite high (18.6%). Java is the most densely populated island in Indonesia and wide areas have been deforested and converted into agricultural land. However, many of the mountains and some areas of lowland retained their natural vegetation of tropical rainforest. For example, western Java mountain forest which harbors diverse habitats which in turn gives way to a rich variety of flora and fauna, with many endemic species. Endemism is highest for mammals, but is also significant for birds. Previous investigation proved that the dung beetle species richness correlated with the level of resource availability (Lumaret *et al*., 1992; Davis, 2000). Areas that are rich in mammals, contain more species of dung beetles which to be expected also contain many mites which share the same habitat and food resources.

The third group is including Sulawesi, Bali and Lesser Sunda. There are no

endemic species in Bali and Lesser Sunda, but Sulawesi has high degree of endemism (21.1%).

The fourth group is Philippines which has percentage of endemic rate 17.4%. During the last ice-age the Philippines were already an archipelago and not connected to mainland Asia. While other islands in South East Asia were at that time connected to the mainland (like Borneo, Java and Sumatra), the Philippines was separated by deep water channels. The result is that many of the species living in the Philippines have been separate populations for a very long time, allowing them to develop into separate species and subspecies (Vallejo, 2011).

The last group comprise of New Guinea with highest endemic rate (50%). Study conducted by Hartini (2008) and Hartini and Takaku (2006a, b) showed that several species from Papua (Indonesian part of New Guinea) have special characteristic which is not shown in other species of Macrochelidae from other areas, i.e., 29 pairs of dorsal setae and paranal extension of cribrum. These two characters usually were shown in soil-inhabiting macrochelid mites.

Sørensen's coefficient index (Sørensen, 1948) (Table 8), indicating similarity of fauna between two areas, is high between Borneo and Sumatra and between Borneo and Java. As well, several species in Borneo are common to the fauna of other surrounding islands, *e.g.,* Sulawesi and the Philippines. These similarities may be due to the geological history of these islands and/or the dispersal ability of the phoretic vehicles, dung beetles. Macrochelid mites in Borneo mostly utilize scarab beetles of the genera *Catharsius*, *Onthophagus* and *Paragymnopleurus* (Fig. 31). Based on the result study by Ochi (2010), Borneo and Philippines (Palawan) share several same species of genera *Paragymnopleurus* and *Onthophagus*. Those two genera also distributed in other

areas in South East Asia, including Myanmar, Indo-China, Malay Peninsula and Java. This study reflected the geological history and ancient land connections. During the greater part of the Pleistocene, most of the Sunda Shelf was exposed above sea level, which resulted the Malay Peninsula, Sumatra, Java, and Borneo were connected with each other while most of the Philippines except Palawan were separated from the Sunda Shelf (Corlett, 2009) (Figs. 35, 36). This condition may contribute to the greater similarity between Borneo, Java, and Sumatra, and dissimilarity to the Philippines.

Distribution of macrochelid mites in Indonesia and the world

As a result of investigation about the distribution of Indonesian macrochelid mites in Indonesia and the world, macrochelid fauna in Indonesia showed peculiarity due to restricted distribution in Australian Region and/or Oriental Region and high endemic rate exceeding 50%. This peculiarity depends mostly on fauna of New Guinea and Sulawesi. New Guinean fauna of macrochelids is considerably different from that in other parts in Oriental and Australian Regions. To clarify the cause of endemism in Indonesia, it will be necessary to conduct faunal survey intensively. The fauna of Greater Sunda land, i.e. Java, Sumatra, and Borneo, also contribute to the peculiarity of Indonesian macrochelid fauna. Fauna of Sunda land in Indonesia may be derived from mainland of SE Asia. Especially, fauna in Borneo seems to be affected by fauna of South East Asia, because of the result of cluster analysis in the present study. However, faunal data in mainland of South East Asia is insufficient. In future, research in those areas, as well as in further research in Borneo, will be essential to determine cause of the peculiarity of Indonesian fauna.

The species indicating disjunct distribution and wide distribution tended to

associate with large number of beetles genera. The species of disjunct distribution, e.g. *Macrocheles baramensis*, is widely spreading from mainland of South East Asia to Lesser Sunda islands. *Macrocheles dispar* indicating wide distribution is also widely spreading from mainland of South East Asia to New Guinea. Dispersal of phoretic macrochelid mites depends on carrier dung beetles exclusively. If the mites have associations with many kinds of dung beetles, it seems that chance to ride on beetles and to reach appropriate habitat will increase. Some dung beetles, as *Catharsius* beetle, are larger sized and harbor many individuals and species of mites (as in Tables 5, 6). If the larger beetles will have high flight ability, and if mites can attach on such beetles, the mites may be able to disperse to distant islands. Although relationship between distant distribution and diversity of carrier beetles is mere hypothesis, it will be one worthy hypothesis to test in the future.

II. 5. Summary

Based on the similarity of macrochelid fauna in Borneo and surrounding areas, there are five groups of geographical region presented, i.e.: 1) Sumatra, Borneo, and mainland of South East Asia; 2) Java; 3) Sulawesi and Lesser Sunda; 4) The Philippines; and 5) New Guinea. Macrochelid fauna of Borneo is very similar to that of mainland of South East Asia rather than Sumatra, and it's dissimilar to that of Philippines. These data may be consistent with geological history in Oriental Region. Geological data suggest that Borneo had been connected with Indo-China by land for long geological time, while it had not been connected with the Philippines except for Palawan Island.

Seventynine species of macrochelid mites recorded in Indonesia. Of those, 6 species (*Glyptholaspis confusa*, *Holostaspella bifoliata*, *Macrocheles glaber*, *M. mammifer*, *M. medarius*, and *M. muscaedomesticae*) are almost cosmopolitan, and most of other species are recorded from Australian Region, mainly Wallacea and New Guinea, and/or Oriental Region.

Macrochelid fauna in Indonesia showed peculiarity due to restricted distribution in Australian Region and/or Oriental Region and high endemic rate exceeding 50%. The highest endemic rate in fauna of island is in New Guinea, followed by Sulawesi and the lowest is in Bali and Lesser Sunda islands. New Guinean fauna of macrochelids is considerably different from that in other parts in Oriental and Australian Regions. The fauna of Greater Sunda land, i.e. Java, Sumatra, and Borneo, also contribute to the peculiarity of Indonesian macrochelid fauna. Fauna of Sundaland in Indonesia may be derived from mainland of South East Asia.

Macrochelid mites in Indonesia showed various distribution patterns. Eight species have disjunct distribution, 22 species are endemic to one island, 13 species are endemic to New Guinea, 17 species are restricted in Oriental Region, 5 species are endemic to Lesser Sunda or Sulawesi, and 14 species are widely distributed in Indonesia. The species indicating disjunct distribution and wide distribution tended to associate with large number of beetles genera.

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Appendix: A list of Macrochelidae in Kalimantan

Four genera and 35 species of the family Macrochelidae have been recorded in Kalimantan, including those recorded and described in this thesis. The list of species is shown below: * new species; ** new record from Kalimantan; *** new to Indonesia; † record based on literature; # species associated with scarabaeid dung beetles.

Genus ***Glyptholaspis*** Filipponi and Pegazzano, 1960

Glyptholaspis asperrima (Berlese, 1905)#

East Kalimantan**

West Kalimantan**

Glyptholaspis confusa (Foà, 1900) #

East Kalimantan***

Genus ***Holostaspella*** Berlese, 1903

Holostaspella bifoliata (Trägårdh, 1952) #

West Kalimantan**

South Kalimantan**

Holostaspella katakurai Hartini and Takaku, 2003#

East Kalimantan

North Kalimantan**

Holostaspella moderata Berlese, 1921#

East Kalimantan**

Genus ***Macrocheles*** Latreille, 1829

Macrocheles baramensis Evans and Hyatt, 1963#

East Kalimantan

North Kalimantan**

West Kalimantan**

Central Kalimantan

South Kalimantan**

Macrocheles dayaci Dwibadra and Takaku, 2014#

East Kalimantan

Macrocheles dispar (Berlese, 1910) #

East Kalimantan

North Kalimantan**

Central Kalimantan[**]

South Kalimantan[**]

Macrocheles entetiensis Hartini and Takaku, 2005[#]

East Kalimantan[**]

West Kalimantan[**]

Macrocheles hallidayi Walter and Krantz, 1986[#]

East Kalimantan

North Kalimantan[**]

West Kalimantan[**]

Central Kalimantan

South Kalimantan[**]

Macrocheles jabarensis Hartini and Takaku, 2003[#]

East Kalimantan

North Kalimantan[**]

West Kalimantan[**]

South Kalimantan[**]

Central Kalimantan

Macrocheles kalimantanensis Hartini and Takaku, 2003[#]

East Kalimantan

North Kalimantan[**]

West Kalimantan

Central Kalimantan

South Kalimantan[**]

Macrocheles kraepelini (Berlese, 1904)[#]

East Kalimantan

Central Kalimantan

Macrocheles krantzi Evans and Hyatt, 1963[#]

West Kalimantan[**]

Macrocheles lorensis sp. nov.[*, #]

North Kalimantan

Macrocheles lumbiensis sp. nov.[*, #]

North Kalimantan

Central Kalimantan

Macrocheles mammifer Berlese, 1918[#]

East Kalimantan[**]

Macrocheles merdarius (Belese, 1889)[#]

East Kalimantan

South Kalimantan[**]

Macrocheles muscaedomesticae (Scopoli, 1772)[#]

East Kalimantan[**]

Macrocheles nidus Hartini and Takaku, 2013[#]

East Kalimantan[**]

Macrocheles oigru Walter and Krantz, 1986[#]

South Kalimantan[**]

Macrocheles persimilis Hartini, Dwibadra and Takaku, 2007[#]

East Kalimantan[**]

West Kalimantan[**]

Macrocheles plumosus Evans and Hyatt, 1963[#]

East Kalimantan

South Kalimantan[**]

Macrocheles pumilus Hartini, Dwibadra and Takaku, 2009[#]

North Kalimantan[**]

Macrocheles riparius Dwibadra and Takaku, 2014[*,#]

East Kalimantan

Macrocheles sukaramiensis Takaku, 2001[#]

East Kalimantan

North Kalimantan[**]

Central Kalimantan

South Kalimantan[**]

Macrocheles sumbaensis Hartini and Takaku, 2005[#]

East Kalimantan[**]

Macrocheles wainensis Dwibadra and Takaku, 2014[*,#]

East Kalimantan

West Kalimantan

Macrocheles sp. aff. ***glaber*** (Mülller, 1860)[#]

Central Kalimantan

West Kalimantan[**]

Genus ***Neopodocinum*** Oudemans, 1902

Neopodocinum bosschai (Oudemans, 1901) [#]

East Kalimantan
North Kalimantan[**]
West Kalimantan[**]
South Kalimantan[**]
Central Kalimantan[**]

Neopodocinum halimunense Hartini and Takaku, 2003 [#]

East Kalimantan

Neopodocinum kalimantanense Hartini and Takaku, 2004 [#]

East Kalimantan
North Kalimantan[**]
West Kalimantan[**]
South Kalimantan[**]
Central Kalimantan[**]

Neopodocinum maius Berlese, 1911 [#]

East Kalimantan
North Kalimantan[**]
West Kalimantan[**]
South Kalimantan[**]
Central Kalimantan[**]

Neopodocinum murungensis sp. nov[*,#]

Central Kalimantan

Neopodocinum subjaspersi Hartini and Takaku, 2003 [#]

East Kalimantan
West Kalimantan[**]
Central Kalimantan[**]

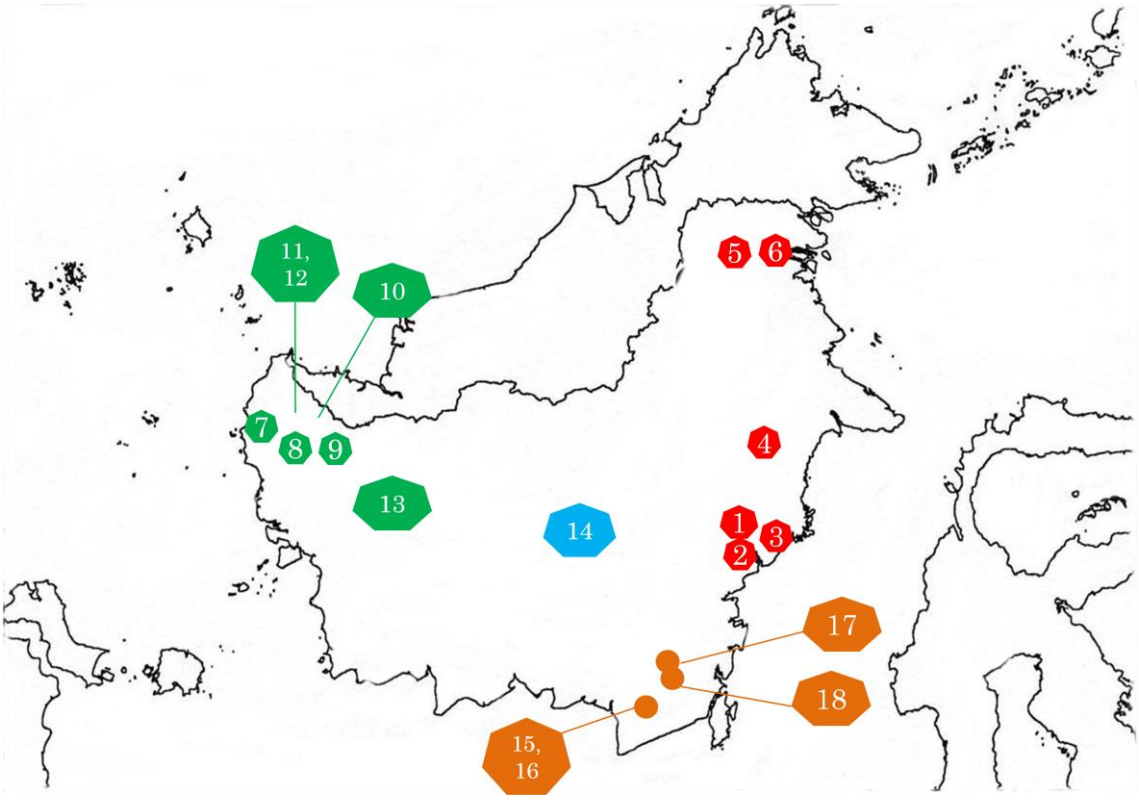
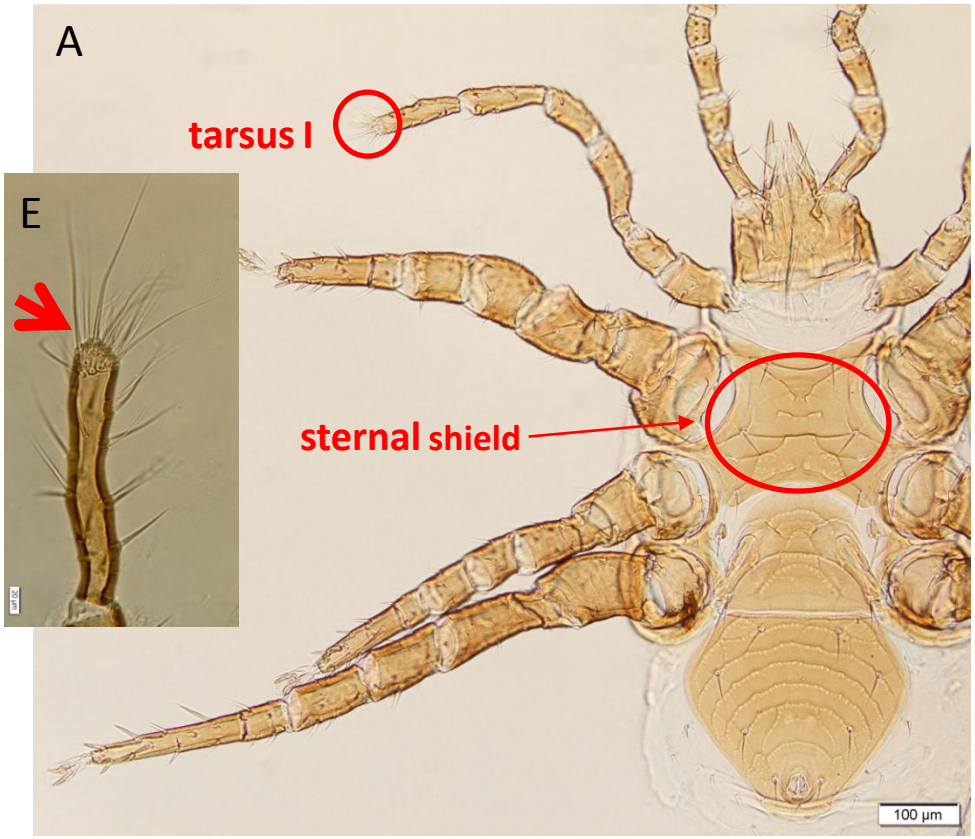
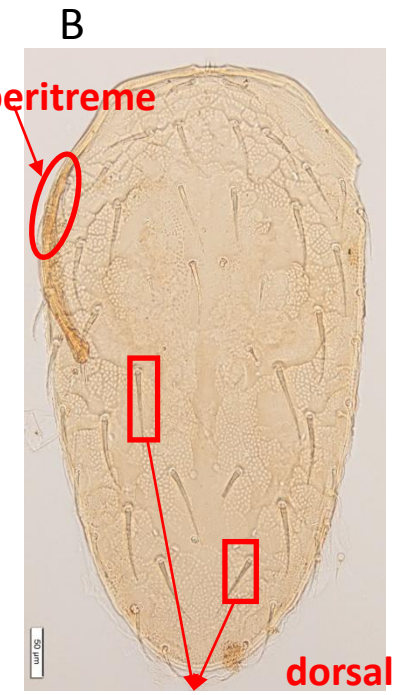


Fig. 1. Collection sites of Macrochelidae in the present study: **East Kalimantan**: 1, Sungai Wain Protection Forest, Balikpapan; 2, Balikpapan Botanical Garden, Balikpapan; 3, km. 12 to km. 38: points 12–38 km (km. 15, 18, 22, 23, 24, 29, 38) away from Balikpapan on the road from Balikpapan to Samarinda; 4, TWA Bukit Bangkirai, Batu Ampar, Kutai Kartanegara; **North Kalimantan**: 5, Kabunglor, Lumbis, Nunukan, N 4°19'23,7" E 116°10'44,2"; 6, Lumbis, Tau lumbis, Tau lumbis, Nunukan, E 116°13'05,4" N 04°18'18“; **West Kalimantan**: 7, Gua Maria Anjungan, Kepayang, Anjungan, Landak; 8, Singkong, Simpangkasturi, Anjungan, Landak; 9, Sepatah, Aur Sampuk, Sengah Temila, Landak; 10, Benuang, Toho, Pontianak; 11, Sebadu, Mandor, Landak; 12, Pasir Panjang, Mandor, Landak, 13, Ranao Teluk, Tayan Hilir, Sanggau; **Central Kalimantan**: 14, BHP Billiton Bumbun Camp, Tumbang Olong, Uut Murung, Murung Raya, Palangkaraya; **South Kalimantan**: 15, Tahura Sultan Adam, Karang Intan, Banjar, 16, Padang Panjang, Karang Intan, Banjar, 17, C. A. Gunung Kentawan, Loksado, Hulu Sungai Selatan; 18, Batu Bini, Padang Batung, Hulu Sungai Selatan.





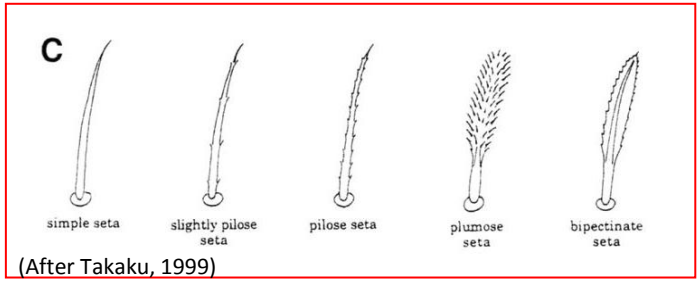


Fig. 2. General morphology of Macrochelidae, I. A, venter; B dorsum; C, various kinds of dorsal setae; D, stigma; E, tarsus I without claw.

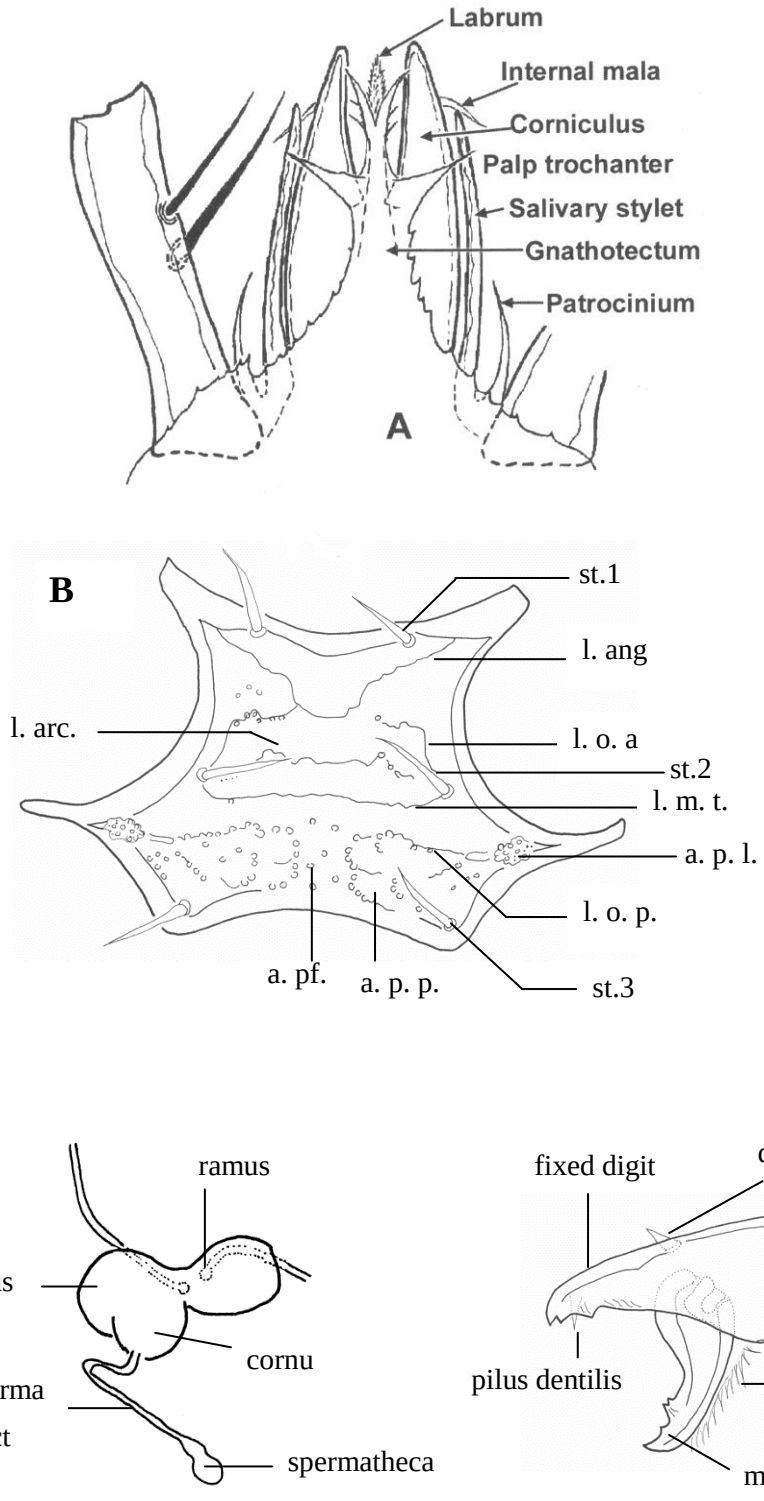


Fig. 3. General morphology of Macrochelidae, II. A, dorsal side of female gnathosoma (after Krantz and Walter, 2009); B, sternal shield; C, sacculus foemineus (Michael's organ); D, chelicerae.

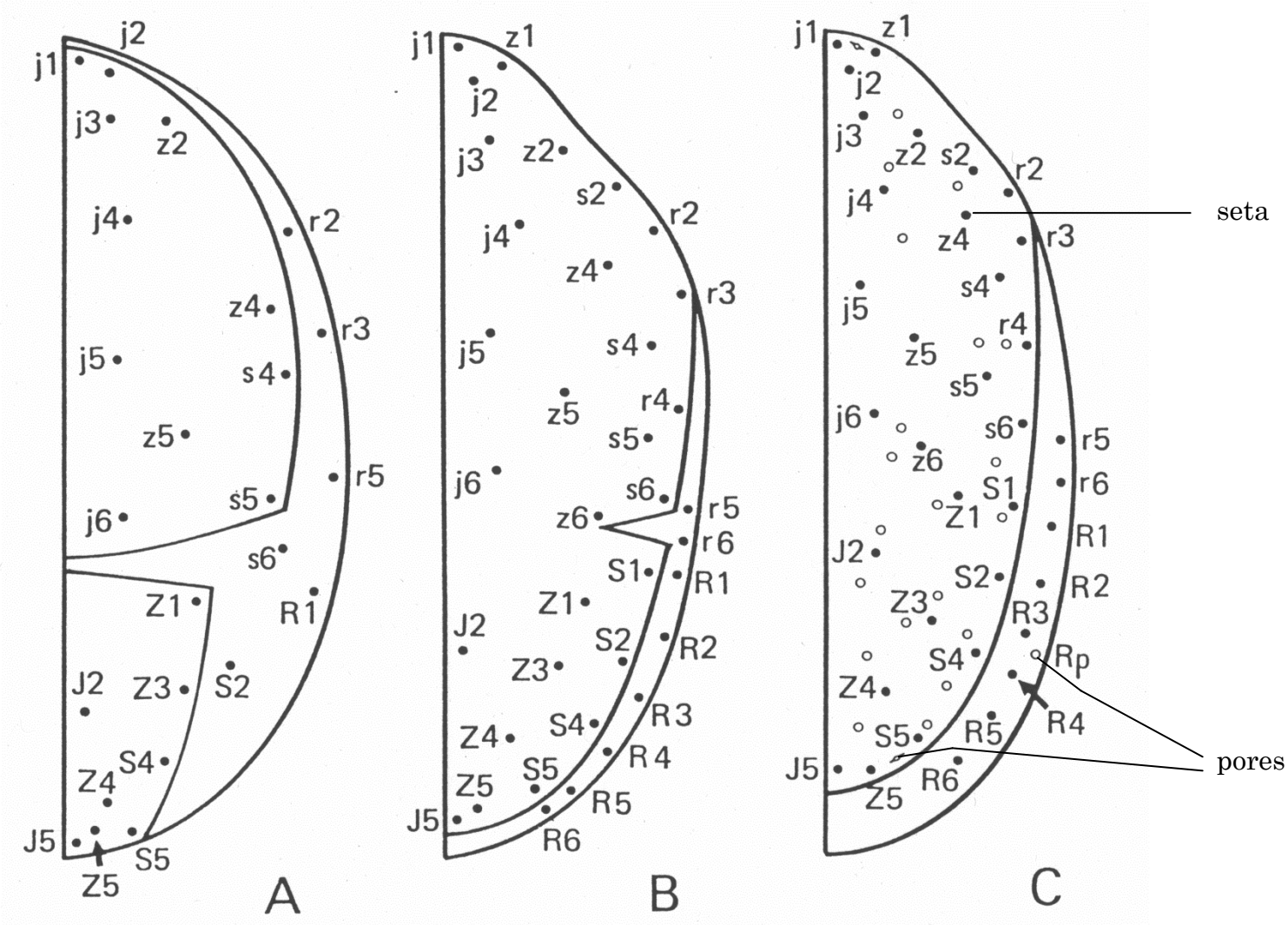


Fig. 4. Dorsal chaetotaxy of Macrochelidae. A, protonymph; B, deutonymph, C, adult female (after Halliday, 1987).

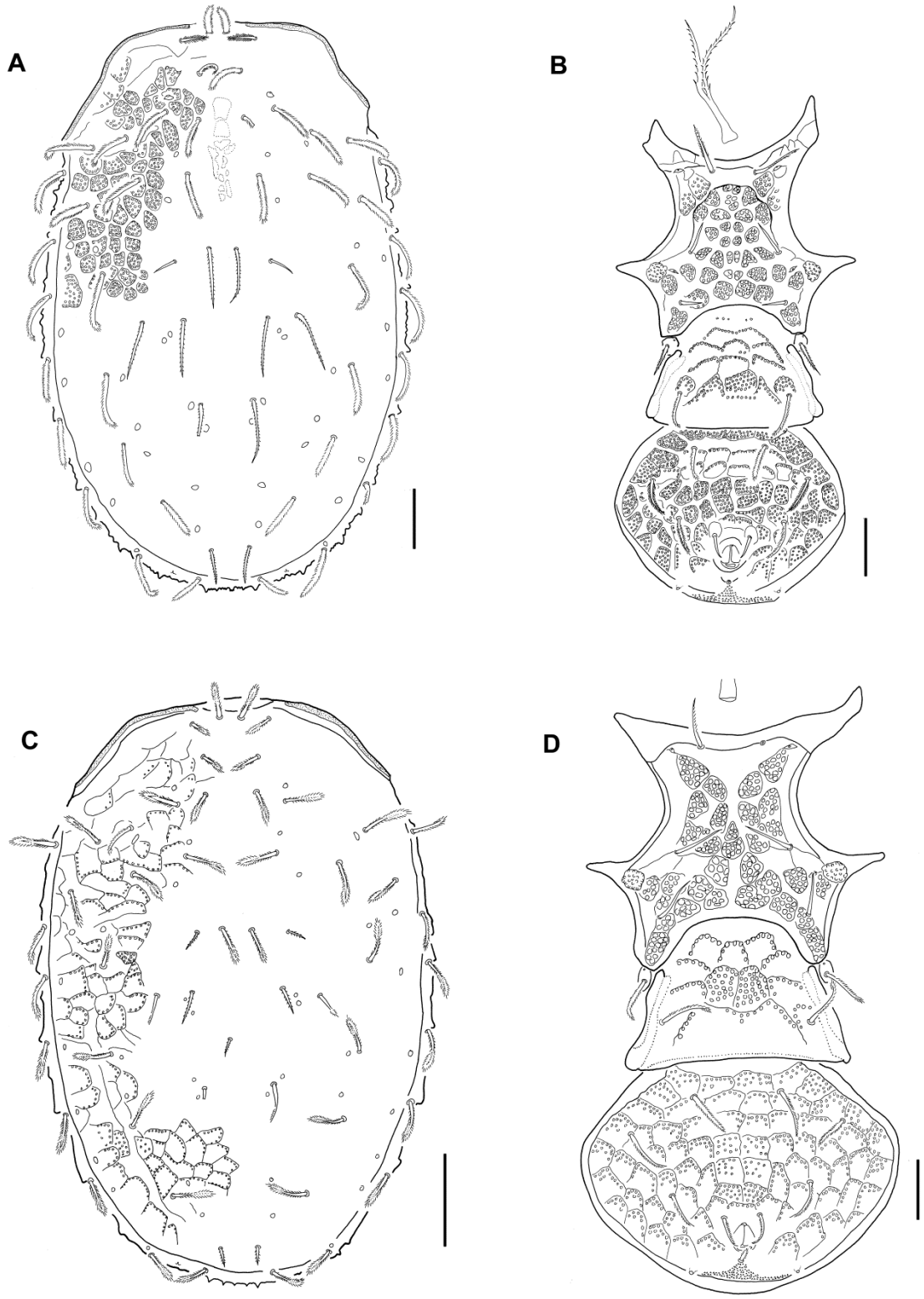


Fig. 5. *Glyptholaspis asperrima* (Berlese, 1905), female (A, B) and *Glyptholaspis confusa* (Foà, 1900), female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm (A, B, D) and 200 μm (C).

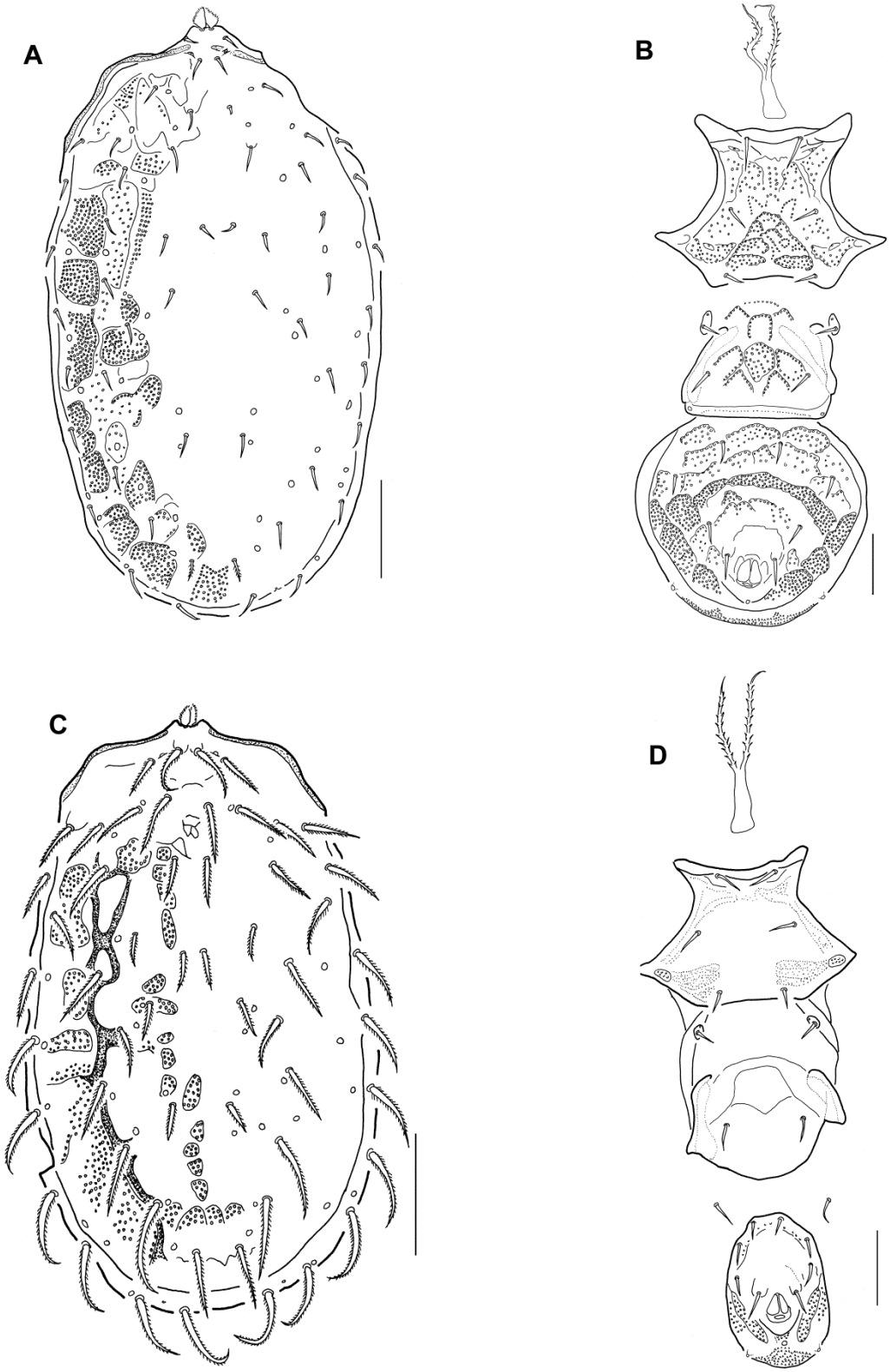


Fig. 6. *Holostaspella bifoliata* (Trägårdh, 1952), female (A, B) and *Holostaspella katakurai* Hartini and Takaku, 2003, female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm (A, C) and 50 μm (B, D).

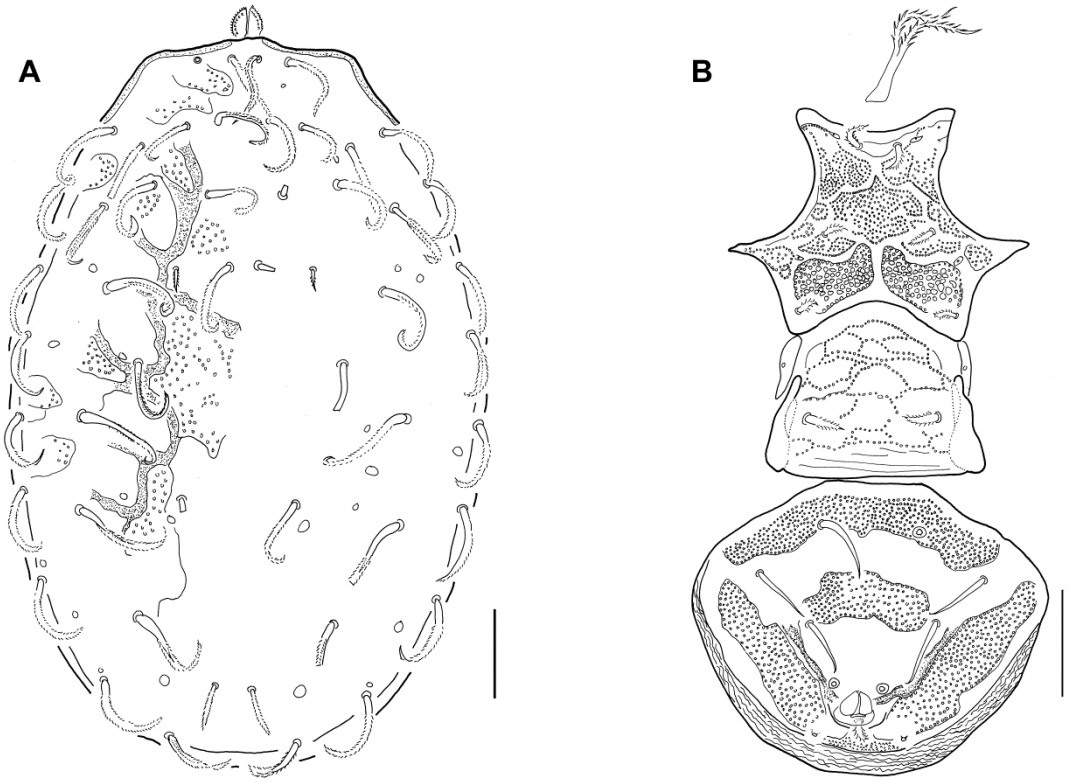


Fig. 7. *Holostaspella moderata* Berlese, 1921. A, dorsal shield; B, venter. Scale bars = 100μm.

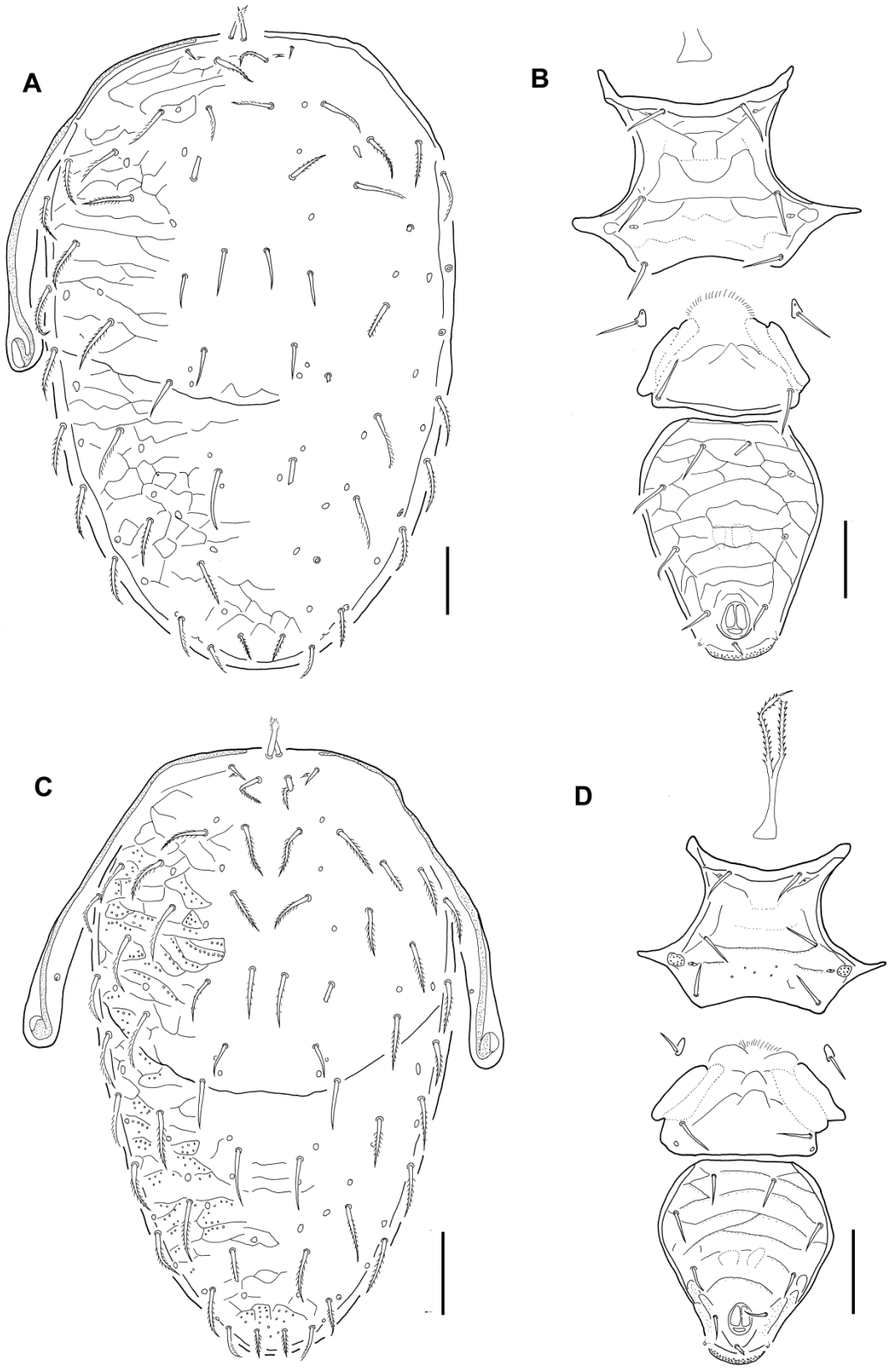


Fig. 8. *Macrocheles baramensis* Evans and Hyatt, 1963, female (A, B) and *Macrocheles kalimantanensis* Hartini and Takaku, 2003; female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 50 μm (A) and 100 μm (B–D).

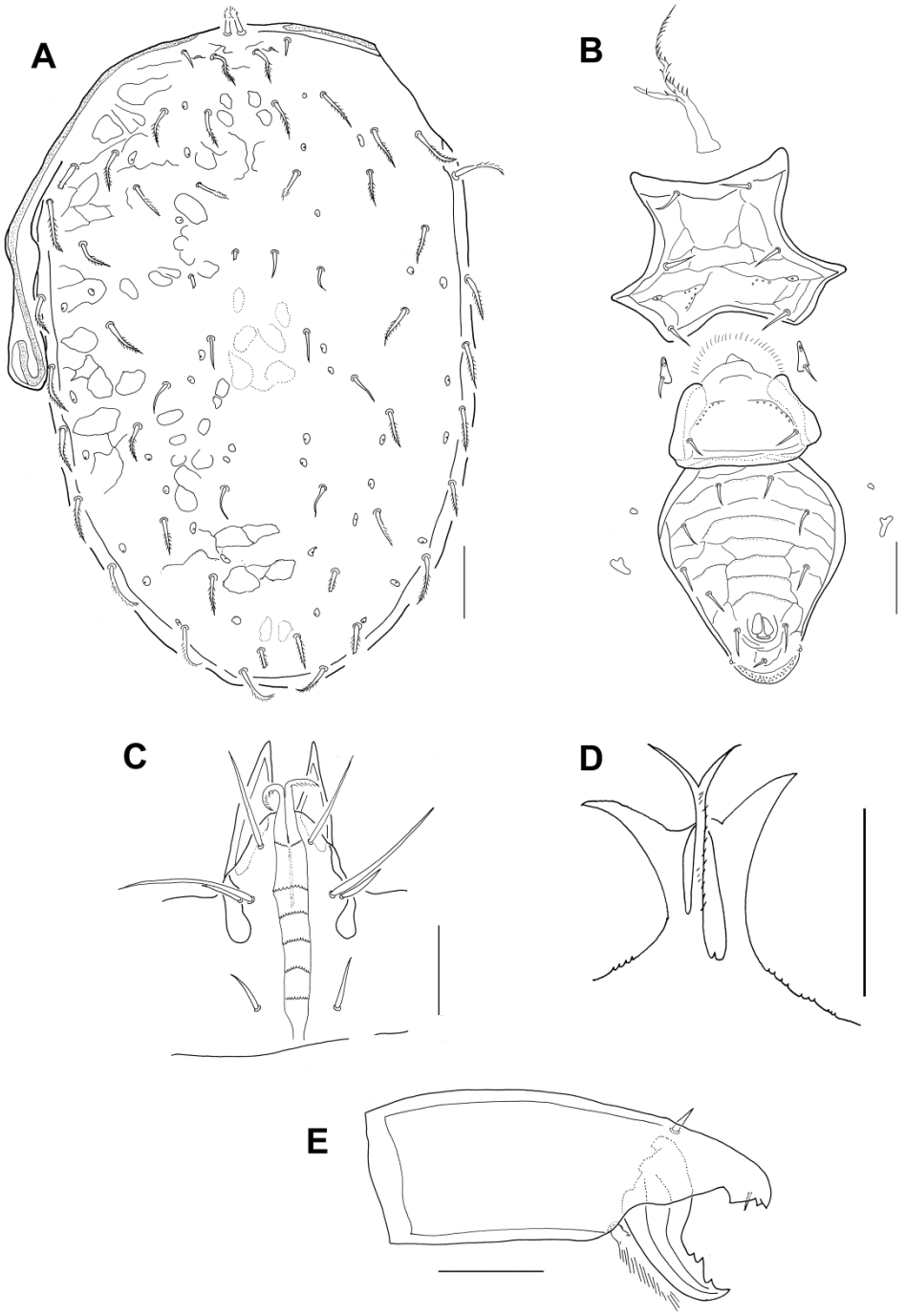


Fig. 9. *Macrocheles lumbiensis* sp. nov., female, holotype (MZB. Acar. 8864). A, dorsal shield; B, venter; C, ventral view of gnathosoma; D, chelicera; E, epistome. Scale bars = 100 µm (A, B); 50 µm (C–E).

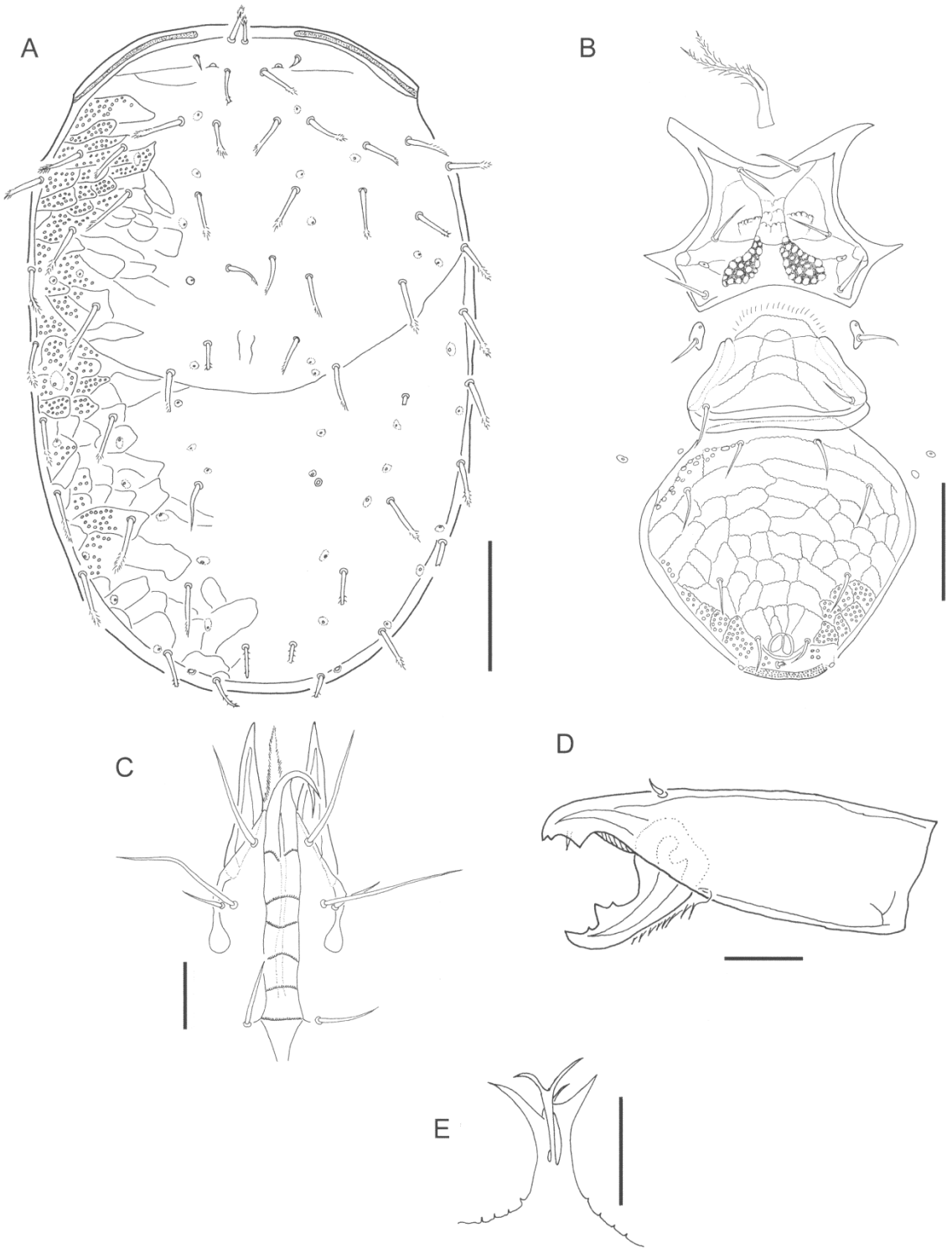


Fig. 10. *Macrocheles dayaci* Dwibadra and Takaku, 2014, female, holotype (MZB. Acar. 7559.2). A, dorsal shield; B, venter (paratype, MZB. Acar. 7560.2); C, ventral view of gnathosoma; D, chelicera; E, epistome (paratype, MZB. Acar. 7559.1). Scale bars = 200 μm (A, B); 50 μm (C–E).

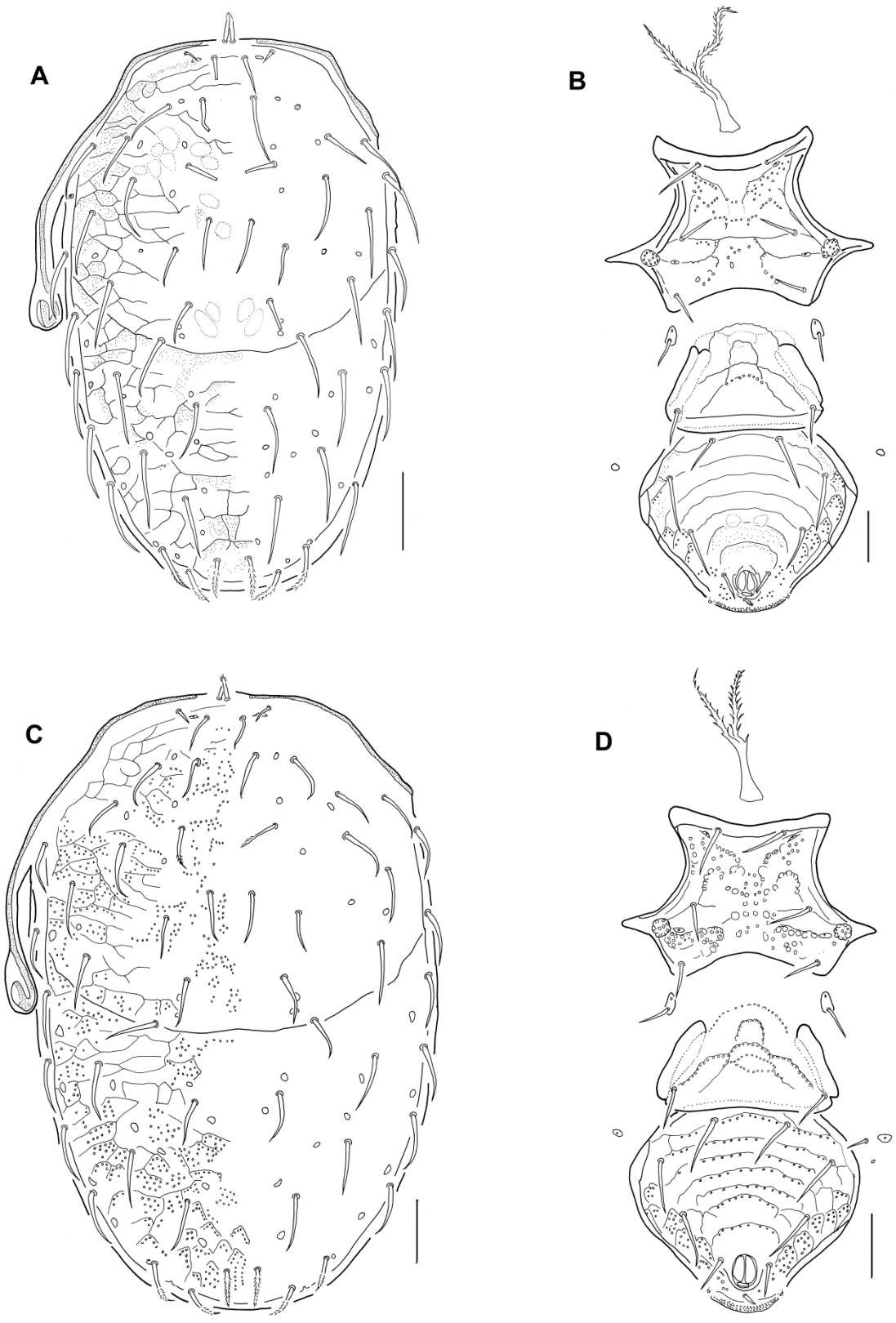


Fig. 11. *Macrocheles oigru* Walter and Krantz, 1986, female (A, B) and *Macrocheles* sp. aff . *glaber* (Müller, 1860), female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm.

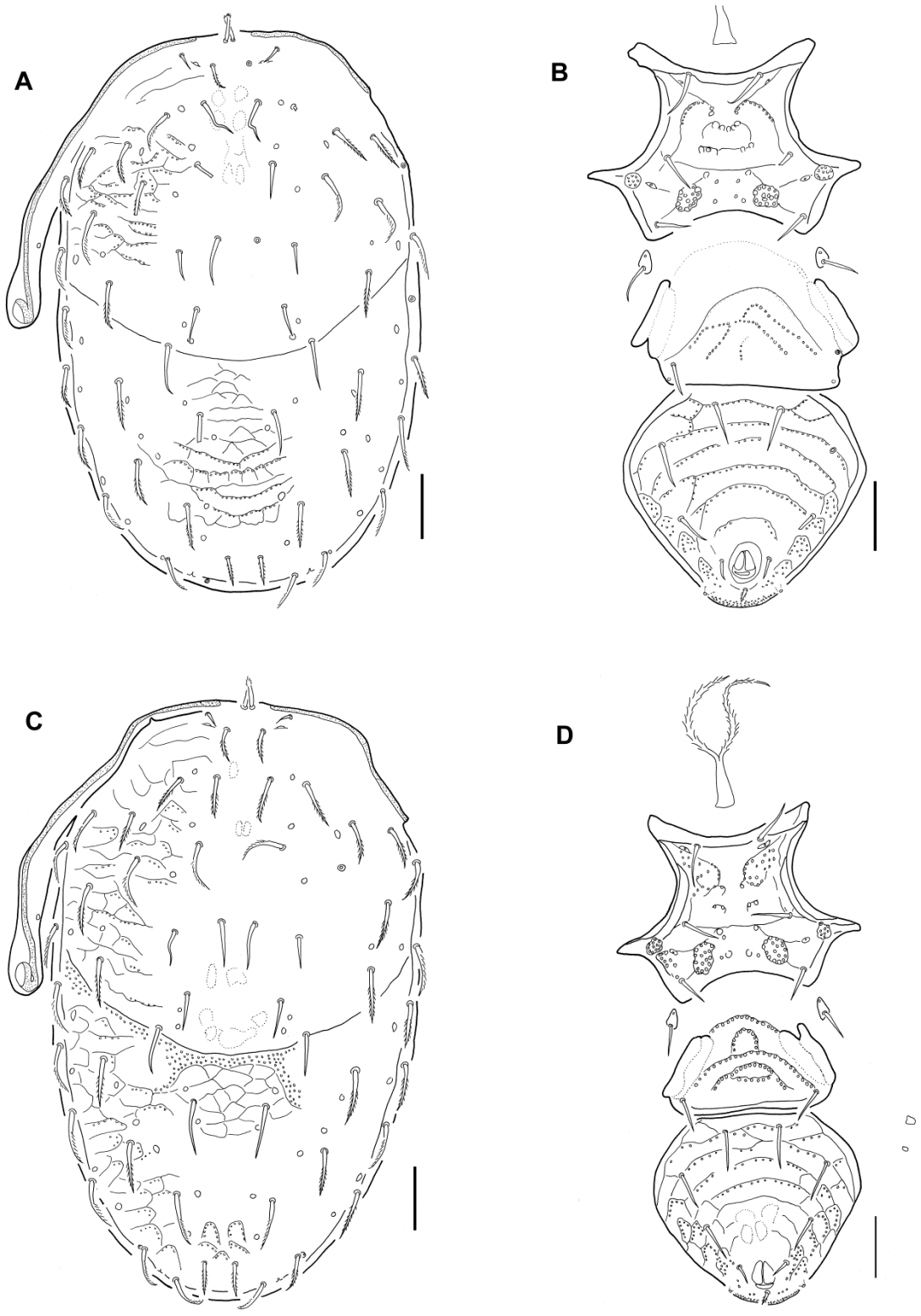


Fig. 12. *Macrocheles hallidayi* Walter and Krantz, 1986, female (A, B) and *Macrocheles kraepelini* Berlese, 1904, female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm (A, B, D); 50μm (C).

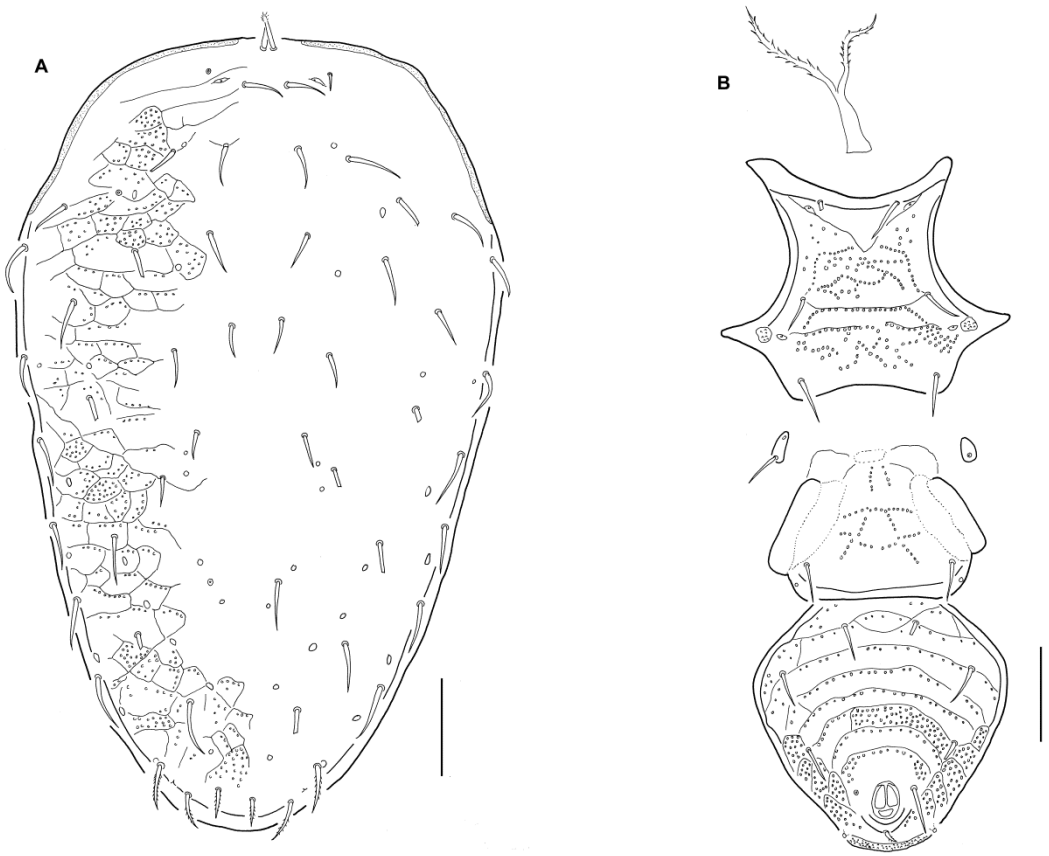


Fig. 13. *Macrocheles pumilus* Hartini, Dwibadra, and Takaku, 2009, female. A, dorsal shield; B, venter. Scale bar = 100 μm.

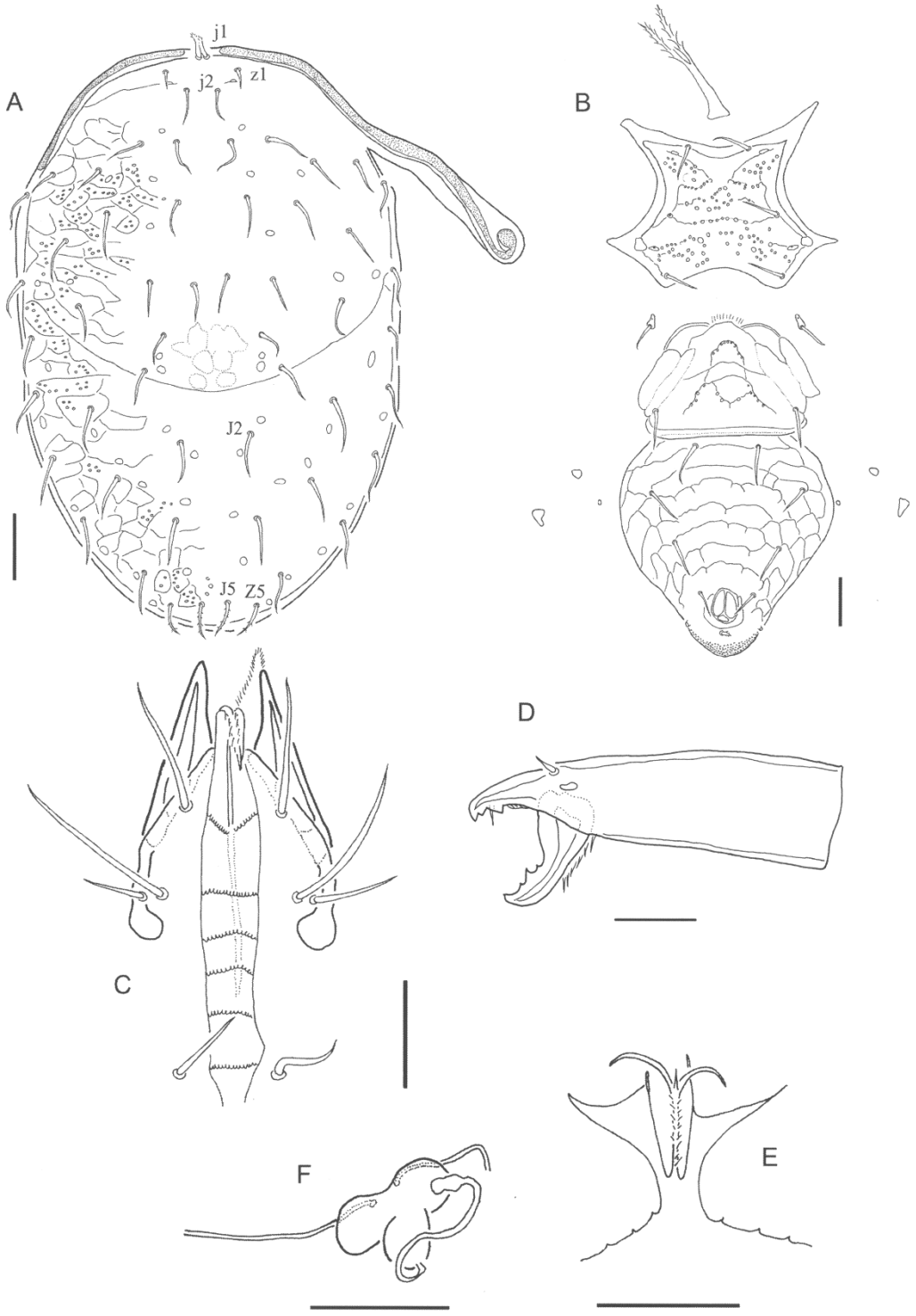


Fig. 14. *Macrocheles riparius* Dwibadra and Takaku, 2014, female, holotype (MZB. Acar. 7566). A, dorsal shield (paratype, MZB. Acar. 7565.2); B, venter; C, ventral view of gnathosoma (paratype, MZB. Acar. 7565.2); D, chelicera; E, epistome; F, sacculus foeminus (paratype, MZB. Acar. 8205). Scale bars = 50 μm.

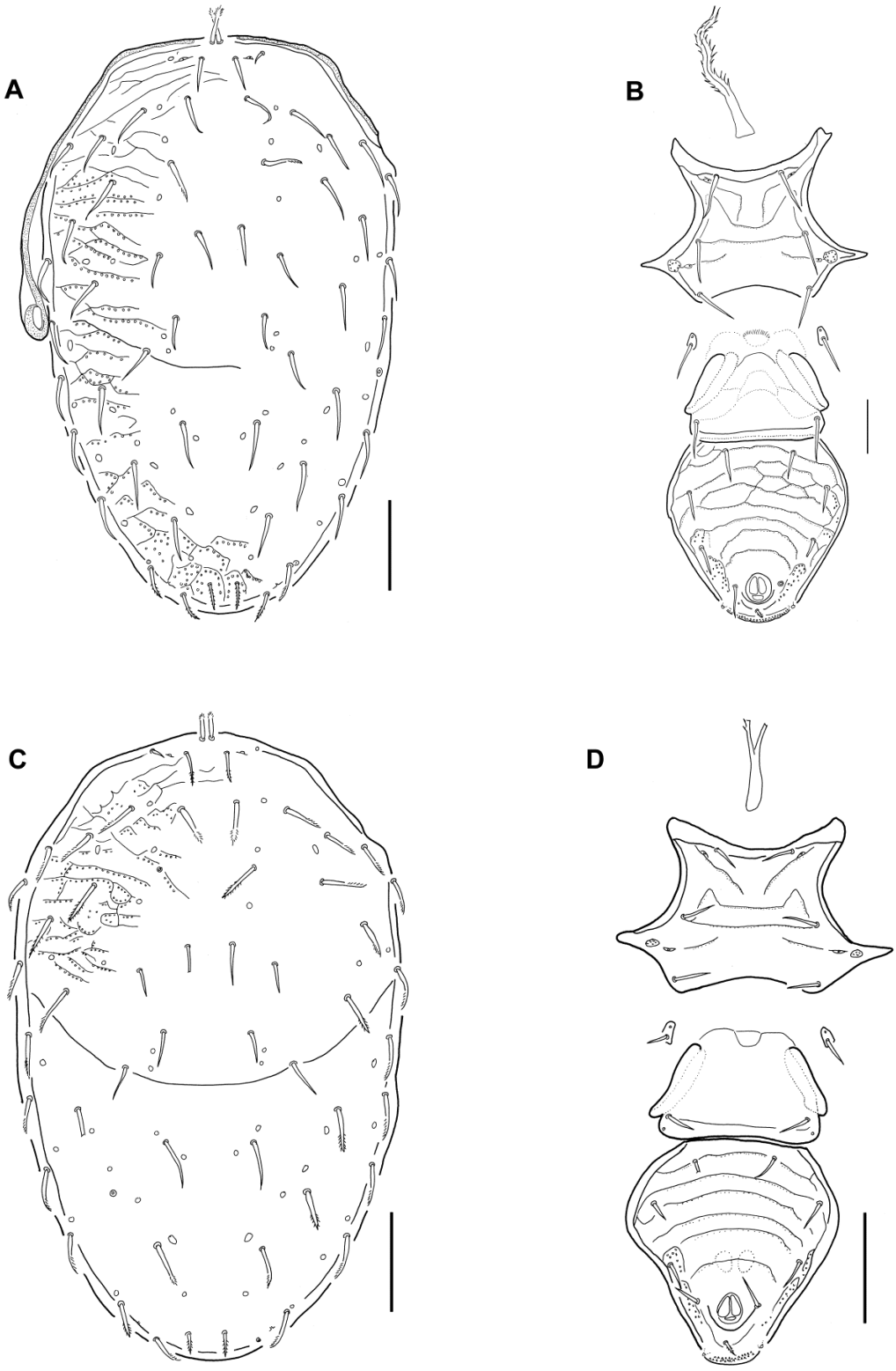


Fig. 15. *Macrocheles dispar* Berlese, 1910, female (A, B) and *Macrocheles entetiensis* Hartini and Takaku, 2005, female (C, D). A, C, dorsal shield; B, D, venter. Scale bars = 100 μm.

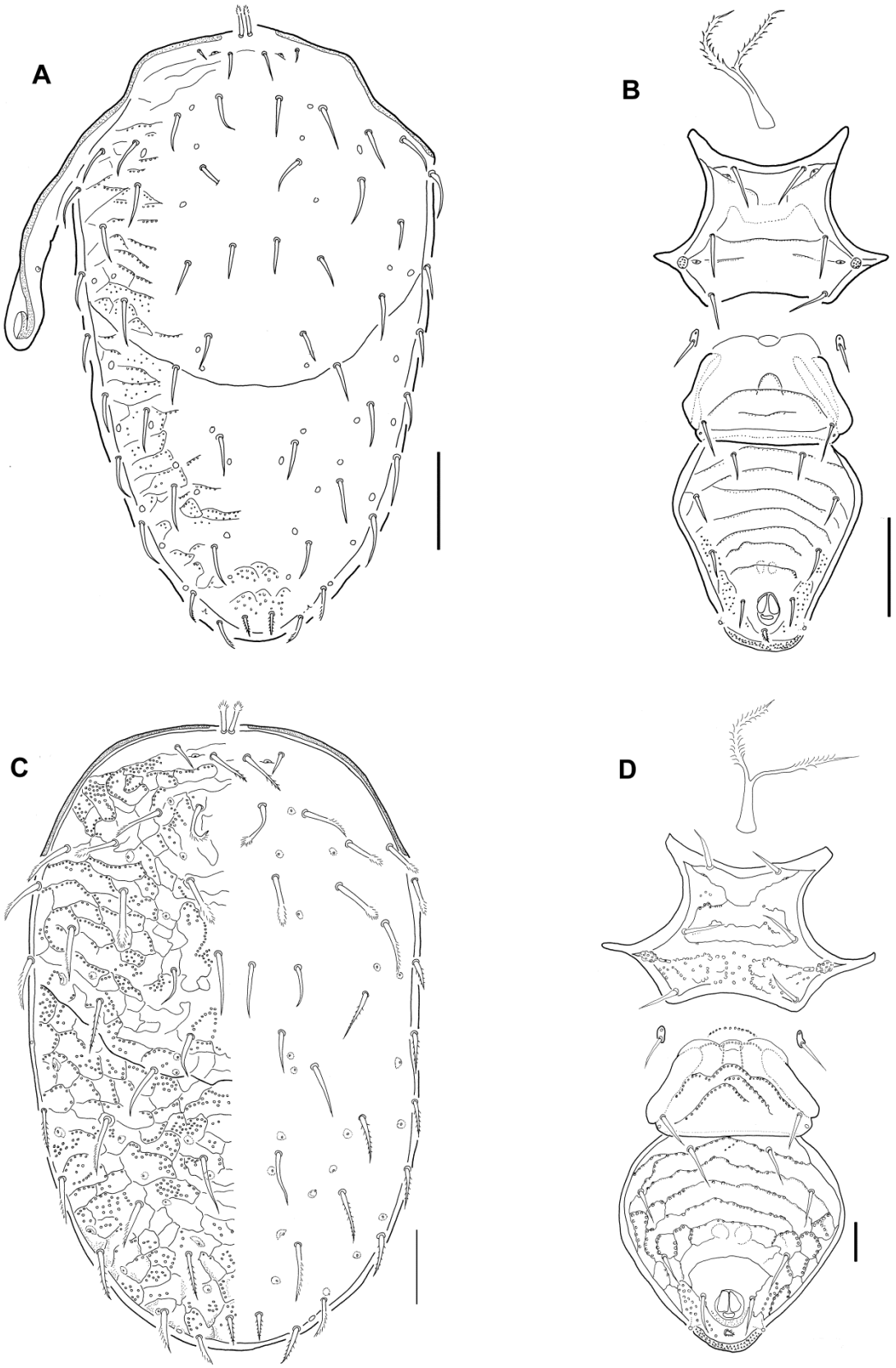


Fig. 16. *Macrocheles jabarensis* Hartini and Takaku, 2003, female (A, B) and *Macrocheles nidus* Hartini and Takaku, 2013, female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm.

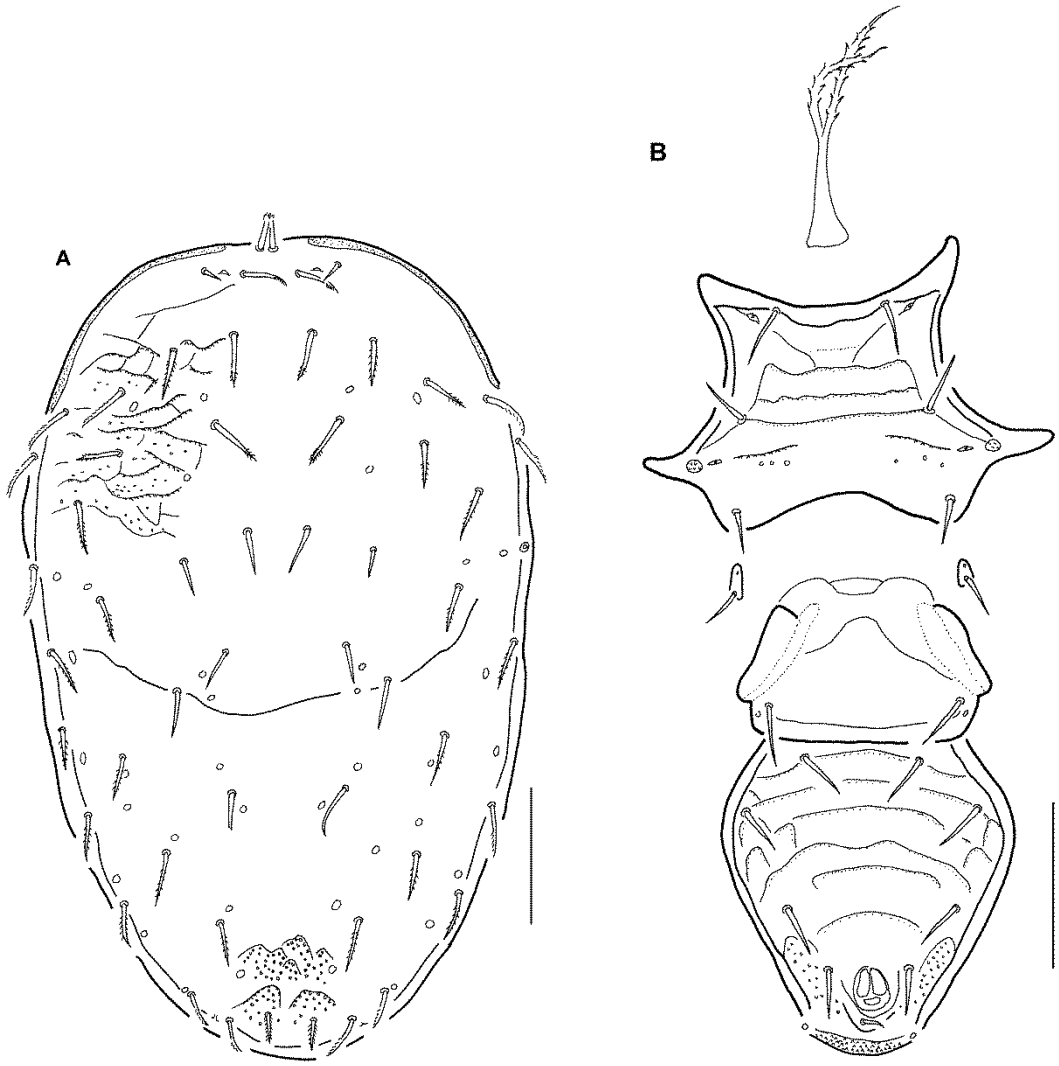


Fig. 17. *Macrocheles persimilis* Hartini, Dwibadra and Takaku, 2007, female. A, dorsal shield; B, venter. Scale bars = 100 μm.

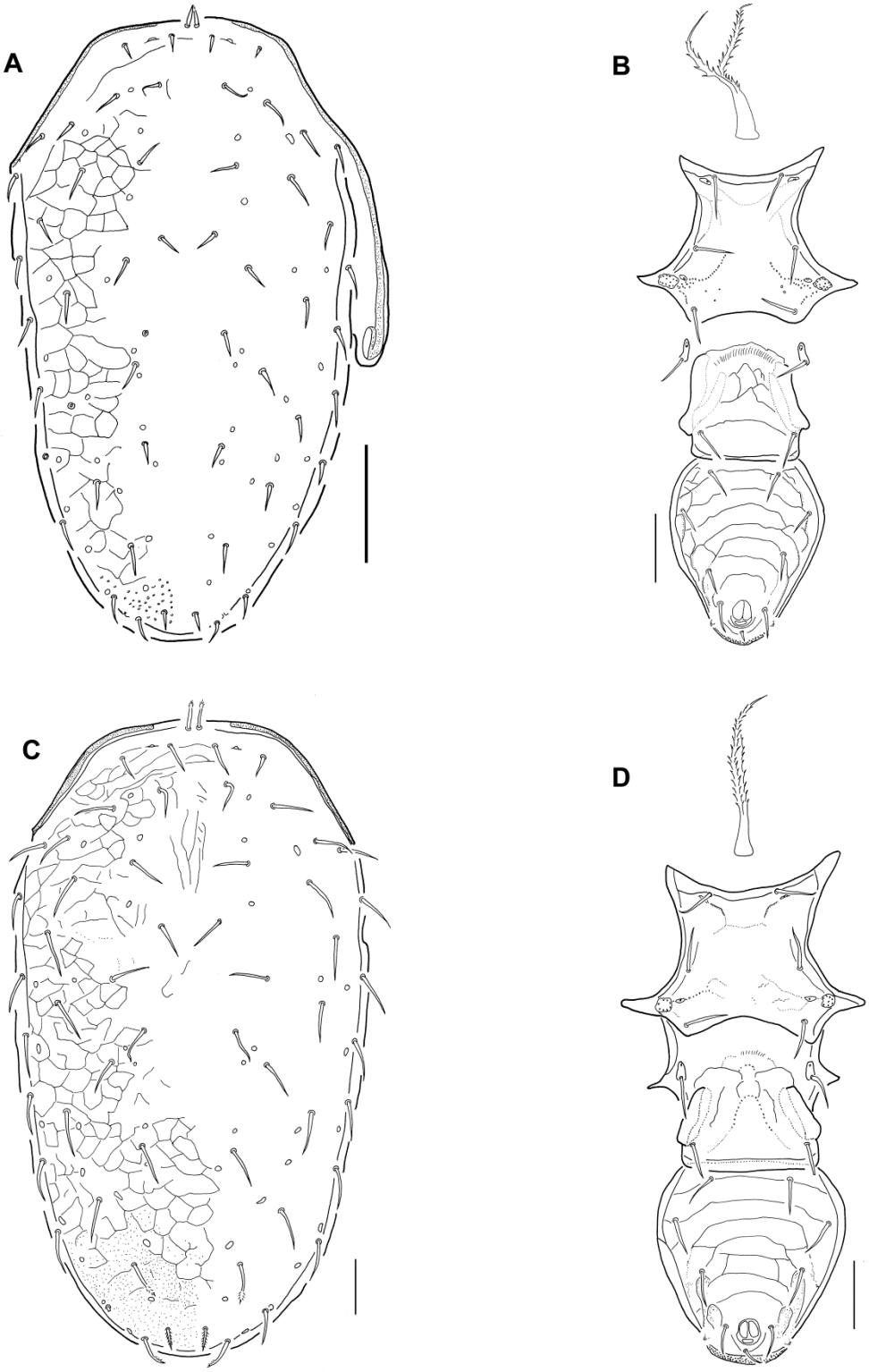


Fig. 18. *Macrocheles krantzi* Evans and Hyatt, 1963, female, (A, B) and *Macrocheles sumbaensis* Hartini and Takaku, 2005, female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm (A); 60μm (B); 50μm (C, D).

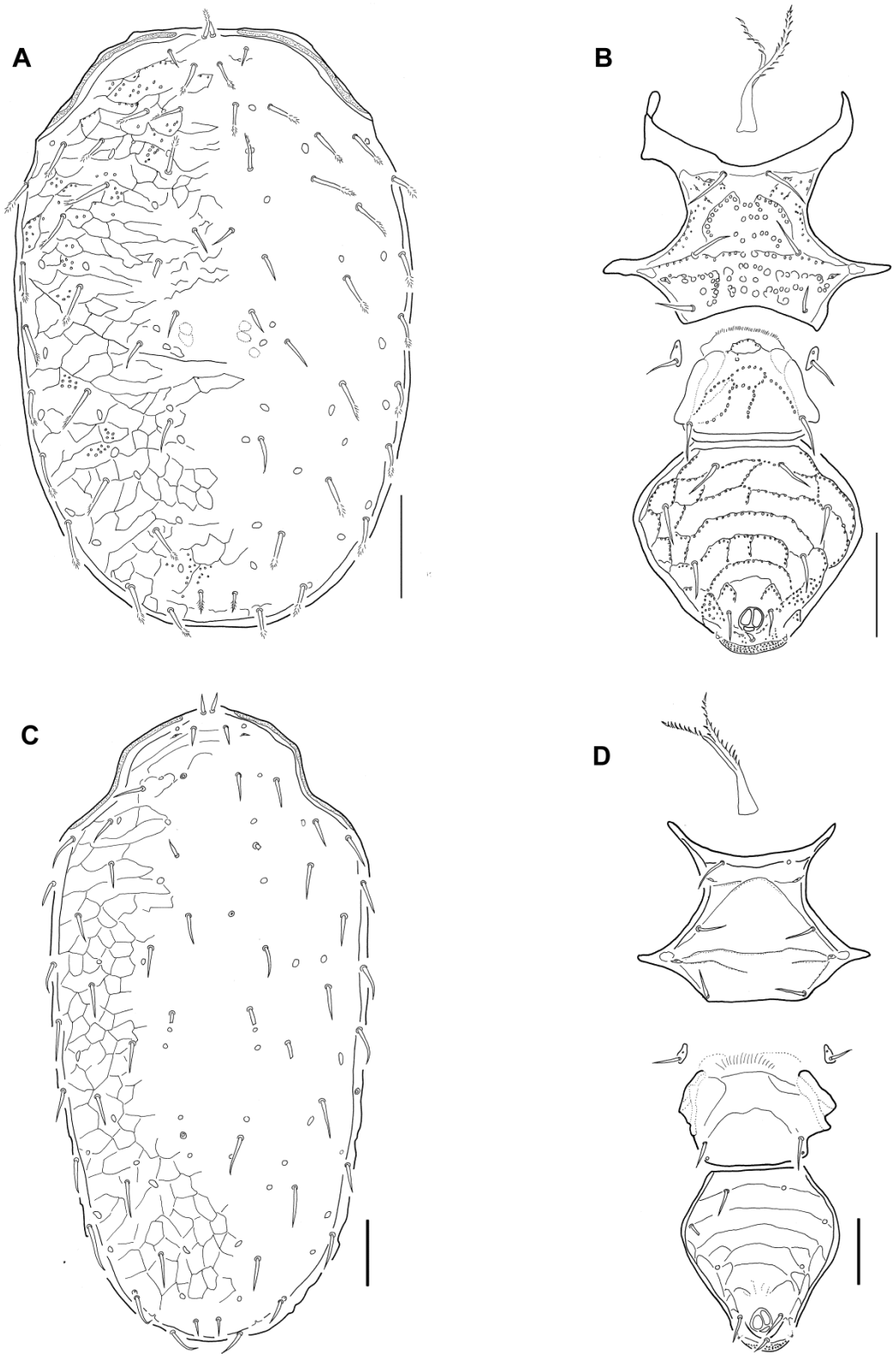


Fig. 19. *Macrocheles muscaedomesticae* (Scopoli, 1772), female, (A, B) and *Macrocheles merdarius* (Berlese, 1889), female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 200 μm (A, B); 50μm (C, D).

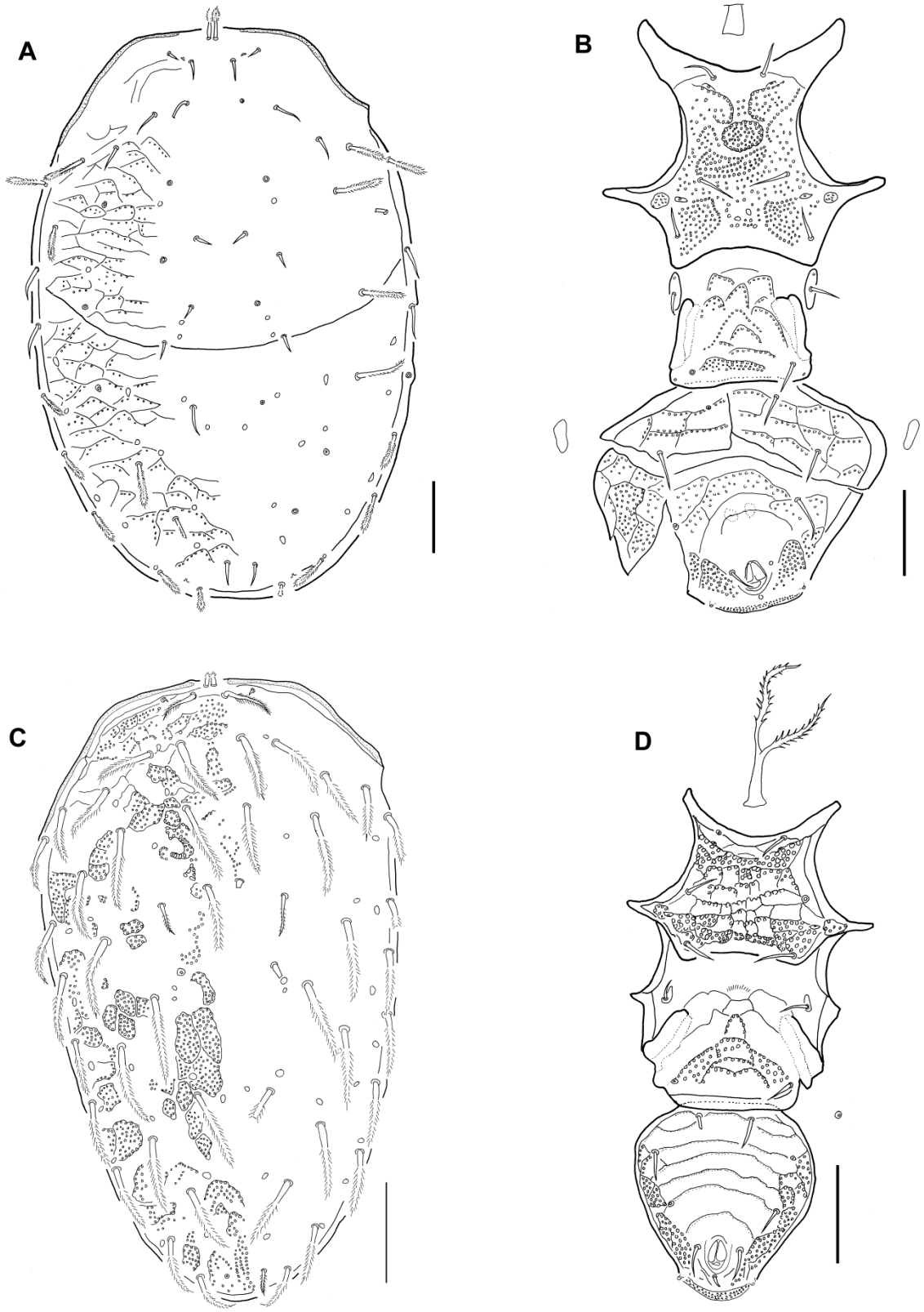


Fig. 20. *Macrocheles mammifer* Berlese, 1918, female, (A, B) and *Macrocheles plumosus* Evans and Hyatt, 1963, female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 100 μm.

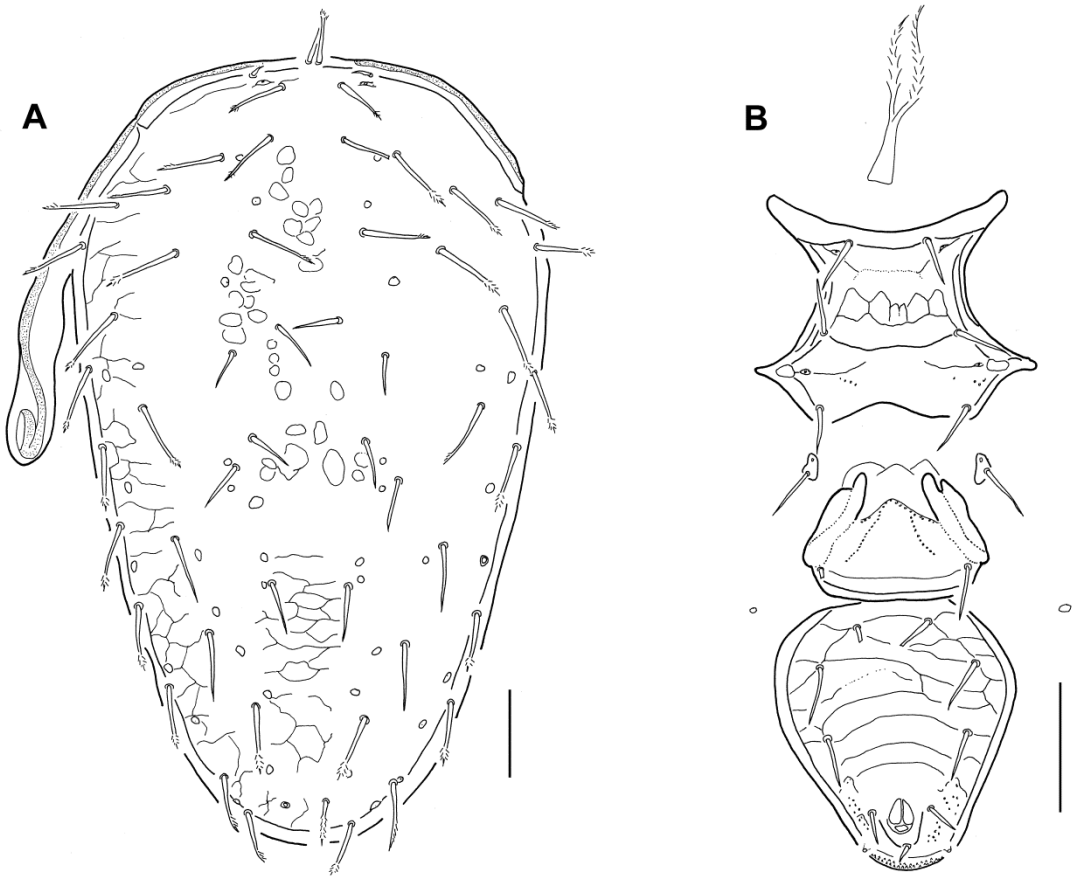


Fig. 21. *Macrocheles sukaramiensis* Takaku, 2001, female. A, dorsal shield; B, venter. Scale bars = 100 μm.

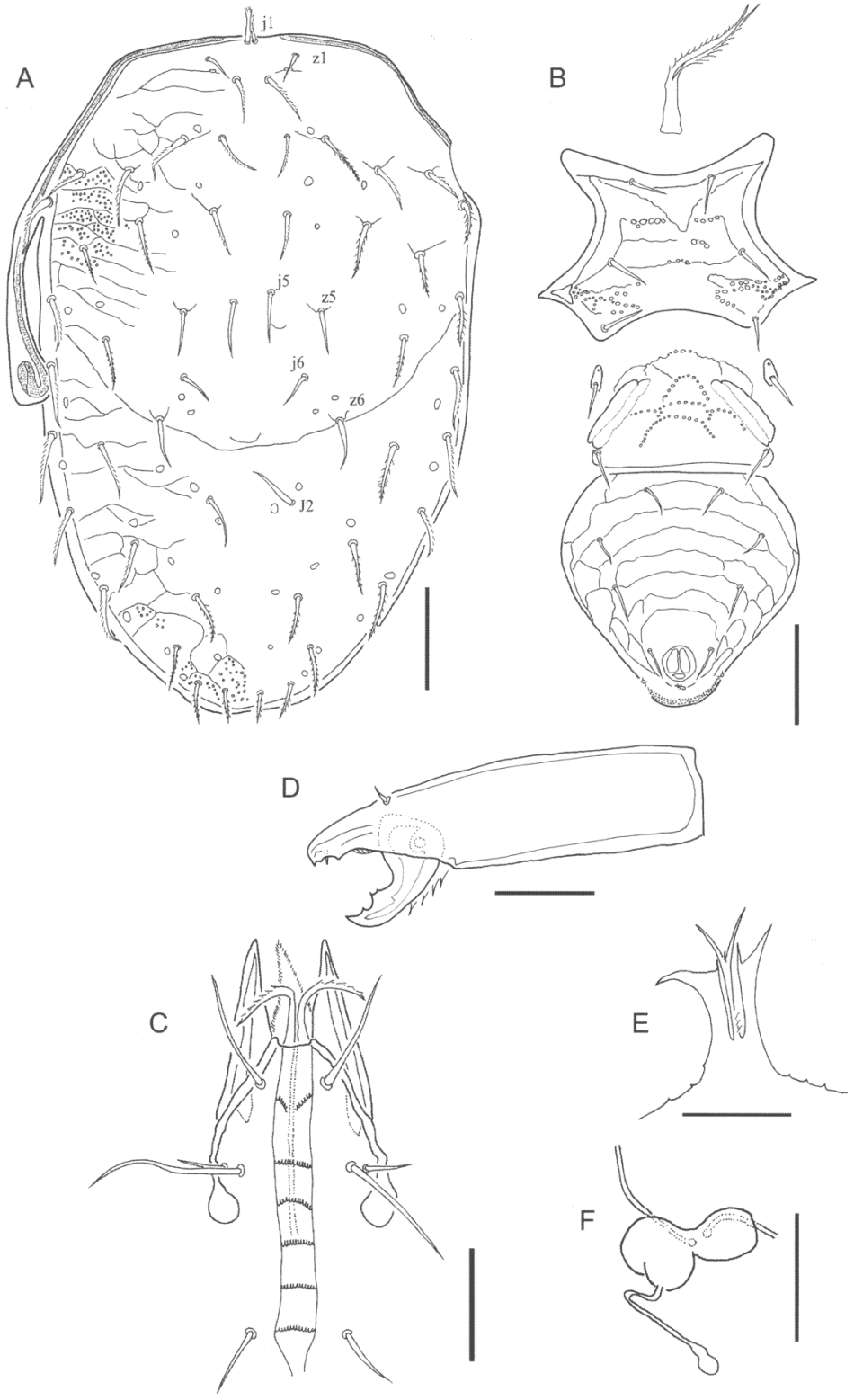


Fig. 22. *Macrocheles wainensis* Dwibadra and Takaku, 2014, female, holotype (MZB. Acar. 7562). A, dorsal shield; B, venter; C, ventral view of gnathosoma (paratype, MZB. Acar. 7564); D, chelicera (paratype, MZB. Acar. 7563); E, epistome; F, sacculus foeminus (paratype, MZB. Acar. 8217). Scales bars = 100 μm (A, B); 50 μm (C–F).

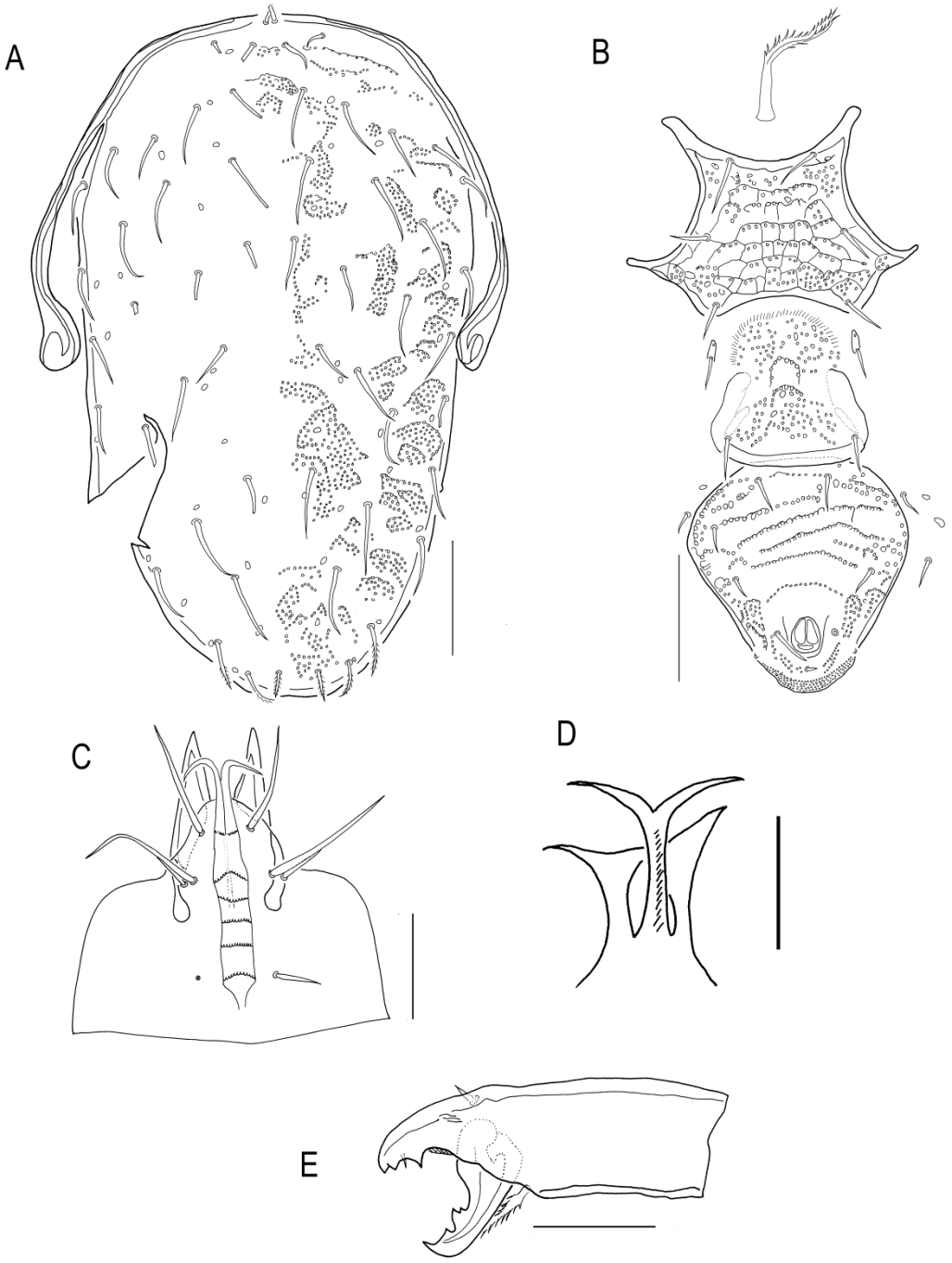


Fig. 23. *Macrocheles lorensis*, sp. nov., female, holotype (MZB. Acar. 8866). A, dorsal shield; B, venter; C, ventral view of gnathosoma; D, epistome; E, chelicerae. Scale bars = 100 μm (A, B); 50 μm (C–E).

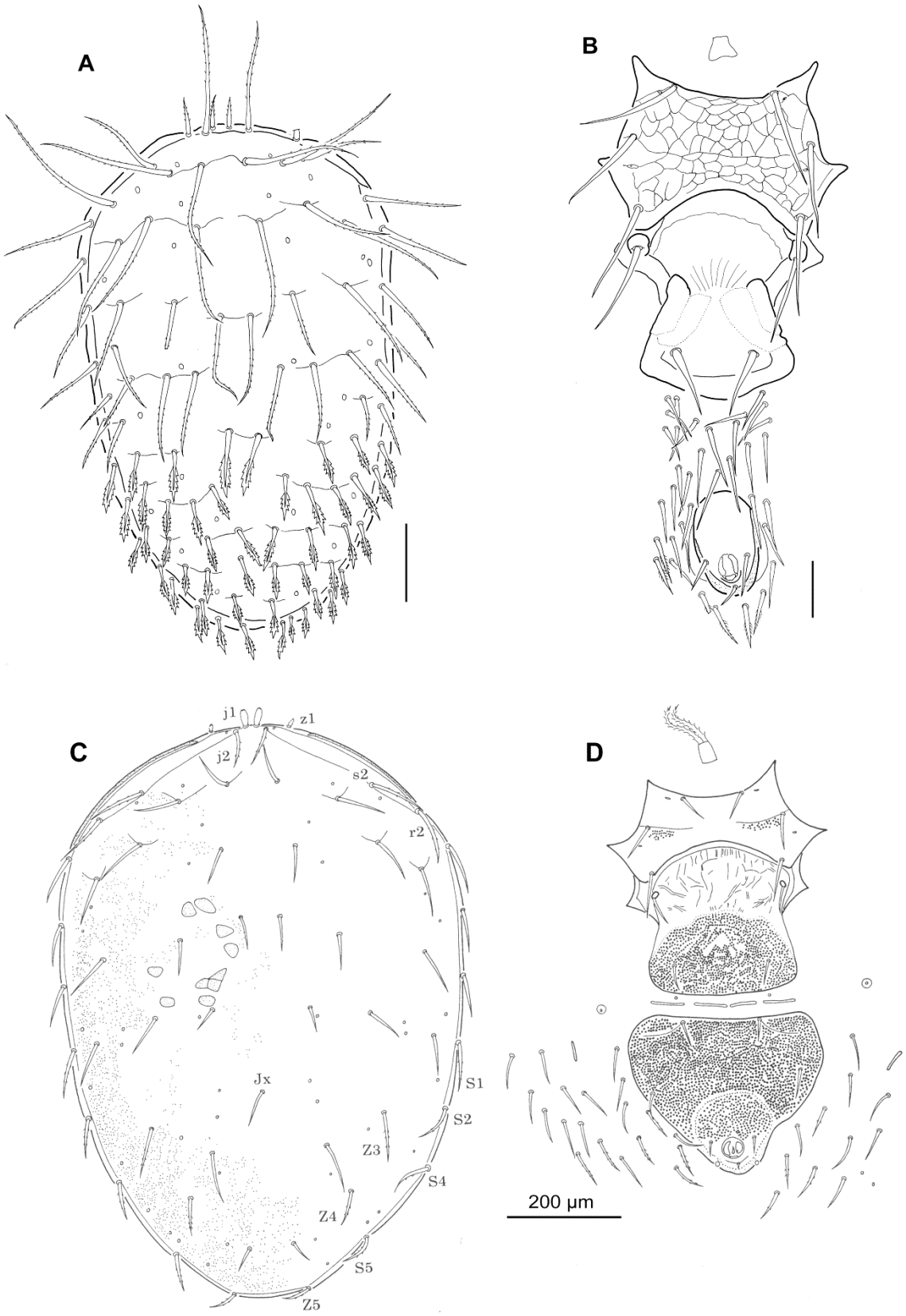


Fig. 24. *Neopodocinum bosschai* (Oudemans, 1901), female, (A, B) and *Neopodocinum halimunense* Hartini and Takaku, 2003, female (C, D) (after Hartini and Takaku, 2003). A, C, dorsal shields; B, D, venters. Scale bars = 200 µm (A, C, D); 100µm (B).

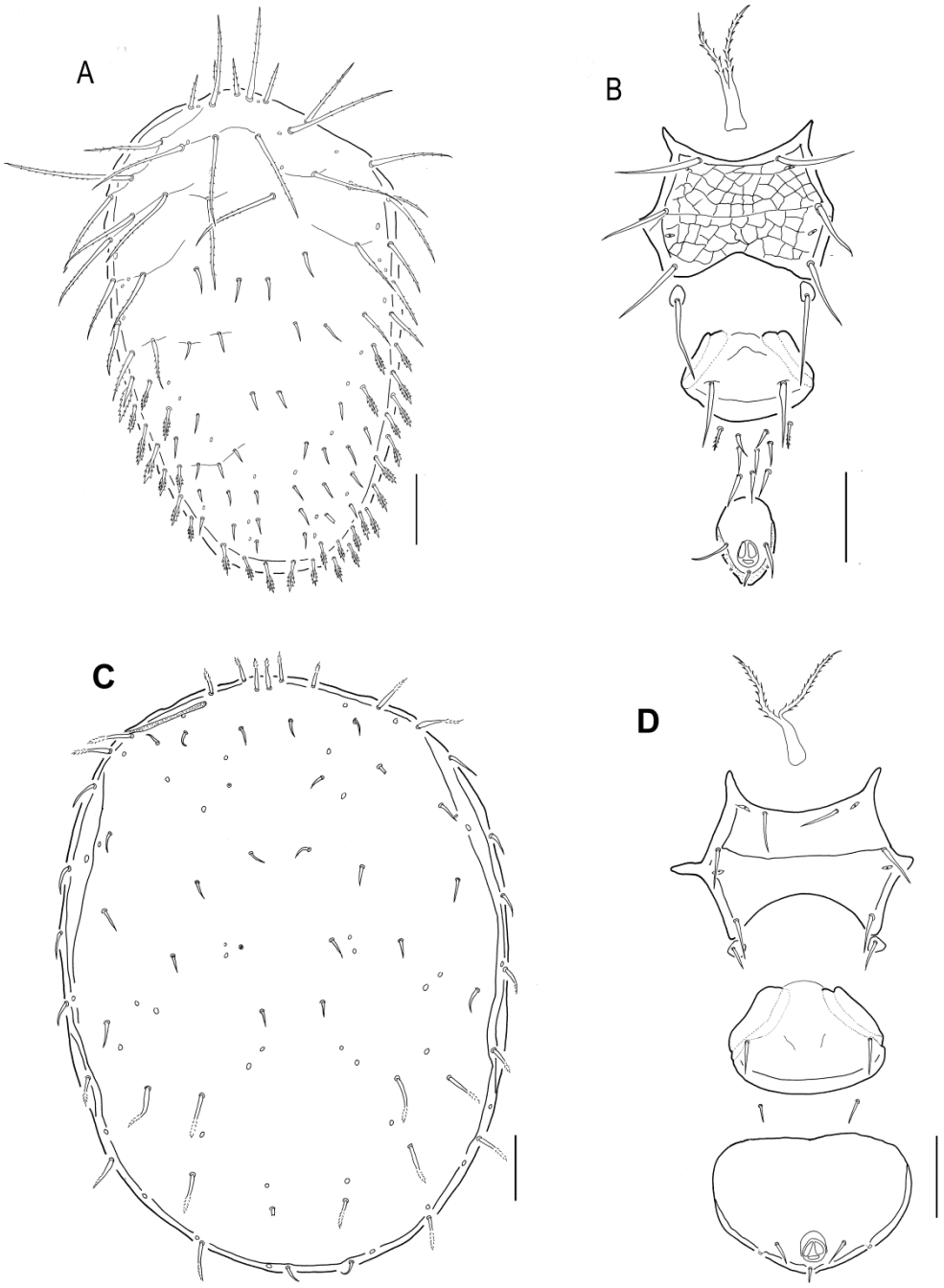


Fig. 25. *Neopodocinum kalimantanense* Hartini and Takaku, 2004, female (A, B) and *Neopodocinum maius* Berlese, 1911, female (C, D). A, C, dorsal shields; B, D, venters. Scale bars = 200 μm.

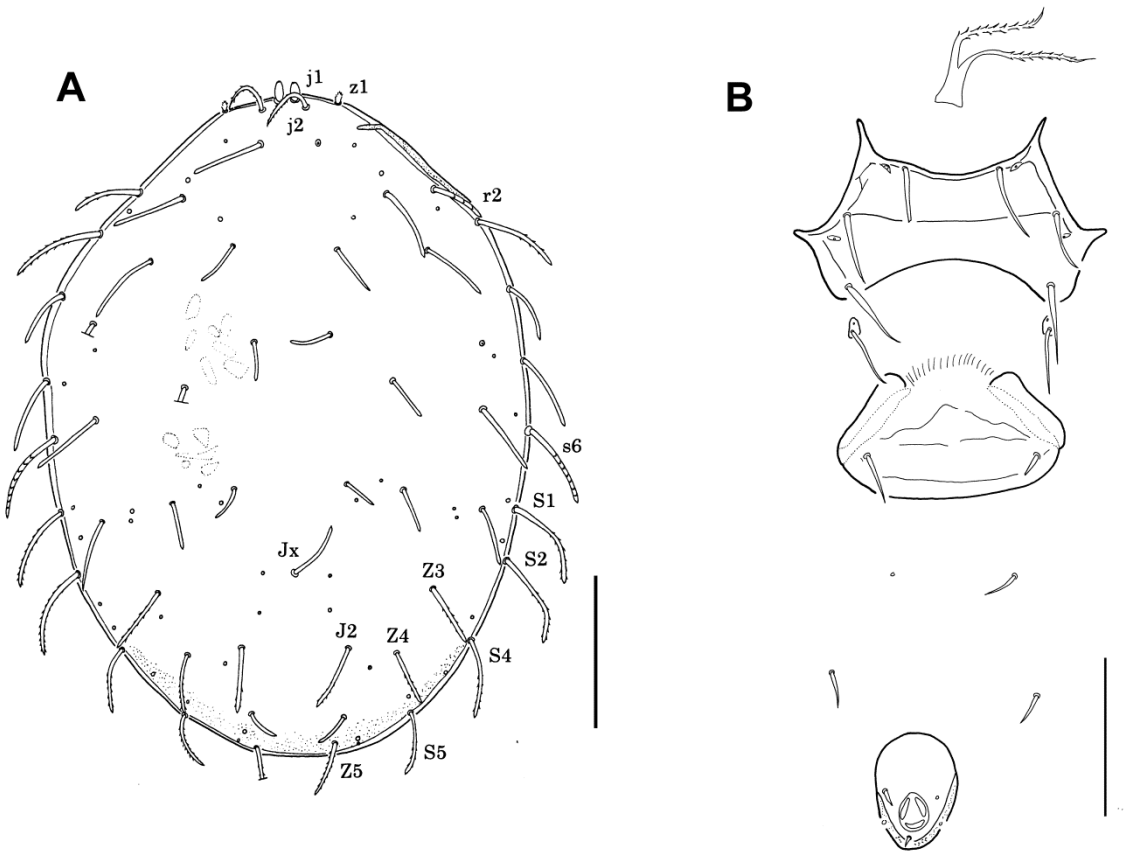


Fig. 26. *Neopodocinum subjaspersi* Hartini and Takaku, 2003, female. A, dorsal shield (after Hartini and Takaku, 2003); B, venter. Scale bars = 100 μm.

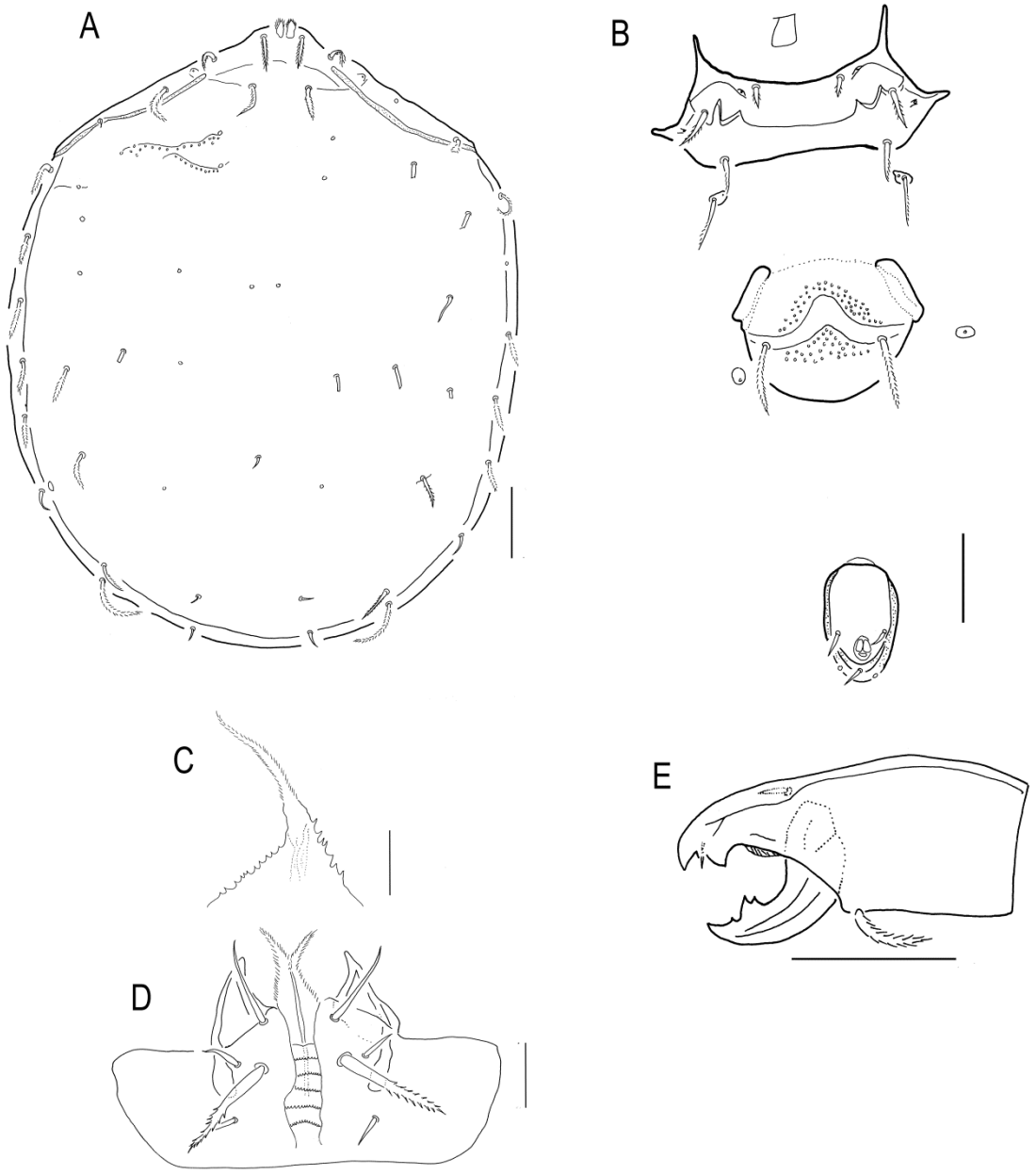


Fig. 27. *Neopodocinum murungensis* sp. nov., female, holotype (MZB. Acar. 9140.1). A, dorsal shield; B, venter; C, epistome; D, ventral view of gnathosoma; E, chelicerae. Scale bars = 100 μm (A, B, E); 50 μm (C, D).

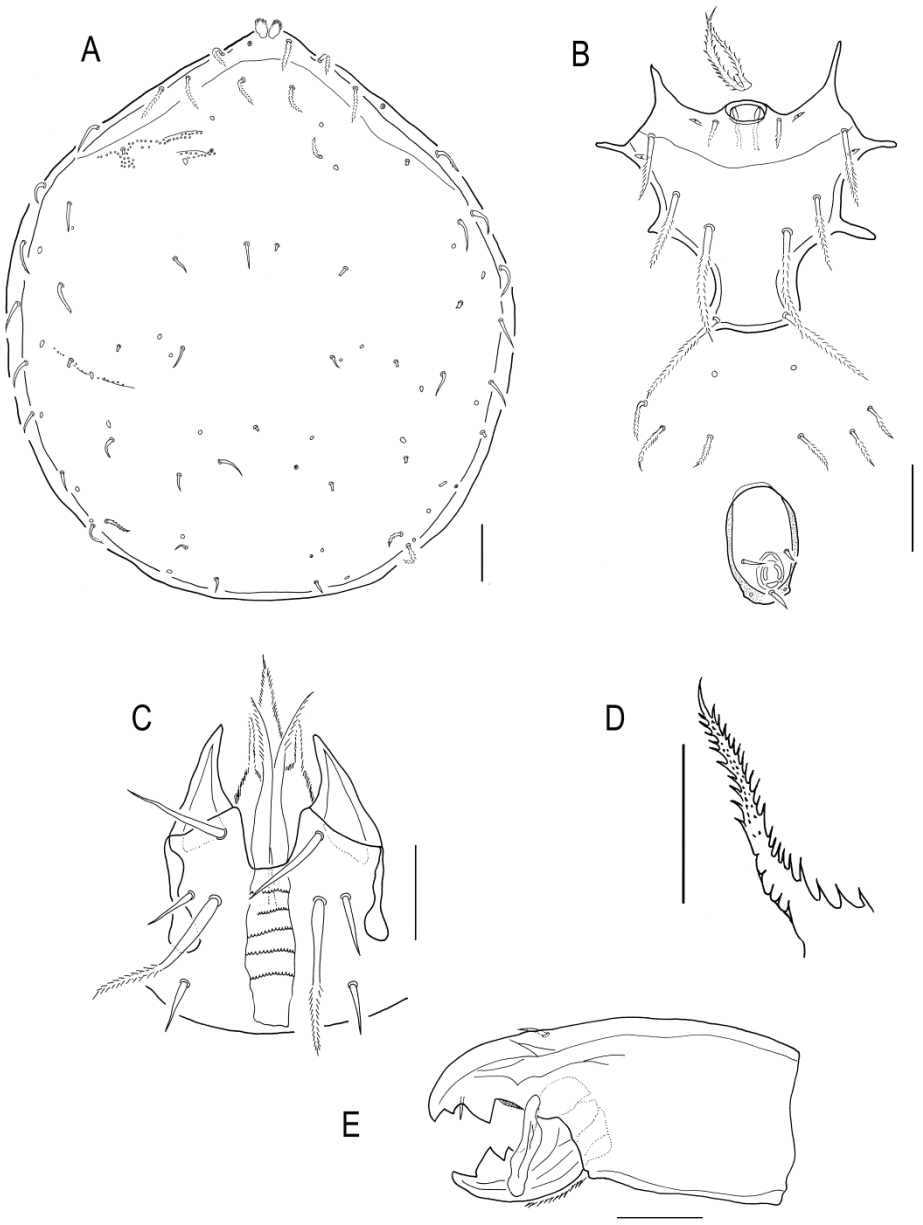


Fig. 28. *Neopodocinum murungensis* sp. nov., male, holotype (MZB. Acar. 9141.3). A, dorsal shield; B, venter; C, ventral view of gnathosoma; D, epistome; E, chelicera. Scale bars = 100 μm (A–C), 50 μm. (D, E).

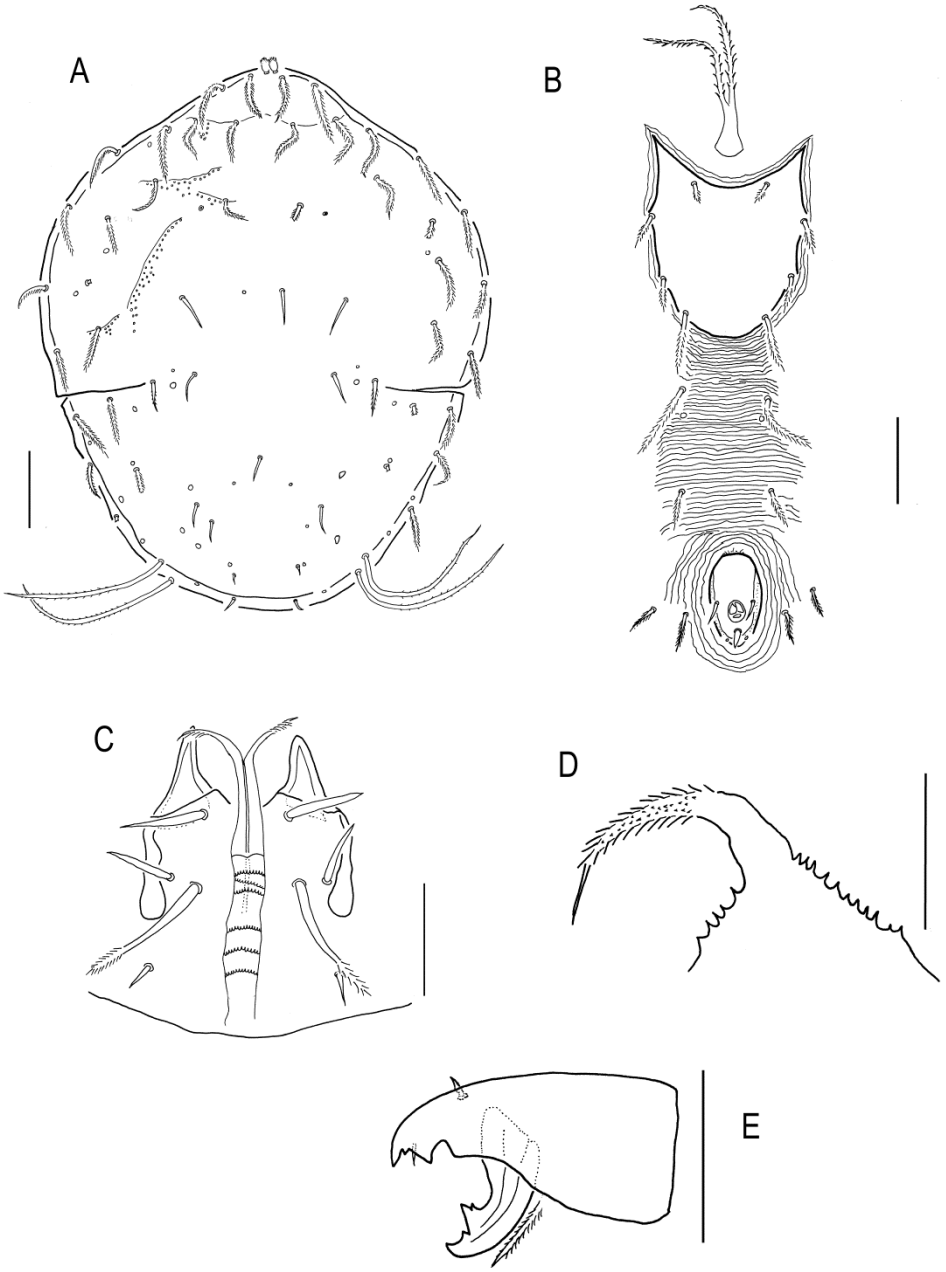


Fig. 29. *Neopodocinum murungensis* sp. nov., deutonymph, paratype (MZB. Acar. 9141.2). A, dorsal shield; B, venter; C, ventral view of gnathosoma; D, epistome; E, chelicerae. Scale bars = 100 μm (A, B); 50 μm (C–E).

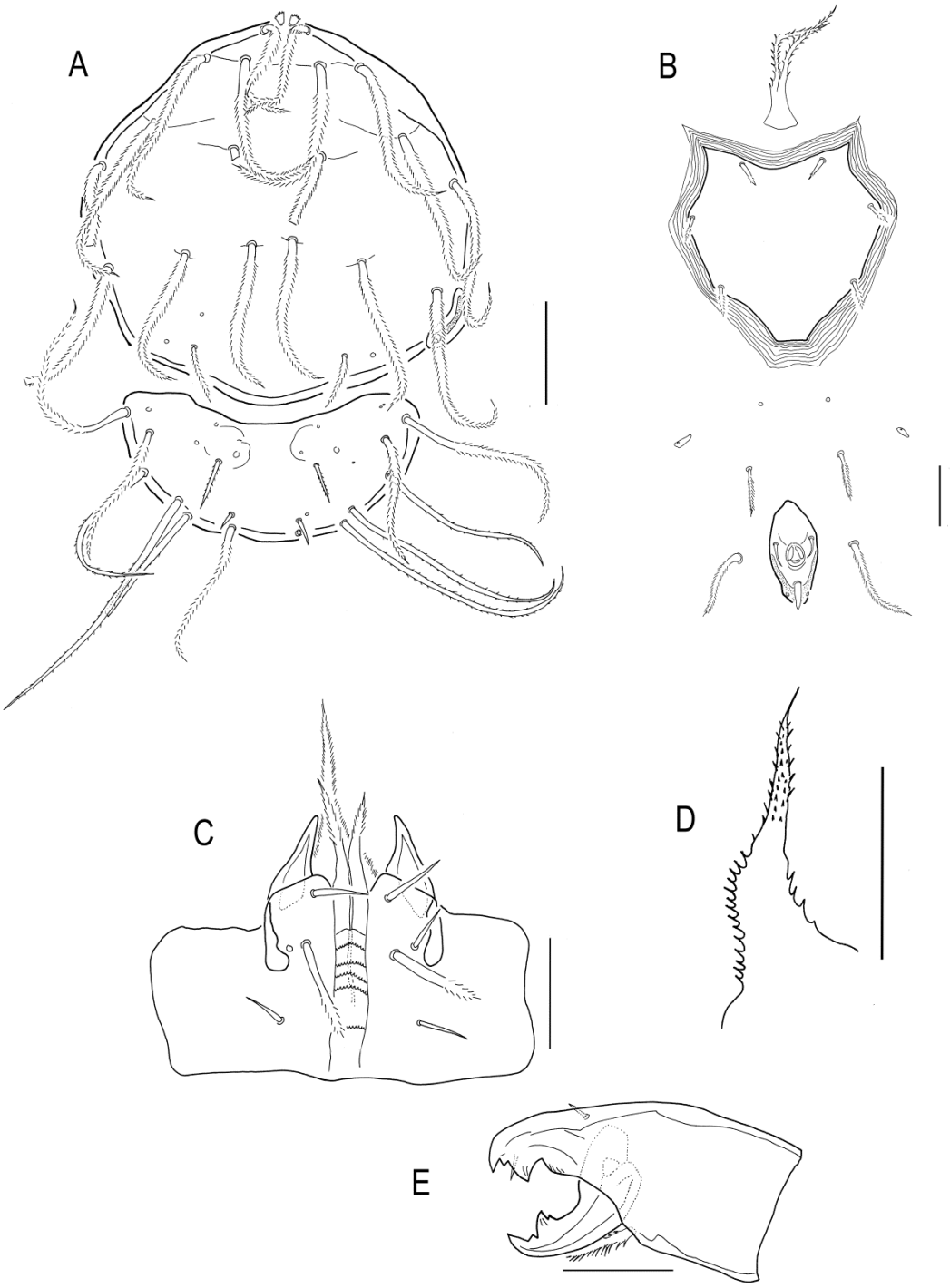


Fig. 30. *Neopodocinum murungensis* sp. nov., protonymph, paratype (MZB. Acar. 9140.4). A, dorsal shield; B, venter; C, ventral view of gnathosoma; D, epistome; E, chelicerae. Scale bars = 100 μm (A); 50 μm (B–E).

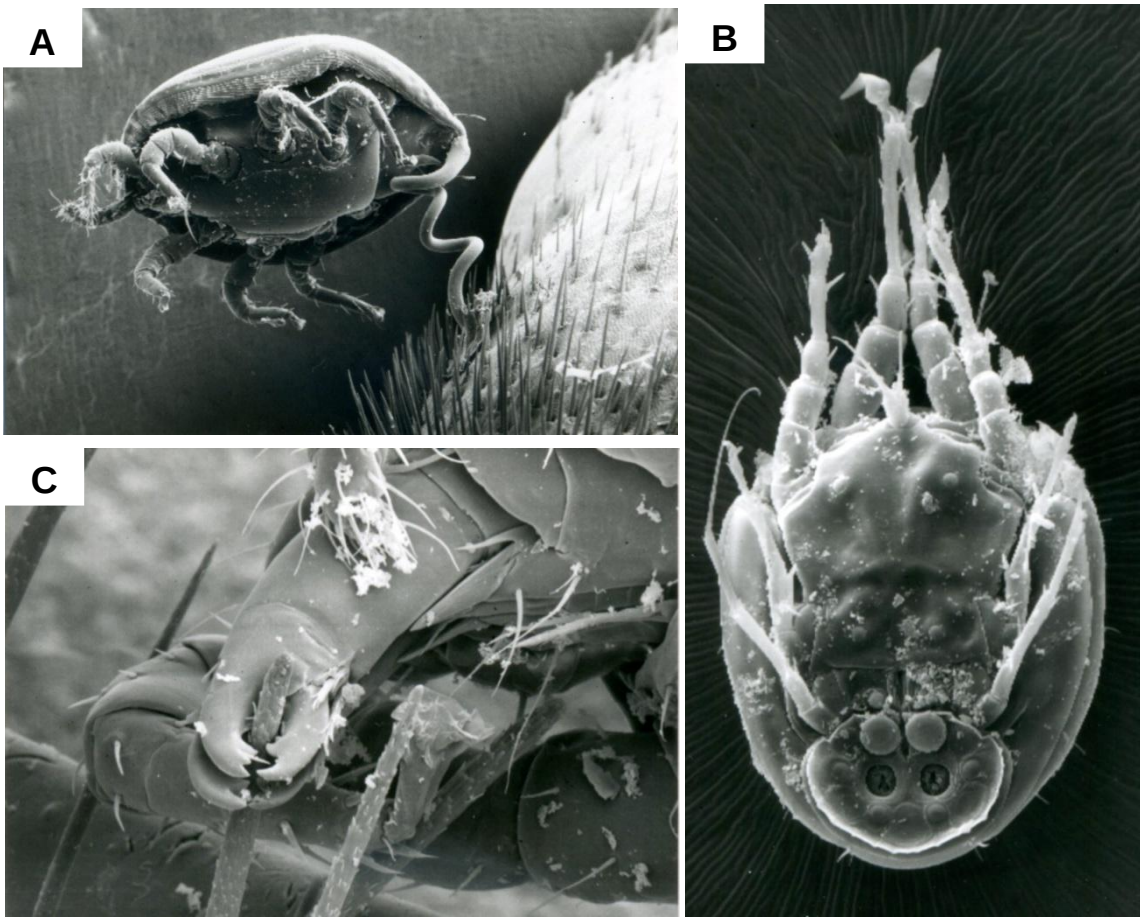


Fig. 31. Adaptive modification for transport in phoretic mites. A, uropodid mites with a stalk secreted from anus; B, hypopus of astigmatid mites with caudoventral sucker; C, macrochelid mites with robust chelicera grasping seta on beetle; D, parasitid mites hanging on by their ambulacral claws and pulvilli. (Photos by Gen Takaku)

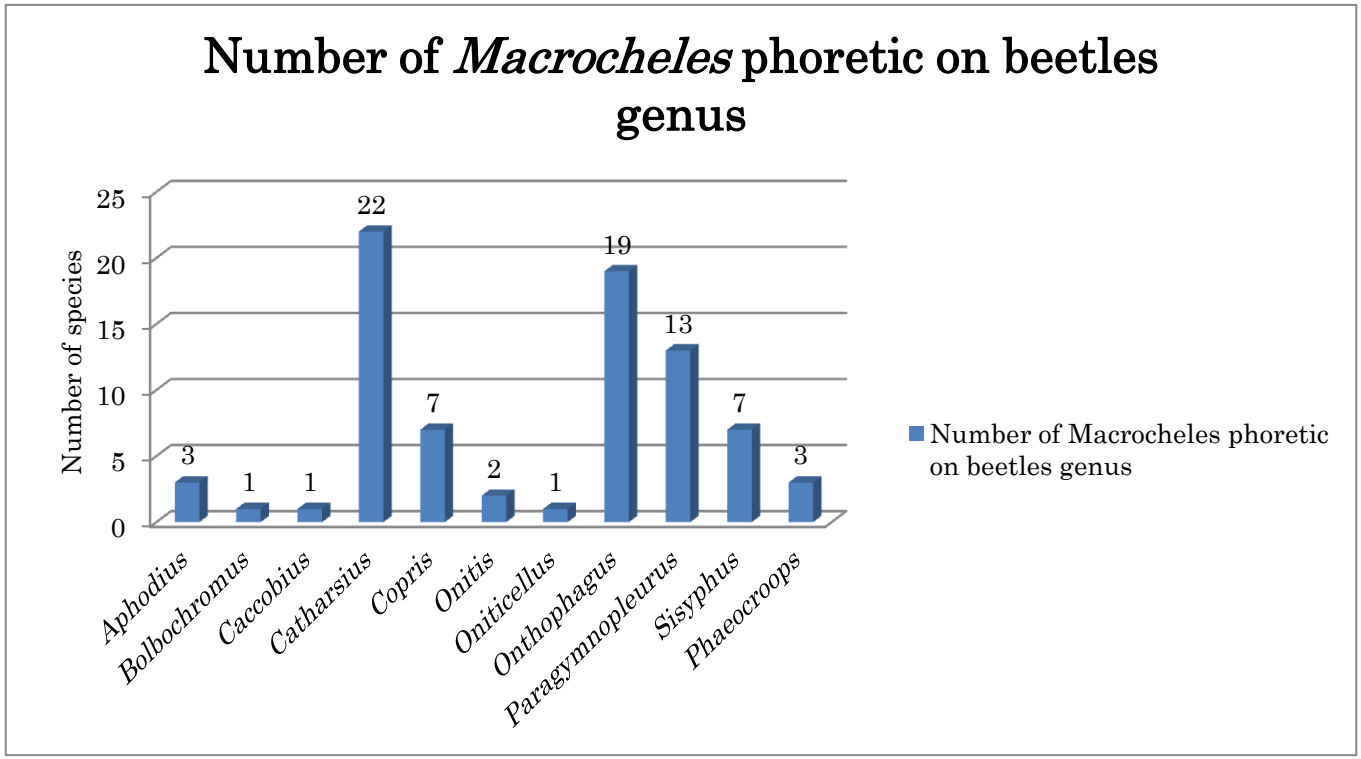


Fig. 32. Number of macrochelid mites collected on various genera of beetles in Borneo.

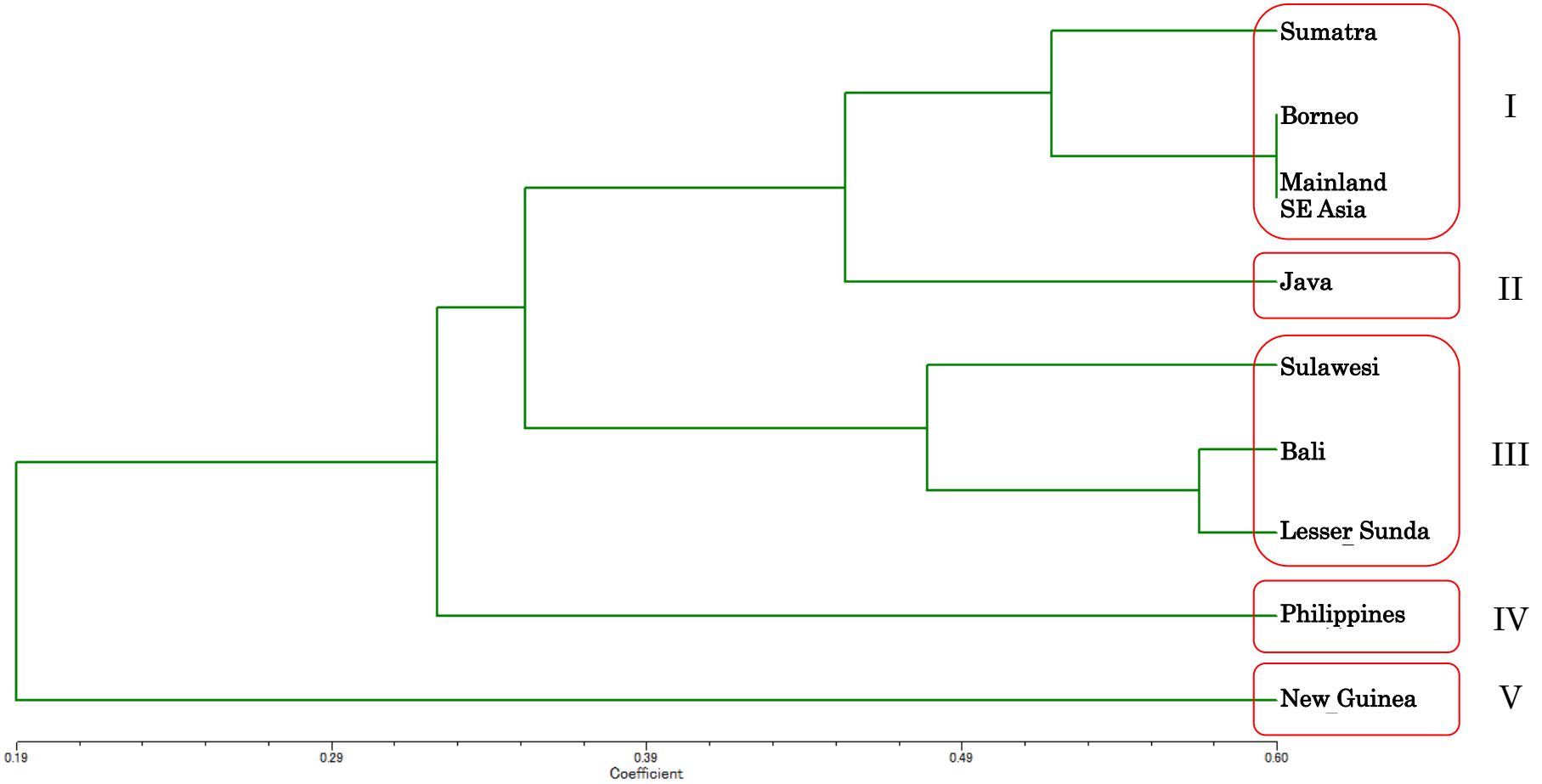


Fig. 33. A UPGMA dendrogram of Borneo and surrounding areas based on the similarity of macrochelid faunas expressed by Sørensen's coefficient index.

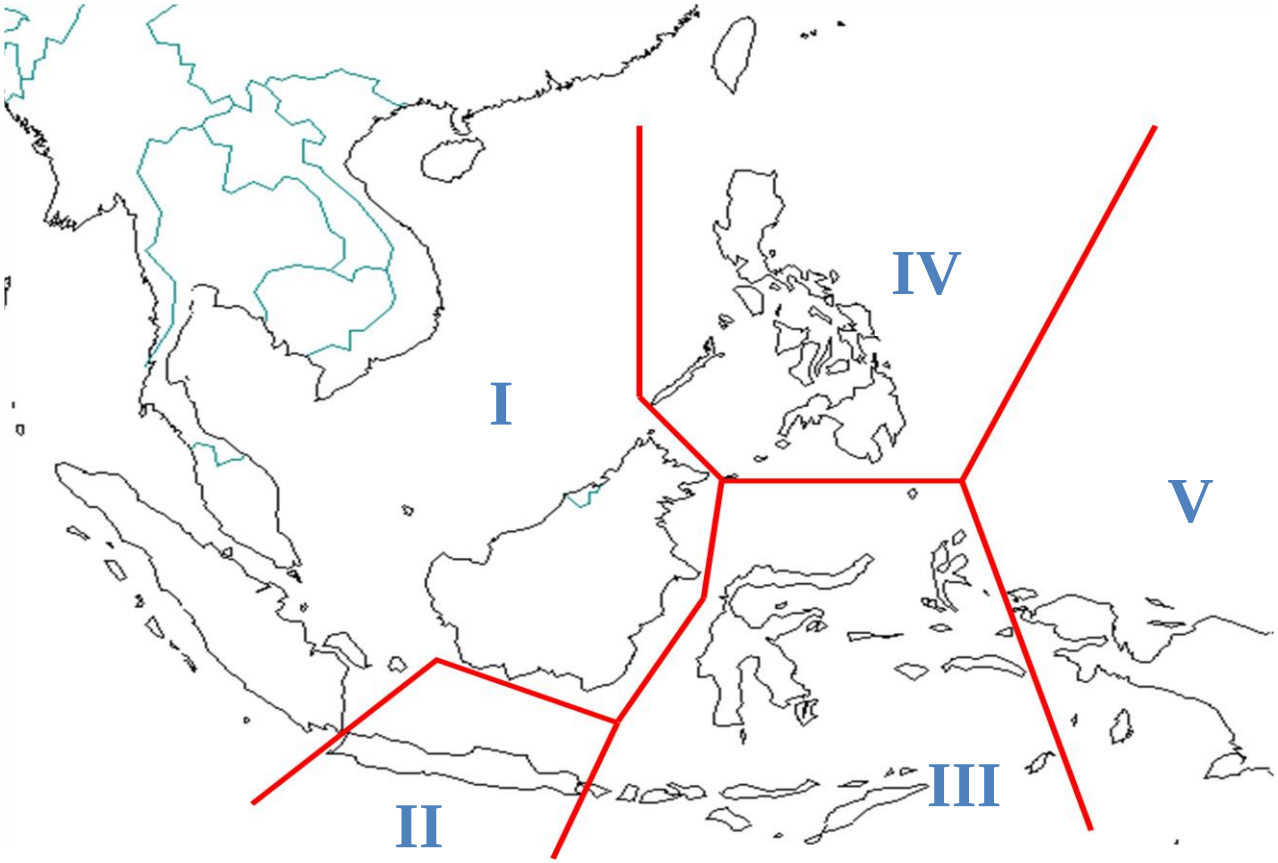


Fig. 34. Five regional groups recognized by the similarity of macrochelid fauna in Fig. 33.

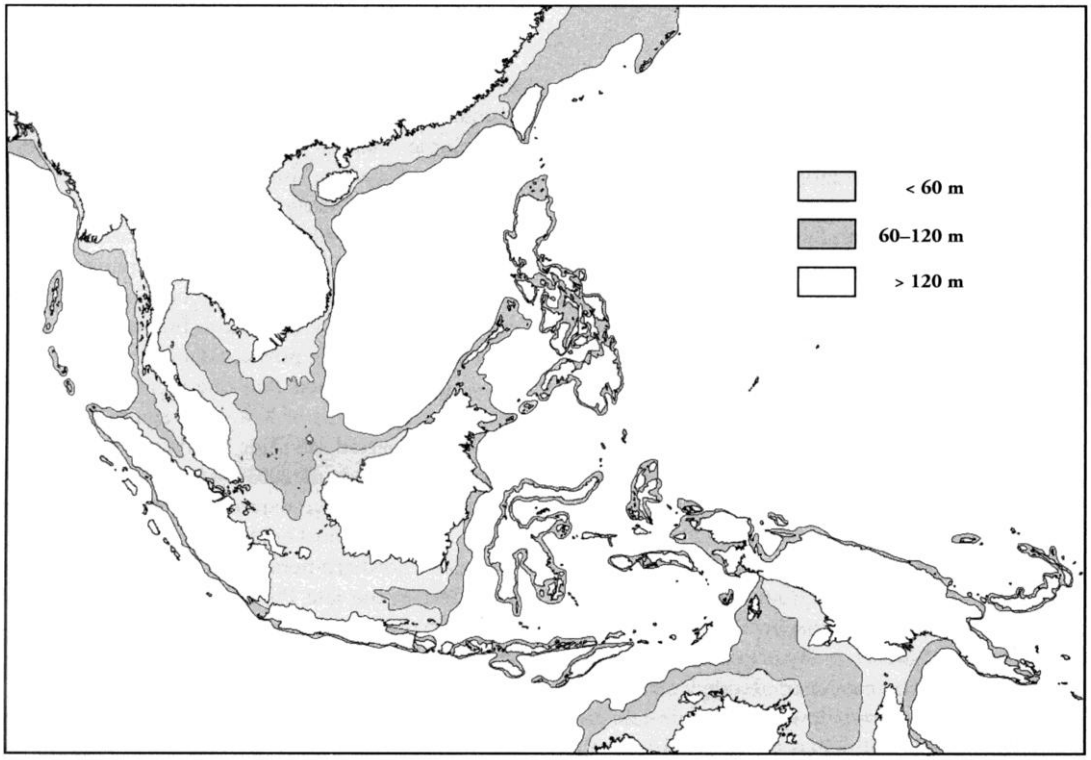


Fig. 35. Oriental and Australian Regions exposed by sea-levels 60 m below present (the average for the last 800,000 years) and 120 m below present (the lowest level reached at the last glacial maximum, 21,000 years) (Corlett, 2009).

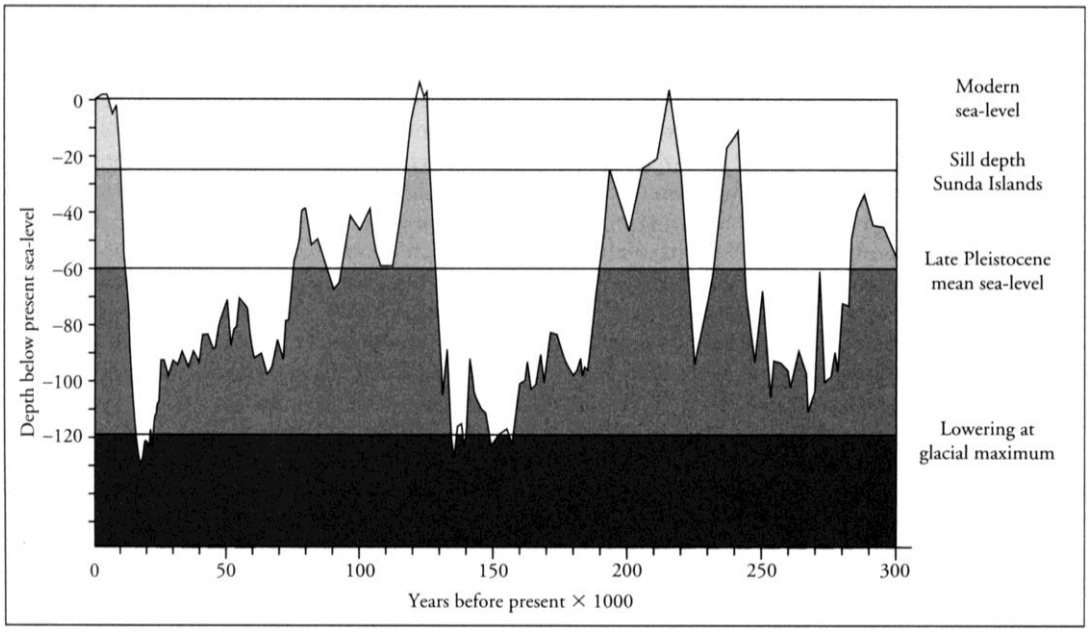


Fig. 36. Sea-levels over the last 300,000 years relative to the present day (Corlett, 2009).

Table 5. List of Macrochelidae in Borneo and carrier beetles

No	**Beetles** / **Macrochelidae**	*Aphodius*	*Bolbochromus*	*Caccobius*	*Catharsius*	*Copris*	*Oniticellus*	*Onitis*	*Onthophagus*	*Paragymnopleurus*	*Sisyphus*	*Phaeocroops*	Other Scarabaeidae/Residue in vial	Total number of host
1	*Glyptholaspis asperrima*				+				+				+	2
2	*G. confusa*												+	-
3	*Holostaspella bifoliata*				+				+					2
4	*H. katakurai*				+					+			+	2
5	*H. moderata*												+	-
6	*Macrocheles baramensis*				+	+	+		+	+	+		+	6
7	*M. dayaci*				+								+	1
8	*M . dispar*	+			+				+	+		+		5
9	*M . entetiensis*								+	+			+	2
10	*M . hallidayi*				+			+	+	+	+		+	5
11	*M . jabarensis*				+	+			+	+	+	+	+	6
12	*M . kalimantanensis*			+	+	+	+		+	+	+		+	7
13	*M. kraepelini*				+	+			+	+			+	4
14	*M . krantzi*												+	-
15	*M. lorensis* sp. nov.												+	-
16	*M. lumbiensis* sp. nov.												+	-
17	*M . mammifer*												+	-
18	*M . merdarius*								+					1
19	*M . muscaedomesticae*				+				+				+	2
20	*M. nidus*												+	-
21	*M . oigru*												+	-
22	*M . persimilis*				+				+					2
23	*M . plumosus*				+				+				+	2
24	*M . pumilus*												+	-
25	*M. riparius*		+		+	+			+		+		+	5
26	*M.* sp. aff. *glaber*				+								+	1
27	*M . sukaramiensis*				+	+				+			+	3
28	*M. sumbaensis*												+	-
29	*M. wainensis*				+				+	+		+	+	4
30	*Neopodocinum bosschai*	+			+				+	+	+		+	5
31	*N. halimunense*				+									1
32	*N. kalimantanense*				+				+	+	+		+	4
33	*N. maius*	+			+				+	+			+	4
34	*N. murungensis* sp. nov.												+	-
35	*N. subjaspersi*				+	+			+				+	3
	Total	**3**	**1**	**1**	**22**	**7**	**2**	**1**	**19**	**13**	**7**	**3**	**-**	**-**

Table 6. Nesting type, size, and number of species in Oriental and Palearctic Region of each genus of Scarabaeidae, and number of species of macrochelid mites associated with each beetle genera in Kalimantan. Data of nesting type (functional group of breeding habits) was cited from Hanski and Cambefort (1991) and Bertone *et al*. (2004), and size and number of species in each genus were cited from Balthasar (1963a, b, 1964).

Genera of scarabaeid beetle	Nesting type	Size	Number of species	Number of species of mites
Aphodius	Dweller	Small (2–15mm)	ca. 600	3
Caccobius	Tunneler	Small (2–9mm)	ca. 45	1
Oniticellus	Tunneler	Small (5–18mm)	ca. 10	2
Onthophagus	Tunneler	Small (3–20mm)	ca. 550	19
Onitis	Tunneler	Large (10–30mm)	ca. 30	1
Catharsius	Tunneler	Large (16–46mm)	ca. 20	22
Copris	Tunneler	Large (9–35mm)	ca. 75	7
Sisyphus	Roller	Small (4–12mm)	ca. 10	7
Paragymnopleurus	Roller	Large (12–22mm)	ca. 10	13

Table 7. Data matrix of distribution of macrochelid mites in Indonesia and surrounding areas (0: absent; 1: present).

Islands or areas / Macrochelid mites	Sumatra	Java	Borneo	Sulawesi	Bali	Lesser Sunda	New Guinea	Indo-China	Philippines
Glyptholaspis asperrima	1	1	1	0	0	0	0	1	1
G. cariasoi	0	0	0	0	0	0	0	0	1
G. confusa	0	0	1	0	0	0	0	0	1
G. fimicola	0	1	0	1	1	1	0	0	1
G . gressitti	0	0	0	0	0	0	1	0	0
G . merapiensis	0	1	0	0	0	0	0	0	0
G. pontina	0	1	0	0	0	0	0	0	0
Geholaspis subspinosus	1	0	0	0	0	0	0	0	0
Holostaspella ancylothrix	0	0	0	0	0	0	0	0	1
H. berlesei	1	0	0	0	0	0	0	0	0
H. bifoliata	0	1	1	0	0	1	1	1	1
H. crenulata	0	0	0	0	0	0	0	0	1
H . fatimahae	0	0	0	0	0	0	1	0	0
H . foai	0	1	0	1	0	0	0	1	0
H . katakurai	1	1	1	0	0	0	0	0	0
H . moderata	1	1	1	0	0	0	0	0	1
H . oblonga	0	1	0	1	0	0	0	0	0
H . pulchella	0	1	0	0	0	0	0	0	1
H . rosichoni	0	0	0	0	0	0	1	0	0
H . similiornata	0	1	0	0	0	0	0	0	0
H. stenaspis	0	0	0	0	0	0	0	0	1
H . villosa	0	1	0	0	0	0	0	0	0
Macrocheles agilis	0	0	0	0	0	0	1	0	0
M . amaliae	0	0	0	0	0	0	1	0	0
M . baliensis	0	1	0	1	1	1	0	0	0
M . baramensis	1	0	1	0	0	1	0	1	0
M . borealis	0	0	0	0	0	0	1	0	0
M . convexus	0	0	0	1	0	0	0	0	0
M . crispa	0	1	0	0	0	0	0	0	0
M. dayaci	0	0	1	0	0	0	0	0	0
M . dispar	1	1	1	1	0	1	1	1	1
M . donggalensis	0	0	0	1	0	0	0	0	0
M . entetiensis	0	1	1	0	0	1	0	0	0
M . erniae	0	0	0	0	0	0	1	0	0
M. garciai	0	0	0	0	0	0	0	0	1
M. glaber	0	0	0	0	0	0	1	0	0
M . hallidayi	1	1	1	1	1	1	0	1	1
M. ijenensis	0	1	0	0	0	0	0	0	0
M. insulicola	0	1	0	0	0	0	0	0	0
M . jabarensis	1	1	1	0	0	1	0	1	0
M . jonggolensis	0	1	0	0	0	0	0	0	0
M . kalimantanensis	1	0	1	1	1	0	0	1	0
M . kojimai	0	0	0	0	0	0	1	0	0
M. kraepelini	1	1	1	1	0	1	0	1	1
M . krantzi	0	1	1	0	1	1	0	0	0
M . limue	1	1	0	1	1	1	1	0	1
***M. lorensis* sp. nov.**	0	0	1	0	0	0	0	0	0
***M. lumbiensis* sp. nov.**	0	0	1	0	0	0	0	0	0
M. luzonensis	0	0	0	0	0	0	0	0	1

M . mammifer	0	1	1	0	0	0	0	1	1
M . manokwariensis	0	0	0	0	0	0	1	0	0
M . merdarius	0	1	1	1	1	1	1	1	1
M . monticola	0	0	0	0	1	1	0	0	1
M . muscaedomesticae	0	1	1	0	0	0	0	1	1
M . nalani	0	0	0	0	0	0	0	1	0
M. nidus	0	1	1	0	0	0	0	0	0
M . oigru	1	1	1	1	1	1	0	0	0
M . persimilis	0	1	1	1	0	0	0	0	0
M . pilosellus	0	0	0	1	0	0	0	0	0
M . plumosus	0	0	1	0	0	0	0	1	0
M . pumilus	0	1	1	0	0	0	0	0	0
M . riparius	0	0	1	0	0	0	0	0	0
M. samarensis	0	0	0	0	0	0	0	0	1
M. scutatus	0	0	0	0	0	0	0	0	1
M . simulans	0	1	0	1	0	0	0	0	0
***M.* sp. 1**	1	0	0	0	0	0	0	0	0
M.* sp. aff. *agilis	0	0	0	0	0	0	0	0	1
M.* sp. aff. *glaber	1	1	1	1	0	1	1	1	0
M. subbadius	0	1	0	0	0	0	0	0	0
M . sukabumiensis	0	1	0	0	0	0	0	0	0
M . sukaramiensis	1	1	1	1	0	0	0	0	0
M . sumbaensis	0	0	1	0	0	1	0	0	0
M. timikaensis	0	0	0	0	0	0	1	0	0
M. transmigrans	0	0	0	0	0	0	0	1	0
M . turgoensis	0	1	0	0	0	0	0	0	0
M . variodecoratus	0	0	0	1	0	0	0	0	0
M. waigeoensis	0	0	0	0	0	0	1	0	0
M . wainensis	0	0	1	0	0	0	0	0	0
M . woroae	0	0	0	0	0	0	1	0	0
Neopodocinum bartkei	0	0	0	0	0	0	0	1	0
N . bosschai	1	1	1	0	0	0	0	1	0
N . halimunense	1	1	1	0	0	0	0	0	0
N . jaspersi	0	1	0	0	1	0	0	0	0
N. javense	0	1	0	0	0	0	0	0	0
N . kalimantanense	0	0	1	0	0	0	0	1	0
N . maius	1	0	1	0	0	0	0	1	0
N . sinicum	0	0	0	0	0	1	0	0	0
***N . murungensis* sp. nov.**	0	0	1	0	0	0	0	0	0
N. spinirostris	0	1	0	0	1	0	0	0	0
N . subjaspersi	1	1	1	0	0	0	0	1	0
N. vanderhammeni	0	0	0	0	0	0	0	1	0
N. vosi	1	0	0	0	0	0	0	0	0
Number of species	**21**	**43**	**35**	**19**	**11**	**17**	**18**	**22**	**23**

Table 8. Number of macrochelid mite species common to compared two islands or areas (below) and Sørensen's coefficient index between islands or areas (above diagonal).

	Sumatra	**Java**	**Borneo**	**Sulawesi**	**Bali**	**Lesser Sunda**	**New Guinea**	**Indo-China**	**Philippines**
Sumatra		0.4	0.5	0.4	0.24	0.42	0.15	0.47	0.23
Java	13		0.56	0.45	0.33	0.43	0.16	0.4	0.36
Borneo	14	22		0.33	0.22	0.23	0.15	0.6	0.35
Sulawesi	8	14	9		0.47	0.5	0.22	0.45	0.29
Bali	4	9	5	7		0.57	0.14	0.18	0.29
Lesser Sunda	8	13	6	9	8		0.29	0.36	0.4
New Guinea	3	5	4	4	2	5		0.2	0.2
Indo-China	10	13	17	7	3	7	4		0.31
Philippines	5	12	10	6	5	8	4	7	
Total number of species	21	43	35	19	11	17	18	22	23

Table 9. Distribution of Indonesian macrochelid mites in the world (AU: Australian Region, including Wallacea and New Guinea; ET: Ethiopian Region; NA: Nearctic Region; NT: Neotropical Region; OR: Oriental Region; PA: Palaearctic Region) (species name in red color: endemic to Indonesia)

Zoogeographic regions **Macrochelid mites**	**AU**	**ET**	**NA**	**NT**	**OR**	**PA**
Glyptholaspis asperrima					■	
G. confusa	■		■	■	■	■
G. fimicola		■	■		■	■
G . gressitti	■					
G . merapiensis					■	
G. pontina					■	■
Geholaspis subspinosus					■	
Holostaspella berlesei		■			■	
H. bifoliata	■	■	■	■	■	■
H . fatimahae	■					
H . foai					■	
H . katakurai					■	
H . moderata	■				■	■
H . oblonga	■				■	
H . pulchella					■	■
H . rosichoni	■					
H . similiornata					■	
H . villosa					■	
Macrocheles agilis	■					
M . amaliae	■					
M . baliensis	■				■	
M . baramensis					■	
M . borealis	■					
M . convexus	■					
M . crispa		■				
M. dayaci					■	
M . dispar	■				■	■
M . donggalensis	■					
M . entetiensis	■				■	
M . erniae	■					
M. glaber	■	■	■	■	■	■
M . hallidayi	■				■	
M. ijenensis					■	
M. insulicola					■	
M . jabarensis	■				■	
M . jonggolensis					■	
M . kalimantanensis					■	
M . kojimai	■					
M. kraepelini	■				■	
M . krantzi	■				■	
M . limue	■	■			■	
***M. lorensis* sp. nov.**					■	
***M. lumbiensis* sp. nov.**					■	
M . mammifer	■		■	■	■	■
M . manokwariensis	■					
M . merdarius	■	■	■	■	■	■
M . monticola					■	
M . muscaedomesticae	■		■	■	■	■

M. nidus						
M . oigru						
M . persimilis						
M . pilosellus						
M . plumosus						
M . pumilus						
M . riparius						
M . simulans						
M. sp. 1						
M. sp. aff. *glaber*						
M. subbadius						
M . sukabumiensis						
M . sukaramiensis						
M . sumbaensis						
M. timikaensis						
M . turgoensis						
M . variodecoratus						
M. waigeoensis						
M . wainensis						
M . woroae						
Neopodocinum bosschai						
N . halimunense						
N . jaspersi						
N. javense						
N . kalimantanense						
N . maius						
N . sinicum						
N . murungensis sp. nov.						
N. spinirostris						
N . subjaspersi						
N. vosi						

Table 10. The number of endemic and non-endemic species of macrochelid mites in Borneo and surrounding islands or areas.

Islands or areas	**Total number of species**	**Endemic species**	**Non endemic species**	**Endemic rate (%)**
Sumatra	21	2	19	9.5
Java	43	8	35	18.6
Borneo	35	4	31	11.4
Sulawesi	19	4	15	21.1
Bali	11	0	11	0
Lesser Sunda	17	0	17	0
New Guinea	18	9	9	50
Mainland of SE Asia	22	2	20	9.1
Philippines	23	4	19	17.4

Table 11. Species richness of macrochelid mites in Indonesia.

	Genera of the family Macrochelidae				Total
	Glyptholaspis	*Holostaspella*	*Macrocheles*	*Neopodocinum*	
Number of species recorded from Indonesia (A)	6	11	50	11	78
Number of species in the world (B)	16	37	337	37	427
Percentage of Indonesian species in the world (100*A/B) (%)	37.5	29.7	14.8	29.7	18.5
Number of species endemic to Indonesia (C)	1	5	32	7	45
Endemic species rate (100*C/A) (%)	16.7	45.5	64.0	63.6	57.7

Table 12. Pattern of distribution of Indonesian macrochelid mites (DJ: disjunct distribution; ED: endemic to one island or area; NG: distribution restricted in New Guinea; OR: distributon restricted in Oriental Region; WA: distribution restricted in Wallacea; WD: wide distribution in Indonesia).

Macrochelid mites	SE Asia (incl. Philippines)	Sumatra	Java	Borneo	Sulawesi	Bali	Lesser Sunda	New Guinea	Pattern of distribution	Number of carrier beetle genera in Borneo	Average of the number of carrier beetle genera
Holostaspella foai	■		■		■				DJ		
H . oblonga			■		■				DJ		
Macrocheles baramensis	■	■		■			■		DJ	6	
M . entetiensis			■	■			■		DJ	2	
M . jabarensis	■	■	■	■			■		DJ	6	
M . monticola	■					■	■		DJ		
M . simulans			■		■				DJ		
M . sumbaensis				■			■		DJ	0	3.50
Glyptholaspis merapiensis			■						ED		
G. pontina			■						ED		
Geholaspis subspinosus		■							ED		
Holostaspella berlesei		■							ED		
H . similiornata			■						ED		
H . villosa			■						ED		
Macrocheles crispa			■						ED		
M. dayaci				■					ED	1	
M. ijenensis			■						ED		
M. insulicola			■						ED		
M . jonggolensis			■						ED		
M. lorensis sp. nov.				■					ED	0	
M. lumbiensis sp. nov.				■					ED	0	
M . riparius				■					ED	5	
M. sp. 1		■							ED		
M. subbadius			■						ED		
M . sukabumiensis			■						ED		
M . turgoensis			■						ED		
M . wainensis				■					ED	4	
Neopodocinum javense			■						ED		
N . murungensis sp. nov.				■					ED	0	
N. vosi		■							ED		1.67
Holostaspella fatimahae								■	NG		
H . rosichoni								■	NG		
Glyptholaspis gressitti								■	NG		
Macrocheles agilis								■	NG		
M . amaliae								■	NG		
M . borealis								■	NG		
M . erniae								■	NG		
M. glaber								■	NG		

M . kojimai									**NG**		
M . manokwariensis									**NG**		
M. timikaensis									**NG**		
M. waigeoensis									**NG**		
M . woroae									**NG**		
Glyptholaspis asperrima									**OR**	**2**	
G. confusa									**OR**	**0**	
Holostaspella katakurai									**OR**	**2**	
H . moderata									**OR**	**0**	
H . pulchella									**OR**		
Macrocheles mammifer									**OR**	**0**	
M . muscaedomesticae									**OR**	**2**	
M. nidus									**OR**	**0**	
M . plumosus									**OR**	**2**	
M . pumilus									**OR**	**0**	
Neopodocinum bosschai									**OR**	**5**	
N . halimunense									**OR**	**1**	
N . subjaspersi									**OR**	**3**	
N . jaspersi									**OR**		
N . kalimantanense									**OR**	**4**	
N . maius									**OR**	**4**	
N. spinirostris									**OR**		**1.79**
Macrocheles convexus									**WA**		
M . donggalensis									**WA**		
M . pilosellus									**WA**		
M . variodecoratus									**WA**		
Neopodocinum sinicum									**WA**		
Glyptholaspis fimicola									**WD**		
Holostaspella bifoliata									**WD**	**2**	
Macrocheles baliensis									**WD**		
M . dispar									**WD**	**5**	
M . hallidayi									**WD**	**5**	
M . kalimantanensis									**WD**	**7**	
M. kraepelini									**WD**	**4**	
M . krantzi									**WD**	**0**	
M . limue									**WD**		
M . merdarius									**WD**	**1**	
M . oigru									**WD**	**0**	
M . persimilis									**WD**	**2**	
M.* sp. aff. *glaber									**WD**	**1**	
M . sukaramiensis									**WD**	**3**	**2.73**