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ARCHAEOGNATHA (INSECTA) FROM THE KRAKATAU ISLANDS AND THE SUNDA STRAIT AREA, INDONESIA

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Abstract

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From the family Machilidae the genus *Graphitarsus* Silvestri, 1908 is redescribed and the species *G. sumatranus* newly described. The genus *Machilontus* Silvestri, 1912 family Meinertellidae and the species *Machilellus orientalis* Silvestri 1911, are redescribed, the species *Machilontus sumatranus* and *Macropsontus secundus* are newly described. The monotypic genus *Megalopsobis* Silvestri 1912, is considered to be a subgenus of *Machilontus* (new combination).

The phylogenetic relationships of the taxa mentioned and the zoogeographical importance of the material are discussed. The dispersal of eggs by drift material is considered as the most probable way of colonisation of the Krakataus.

Introduction

On the Zoological Expedition of La Trobe University to the Krakataus in 1984 eighteen specimens representing six genera of Archaeognatha were collected (Table 1).

Comparison of geographical distribution between the newly collected taxa and that of former collections from the three islands shows how incomplete our knowledge of the existing distribution was and probably still is. On each of the three islands a genus was newly discovered (Table 1).

Type material is located in: Instituto di Entomologia Agraria, Università degli Studi di Napoli, 80055 Portici, Italy (IEPA); Zoological Museum, Bogor, Indonesia (ZMB); and Museum of Victoria, Melbourne, Australia (NMV).

Machilidae

Graphitarsus Silvestri, 1908

Figures 1–17

Type species. Graphitarsus maindronii Silvestri, 1908: IEAP.

Redescription of genus. Relatively large, females reaching 15 mm body length. Dorsal curvature of thorax regular. Tergites, urosternites, head, head appendages, legs and abdominal styli with scales. Hypodermal pigment faintly developed, often indistinctly limited, more obvious on head.

Head. Frons between lateral ocelli strongly protruding. Eyes broader than long, line of contact at most equal to half length of eye. Lateral ocelli sole-shaped; median end wider and situated on frontal protrusion.

Maxillary palps. Without obvious sexual dimorphic characters.

Labial palps. Segment 3 in males and females distinctly widened, width of sensorial field nearly half of head width.

Legs. Relatively short and stout. Coxae II and III with markedly long styles, more than half coxal length. All tarsi with 3 segments, tips with paired scopulae of densely arranged, dark bristles normally S-shaped, with characteristic microstructure (fig. 9) very similar to that of scopula bristles of *Meinertellus*.

Urosternites II–IX with stylets, I and V–VII or V–VI each with pair of coxal vesicles, II–IV each with 2 pairs. Sternites relatively large; length and width between third and half that of corresponding coxites.

Penis. Longer than half coxite IX, aedeagus nearly cylindrical, without specialized setae and with small terminal aperture. Urosternites VIII and IX with articulated parameres, markedly shorter than penis.

Ovipositors. Surpassing apices of stylets IX, of primary type. Distal third of ovipositors VIII with at least 4 macrochaetae on each segment.

Remarks. The validity of the closely related genus *Hybographitarsus* Paclt, 1969 from Java has yet to be proven. It differs from *Graphitarsus* by the extreme dorsal protrusion of the thorax, and from

Table 1. Collections of Archaeognatha on Java, Sumatra and the Krakataus

	Former collections	Krakatau Expedition,1984
Java	*Graphitarsus javanicus* Wygodzinsky, 1953, male	*Graphitarus* cf. *javanicus*, 1 male, Ujung-Gunung Payung
	Hybographitarsus zebu Paclt, 1969, female, Sukabumi	?*Hybographitarsus* sp., 1 juvenile, Ujung Kulon–Cibunar
	Machilellus orientalis Silvestri, 1911, female, Samarang *Machilontus javanicus* Silvestri, 1912, male, female, Nongkodjadjar	
		Macropsontus secundus n. sp., 1 male, 1 female, Ujung-Kulon-Cidaon *Macropsontus* sp., 1 female subadult, 2 juveniles, Ujung Kulon–Gunung Payung, Pulau Peucang, Cidaon
Sumatra	*Graphitarsus maindronii* Silvestri, 1908, female, Mts Médan	*Graphitarsus sumatranus* n. sp., 1 male, Liwa
		Graphitarsus sp., 1 female subadult, 1 juvenile, Liwa *Machilontus sumatranus* n. sp., 2 males, 2 females, Liwa *Machilontus* sp., 1 female subadult, Liwa
Krakatau (Rakata)	*Allomeinertellus jacobsoni* Silvestri, 1911, males, females	?*Allomeinertellus* sp., 1 juvenile, Owl Bay *Machilellus orientalis* Silvestri, 1911, 1 female, Zwarte Hoek

the also closely related genus *Metagraphitarus* Paclt, 1969 from Fernando Poo by the presence of coxal stylets on legs II. The genus *Graphitarsus* can be differentiated from remaining genera of Machilidae by the combination of the following characters: paired scopulae with setae of specific microstructure on the tips of all tarsi, median part of frons strongly protruding, median part of lateral ocelli markedly widened, particularly large coxal stylets on legs II and III, 2 pairs of coxal vesicles on each of the urocoxites II–IV. Dorsal curvature of the thorax as usual.

Key to species of *Graphitarsus*

(As parts of the species descriptions are incomplete the key can be only provisional.)

1 Urocoxites VII each with one coxal vesicle 2
— Urocoxites VII without coxal vesicles *G. maindronii* Silvestri, 1908 (Sumatra)
2 Length of setae on the ventral border of femur and tibia of all legs nearly attaining or surpassing the diameter of the corresponding segments (figs 6–8) 3
— Ventral setae on femur and tibia of all legs shorter than described above 4
3 Middle of scapus clearly pigmented; head pigment faint, more developed on frons ..... *G. surindicus* Bach, 1981 (India, Kerala)
— Middle of scapus faintly pigmented; head pigment around the base of antenna well developed (figs 1, 3) .. *G. sumatranus* sp. nov. (Sumatra)
4 Distance between inner borders of lateral ocelli shorter than 0.25 length of one ocellus. Dorsal half of frons only faintly pigmented .... *G. schmidi* Wygodzinsky, 1957 (Sri Lanka, Ratnapura)
— Distance between inner borders of lateral ocelli longer than 0.25 of one ocellus 5
5 Ratio length line of contact of the eyes: length of eyes less than 0.2 ... . *G. phillipsi* Wygodzinsky, 1957 (Sri Lanka, Horton Plains)
— Ratio line of contact/length of eyes greater than 0.2 .... *G. javanicus* Wygodzinsky, 1953 (Java)

Graphitarsus sumatranus sp. nov.

Figures 1–13

Material examined. Holotype female (11 mm); Sumatra, Barisan Selatan National Park, near Liwa; sweeping; 6 Sep 1984; ZMB.

Description. Body length 11 mm (female); maximum observed length of antenna 10.5 mm; caudal appendages broken. General colour of body yellowish; hypodermal pigment blackish-brown, generally faintly developed; more obvious on head, scapus and labial palps.

Head. Median part of frons strongly protruding and covered by semi-erect scales. Eyes broader than long with short line of contact. Lateral ocelli from black to redish brown, sole shaped, strongly approached. Hypodermal pigment concentrated near base of antenna (figs 1, 2). Width of eyes: width of head = 0.86. Length of eye: width of eye = 0.77. Line of contact: length of eye = 0.27. Distance between inner borders of lateral ocelli: length of ocellus less than 0.25. Distance between inner borders of lateral ocelli: width of head = 0.06.

Antennae. Scape nearly twice as long as broad, apically widened, the only segment with obvious pigmentation, preserved parts of flagellum with scales (fig. 3).

Maxillary palps. Segments 4–7 broken, once incompletely regenerated; dorsal process on segment 1 of median size, apical border with row of larger bristles (fig. 4).

Labial palps. Segment 2 somewhat broadened, apically with row of larger bristles; median border of segment 3 protruding. Pigment, see figure 5.

Legs. Relatively short and coarse, without distinct pigmentation. Coxal stylets very big and almost reaching length of coxae, pair II slightly curved. Ventral border of trochanter and more distal segments of all legs with many markedly long hyaline straight setae (figs 6–8). Bristles of scopulae slightly S-shaped with characteristic microstructure (fig. 9).

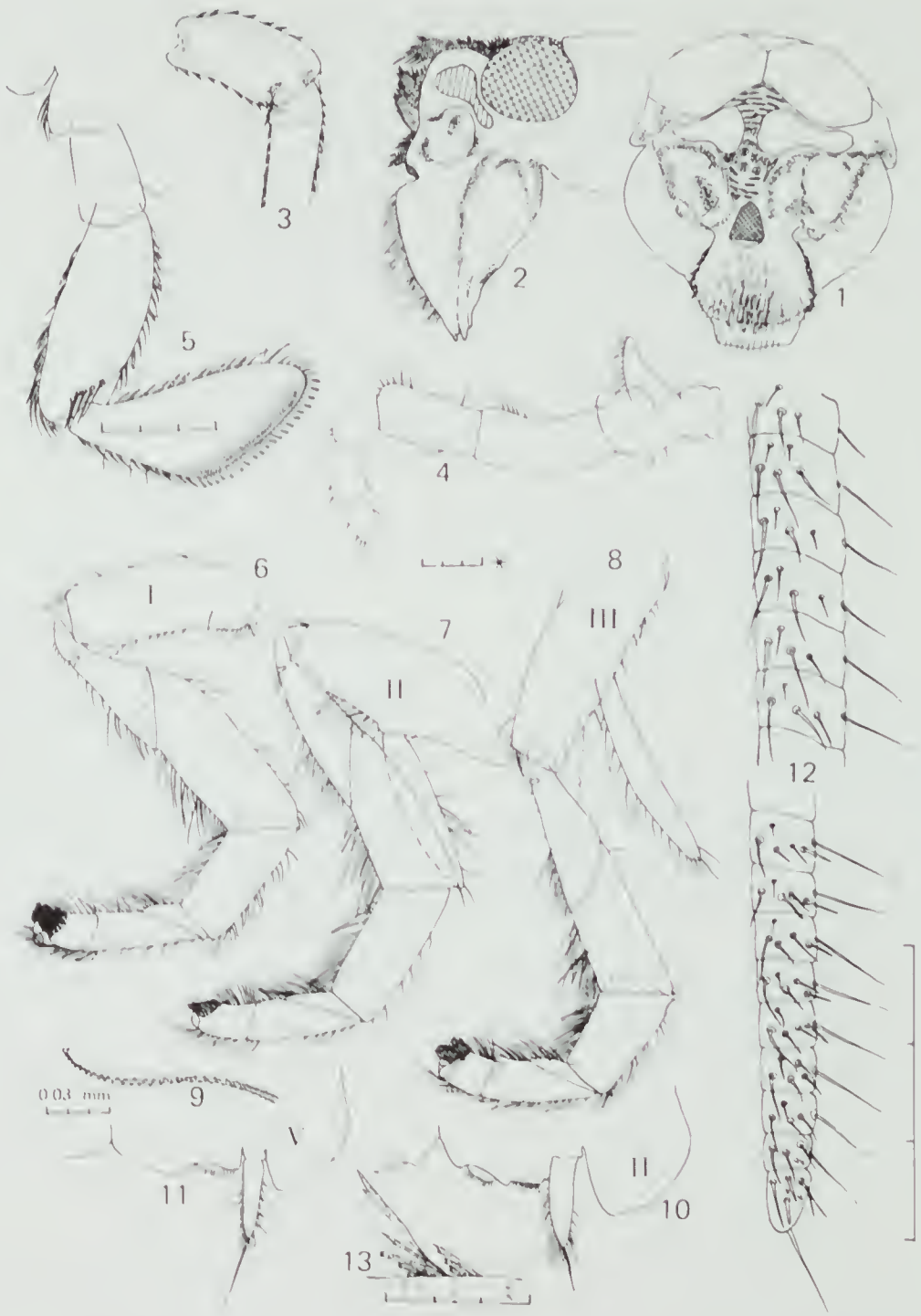
Urosternites. I and V–VII each with 1 pair of coxal vesicles, II–IV each with 2 pairs. Sternites relatively large, length and width more than one-third of that of corresponding coxites. Median angle of sternites II–V more than 90°, that of VI and VII more pointed. Stylets with hyaline bristles and long terminal setae (figs 10, 11). Convex curvature of inner border of stylet II obvious.

Ratio length of coxite: length of stylet: length of terminal spine for II = 2.3:1:0.5; for III = 2.3:1:0.5–0.6; for V = 2.6–2.8:1:1; for VIII = 1.6:1:0.64; for IX = 1.4:1:0.65.

Ovipositor. Nearly 2 mm longer than coxites IX. Distal half of ovipositor VIII with 5–7 long setae on each segment (fig. 12).

Caudal appendages. Terminal filament and median side of cerci with some more erect scales reaching 3 times length of normal scales (fig. 13).

Remarks. The species is close to *G. javanicus.* It differs from it in the lateral ocelli being closer



Figures 1–13. *Graphitarsus sumatranus* sp. nov., female 11 mm. (1) head, frontal view; (2) head, lateral view; (3) antenna, basal portion; (4) maxillary palp, lateral view, segments 4–7 regenerating; (5) labial palp, ventral view; (6–8) legs I–III; (9) hair of the scopula on higher magnification; (10, 11) urocoxites II and V, partly; (12) gonapophysis VIII, in part only; segments 1–9 and 33–38, counted from caudal; (13) scales of the terminal filament. Scale—0.3 mm.

together, the denser and longer bristles on the ventral side of all legs, and the partly different ratios of the urocoxites and stylets. Differences from other species of the genus are mentioned in the key above.

Graphitarsus cf. **javanicus** Wygodzinksky, 1953

Figures 14–17

Material examined. Male 6.7 mm, Java, Ujung Kulon Gunung Payung, 480 m, 6°49'S, 105°16'E, beat, 21 Sep 1984; NMV.

Remarks. The characteristics of the specimen partly correspond to those given by Wygodzinsky (1953) for *G. javanicus*. The lack of pigment in the type specimen (collected in 1917) might be caused by bleaching. The differences in the ratios of eyes and stylets do not justify the description of a new species. Some characters which are important for comparison are mentioned here:

Hypodermal pigment on head, antennae and mandibles obvious.

Head. Scales on median protuberance of the frons less dense and less obvious. Ratio line of contact: eye length = 0.36. Eye length: eye width = 0.8. Distance of inner borders of ocelli: ocellus width = 0.33–0.5 (figs 14, 15).

Antennae. Pigment on scape and pedicel (fig. 16). Pigment of flagellum more concentrated on the proximal three-quarters of each chain, intermediate jointlets light.

Maxillary palps. Ratio length segment 7:6:5 = 1:0.78:0.93 (fig. 17).

Abdominal stylets. Stylets II with convex curvature of inner border (fig. 10). Length of terminal spines of II and III half that of corresponding stylets.

Graphitarsus sp.

Material examined. Sumatra, Barisan Selatan National Park, near Liwa, 700 m; beating in secondary forest; 1 Sep 1984; NMV: female subadult 5.5 mm; 1 juvenile 5 mm.

?Hybographitarsus sp.

Material examined. Java, Ujung Kulon, along track to Cibunar, beating; 20 Sep 1984; NMV: 1 juvenile 4.7 mm.

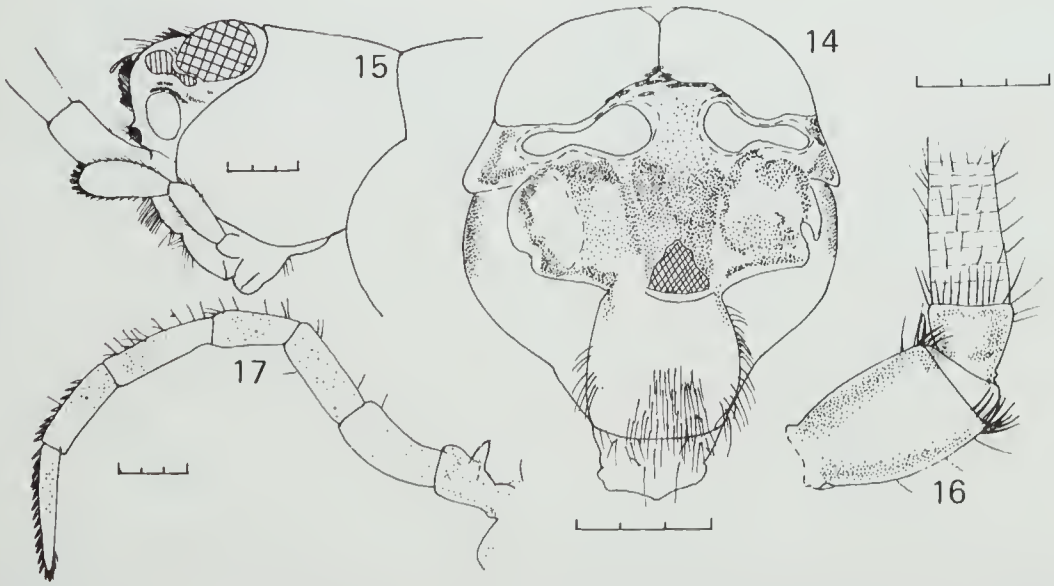
Remarks. The scopulae and the strongly protruded frons prove this to be a member of the *Graphitarsus*-group. The mesothorax distinctly more extruded than usual makes the genus *Hybographitarsus* probable.

Meinertellidae

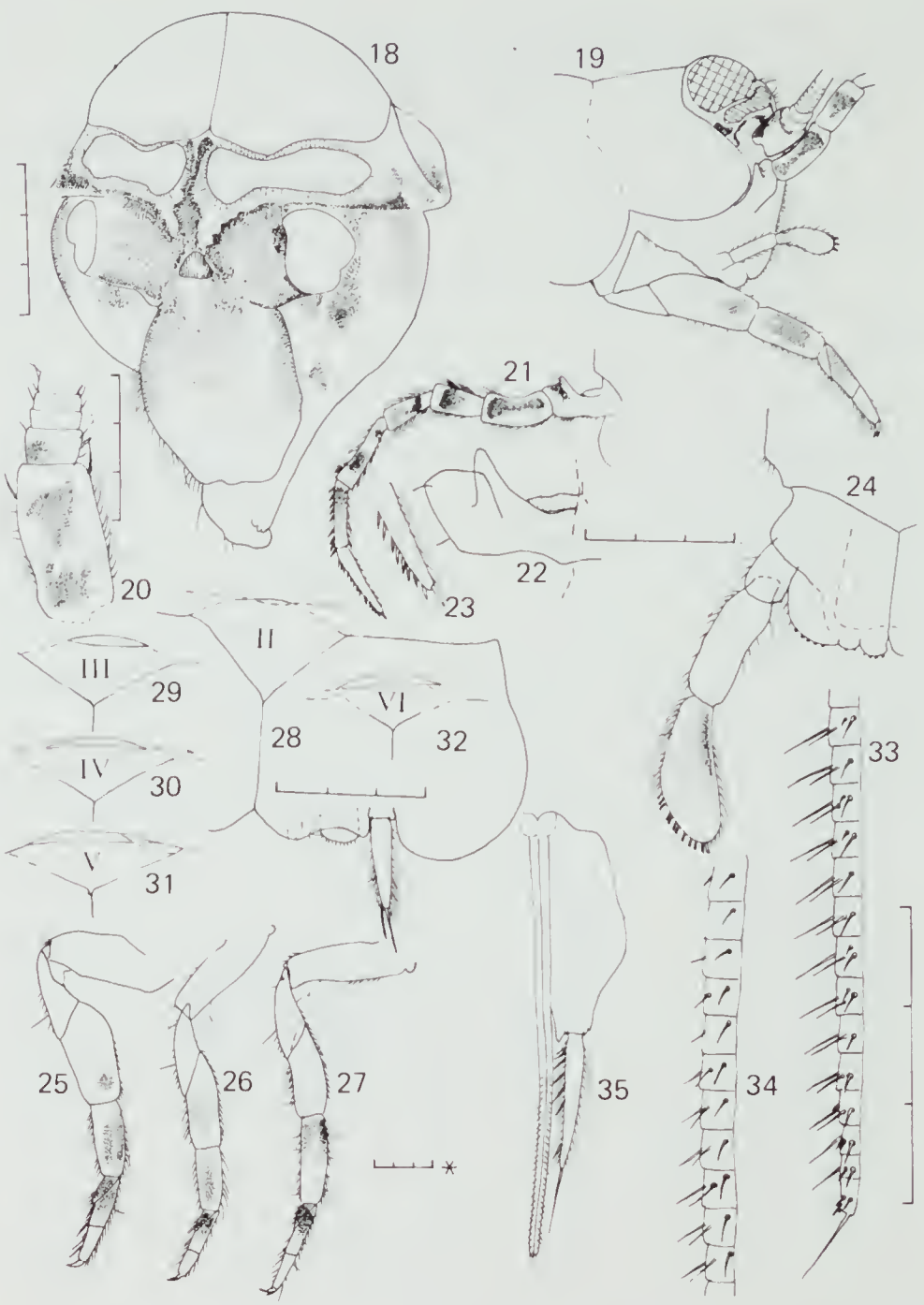
Machilellus orientalis Silvestri, 1911

Figures 18–38

Material examined. Java, Samarang; Ed Jacobson legit; IEAP: 1 female 5 mm. Krakatau Is., Rakata, Zwarte Hoek (6°09'S, 105°25'E), under bark of *Ficus* sp.; 12 Sep



Figures 14–17. *Graphitarus* cf. *javanicus* Wygodzinsky, 1953, male 6.7 mm. (14) head, frontal view; (15) head, lateral view; (16) antenna. basal portion; (17) maxillary palp, lateral view. Scale = 0.3 mm.



Figures 18–35. *Machilellus orientalis* Silvestri, 1911, female 6 mm. (18) head, frontal view; (19) head, lateral view; (20) antenna, basal portion; (21–23) maxillary palp, lateral view: survey, segment 1, apical portion of segment 7; (24) labial palp with part of labium, ventral view, (25–27) legs I–III; (28) urocoxite II; (29–32) urosternites III–VI; (33, 34) gonapophysis VIII, dorsal view; in part: segments 1–14 and 21–31, counted from caudal; (35) urocoxites and oviposotor IX, ventral view. Scale = 0.3 mm.

1984; NMV: female 6 mm.

Description. A very small species (maximum observed body length 6 mm). Colour of body light yellowish; hypodermal pigment dark purple, more developed on head, head appendages and legs.

Head. Frons not strongly protruded. Extensive pigment spots, a median stripe between eyes and clypeus and a V-figure between median ocellus and lateral ocelli more obvious. Eyes relatively large, width nearly three-quarters of head width; length and width of eyes nearly equal; ratio line of contact: length of eyes = 0.8. Lateral ocelli pigmented darkish red-brown, sole shaped, their width reaching 0.9 of eye width, close together medially: distance between inner borders some 0.14 ocellus length (figs 18, 19).

Antennae. 3.3 mm long (broken). Scape nearly twice as long as broad. Pigmentation see fig. 20. Segments of flagellum dark brown, only intermediate jointlets lighter.

Maxillary palps. Horizontal process on base well developed. Process on segment 1 relatively small; segments 1–6 with well limited pigment spots; segments 5–7 almost equal in length (figs 21–23, 36).

Labium. Submentum with blunted lateral corners. Segment 2 of palp with slight constriction on inner border; segment 3 distally somewhat broadened; pigmentation see fig. 24.

Legs. Without coxal stylets. Shape and bristles without specialisation. Pigmentation see figs 25–27 and 37. (In contrast to type specimen, coxae of Krakatau specimen are unpigmented.)

Urosternites. Width of sternite II reaching almost one-third of coxite width, median angle less than 90°; the other sternites are less wide, their median angle more than 90°. Coxites II–IX each with 1 pair of stylets, I–VII each with 1 pair of coxal vesicles. Stylets with well-developed terminal spines. Inner border of stylets II not obviously protruded but with 1–3 long and strong bristles reaching nearly the length of terminal spine. Ratio length of stylet: length terminal spine for II and IX = c. 0.5; for V = c. 0.75; for the rest = 0.6–0.7.

Ovipositor. Of primary type, surpassing terminal spines of stylets IX; gonapophyses VIII with 55–60 segments, distal half with longer setae, in distal third at least 3 macrochaetae on each segment except the terminal one.

Caudal appendages. Terminal filament 5.2 mm (broken). Cerci 3 mm, with simple terminal spines.

Remarks. As the former descriptions were incomplete or combined erroneously, a redescription was necessary.

The specimen described here fits very well the description of Silvestri (1911) based on a specimen from Samarang (Java). Silvestri did not mention the pigmentation of the holotype of *M. orientalis* but reexamination of the type material proved that our specimen is very similar to it. Wygodzinsky's (1953) specimen from East-Sumba, attributed to this species has very different pigmentation and is probably a different species needing description. The genus therefore probably has three species.

M. orientalis differs from the species from Sumba by the stronger and differently distributed pigmentation and also by closer lateral ocelli. *M. heteropalpus* Mendes, 1981 from Vietnam has maxillary palps distinctly different in shape and pigmentation. It also has an excessively protruded mesothorax and a more protruded median part of the frons.

The genus *Machilellus* is probably not so closely related to *Neomachilellus* Wygodzinsky, 1953 as suggested by Wygodzinsky (1953), Bitsch (1963) and Mendes (1981). Similarities reflect either plesiomorphic characteristics of the Meinertellidae (form of lateral ocelli, distribution of coxal vesicles) or apomorphic losses which were apparently realised several times during the phylogeny of Machiloidea (absence of coxal stylets).

Among other characters the chaetotaxy of penis and ovipositor demonstrates that *Neomachilellus* is a much more derived genus. For the separation from other genera see Mendes (1981).

Machilontus Silvestri, 1912 comb. nov.

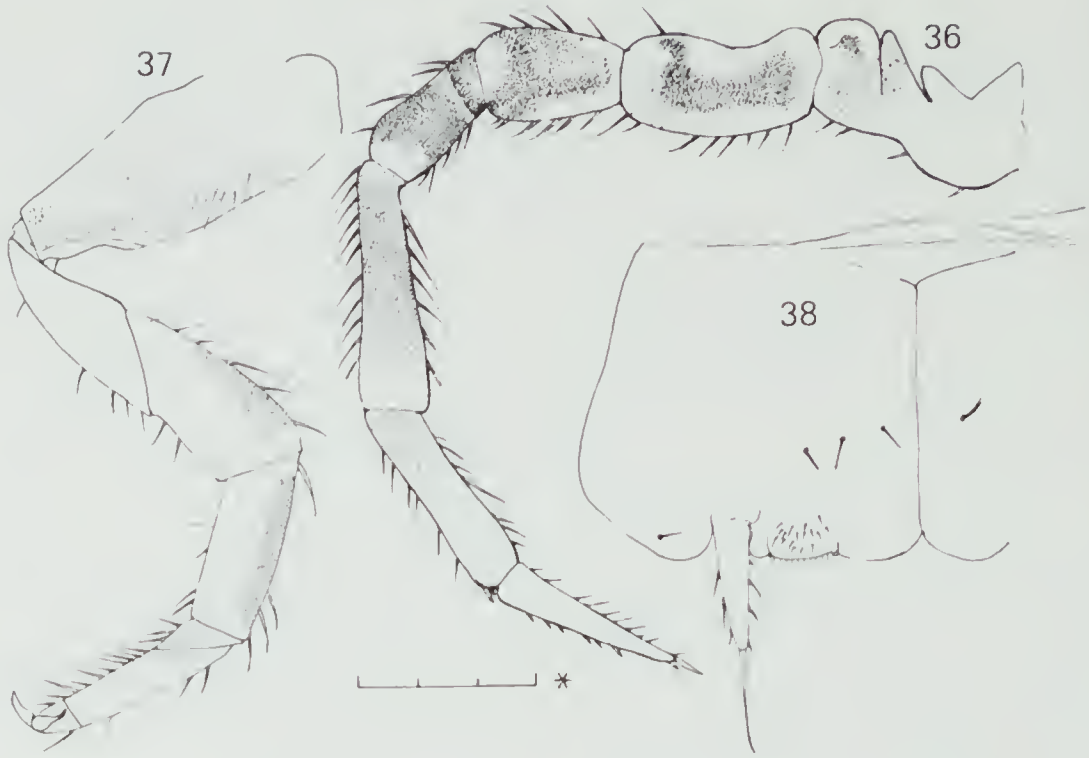
Machilontus Silvestri, 1912: 4–6.
Megalopsobius Silvestri, 1912: 3, 4.

Description. Of moderate length, maximum observed body length 11 mm. Body with scales except on head, head appendages legs and stylets. Hypodermal pigment faintly to strongly developed; on head, head appendages and legs mostly well defined.

Head. Eyes relatively large, width more than 0.8 of head width; ratio eye length: width = 0.8–1.4. Ratio length line of contact: eye length greater than 0.5. Lateral ocelli oblong, median part slightly or not constricted, length attaining 0.5–0.75 of eye width; distance of inner borders reaching 1.2 or more of ocellus length. Median part of frons sometimes somewhat protruded and with characteristic setae (compare figs 39 and 51).

Antennae. Unbroken longer than the body. Flagellum often with brownish pigment.

Maxillary palps. Horizontal process on basis well developed; dorsal process on segment 1 slightly to strongly protruded; segment 2 of male with hook-



Figures 36–38. *Machilellus orientalis* Silvestri, 1911, female type. (36) maxillary palp, lateral view; (37) leg III (?); (38) urosternite V. Scale = 0.3 mm.

shaped process on distal-dorsal border longer than 0.5 of diameter of segment; process sclerotized with darker inner border; if process arises from separate cylindrical dorso-distally erected base this is shorter than 0.5 of hook length (fig. 60); position of hook between parallel and perpendicular to the longitudinal axis of segment (figs 40, 41, 60); ventral side of segment 5 in males may have many long straight setae.

Labium. Submentum laterally protruded. Distal part of segment 3 in males and females only slightly widened; inner border of segment 2 not obviously protruded (figs 42, 43, 61).

Legs. Relatively slender, only pair III with coxal stylets, length of which corresponds approximately to diameter of coxa (0.8–1.2x). All tarsi with only 2 segments (distal segment not subdivided). Ventral border of tibia I in males and females often with characteristic field of setae (fig. 45).

Urosternites. II–IX with stylets; I–VII each with 1 pair of coxal vesicles. Sternites relatively small, II largest but length and width not reaching one-third of corresponding values for coxites.

Ovipositor. Primary type, long and thin, surpassing stylets IX; distal part of gonapophyses VIII (0.5–0.6 of length) with 3–5 macrochaetae on each segment (fig. 57).

Penis. Short, no more than 0.7 of coxite length; aedeagus without specialised bristles, with slash-shaped ventral terminal aperture which is longer than 0.5 length of aedeagus (fig. 50).

Type species. Machilontus gravelyi Silvestri, 1912.

Remarks. The genus *Machilontus* described here also includes the monotypic genus *Megalopsobius* Silvestri, 1912. Examination of the preserved parts of the type species of *Megalopsobius*, *M. convergens* Silvestri, 1912: 4), from IEAP Museum showed no differences which could justify the maintenance of this genus. The name is reduced to a subgenus which is characterised in the following key. The genus *Macropsontus* is closely related to *Machilontus* and shares very large eyes and similar form and chaetotaxy of penis and ovipositor. The specific differences of *Macropsontus* are lack of coxal stylets on all legs and the longer cylindrical base of the hook of segment 2 of the male maxillary palp.

Key to *Machilontus* species

The three subspecies of *M. sutteri* described by Paclt (1969) are not included. Their descriptions are incomplete. In the descriptions of some other species important characters such as pigmentation pattern and some ratios are missing. So the key can be only provisional.

1 Hook of segment 2 of male maxillary palp with a well separated cylindrical base (fig. 60). Ratio eye length: width > 1.2 (Cerci longer than the body.) .... *M. (Megalopsobius) convergens* (Silvestri, 1912) (Burma/Thailand)

– Hook of segment 2 of male maxillary palp without well separated cylindrical base. Ratio eye length: eye width ≤ 1.2 .. *M. (Machilontus)* .. 2

2 Dorsal process on segment 1 of maxillary palps short, maximum length two-thirds of the diameter of distal portion of segment .... *M. gravelyi* Silvestri, 1912 (Burma/Thailand)

– Dorsal process of maxillary palp segment 1 larger than described above 3

3 Tibiae 1 on ventral side with a distinct field of many brownish bristles (fig. 45) 4

– Distinct field of bristles on fore tibiae lacking or only slightly developed ..... *M. javanicus* Silvestri, 1912 (Java)

4 Head with Y-shaped symmetrical pigmentation on frons. Median portion of frons protruded and with many short blackish bristles .... *M. lerang* Wygodzinsky, 1953 (Western Flores)

– Head without Y-shaped pigmentation and/or without field of short blackish bristles on frons 5

5 Legs without well defined pigment spots .... *M. lawrencei* Bach, 1981 (India)

– Legs with well limited pigment spots at least on femur and/or tibia . 6

6 Distinct spots of hypodermal pigment on all trochanters and coxae; segment 5 of maxillary palps without specialised setae .... *M. sumatranus* n. sp. (Sumatra)

– Hypodermal pigment on trochanters and coxae lacking; segment 5 of maxillary palp of male with many long setae on ventral side .... *M. sutteri* Wygodzinsky, 1953 (East Sumba)

Machilontus (Machilontus) sumatranus sp. nov.

Figures 39–59

Material examined. Sumatra, Barisan Selatan National Park, near Liwa, pitfall traps, 5-7-Sep 1984, ZMB: male 7.8 mm holotype, NMV: female 7.7 mm allotype (T-9621), 1 male (T-9622) and 1 female (T-9623) paratypes.

Description. Maximum observed body length 9 mm; colour pattern of eyes and pattern formed by scales unknown. Dark reddish brown hypodermal pigment on head, head appendages and legs conspicuous but not always well limited.

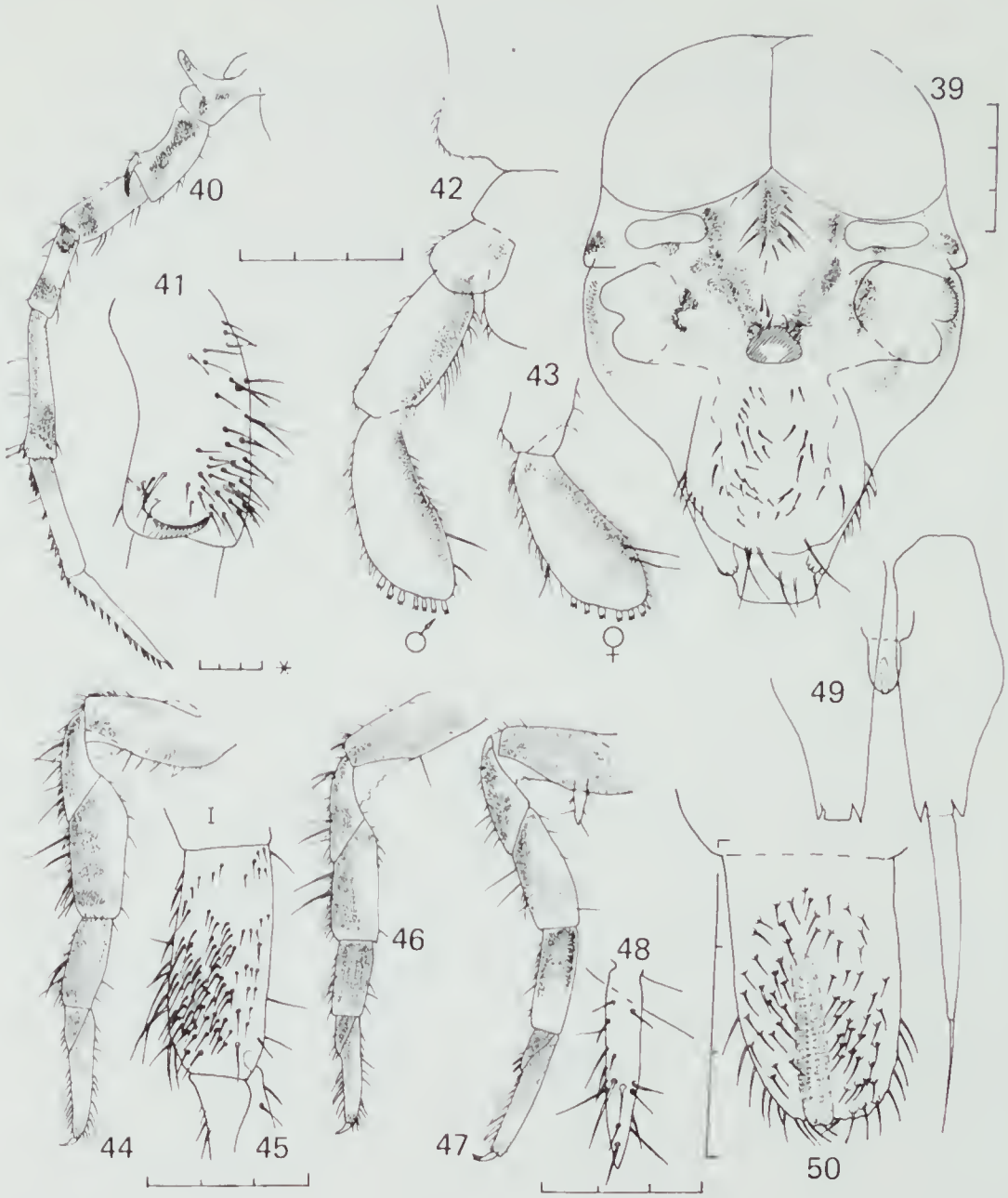
Head. Eyes large, width reaching approximately 0.9 of head width. Ratio eye length: eye width = 0.95–1.2. Line of contact: eye length = 0.65–0.75. Lateral ocelli in alcohol brownish grey to yellowish grey their length only half of eye width, distance between inner borders greater than ocellus length. Hypodermal pigment arranged in V-shape above the median ocellus, frons with median stripe of pigment, other spots around antennal base (fig. 39).

Mandible. With 4 teeth and pigment spots.

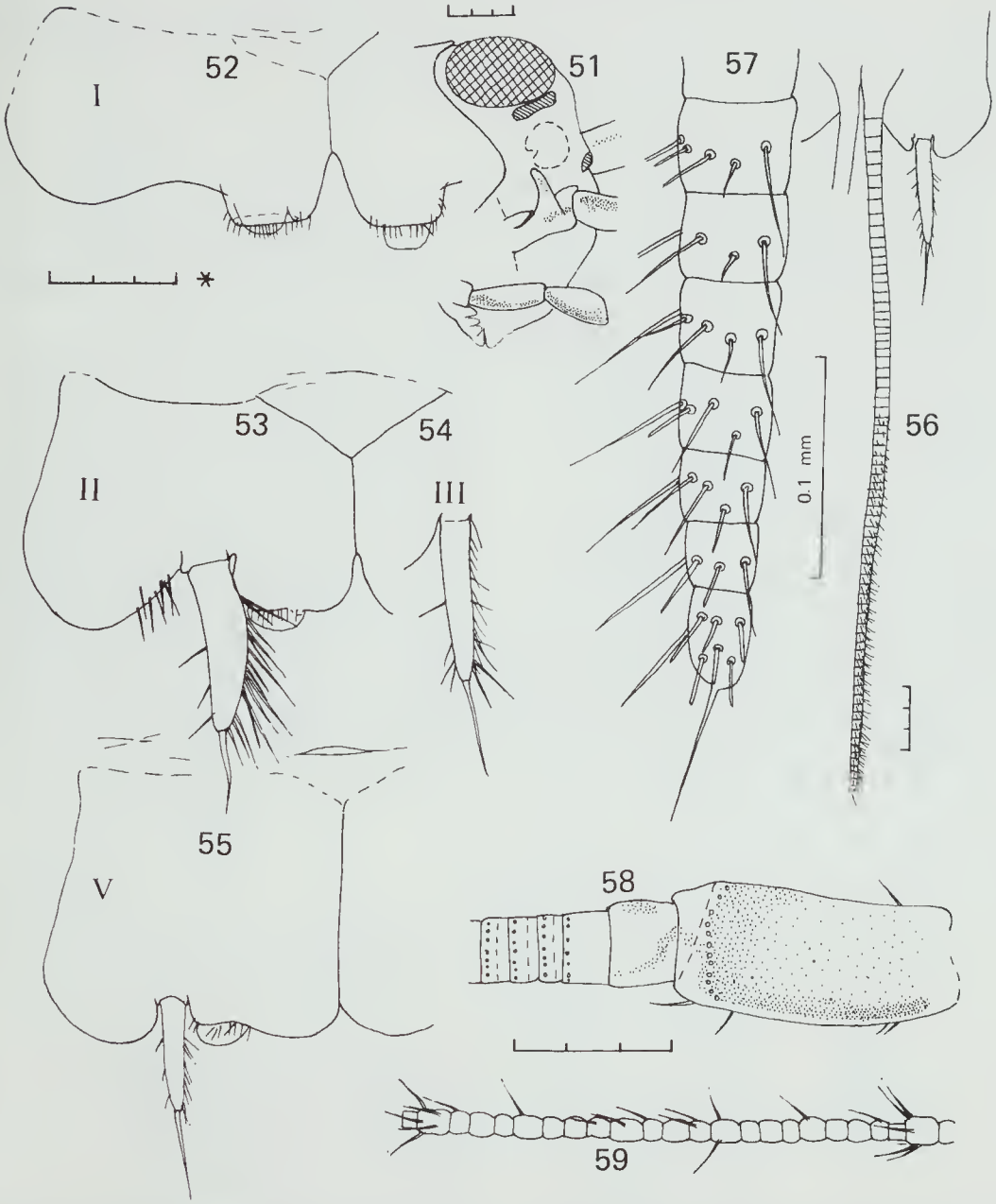
Antennae. Maximum observed length 10 mm; scape 2–2.5 times longer than broad. Pigmentation (fig. 58). Flagellum uniformly dark brown.

Maxillary palps. Dorsal process on segment 1 long and somewhat cylindrical, little longer than maximum diameter of segment. Hook on segment 2 of male typical for the subgenus, about as long as the diameter of segment 2 (fig. 41); segments 4–7 markedly thinner than those more proximal; segment 5 both in female and in male without special bristles. Ratio length of segments 7:6:5 = 1:1–1.05:1.2–1.25. Pigmentation (fig. 40).

Labium. Submentum laterally protruded; segment 3 of palpus in male and female only slightly protruded; inner borders of segment 2 and 3 with pigment stripe (figs 42, 43).



Figures 39–50. *Machilontus sumatranus* n. sp., males 7.8 and 8 mm, female 7.8 mm. (39) head, frontal view, male 8 mm; (40) maxillary palp, lateral view of inner side, male 8 mm; (41) maxillary palp, segment 2, with hook, lateral view, male 7.8 mm; (42, 43) labial palp, ventral view, male 8 mm and female 7.8 mm; (44, 45) leg I, male 8 mm: survey, tibia on higher magnification; (46) leg II, male 8 mm; (47) leg III, male 8 mm; (48) coxal stylet of leg III, male 7.8 mm; (49) urocoxite IX with penis, ventral view, male 8 mm; (50) penis, ventral view, male 8 mm. Scale = 0.3 mm.



Figures 51–59. *Machilontus sumatranus* n. sp., male 8 mm, female 7.8 mm. (51) head, lateral view, male; (52–55) urocoxites, ventral view, male, I, II, stylet III, V; (56, 57) gonapophysis VIII, ventral view: survey and terminal part; (58) antenna, basal portion, male; (59) antenna, flagellum c. 10 mm from the base, male. Scale = 0.3 mm.

Legs. Coxal stylets on pair III somewhat longer than maximum diameter of corresponding coxae and about 0.3 of coxal length. All segments of all pairs with pigment spots (figs 44, 46, 47). Tibia I with characteristic field of brownish bristles (fig. 45).

Urosternites. I–VII each with 1 pair of coxal vesicles, II–IX with stylets. Base of coxal vesicles I pro-

truded; sternite II relatively large; stylets II with conspicuous convex curvature of inner border, a small field of bristles lateral to stylet base. Coxites II, III, VIII and IX 1.3–1.8 times as long as the corresponding stylets, coxites IV–VII 1.9–2.5 times. Terminal spines II, III, VIII and IX 0.4–0.7 times as long as corresponding stylets, spines IV–VII 0.7–1.9 times as long (figs 52–55).

Penis. Reaching nearly half length of coxites IX, without specialised bristles, aperture forming median ventral fissure, sligthly longer than half aedeagus length (figs 49, 50).

Ovipositor. Of primary type, long and slender, surpassing stylets IX; gonapophyses VIII with long setae distally on more than half of length, gonapophyses IX on about 1/3; number of macrochaetae per segment on ovipositor VIII 4–5, on IX 3 (except for terminal segments) (figs 56, 57).

Caudal appendages. Broken, preserved parts without specialisation.

Remarks. The species can be separated from others by: legs with hypodermal pigment on all segments, characteristic pigment pattern on head and labial palps, field of specialised setae on tibiae I, lack of specialised setae on the ventral side of segment 5 of male maxillary palps, up to 5 macrochaetae on each of the distal segments of gonapophyses VIII. The specialised shape of urostylets II could not be compared with that of other species. The new species is perhaps related to *M. sutteri* although Wygodzinsky (1953) noted a lack of coxal vesicles VIII. This character needs to be verified.

Macropsontus secundus sp. nov.

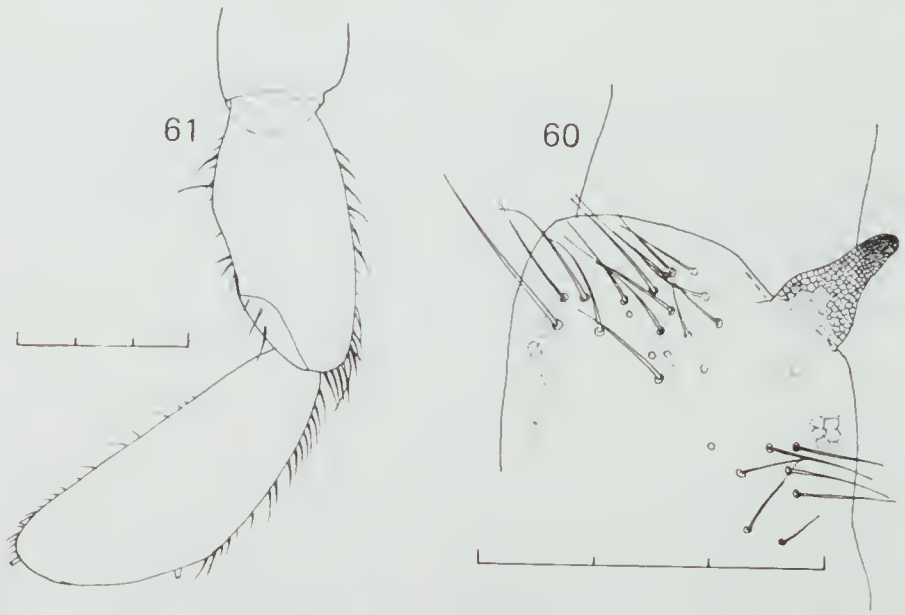
Figures 62–84

Material examined. Java, near Ujung Kulon Cidaon, 15 Sep 1984; ZMB: male 10.1 mm holotype; NMV: female 8.6 mm allotype (T-9624). Ujung Kulon-Gunung Payung, 300 m, beating, NMV: 1 female inadult.

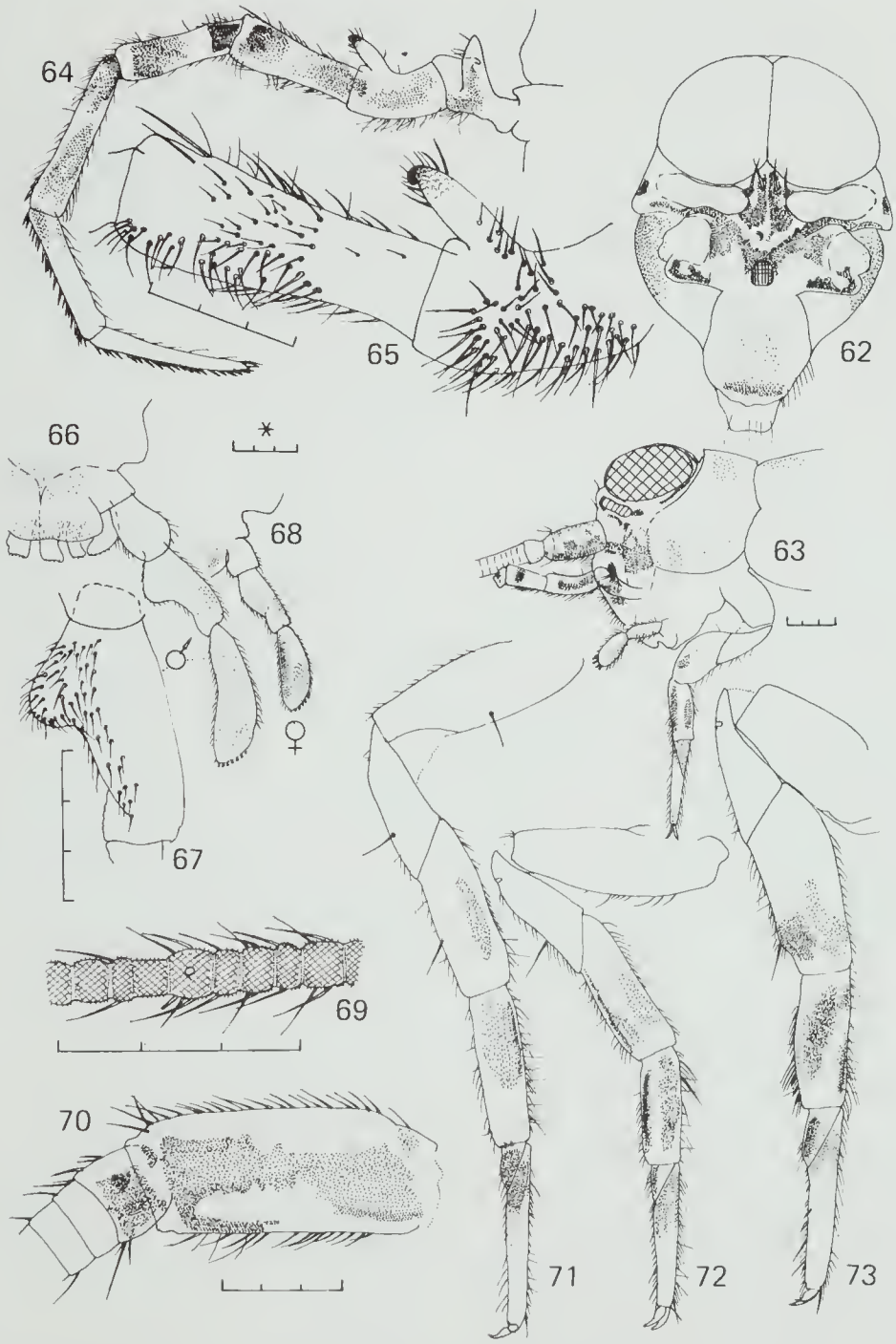
Description. Medium-sized animals (maximum observed body length 10.1 mm). Colour of eyes and scale pattern unknown. Head, head appendages, legs and stylets without scales. Hypodermal pigment on head, scape, mouthparts, legs and some tergites faintly to strongly developed.

Head. Eyes very large, width attaining more than 0.8 of head width; ratio length line of contact: eye length = 0.69–0.76, eye length: eye width = 1.08–1.2. Median part of frons sligthly protruding with some strong setae; lateral ocelli sole-shaped with slight constriction in median part; distance between inner borders smaller than half of ocellus length. Hypodermal pigment forming V-pattern above median ocellus and median spot between lateral ocelli (fig. 62).

Antennae. Maximal oberserved length 18 mm



Figures 60, 61. *Machilontus (Megalopsobius) convergens* Silvestri, 1912, male type. (60) maxillary palp, distal portion of segment 2 with hook, inner side; (61) labial palp, dorsal view. Scale = 0.3 mm.



Figures 62–73. *Macropsontus secundus* n. sp., male 10.1 mm. (62) head, frontal view; (63) head, lateral view; (64, 65) maxillary palp, lateral view, outside: survey segments 2 and 3; (66–68) labial palp, ventral view: survey male, segment 2 male, survey female; female 8.6 mm; (69, 70) antenna, distal portion of flagellum; basal portion; (71–73) legs I–III. Scale = 0.3 mm.

(male); scape 2.0–2.3 times as long as broad; proximal part of flagellum slightly annulated: segments dark brown, intermediate jointlets light brown; distal part uniformly dark brown. Pigment on scape and pedicel see fig. 70.

Mandible. With 4 teeth; pigment see fig. 62.

Maxillary palps. Horizontal process on base very short (apparently a generic character); dorsal process on segment 1 slightly triangular, little longer than distal diameter of segment. Distal-dorsal process on segment 2 of male with relatively long cylindrical base which turns distally to dark hook curved to median side (fig. 65). Specialised setae lacking in both sexes. Pigmentation see fig. 64. Ratio length of segments 7:6:5 = 1:0.85–0.93:1–1.1.

Labium. Sumentum with lateral protrusions. Segment 1 of palpus relatively long attaining more than half length of segment 2; inner border of segment 2 in male protruded, in female only slightly curved; segment 3 in both sexes slightly widened, distal sensorial field on male broader than that of female (figs 66–68).

Legs. All legs without coxal stylets; all tarsi with 2 segments; distal segment not subdivided (see remarks), relatively long and slender. Spots of hypodermal pigment on all tarsi, tibiae and femora; conspicuous fields of specialised setae missing; some short dark spine-like setae on the ventral sides of all tarsi combined with longer less pigmented transitional setae (figs 71–73).

Urosternites. I–VII each with 1 pair of coxal vesicles, vesicles small and those of each pair relatively far apart; II–IX with stylets; all sternites relatively small, sternite II largest, its width however not reaching more than one-third of breadth of corresponding coxites; median angle of all sternites greater than 90°; inner border of stylets II conspicuously convex, lateral to each base a small field of setae; coxites VIII of male protruding between stylet bases (fig. 78). Ratio length coxite: stylet length for IX 1.2–1.3, for II and III 1.5–1.6, for III–VII 1.7–2.1; ratio terminal spine length: stylet length for II and IX 0.25–0.35, for III–VIII 0.35–0.45 (figs 74–80).

Ovipositor. Of primary type, surpassing stylets IX, distal parts with long setae: on VIII half on IX c. 0.33–0.25 of total length; external setae per segment on the distal segments of VIII 4–5, of IX generally 3 (figs 81, 82).

Penis. Stout, only reaching half length of coxites IX; aperture a median ventral fissure which nearly reaches the length of aedeagus; setae near aperture somewhat shorter and broader (figs 83, 84).

Caudal appendages. Broken, without conspicuous characteristics.

Remarks. Macropsontus greeni Silvestri, 1911 from Sri Lanka was the only species of the genus previously known. Reexamination of the holotype (IEAP-Museum) proved that there are only two segments on all tarsi. In this point the description of the genus has to be revised. The new species differs from *M. greeni* in the proportions of the lateral ocelli, the longer cylindrical basis of the hook on segment 2 of male maxillary palps, the obviously protruded inner border of segment 2 of the male labial palps, and the pigmentation of maxillary palps, labial palps and legs (figs 85–93).

From the closely related genus *Machilontus* the genus can be separated by the lack of coxal stylets on legs III and the relatively long cylindrical base of the hook on segment 2 of the male maxillary palps. Its subgenus *Megalopsobius* is related to *Macropsontus* in the form of the hook-base on the maxillary palps of the male and the slight protrusion on segment 2 of the labial palps. *Macropsontus* is also related to *Hypomachiloides* in the tendency to protrusion on segment 2 of the labial palp, but *Hypomachiloides* has plesiomorphic tarsi with three segments.

Macropsontus sp.

Material examined. Java, Ujung Kulon, Gunung Payung (6°49'S, 105°16'E), 300 m, beating; 13 Sep 1984, NMV: female 5.4 mm (subadult). Ujung Kulon, Pulau Peucang (5°45'S, 105°15'E), beating, 11 Sep 1984, NMV: juvenile specimen, 3.4 mm (some characters correspond fairly well with those of the subadult female above). Ujung Kulon, Cidaon (6°46'S, 105°15'E), 22 Sep 1984, NMV: juvenile specimen, 3.1 mm, with scales (the colour patterns correspond fairly well with those of *M. secundus* from the same locality).

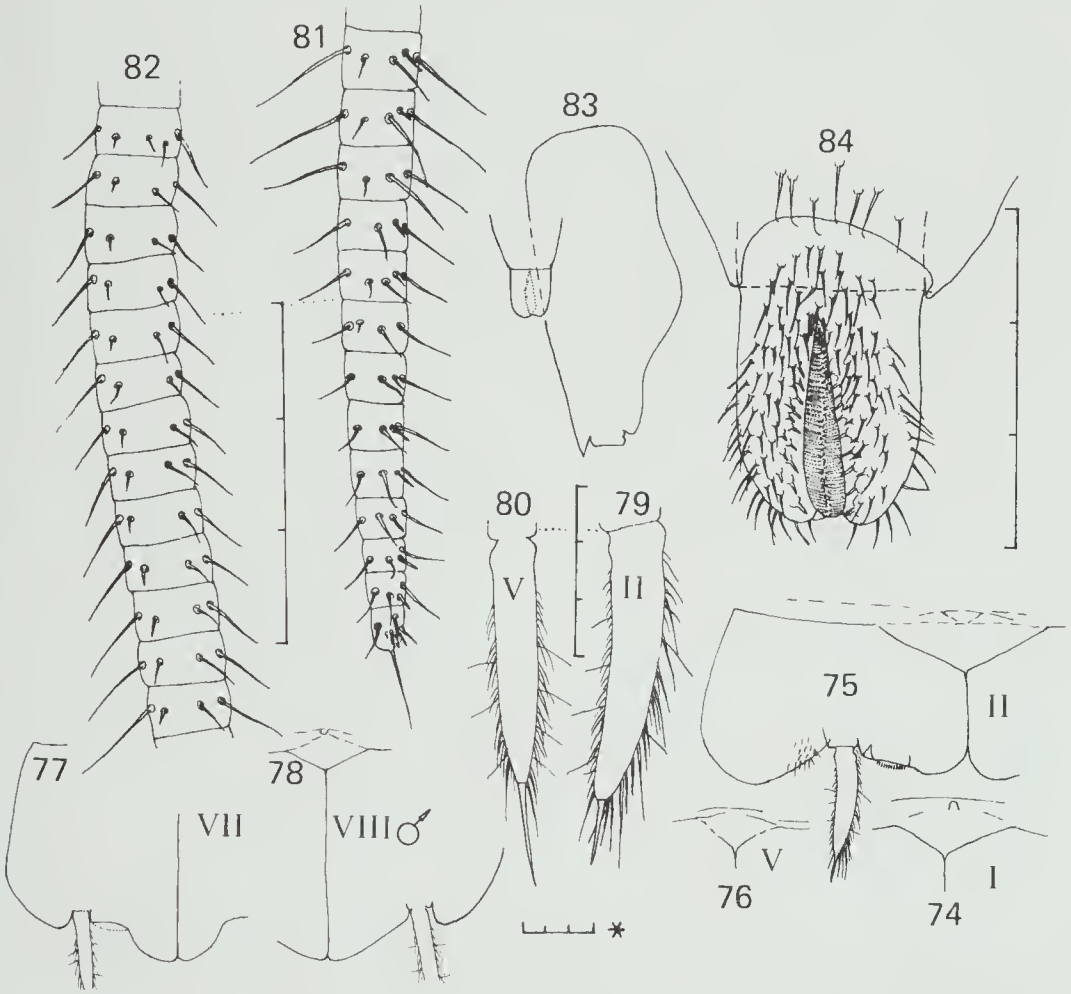
?**Allomeinertellus** sp.

Material examined. Krakatau Is., Rakata, Owl Bay (6°09'S, 105°28'E), 22 Sep 1984, NMV: juvenile specimen, 3.2 mm.

Remarks. Well developed scopulae on all tarsi. The barely protruded frons seems to indicate that it does not belong to the *Graphitarsus*-group. The only other genus with scopulae which was collected in this region and on the Krakataus is *Allomeinertellus*.

Discussion

The Machilidae, which have their centre of distribution in the northern hemisphere, reach Indonesia south of the equator with the genera *Graphitarsus* and *Hybographitarsus*. Its area of dis-



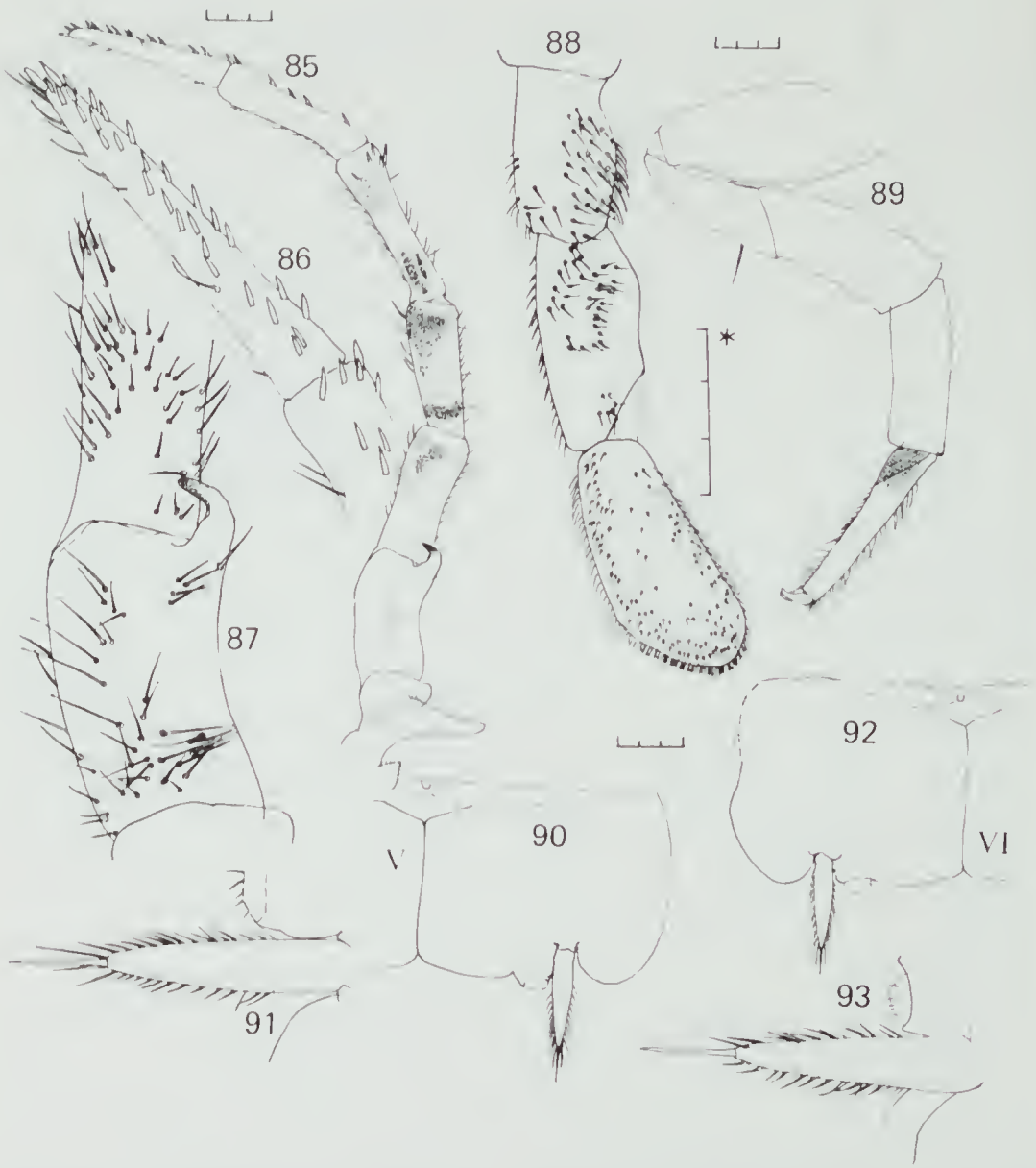
Figures 74–84. *Macropsontus secundus* n. sp., male 10.1 mm, female 8.6 mm. (74–77) urocoxites female I, II, V, VII; (78) urocoxite VIII; (79, 80) stylets II, V, female; (81, 82) gonapophysis VIII, dorsal view, in part: segments 1–13 and 22–34, counted from caudal; (83) urocoxite IX with penis; (84) penis ventral view. Scale = 0.3 mm.

tribution overlaps here with that of the second and more derived family of Machiloidea, the Meinertellidae. Both genera reach the eastern limit of their distribution apparently on Java (Wygodzinsky, 1953; Paclt, 1969). The only indication of their existence on the Krakataus is a juvenile specimen with scopulae collected on this Island but it is more probable that it belongs to *Allomeinertellus* already described from there.

The Meinertellidae have their centre of distribution, except for the genus *Machilinus,* in the southern hemisphere. In the region of Farther India, Indonesia and Australia it has developed a centre of generic diversity with seven genera out of a total of 14 (Sturm, 1984). Of these seven genera, four had been previously recorded from Java, the Krakataus and Sumatra, the fifth was collected by the Krakatau expedition in 1984.

In view of the small number of specimens per genus in this region the chances of collecting new genera and species are high. For the same reasons definition of distribution does not seem advisable now.

Until now only two precisely identified genera of Archaeognatha, each with one species, have been collected on the Krakataus. One genus is known only from the Krakataus (*Allomeinertellus*). It must also exist elsewhere. The second genus and species,



Figures 85–93. *Macropsontus greeni* Silvestri, 1911, male type. (85–87) maxillary palp, inner side: survey, segment 7, segment 2 with hook; (88) labial palp, dorsal view; (89) leg III (?); (90) urocoxite V, part; (91) stylet V; (92) urocoxite VI; (93) stylet VI. Scale = 0.3 mm.

(*Machilellus orientalis*) has also been taken at Samarang, Java (Silvestri, 1911).

Distribution of Archaeognatha is improbable by propagation through the air, by winds or hurricanes, because of their sensitivity (especially of young animals) to mechanical stress, their lack of wings, their size (body length of adults 6–15 mm), and the almost total absence of hurricanes in the Krakatau region. Transport on larger animals or directly by man is improbable because all members of the group react to any irritation by springing.

Dispersal of Archaeognatha through the ballast

of ships in historical times is probable for two species which deposit eggs on rocks, namely *Trigoniophthalmus alternatus* and *Petrobius brevistylis* (Wygodzinsky and Schmidt, 1980). For the Krakataus transport of eggs on rocks or wood by man's agency does not seem probable in spite of the fact that there has been some human contact with the Krakataus.

In this case the most probable way of dispersal is over water. On fresh water, adult Machilidae can survive several days (Sturm, 1984). Unfortunately experiments on sea water were not made. The eggs probably have a higher resistance to water. Larink (1972) stated that the egg blastoderm of two species of *Petrobius* is virtually impermeable even for fixing fluids. If one adds to this observation that many tropical species of Machiloidea probably lay their eggs on bark, wood and other vegetable matter and that the eggs of all species examined in this regard have a very long period of inner egg development, some more than 400 days (Larink, 1979), dispersal of eggs by drift-material on rivers and then by oceanic currents is perhaps the most probable way.

Moreover the purely volcanic Hawaiian islands possess a strongly specialised fauna of Machiloidea (Silvestri, 1904) which indicates a long period of isolated adaptation. Given the degree of specialisation, this must have begun much earlier than the arrival of man on the islands.

Acknowledgements

We wish to express our gratitude to Prof. I.W.B. Thornton and Mr P. Vaughan (both from La Trobe University) who made it possible for us to examine this interesting material, and to Prof. E. Tremblay who placed at our disposal the type material of *Machilontus (Megalopsobius) convergens* Silvestri, 1912 and *Machilellus orientalis* Silvestri, 1911. Mr P. Vaughan and Dr G.C.B. Poore were so kind as to revise the English version of the manuscript.

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