Malaysian Journal of Science **16A**: 87-105 (1995)

Six new weaver ant species from Malaysia : *Camponotus (Karavaievia) striatipes, C. (K.) melanus, C. (K.) nigripes, C. (K.) belumensis, C. (K.) gentingensis,* and *C. (K.) micragyne*

K. Dumpert[1], U. Maschwitz[1], A. Weissflog[1], K. Rościszewski[1] and I. Hj. Azarae[2]
[1] Fachbereich Biologie, Zoologisches Institut der Universität, 60054 Frankfurt am Main, Germany
[2] Department of Zoology, University of Malaya, 59100 Kuala Lumpur, Malaysia

ABSTRACT Six silk nest weaving ant species from Malaysia are described as members of the *Camponotus* subgenus *Karavaievia* Emery 1925: *Camponotus (Karavaievia) striatipes* sp. n., *C. (K.) melanus* sp. n., *C. (K.) nigripes* sp. n., *C. (K.) belumensis*, sp. n., *C. (K.) gentingensis* sp. n. and *C. (K.) micragyne* sp. n.. In addition, males from *Camponotus (K.) gombaki* Dumpert 1985 and *C. (K.) asli* Dumpert 1989 are described. Subsequently, the subgenus now consists of thirteen species which are most likely all weaver ants. The new *Karavaievia* species are compared with the already described ones, both with respect to morphological and behavioural characteristics. A key to all hitherto described species of the subgenus *Karavaievia* is added.

ABSTRAK Enam spesies semut Penenun sarangsutera dari Malaysia telah dikenalpasti sebagai ahli dalam genus *Camponotus* dan subgenus *Karavaievia* Emery 1925: *Camponotus (Karavaievia) striatipes* sp.n., *C. (K.) melanus* sp.n., *C. (K.) nigripes* sp. n., *C. (K.) belumensis*, sp. n., *C. (K.) gentingensis* sp. n. dan *C. (K.) micragyne* sp. n.. Serangga jantan dari spesies *Camponotus (K.) gombaki* Dumpert 1985 dan *C. (K.) asli* Dumpert 1989 turut juga dihuraikan. Justeru itu subgenus tersebut buat masa kini mempunyai tiga belas spesies yang mana kesemuanya kemungkinan besar adalah dari golongan semut penenun. Spesies baru *Karavaievia* ini telah dibandingkan dari segi ciri-ciri morfologi dan kelakuan dengan spesies-spesies terdahulu yang telah dihuraikan sebelum ini. Satu kekunci untuk menghuraikan spesies-spesies dari subgenus *Karavaievia* yang terdapat sehingga kini juga diberikan.

(*Camponotus*, subgenus *Karavaievia* Emery 1925, *Camponotus (Karavaievia) striatipes* sp. n., *C. (K.) melanus* sp. n., *C. (K.) nigripes* sp. n., *C. (K.) belumensis*, sp. n., *C. (K.) gentingensis* sp. n. and *C. (K.) micragyne* sp. n..)

INTRODUCTION

One of the most fascinating phenomena in ant social biology is silk nest weaving. Mature larvae of many ants spin a pupal cocoon with silk from their labial gland. In weaver ants, however, this silk is also used for nest construction. Like weaver's shuttles worker ants take large larvae with their mandibles and use the silk excreted by them for spinning together leaves or to form flexible and firm carton nest walls out of particles with help of the fresh sticky silk. Natural preformed nesting sites are rather limited in the canopy region of the forest. By constructing free-hanging nests in this habitat, the weaver ants get access to the leaf and crown region in this way. Until recently four independent groups of weaver ants were known, two from the Old World tropics, e.g. the famous genus *Oecophylla*, the kerengga ants, and two from the New World tropics, e.g. two species of the *Camponotus* subgenus *Myrmobrachys* [1,2]. All of them belong to the subfamily Formicinae.

In 1984 we discovered in Peninsular Malaysia near the Ulu Gombak Field Studies Centre of the University of Malaya an Old World silk weaving *Camponotus* species, *C. texens*. It produces silk carton nests mainly beneath leaves of trees, which contain brood as well as trophobiotic Homoptera symbionts. This species turned out to belong to the subgenus *Karavaievia* from which two species and one subspecies were described from Singapore and Borneo [3-5]. Since then we discovered eleven further species, of which six had been described [6]. Six will be described in this paper. All of them are weaver ants which produce silk carton nests. As *C. (K.) dolichoderoides overbecki* discovered by Viehmeyer (1915) was also found in carton pavilions we can suppose that the whole subgenus is silk weaving. The majority of the species were found on Peninsular Malaysia possibly due to more thorough collection. Most of the species were found in primary forests, two in the Pasoh Forest Reserve and three in Belum during the Expedition of the Malaysian Nature Society in 1994. In some cases, only one colony or a few pavilions could be found. We do not know whether *Karavaievia* species are very rare or are only seldom found because of their canopy dwelling life habits. Certainly more species will be discovered in the future. The numerous new species demonstrate the extreme high biodiversity of

the Malaysian rainforests and also indicate our scanty knowledge of this richness.

During March 1992 three silk nest weaving species of *Camponotus* were collected by K. Rościszewski in the Pasoh Forest Reserve, a lowland rain forest in Negeri Sembilan, Peninsular Malaysia. Two of them turned out to be new species of the subgenus *Karavaievia*. They are described as *Camponotus (Karavaievia) striatipes* and *C. (K.) melanus*. The third one was a colony of the already described *C. (K.) asli* Dumpert 1989, including males. Since the identification of this species could only be based on the worker ants and the females, the identification of the males could now be made because of the new finding of this species. About two months later (May 1992) *Camponotus (Karavaievia) striatipes* was found by A. Floren in the Kinabalu area (Borneo, Sabah) at an elevation of about 650 m. This finding brought us a dealate queen which has not been found by K. Rościszewski. *Camponotus (Karavaievia) melanus* has already been found in Borneo about a month before by A. Buschinger. In contrast to the finding of Rościszewski which contained workers and males, the finding of Buschinger contained 6 alate females in addition. Also in February 1992 a colony of a silk nest weaving *Camponotus* was found by U. Maschwitz in a rain forest in the Gombak Valley near the Ulu Gombak Field Studies Centre of the University of Malaya, about 25 km north of Kuala Lumpur which also turned out to be an undescribed species of the subgenus *Karavaievia*. In the following it is given the name *Camponotus (K.) gentingensis*. Finally A. Weissflog collected in Belum (region in the northern part of Peninsular Malaysia) three new *Karavaievia* species during the Belum expedition of the Malaysian Nature Society. They were given the names *C. (K.) belumensis, C. (K.) nigripes* and *C. (K.) micragyne*.

TAXONOMY

(K. Dumpert)

MATERIALS AND METHODS

In February 1992 A. Buschinger found in a disturbed forest at Lambir near Miri, Sarawak, a silk pavilion containing workers, males and some females of a hitherto undescribed *Camponotus (Karavaievia)* species on a branch fallen to the ground. Four females were taken for the description under the name *C. (K.) melanus*. Another finding of this new species ar another undescribed *Karavaievia* species (*C. (K striatipes* sp. n.) were found by K. Rościszewski in lowland rain forest in Negeri Sembilan in the Pasc Forest Reserve in March 1992. Seventeen worke and eight males of *C. (K.) striatipes* and ninete workers and four males of *C. (K.) melanus*, respe tively, were used for the descriptions. For the descri tion of the *striatipes* females the only female w used; this was found by A. Floren in the Kinabalu r gion (Borneo/Sabah) on *Aporusa subcaudata* at height of about 6 m from the ground. A colony wi males of *C. (K.) gombaki* and a colony of *C. (K gentingensis* were found by U. Maschwitz near t Ulu Gombak Field Studies Centre of the University Malaya about 25 km north of Kuala Lumpur. O male of *C. (K.) gombaki* and eighteen workers, sev males and five females of *C. (K.) gentingensis* we used for the descriptions. *C. (K.) belumensis, C. (K nigripes*, and *C. (K.) micragyne* were found by Weissflog in a primary rain forest in northern Pen sular Malaysia, called Belum. Belum is a region northern Perak, bounded by the Thailand and t Perak-Kelantan border. The area has been propos as a national park by the Department of Wildlife a National Parks in 1988. Fourteen workers and c dealate female were used for the description of *(K.) belumensis*. No males of this species were det ted. One completely censused colony of *C. (K.) be mensis* contained 323 workers, 282 pupae, 39 lar and one dealate queen. The colony extended over pavilions with a max. length of 10.5 cm and a m width of 2 cm. Normally situated at the midrib o one pavilion was constructed between 2 leaves. *(K.) nigripes* was found in no more than four pa lions 3 m above ground. These pavilions contai only workers but no queen or other females and males; twenty-two workers were used for the d cription. No more than three pavilions contained specimens from *C. (K.) micragyne* including two al females and two males. One of the females and ma was used for the description, the other for the sc ning electron micrographs.

The examination of the investigated specim was made with the aid of a binocular. The measu ments of the animals were made using a microsc at a magnification of 65 x. Scanning electron mic graphs were taken by means of a Hitachi S 5

Thanks are due to M. Ruppel, Frankfurt.

DESCRIPTIONS

Camponotus striatipes sp. n.

Derivatio nominis: The name is derived from a typical brown stripe on the worker legs of this species.

Diagnosis: *C. striatipes* is the most slender of all *Karavaievia* species. In contrast to *C. texens*, *C. gombaki*, *C. asli*, *C. orinus* [6] and *C. melanus* (present paper) the length of the heads of ☿☿ and ♂♂ is not equal to its width but greater. Compared with these *Karavaievia* species the differences for HW, CI, and PW are highly significant ($P < 0.01$) in the worker caste. Scapus of the ☿☿ is as long as in *C. orinus* but significantly longer than in *C. texens*, *C. gombaki*, and *C. asli*. The cuticle of *C. striatipes*-☿☿ is much more shining than in all other *Karavaievia* species because of the lack of decumbent pubescence and the weak cuticular sculpture. Also the cuticle of the *C. striatipes*-♂♂ is especially shining because of their weak cuticular sculpture. Compared with *C. texens*, *C. gombaki*, *C. asli*, and *C. orinus*, *striatipes* has the smallest males.

A. Holotype ☿: TL 5.2, HL 1.3, HW 1.16, CI 89.7, SL 1.75, SI 66.6, PW 0.69, OD 0.36.

Head trapezoidal, with strongly rounded occipital corners; occipital margin and head sides convex (Fig. 1*a*). Head longer than wide (CI 89.7). Eyes are situated behind the midlength of the sides of the head; their maximum diameter is 0.36 mm, or about 0.3 HW. Apart from a slight projection behind the scapal insertion, frontal carinae are straight, slightly divergent, and extended to about midlength of head. Anterior clypeal margin with a slight excision in the middle (Fig. 1*a*). Mandibles short, with lateral borders strongly curved and five subequal teeth on each masticatory border. Antennal scapes projecting beyond the occipital margin by about one third of their length. Pedicel longer than the following flagellar segments; apical flagellar segments slightly thickened.

Head and alitrunk uniformly reddish brown, gaster blackish dark brown. Front part of head, antennal flagellum, and legs slightly lighter brown than the rest of head and alitrunk. Tibiae of all six legs nearly white with a broad crosswise stripe in the middle. Surface of head, alitrunk, and gaster conspicuous shining due to only very weak reticulated structure (Fig. 1*a*). Decumbent pubescens is lacking. Longer erect and suberect yellowish white hair especially on clypeus, but also on rest of head, alitrunk and gaster.

Alitrunk - as in all other *Karavaievia* species - with a deep impression between promesonotum and propodeum, and two raised stigmata at the deepest point of the impression. Promesonotum, seen in profile, broadly rounded and higher than propodeum. Propodeal profile considerably flattened on top.

Paratype ☿☿: TL 5.3 ± 0.3 (standard deviation), HL 1.26 ± 0.07, HW 1.14 ± 0.06, CI 90.4 ± 2.4, SL 1.68 ± 0.06, SI 68.6 ± 2.6, PW 0.69 ± 0.05, OD 0.36 ± 0.015 or 0.29 ± 0.31 HW (16 measured).

Holotype: Peninsular Malaysia, Negeri Sembilan, Pasoh Forest Reserve, March/28/1992 K. Rościszewski leg. (Naturhistorisches Museum, Basel).

Paratypes: 15 ☿☿ with same data as holotype (2 in Museum of Comparative Zoology at Harvard University; 2 in collection of the Forest Research Institute of Malaysia (FRIM) in Kepong; 2 in Museo Civico di Storia Naturale, Genova; 3 in collection of Staatliches Museum für Naturkunde Karlsruhe; 6 in collection of the author).

Explanation of the abbreviations used:

TL : total length. The total outstretched length of the individual from the mandibular apex to the gastral apex.
HL : head length. The straight-line distance between the anterior clypeal margin and the mid-point of the occipital margin in full-face view.
HW : head width. The maximum width of the head excluding the eyes.
CI : cephalic index = (HW x 100)/HL
SL : scapus length. The straight-line length of the antennal scape excluding the radicle.
SI : scapus index = (HW x 100)/SL
PW : pronotal width. The maximum width of the pronotum in dorsal view.
OD : ocular diameter. The maximum width of the eyes.
All measurements are expressed in millimetres and conducted as in [6].

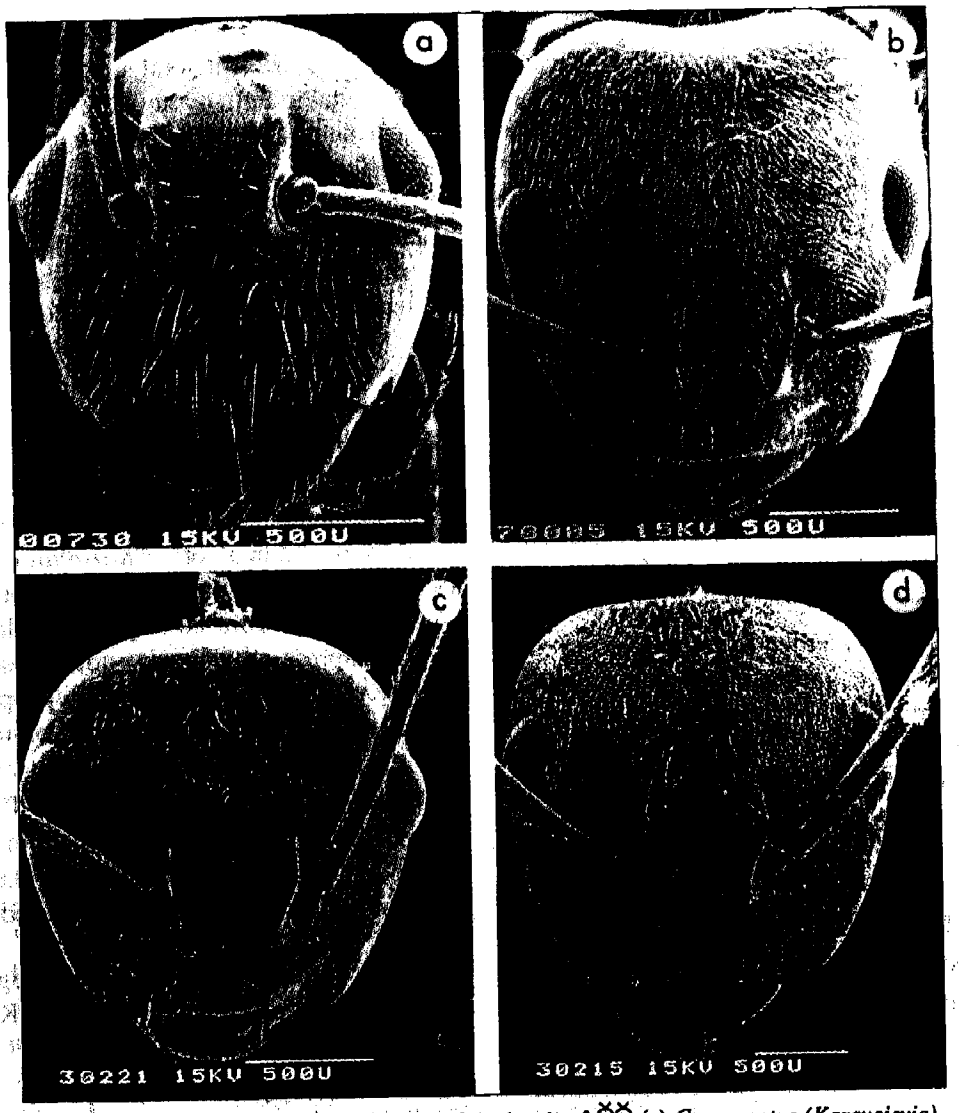

Figure 1. Scanning electron micrographs of the heads of ♀♀ (a) *Camponotus (Karavaievia) striatipes* (b) *C. (K.) melanus* (c) *C. (K.) belumensis* (d) *C. (K.) gentingensis.*

B. Allotype ♂ : TL 4.1; HL 0.83; HW 0.76; CI 91.4; SL 0.98; SI 78; PW 1.0; OD 0.38.

The trapezoidal head longer than wide (CI 91.4), with prominent convex eyes, extending to the upper end of the head sides. Occipital margin strongly convex with protruding ocelli. Clypeus narrow, width about 0.17 mm; anterior margin of the clypeus slightly protruding with straight anterior margin. Short frontal carinae nearly straight, reaching back to mid-length of head. Eyes relatively large; maximum diameter 0.38 mm, or about 0.5 HW. Scapes long, projecting beyond occipital margin of the head by more than half their length. Pedicel expanded at its distal end and thicker than following flagellar segments.

Head, alitrunk, and gaster shining, with numerous small punctures seen under the binocular and a weak imbricated structure, revealed by the electron microscope (Fig. 2*a*). Head and alitrunk reddish brown, gaster dark brown; front part of head, anterior part of head, scapes, pedicells and legs lighter. Antennal flagellum - except pedicel - dark brown. Wings are nearly white with brown veins. Decumbent pubescence nearly missing, longer decumbent or erect hairs on the whole body but not dense. Propodeal profile nearly plane with very weak convex dorsal and weakly concave descending part. Petiolar scale triangular in profile, with a broad base tapering to a ridge. Ridge with a very slight median excision.

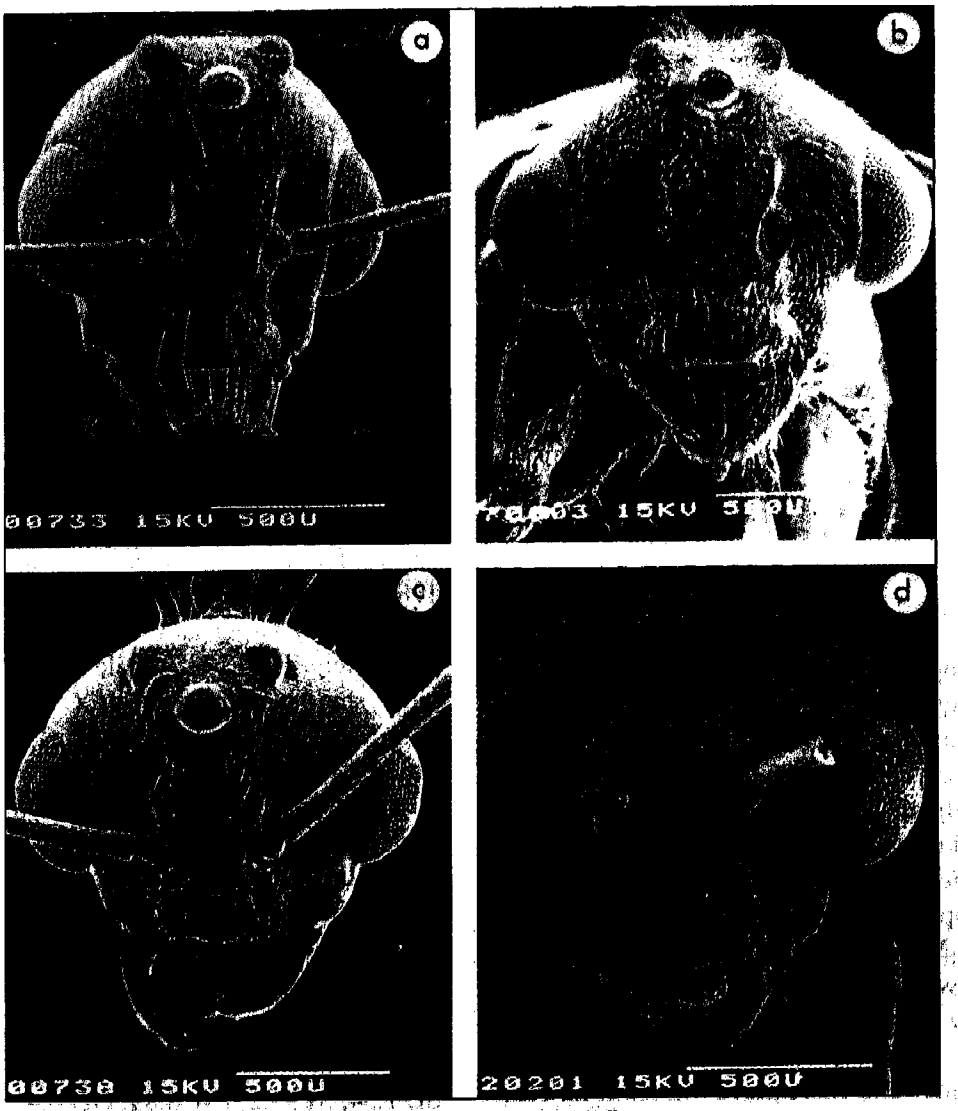

Figure 2. Scanning electron micrographs of the heads of ♂♂ (a) *Camponotus (Karavaievia) striatipes*, (b) *C. (K.) melanus*, (c) *C. (K.) gentingensis*, (d) *C. (K.) gombaki*.

Paratype ♂♂ : TL 4.1 ± 0.1 (standard deviation); HL 0.80 ± 0.03; HW 0.74 ± 0.025; CI 91.6 ± 2.4; SL 0.94 ± 0.04; SI 78.8 ± 2.3; PW 0.94 ± 0.04; OD 0.37 ± 0.01 (8 measured)

Allotype ♂, Peninsular Malaysia, Negeri Sembilan, Pasoh Forest Reserve, March/28/1992, K. Rościszewski leg. (Naturhistorisches Museum, Basel).

Paratypes: 7 ♂♂ with the same data as holotype (2 in Museum of Comparative Zoology at Harvard University; 2 in collection of the Forest Research Institute of Malaysia (FRIM) in Kepong; 1 in the collection of Staatliches Museum für Naturkunde Karlsruhe; 2 in the collection of the author).

C. Gynetype ♀: TL 8.1; HL 1.5; HW 1.48; CI 98; SL 2.08; SI 71.08; PW 1.15; OD 0.65; dealate, active queen of the colony

Head nearly as wide as long (CI 98); sides of the head convex, occiptal corners rounded, occiptal margin - in contrast to all other known *Karavaievia* females - strongly convex (Fig. 3). Eyes are situated behind the midlength of the sides of the head and relatively large compared with other *Karavaievia* females (0.44 x HW as against 0.27 - 0.32; [6]). Frontal carinae extend

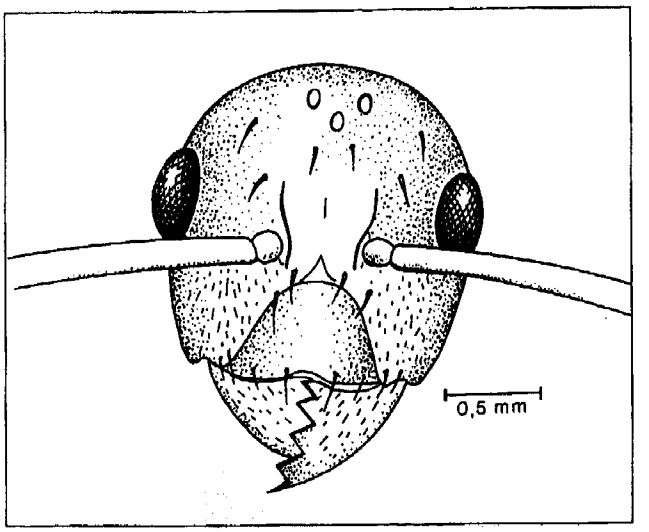

Figure 3. Head of *Camponotus (Karavaievia) striatipes* ♀.

to about midlength of the head. Apart from a lateral projection beyond the scapal insertion, they are almost straight and only slightly divergent. Clypeus similar in shape than that of the workers with the exception that its anterior margin shows a slight median semicircular excision. In contrast to all other known *Karavaievia* females this is by far the slightest median clypeal excision and shows no indented edges (Fig. 3). Mandibles strong, distinctly rounded on outside and with 5 subequal teeth on inside. Frontal area weakly delimited and as much shining as surroundings.

Alitrunk slender and more narrow than in all other known *Karavaievia* females (PW 1.15 as against 1.68 - 2.26). Petiole with a broad base, tapering toward the apex into a narrow ridge, seen from the side.

Body in most of its parts uniformly reddish brown, gaster black, antennal flagellum yellowish, legs with three whitish rings, two on the tibiae and one on trochanter and the upper most part of the femur. The body as a whole shining, gaster not as much as the rest of the body. Decumbent pubescence scarcely on the mandibles and the front parts of the head, longer erect and suberect hairs on the whole body including scapes, legs, and gaster.

Gynetype ♀: Borneo/Sabah: Poring Hot Springs on *Aporusa subcaudata*, Lower Montane > 650 m, mixed dipterocarp forest, May/9/1992, A. Floren leg. (Naturhistorisches Museum, Basel)

Camponotus melanus sp. n.

Derivatio nominis: The name is derived fr colour of the females and some of the work which are especially dark.

Diagnosis: *Camponotus melanus* is the darkes *Karavaievia* species except *C. orinus* which is ficantly larger and much more sculptured t *melanus*. The colour of the *melanus*-workers from a uniformly dark brown (specimens from sular Malaysia) to others with reddish brow and alitrunk and dark brown gaster (*melanus*-v from Borneo). With respect to sexuals there a other *Karavaievia* species with uniforml brown females: *C. orinus* (*C. montanus* D 1989) and *C. texens*. The females of *C. ori* significantly larger and - in contrast to *C. me* completely dull. The females of *C. texens* ar more shining than those of *C. melanus*. Co with *C. asli* the worker ants of *C. melanus* are The differences of TL, HL, and HW are higl nificant ($P < 0.01$). Compared with *C. gomb* occipital margin of the *melanus*-workers is contrasting to a conspicuous concave occipit gin in the workers of *C. gombaki*. In additi colour and the cuticular surface are quite d in both species.

A. Holotype ♀: TL 5.5, HL 1.41, HW 1.54, C SL 1.54, SI 99.2, PW 0.89, OD 0.4.

Head nearly as long as broad (CI 108.4 sides convex, occipital corners strongly roun cipital margin concave (Fig. 1*b*). Frontal cari ghtly sinuate, reaching back to midlength of t with maximum diameter of 0.45 mm or abo HW. Anterior clypeal margin almost straigh a slight broad protrusion. Eyes are situated the midlength of the sides of the head; thei mum diameter is 0.4 mm or about 0.25 HW. bles short, with lateral borders strongly cur five subequal teeth on each masticatory bor tennal scapes projecting beyond the occipital by about one third of their length. Pedicel lon the following flagellar segments; apical f segments slightly thickened.

Alitrunk with a deep impression betwe mesonotum and propodeum, and two raised

at the deepest point of the impression. Promesonotum, seen in profile, strongly rounded and higher than the likewise rounded propodeum. Petiole with a broad base, tapering toward the apex into a narrow ridge, seen from the side. Seen from behind, the ridge is getting rather narrow on top.

Colour uniformly dark brown; head - except the yellow brown mandibles, clypeus, part of the cheeks adjacent to the clypeus, and antennal flagellum - blackish brown as well as meso-, meta-, and epinotum. Tibiae and tarsi yellow brown. Specimens from Borneo - found by A. Buschinger - are lighter in colour. They are uniformly reddish to dark brown; head - except the yellow brown mandibles, clypeus, cheeks, and antennal flagellum - mesonotum and especially epinotum are dark to blackish brown. Surface of head, alitrunk, and gaster shining with densely located weak punctures, which are caused by a reticulated structure (Fig. 1*b*). Yellowish white decumbent pubescence is dense on the whole body, including scapes and legs. Longer erect and suberect yellowish white hair especially on clypeus, but also on rest of head, alitrunk, and gaster.

Paratype ☿☿ : TL 5.6 ± 0.1 (standard deviation); HL 1.33 ± 0.4; HW 1.39 ± 0.08; CI 104.3 ± 2; SL 1.50 ± 0.04; SI 95.7 ± 4.3; PW 0.87 ± 0.04; OD 0.37 ± 0.01 (20 measured).

Holotype ☿, Peninsular Malaysia: Negeri Sembilan, Pasoh Forest Reserve, March/13/1992, K. Rościszewski leg. (Naturhistorisches Museum, Basel).

Paratypes: 20 ☿☿ with the same data as holotype (2 in Museum of Comparative Zoology at Harvard University; 2 in collection of the Forest Research Institute of Malaysia (FRIM) in Kepong; 2 in Museo Civico di Storia Naturale, Genova; 3 in collection of Staatliches Museum für Naturkunde Karlsruhe; 11 in collection of the author).

B. Gynetype ♀: TL 9.1 mm; HL 2.45; HW 2.33; CI 95.15; SL 2.18; SI 106.52; PW 1.76; OD 0.65; alate female.

Head nearly as long as wide (CI 95); sides of the head convex, occipital corners rounded, occipital margin slightly convex. Eyes are situated behind the midlength of the sides of the head and relatively larger than those of *gentingensis*- ♀♀ (0.28 as against 0.26 x HW). Frontal carinae extend about to midlength of head. Apart from a lateral projection behind the scapal insertion, they are almost straight and slightly divergent. Anterior clypeal margin - as in all known *Karavaievia*- ♀♀ - with semicircular excision (Fig. 3). Frontal area - as in *C. gombaki* and *C. orinus* (*montanus* Dumpert 1989) - clearly delimited and slightly more shining than the surrounding head parts. Mandibles strong, distinctly rounded on outside, and with 5 subequal teeth on inside.

Body uniformly dark brown, except the yellow brown clypeus, the adjacent parts of the cheeks, the distal antennal flagella, the coxae, trochanter, and basal parts of the tibiae. Head, alitrunk, and gaster are weakly shining and covered with weak, but dense punctures, seen under the binocular. The scanning electron micrographs reveal a reticulated structure of the cuticle. Yellowish white decumbent pubescence densely covers the whole body. Erect and suberect longer hairs occur mainly on forehead and vertex, less dense on alitrunk and gaster. Wings whitish, veins yellow brown. Petiolar profile with broad base, tapering to a transverse ridge; petiolar ridge nearly straight without median excision.

Paratype ♀♀ : TL 9.1 ± 0.2 (standard deviation); HL 2.37 ± 0.05; HW 2.31 ± 0.02; CI 97.41 ± 2.4; SL 2.09 ± 0.09; SI 110.66 ± 2.2; PW 1.77 ± 0.03; OD 0.67 ± 0.013 (3 measured).

Gynetype ♀, Borneo, Sarawak, Lambir, February/28/1992, A. Buschinger leg. (Naturhistorisches Museum, Basel).

Paratypes: 3 ♀♀ with the same data as gynetype (1 Museum of Comparative Zoology at Harvard University; 1 in collection of the Forest Research Institute of Malaysia (FRIM) in Kepong; 1 in collection of the author).

C. Allotype ♂ : TL 4.9, HL 0.81, HW 074, CI 91.2, SL 0.9, SI 79.5, PW 0.95, OD 0.36.

The trapezoidal head nearly as wide as long (CI 91.2), with prominent eyes, extending to the upper end of the head sides. Occipital margin strongly convex with protruding ocelli. Anterior clypeal margin almost straight, but in the middle third weakly con-

cave, with slightly indented edges (Fig. 2*b*). Short frontal carinae sinuate, reaching back to midlength of head. Eyes very large; maximum diameter 0.36 mm, or nearly 0.5 HW. Scapes long, projecting beyond occipital margin of the head by more than half their length. Pedicel strongly expanded at its distal end and thicker than following flagellar segments.

Head and alitrunk reddish brown, gaster dark brown and weakly shining. Under the binocular the cuticle shows dense punctures which depend on a reticulated structure, revealed by scanning electron micrographs (Fig. 2*b*). Wings slightly brownish with yellow brown veins. Decumbent pubescence on head and alitrunk, denser on gaster; in addition, body provided with longer, erect hairs. Petiolar scale triangular in profile, with a broad base tapering to a ridge; ridge straight, showing no excision.

Paratype ♂♂ : TL 4.9 ± 5.8; HL 0.81 ± 0.92; HW 0.74 ± 0.90; CI 91.2 ± 102.78; SL 0.9 ± 1.05; SI 79.5 ± 88.1; PW 0.95 ± 1.12; OD 0.36 (0.48 (3 measured).

Allotype ♂, Peninsular Malaysia, Negeri Sembilan, Pasoh Forest Reserve, March/13/1992, K. Rościszewski leg. (Naturhistorisches Museum, Basel).

Paratypes: 3 ♂♂ with the same data as allotype (1 in Museum of Comparative Zoology at Harvard University, 1 in Forest Research Institute of Malaysia (FRIM) in Kepong; 1 in collection of the author).

Camponotus gentingensis sp. n.

Derivatio nominis: The name is derived from the fact that the first and hitherto only colony of this species was found near a street going to Genting Highlands.

Diagnosis: *Camponotus gentingensis* is one of the lightest *Karavaievia* species, together with *C. asli*, *C. belumensis*, and *C. micragyne*. The worker ants of these species are predominantly yellowish brown. Typical for *C. gentingensis* is the distinctly lighter colour of the alitrunk compared with head and gaster. Different between *C. asli* and *C. gentingensis* is the significant larger and wider head of the worker ants. Corresponding differences are valid for the PW-values. In contrast to *C. belumensis* and *C. asli*, the *C. gentingensis*-workers are not at all shining. The same holds for the females of these species which are shining in the case of *C. asli* and *C. belu* and opaque in the case of *C. gentingensis*.

A. Holotype ☿: TL 5.9, HL 1.64, HW 1.68, CI 1 1.8, SI 92, PW 1.0, OD 0.42.

Head trapezoidal with rounded occipital c occipital margin straight or slightly concave sides convex (Fig. 1*d*). Length of head r nearly HW (CI 102). Eyes are situated behi midlength of the sides of the head; their ma diameter is 0.43 mm, or about 0.25 HW. Apa a slight projection behind the scapal insertior tal carinae are straight, slightly divergent, and ded to about midlength of head. Anterior clype gin straight, neither protruded nor excised (F Mandibles short, with lateral borders strongly and five subequal teeth on each masticatory Antennal scapes projecting beyond the occipit gin by about one third of their length. Pedicel than the following flagellar segments; apical lar segments slightly thickened.

Alitrunk with deep impression between sonotum and propodeum, and two raised stig the deepest point of the impression. Promesc seen in profile, broadly rounded and high propodeum. Dorsal part of the propodeum convex, descending part shorter and straight. profile with broad base, which tapers to a tra ridge. Petiolar ridge pointed while seen from behind.

Head, gaster, and legs uniformly brown, yellowish, scapes and basal antennal segmer brown. Surface of head, alitrunk and gaster covered with very dense punctures; cuticula ture under SEM strongly reticulated (Fig. 4), than in all other *Karavaievia* species except *orinus*. Yellowish white decumbent pub scarce. Yellowish white, erect and suberect hairs occur mainly on forehead and vertex, le on alitrunk and gaster.

Paratype ☿☿ : TL 5.4 ± 0.2 (standard deviati 1.4 ± 0.15, HW 1.4 ± 0.17, CI 99.5 ± 4.4, SL 1.8 SI 94.6 ± 3.4, PW 0.98 ± 0.09, OD 0.45 ± (measured).

Holotype ☿, Peninsular Malaysia, Selangor: Valley, ca. 25 km north of Kuala Lumpur,

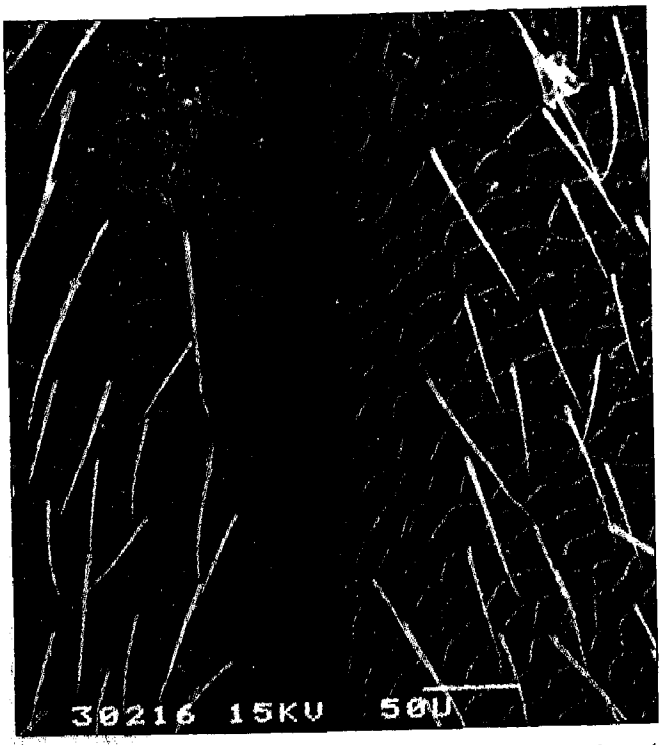

Figure 4. Cuticular structure of the head (between the frontal carinae) of *Camponotus (Karavaievia) gentingensis* (☿).

Gombak Field Studies Centre of the University of Malaya, February/12/1992, U. Maschwitz leg. (Naturhistorisches Museum, Basel).

Paratypes: 17 ☿☿ with the same data as holotype (2 in Museum of Comparative Zoology at Harvard University; 2 Forest Research Institute of Malaysia (FRIM) in Kepong; 2 in Museo Civico di Storia Naturale, Genova; 11 in collection of the author).

B. Gynetype ♀: TL 11.3, HL 2.4, HW 2.5, CI 104, SL 2.38, SI 105, PW 2.0, OD 0.65 (alate female).

Head nearly as long as wide (CI 104); sides of the head convex, occipital corners rounded, occipital margin slightly concave. Eyes are situated behind the midlength of the sides of the head and relatively smaller than those of *C. (K.) striatipes* (0.26 as against 0.44 x HW). Frontal carinae extend about to midlength of the head. Apart from a lateral projection beyond the scapal insertion, they are almost straight and only slightly divergent. Anterior clypeal margin - as in all known *Karavaievia*- ☿☿ - with distinct semicircular excision (Fig. 5*a*). The edges of the

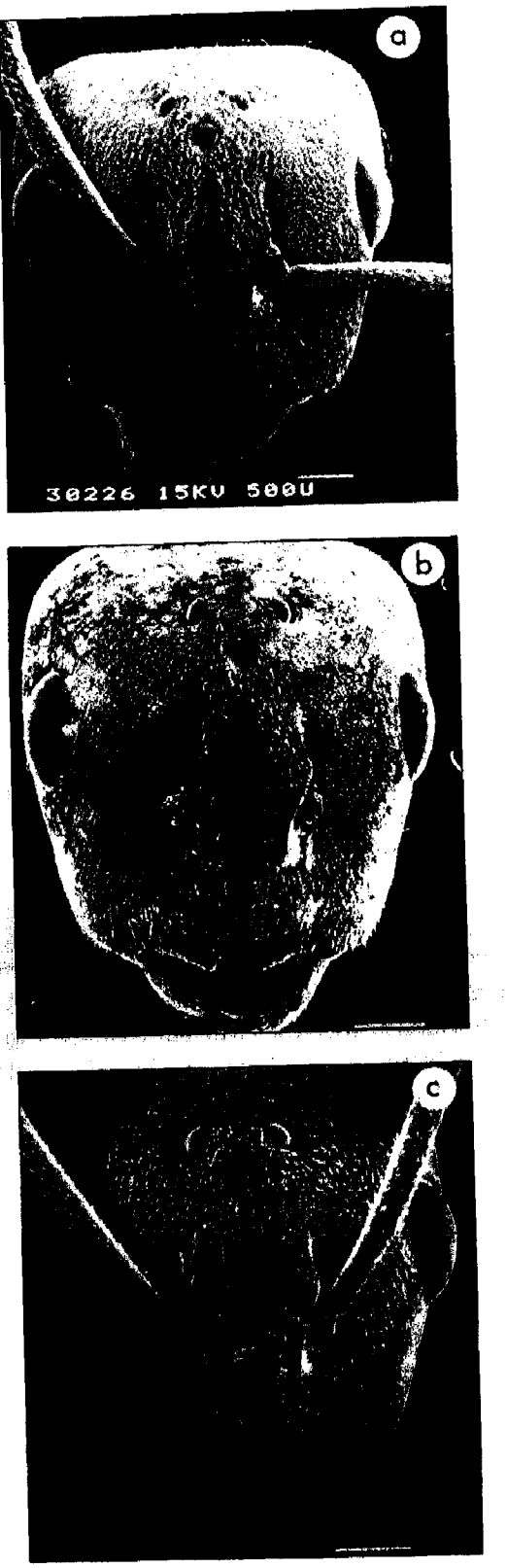

Figure 5. Scanning electron micrographs of the heads of ☿☿ of (a) *C. (Karavaievia) gentingensis*, (b) *C. (K.) melanus*, (c) *C. (K.) micragyne*.

excision indented. Frontal area weakly delimited and not at all shining. It is as dull or opaque as the surrounding head parts. Mandibles strong rounded on outside and with 5 subequal teeth on inside. Petiolar profile with broad base which tapers to a transvers ridge. Petiolar ridge rounded when seen from front or behind.

Head uniformly brown, alitrunk distinctly lighter, gaster and most parts of legs and antennae darker brown. Within the alitrunk, metanotum and borders of scutellum darker brown than the rest of alitrunk. Cuticular structure of head and alitrunk reticulated and not shining. Wings brownish, veins yellow brown. Body covered with short decumbent pubescence; longer erect and suberect hairs scarcely on the whole body, denser between the frontal carinae and on clypeus.

Paratype ♀♀: TL 11.5±0.2 (standard deviation), HL 2.5 ± 0.05, HW 2.54 ± 0.04, CI 102 ± 0.001, SL 2.5 ± 0.06, PW 1.99 ± 0.03, OD 0.67 ± 0.01 (4 measured).

Gynetype ♀, Peninsular Malaysia, Selangor: Gombak Valley, ca 25 km north of Kuala Lumpur near Ulu Gombak Field Studies Centre of the University of Malaya, February/12/1992, U. Maschwitz leg. (Naturhistorisches Museum, Basel).

Paratypes: 4 ♀♀ with same data as gynetype (1 in Museum of Comparative Zoology at Harvard University; 1 in Naturhistorisches Museum, Basel; 1 in Forest Research Institute of Malaysia (FRIM) in Kepong, Malaysia; 1 in collection of the author).

C. Allotype ♂: TL 6.5, HL 0.81, HW 0.85, CI 104.4, SL 0.95, SI 99.7, PW 1.57, OD 0.43.

Head trapezoidal and nearly as long as wide (CI 104.4). Eyes prominent and extending to the upper end of the head sides. Occipital margin strongly convex with protruding ocelli (Fig. 2*c*). Anterior clypeal margin straight, neither protruding nor excised. Short frontal carinae sinuate, reaching back to midlength of head. Eyes large; maximum diameter 0.43 mm, or about 0.45 HW. Scapes long, projecting beyond occipital margin of the head by about half their length. Pedicel expanded at its distal end and thicker than following flagellar segments. Propodeal profile rounded, with convex dorsal and weakly concave descending part. Petiolar scale triangular in profile, with a broad base tapering to a ridge. Ridge with median excision.

Colour uniformly reddish brown, with the tion of the yellow brown mandibles, clypeus a adjacent parts of the cheeks and distal antenn gellum. Cuticle of head, alitrunk, and gaster s shining with dense punctures, seen under the cular, caused by a distinct reticulated cuticular st (Fig. 2*c*). Decumbent pubescence on gaster, but lacking on head and alitrunk (clear differenc *melanus*); longer erect and suberect hairs sca head and even less dense on alitrunk and gaster

Paratype ♂♂: TL 6.5 ± 0.01 (standard deviatic 0.85 ± 0.04; HW 0.8 ± 0.035; CI 105,0 ± 4.5; S 0.03; SI 89.8 ± 0.03; PW 1.12 ± 0.04; OD 0.43 (6 measured).

Allotype ♂, Peninsular Malaysia, Gombak Va 25 km north of Kuala Lumpur, near the Ulu C Field Studies Centre of the University of Malay ruary/12/1992, U. Maschwitz leg. (Naturhistc Museum, Basel).

Paratypes: 6 ♂♂ with same data as allotype seum of Comparative Zoology at Harvard Uni 1 Forest Research Institute of Malaysia (FI Kepong; 1 in Museo Civico di Storia Naturale, 3 in collection of the author).

Camponotus nigripes sp. n.

Derivatio nominis: The name is derived from that this is the only known *Karavaievia* spec dark legs.

Diagnosis: Typical for this species is the colo worker ants and especially the colour of th The comparison with the similar dark *C. (K.* shows that the worker ants of this species ar on an average and even darker but their legs dish brown while those of *C. (K.) nigripes* a ish brown. Also the worker ants of *C. (K.)* are dark in colour. They are uniformly dar including the legs. *C. (K.) nigripes*, in cont middle brown head and alitrunk but blackis legs. In addition, *C. (K.) melanus* workers shining than those of *C. (K.) nigripes*. Work *(K.) texens* are much more shining and lig

those of *C. (K.) nigripes*. Workers of *C. (K.) gombaki* are as opaque as those of *C. (K.) nigripes*, but their legs are as reddish brown as head and alitrunk.

Holotype ☿: TL 5.2, HL 1.1, HW 1.1, CI 100, SL 1.3, SI 83, PW 0.75, OD 0.33.

Head trapezoidal, with rounded occipital corners; occipital margin straight, head sides convex (Fig. 6*a*). Length of head equal to its width (CI 100). Eyes are situated behind the midlength of the sides of the head; their maximum diameter 0.33 mm or 0.3 HW. Apart from a slight projection behind the scapal insertion, frontal carinae are straight, slightly divergent, and extend to about midlength of head. Anterior clypeal margin straight. Mandibles short, with lateral borders strongly curved and five subequal teeth on each masticatory border. Antennal scapes projecting beyond the occipital margin by about one third of their length. Pedicell longer than the following flagellar segments; apical flagellar segments slightly thickened.

Alitrunk with a deep impression between promesonotum and propodeum, and two raised stigmata at the deepest point of the impression. Promesonotum, seen in profile, broadly rounded and higher than propodeum. Propodeal profile considerably flattened on top. Petiole with a broad base, tapering toward the apex into a narrow ridge, seen from the side. Petiolar apex, seen from front or behind, rounded.

Head, most of the alitrunk, and gaster middle to dark brown, pronotum lighter, legs and antennae dark to blackish brown. Surface of head, alitrunk and gaster opaque, covered with very dense punctures; cuticular structure under SEM strongly reticulated (Fig. 6*a*). Yellowish white decumbent pubescence scarce. Longer erect and suberect hairs scarce on head and gaster and nearly lacking on alitrunk.

Paratype ☿☿ : 5.3 ± 0.2 (standard deviation), HL 1.25 ± 0.08, HW 1.28 ± 0.1, CI 100.5 ± 0.03, SL 1.48 ± 0.06, SI 85.7 ± 3.4, PW 0.79 ± 0.02, OD 0.33 ± 0.015 (21 measured).

Holotype ☿, Peninsular Malaysia, Belum, primary rain forest 320 m above sea level, 3 m above ground on a tree, March/3/1994, A. Weissflog leg. (Naturhistorisches Museum, Basel).

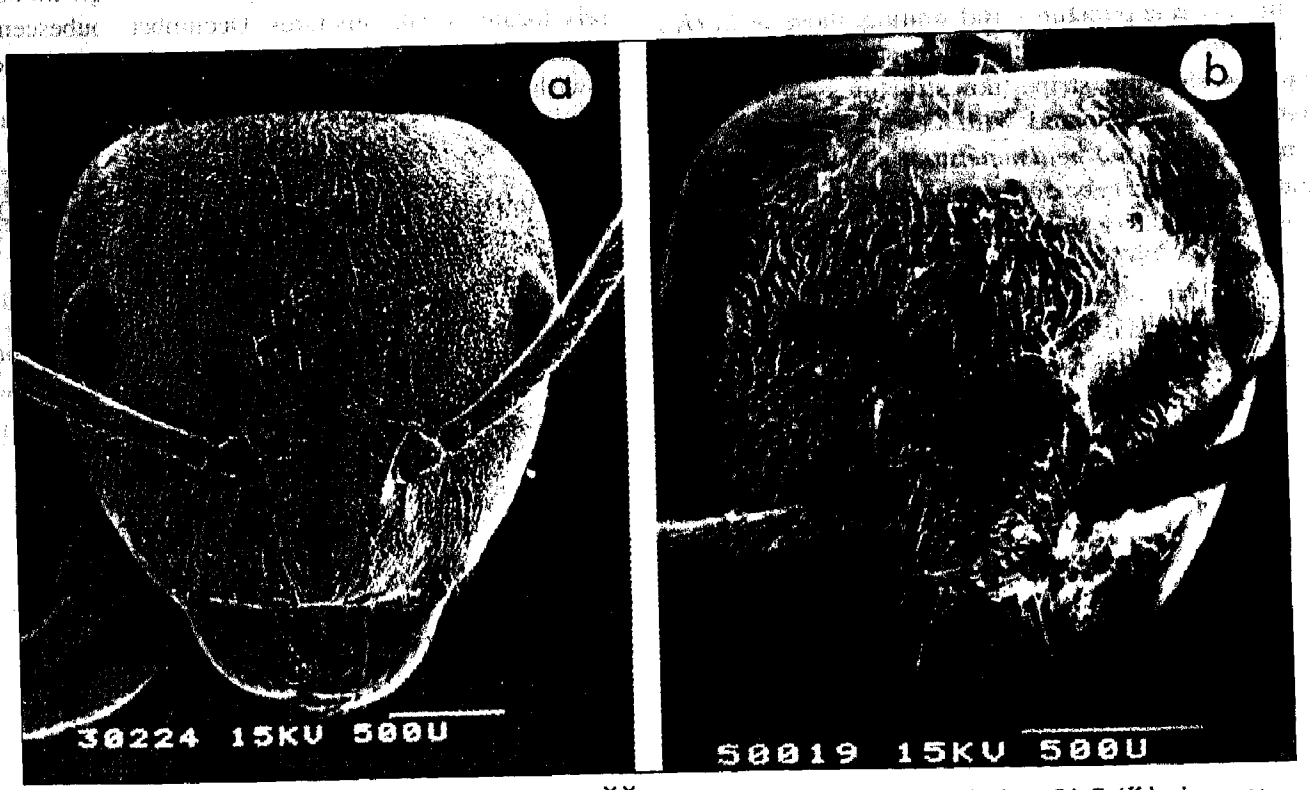

Figure 6. Scanning electron micrographs of the heads of ☿☿ (a) *Camponotus (Karavaievia) nigripes*, (b) *C. (K.) micragyne.*

Paratypes: 21 ☿☿ with same data as holotype (2 in Museum of Comparative Zoology at Harvard University; 2 Forest Research Institute of Malaysia (FRIM) in Kepong; 2 in Museo Civico di Storia Naturale, Genova; 15 in collection of the author).

Camponotus belumensis sp. n.

Derivatio nominis: The name is derived from the Belum area in Perak in which this species was found during the expedition of the Malaysian Nature Society in 1994.

Diagnosis: The worker ants of *C. (K.) belumensis* are very similar to those of *C. (K.) asli*. Both are uniformly yellowish brown in colour and distinctly shining. They, however, differ significantly in the width and length of their heads: *C. (K.) asli*: HL 1.21 ± 0.07 (standard deviation), HW 1.21 ± 0.07 [6] ; *C. (K.) belumensis*: HL 1.06 ± 0.04, HW 1.08 ± 0.05. In addition, the heads of the *C. (K.) belumensis*-workers are a little bit wider than long (CI 104 ± 4) as against CI 100 ± 3 in *C. (K.) asli* [6]. Clear differences between the two species are shown by the females. Those of *C. (K.) asli* are uniformly covered with very fine punctures and shining, those of *C. (K.) belumensis* have alitrunks with strongly sculptured cuticles showing stripe-like structures on pro- and mesonotum. Compared with *C. (K.) micragyne*, the females of *C. (K.) belumensis* are significantly larger and the worker ants differ in their PW: *C. (K.) micragyne* PW 0.8 ± 0.05 (standard deviation), *C. (K.) belumensis* PW 0.66 ± 0.03. *C. (K.) gentingensis* workers differs from *C. (K.) belumensis* in the cuticle structure which is opaque and not at all shining and in their bigger size. Also the females of *C. (K.) gentingensis* are bigger than those of *C. (K.) belumensis* and uniformly opaque. All other *Karavaievia* species considerably differ from *C. (K.) belumensis* in their colour; these other species are much darker and quite differently coloured.

A. Holotype ☿: TL 4.2, HL 1.05, HW 1.1, CI 104, SL 1.3, SI 84, PW 0.65, OD 0.3.

As in all *Karavaievia* species, head trapezoidal with rounded occipital corners; occipital margin straight and not al all concave. Head sides strongly convex (Fig. 1*c*). Length of head subequal to its width (CI 104). Eyes are situated behind the midlength of the sides of the head. Their maximum diameter is 0.3 mm or 0.27 HW. Frontal carinae nearly straight, apart from a slight projection behind the scapal insertion. They are slightly divergent and extend to about midlength of head. Anterior clypeal margin straight. Mandibles short, with lateral borders strongly curved and five subequal teeth on each masticatory border. Antennal scapes projecting beyond the occipital margin by about one third of their length. Pedicel longer than the following flagellar segments; apical flagellar segments slightly thickened.

Alitrunk with a deep impression between promesonotum and propodeum, and two raised stigmata at the deepest point of the impression. Promesonotum, seen in profile, broadly rounded and higher than propodeum. Propodeal profile flattened on top; dorsal part of the propodeum convex, descending part straight and considerably steeper. Petiolar scale triangular in profile, with a broad base tapering to a ridge. Ridge seen from front or behind pointed.

Colour uniformly yellow brown; head - except the dirty yellow front part - and alitrunk darker than gaster. Antennal scapes dark brown, flagella dirty yellow. Surface of head, alitrunk and gaster shining with densely located weak punctures. Decumbent pubescence is nearly lacking. Longer erect and suberect yellowish white hairs especially on the whole body.

Paratype ☿☿ : TL 4.3 ± 0.2 (standard deviation), HL 1.06 ± 0.04, HW 1.08 ± 0.05, CI 104 ± 4, SL 1.3 ± 0.03, SI 84.2 ± 2.5, PW 0.66 ± 0.03, OD 0.3 ± 0.03 (13 measured).

Holotype ☿, Peninsular Malaysia, Belum/Perak, primary rain forest 320 m above sea level, 3 m above ground, March/3/1994 A. Weissflog leg. (Naturhistorisches Museum, Basel).

Paratypes: 13 ☿☿ with same data as holotype (2 in Museum of Comparative Zoology at Harvard University; 2 Forest Research Institute of Malaysia (FRIM) in Kepong; 2 in Museo Civico di Storia Naturale, Genova; 7 in collection of the author).

B. Gynetype ♀: TL 9.0 mm; HL 2.40; HW 2.31; CI 96.25; SL 2.15; PW 1.77; OD 0.64; dealate female.

Head nearly as long as wide (CI 96.25); sides of

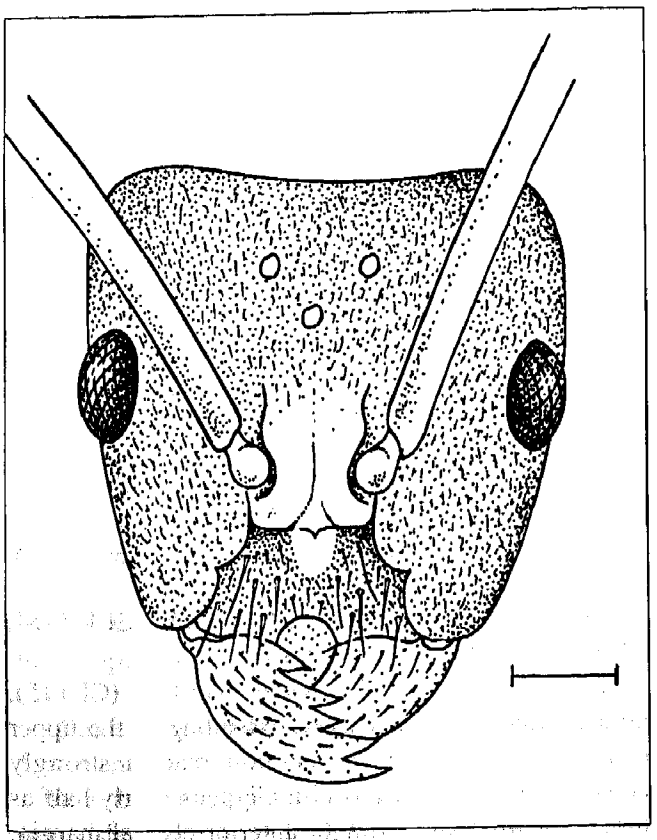

Figure 7. Head of *Camponotus (Karavaievia) belumensis* ♀.

the head convex, occipital corners rounded, occipital margin slightly convex. Eyes are situated behind the midlength of the sides of the head. Frontal carinae extend about to midlength of head. Apart form a lateral projection behind the scapal insertion, they are almost straight and slightly divergent. Anterior clypeal margin - as in all known *Karavaievia*- ♀♀ - with semicircular excision (Fig. 7). Frontal area - as in *C. gombaki* and *C. orinus* (*montanus* Dumpert 1989) - clearly delimited and as much shining as the surrounding head parts. Mandibles strong, distinctly rounded on outside, and with 5 subequal teeth on inside. Petiolar scale tapering to a ridge when seen in profile; ridge strongly rounded when seen from front or behind.

Body dark brown with reddish brown segment borders; also the front parts and the occipital corner of the head and parts of the legs (tarsi, trochanter and half of the femur) are reddish brown, coxae yellowish. All body parts shining, especially alitrunk, frontal area, and gaster. Head covered with weak but dense punctures, seen under the binocular; alitrunk with strongly sculptured cuticle showing stripe-like structures on pro- and mesonotum. Yellowish white decumbent pubescence on the whole body, erect and suberect longer hairs occur mainly on gaster, less dense on alitrunk and head.

Gynetype ♀, Peninsular Malaysia, Belum/Perak, primary rain forest 320 m above sea level, 3 m above ground, March/3/1994, A. Weissflog leg. (Naturhistorisches Museum, Basel).

Camponotus micragyne sp. n.

Derivatio nominis: The name is derived from the fact that the females of this species are considerably smaller than those of all other yet known *Karavaievia*-species.

Diagnosis: *C. (K.) micragyne* workers are similar to *C. (K.) gentingensis, C. (K.) asli* and *C. (K.) belumensis* because of their similar light (yellowish) colour. *C. (K.) gentingensis* is the darkest and largest of these species and can easily be distinguished from the remaining three species because of their opaque cuticle of all body parts. The cuticles of *C. (K.) micragyne, C. (K.) asli* and *C. (K.) belumensis* are considerably shining. Compared with *C. (K.) belumensis*, the workers of *C. (K.) micragyne* are significantly larger. Compared with *C. (K.) asli*, the heads of *C. (K.) micragyne* are significantly wider. The females of *C. (K.) micragyne* can easily be distinguished from all other *Karavaievia* females by the considerably smaller length of their bodies (TL 7.9). TL of all other *Karavaievia* females ranges between 9.6 and 11.5.

A. Holotype ♀: TL 4.3, HL 1.1, HW 1.2, CI 112, SL 1.28, SI 97, PW 0.73, OD 0.3.

Head trapezoidal and wider than long (CI 112); occipital corners strongly rounded, occipital margin slightly concave, head sides strongly convex, more than in most other *Karavaievia* species and similar to *C. (K.) gombaki* [6] (Fig. 6*b*). Eyes are situated behind the midlength of the sides of the head; their maximum diameter is 0.3 mm, or about 0.25 HW. Frontal carinae are slightly divergent, and extend to about midlength of head. Anterior clypeal margin straight. Mandibles shorter than in most other *Karavaievia* species as *C. (K.) nigripes, C. (K.) asli, C. (K.)*

orinus, C. (K.) gentingensis, C. (K.) belumensis and *C. (K.) striatipes*. They are distinctly rounded on outside and with 5 subequal teeth on inside. Frontal area not clearly delimited from neighbouring head parts and as much shining.

Alitrunk with a deep impression between promesonotum and propodeum, and two raised stigmata at the deepest point of the impression. Propodeum in profile strongly rounded and higher than promesonotal dorsum. Dorsal part of promesonotal dorsum flatter than descending part. Petiolar scale triangular in profile, with a broad base tapering towards the apex into a narrow ridge. Petiolar apex, seen from above, pointed.

Body uniformly yellowish brown; alitrunk with alternating lighter and darker rings. Cuticle of head, alitrunk and gaster shining. Decumbent pubescence nearly lacking. Longer erect and suberect hairs distributed over the whole body.

Paratype ♀♀: TL 4.0 ± 0.15 (standard deviation), HL 1.24 ± 0.08), HW 1.33 ± 0.09, CI 107 ± 1.6, SL 1.34 ± 0.07, SI 99.1 ± 1.8, PW 0.80 ± 0.04, OD 0.34 ± 0.02 (7 measured).

Holotype ♀, Peninsular Malaysia, Belum/Perak, primary rain forest 320 m above sea level, March/2/1994 A. Weissflog leg. (Naturhistorisches Museum, Basel).

Paratypes: 7 ♀♀ with same data as holotype (1 in Museum of Comparative Zoology at Harvard University; 1 Forest Research Institute of Malaysia (FRIM) in Kepong; 1 in Museo Civico di Storia Naturale, Genova; 4 in collection of the author).

B. Gynetype ♀: TL 7.0, HL 1.85, HW 2.03, CI 109, SL 1.75, SI 115, PW 1.68, OD 0.63 (alate female).

Head slightly broader than long (CI 109); sides of the head straight, occipital corners rounded, occipital margin concave (Fig 5*c*). Frontal carinae extend about to midlength of the head. Apart from a lateral projection beyond the scapal insertion, they are almost straight and only slightly divergent. Eyes are situated behind the midlength of the sides of the head and relatively large (0.31 x HW). Clypeus - as in all other *Karavaievia* females - with a median semicircular excision at its anterior margin. Mandibles strong, distinctly rounded on outside, and with 5 subequal teeth on inside.

Body uniformly dirty yellowish brown w
ker front parts of the head and rings of
brown colour on the gastral tergites. Cuticle s
of head, alitrunk and gaster shining. Wings
veins yellow brown. Body covered with ye
white decumbent pubescence; longer erect, ye
white hairs are particularly dense on clypeus,
on rest of body, including scapes and legs.
profile with broader base, which tapers to
verse ridge. Petiolar ridge rounded when se
above or behind.

Gynetype ♀, Peninsular Malaysia, Belum/Pe
mary rain forest 320 m above sea level, March
A. Weissflog leg. (Naturhistorisches Museum,

C. Allotype ♂: TL 4.1, HL 0.83, HW 0.95, CI 0.95, SI 86, PW 1.23, OD 0.53.

The trapezoidal head is wider than long (C
with prominent convex eyes, extending to th
end of the head sides. Occipital margin s
convex with protruding ocelli. Clypeus nearly
high than wide with straight anterior clypeal
Mandibles with only one apical tooth. Frontal
sinuate, reaching back to upper end of th
Eyes very large; maximum diameter 0.53, o
0.56 HW. Scapes long, projecting beyond c
margin of the head by about half their length.
expanded at its distal end and thicker than fo
flagellar segments.

Propodeal profile rounded, with weakly
dorsal and weakly concave descending part
lar scale triangular in profile, with a broad b
ering equally from front and behind to a ridge
with a deep median excision.

Body uniformly dark brown with the exc
of the dirty yellow brown frontal head parts
ding the mandibles) and the likewise lighter c
flagella and tarsi. All body parts are shini
showing densely arranged strong punctures ur
dissecting microscope. Wings whitish with ye
veins. Decumbent pubescence on whole body
erect and subtract hairs not very dense on he
trunk and gaster.

Allotype ♂, Peninsular Malaysia, Belum/Per
mary rain forest 320 m above sea level, March
A. Weissflog leg. (Naturhistorisches Museum,

Camponotus gombaki Dumpert 1985

Allotype ♂ : TL 5.5, HL 0.88, HW 0.95, CI 108.1, SL 1.0, SI 95.2, PW 1.24, OD 0.43.

Head trapezoidal and nearly as long as wide (CI 108.1); occipital margin strongly convex with protruding ocelli (Fig. 2*d*) and prominent convex eyes, extending to the upper end of the head sides. Anterior clypeal margin almost straight but with a slight, but broad median excision. Frontal carinae short and sinuate, reaching back to about midlength of head. Maximum diameter of the eyes 0.43 mm or about 0.5 HW. Scapes long, projecting beyond occipital margin of the head by about half their length. Pedicel expanded at its distal end and thicker than following flagellar segments. Propodeal profile rounded with convex dorsal and weakly convex descending part. Petiolar scale triangular in profile, with a broad base tapering to a ridge. Ridge with deep median excision.

Colour uniformly reddish brown, except the yellow mandibles, tarsi, and distal antennal flagella, the yellow brown clypeus and gastral stripes, and the blackish brown scutellum. Except the shining scutellum and the slightly shining gaster, cuticle opaque. Wings nearly white with yellow veins. Decumbent pubescence especially on gaster, but also on head and alitrunk; additional longer erect and suberect hair predominantly on head.

Paratype ♂: TL 5.3, HL 0.9, HW 0.9, CI 100, SL 0.93, SI 97.4, PW 1.18, OD 0.43 (1 measured).

Allotype ♂, Peninsular Malaysia, Gombak Valley, 25 km north of Kuala Lumpur, near the Ulu Gombak Field Studies Centre of the University of Malaya, Febr. /3/1993, U. Maschwitz leg. (Naturhistorisches Museum, Basel).

Paratype: 1 ♂ with same data as holotype (used for SEM).

Camponotus asli Dumpert 1989

Allotype ♂: TL 4.1, HL 0.85, HW 0.78, CI 91, SL 0.95, SI 82, PW 1.03, OD 0.43.

Head trapezoidal and nearly as wide as long (CI 91). Eyes are prominent and extending to the upper head sides. Occipital margin strongly rounded with

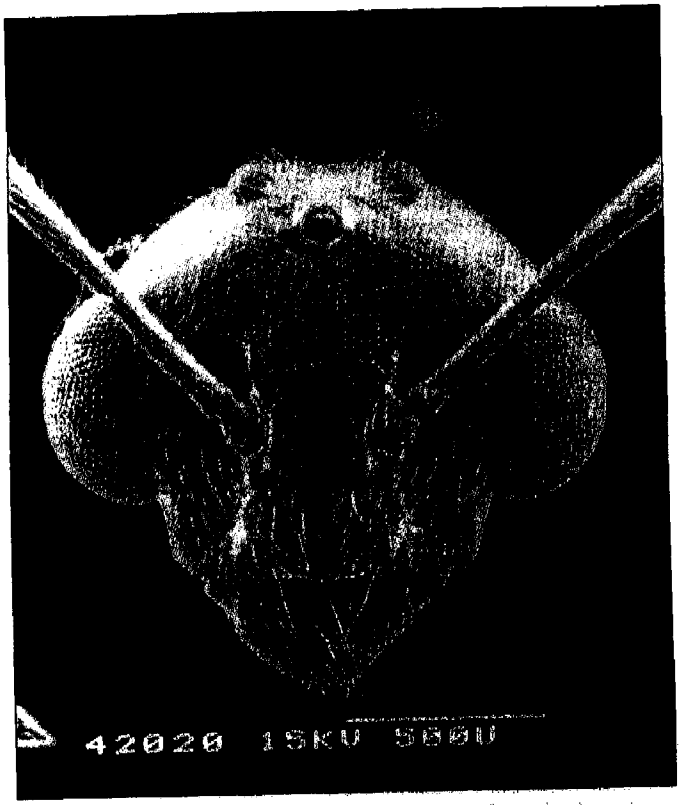

Figure 8. Scanning electron micrograph of a *Camponotus (Karavaievia) asli* head (♂).

protruding ocelli (Fig. 8). Clypeus high with a slightly excised anterior margin. The sinuate frontal carinae are not reaching back to the upper end of the eyes. Eyes very large; maximum diameter 0.43 mm, or about 0.55 HW. Scapes long, projecting beyond occipital margin of the head by about half their length. Pedicel expanded at its distal end and thicker than following flagellar segments.

Head, alitrunk and gaster uniformly yellowish light brown, sentellum and metanotum dark brown. Front parts of head, antennal flagellum and tarsi lighter than the rest of body. All body parts shining. Cuticle covered with densely located small punctures, seen under the dissecting microscope. Decumbent pubescence on head, alitrunk and gaster; longer erect and suberect hairs scarcely on whole body. Petiolar scale triangular in profile, with a broad base tapering equally from front and behind to a ridge. Ridge with strong median excision.

Paratype ♂ : TL 3.9, HL 0.75, HW 0.8, CI 107, SL 0.8, SI 100, PW 1.05, OD 0.4.

Allotype ♂, Peninsular Malaysia, Negeri Sembilan, Pasoh Forest Reserve, March/31/1992, K. Rościszewski leg. (Naturhistorisches Museum, Basel).

Paratype: 1 ♂ with the same data as allotype (used for the scanning electron micrograph).

Correction

In 1989 a new *Karavaievia* species was described as *Camponotus (Karavaievia) montanus* by Dumpert. In the meantime it turned out that the name *"montanus"* is occupied. The replacement name of the *Camponotus (Karavaievia)* species, described by [6], is *Camponotus (Karavaievia) orinus*.

BEHAVIOUR

(K. Dumpert, U. Maschwitz, A. Weissflog, K. Rościszewski, I. Hj. Azarae)

RESULTS AND DISCUSSION

The subgenus *Karavaievia* is a very well defined taxonomic unit containing not only morphological but also behavioural characteristics. The common morphological traits include the subuniform size of workers, females and males, the shape of the head, the position of the eyes, the characteristic shape of frontal carinae, clypeus, mandibles, antennae and alitrunk. From these common morphological characteristics of *Karavaievia* which are defined by [7] and [6], *Camponotus (Karavaievia) orinus* deviations by the slight polymorphism of the caste [6]. Though the six presently described fit quite well in this subgenus, there are some differences in a species to the rest of the *Karavaievia* species. This contains the relatively small of the *C. (K.) micragyne* females and the sl the workers and females of *C. (K.) striatipes*. gaster and especially alitrunks of these spec much thinner and distinctly more slender thar in all other *Karavaievia* species. Also the exci the anterior clypeal margin of the *C. (K.) st* females differs in shape and extension from tl uniform clypeal shapes of the females in al *Karavaievia* species.

On the other hand, there is no doubt tha species all belong to the *Camponotus* sul *Karavaievia*. All the other characteristics of *K ievia* fit quite well including a lacking of polymorphism to a large extent. The main teristic of *Karavaievia*, however, seems to weaving of silk nests with the aid of their (Fig. 9). This was shown for *C. (K.) texens (K.) gombaki* by [8] and revealed by [6] for *asli* and *C. (K.) orinus*. It could be shown for newly described species that they build sill too. Most of these nests are built at the unders leaves, forming free-hanging pockets (Fig. 10 holds for the vast majority of the pavilions *(K.) melanus*, *C. (K.) gentingensis*, *C. (K.) be sis*, *C. (K.) nigripes*, and *C. (K.) asli*. In al cases, the silken material at the outside of th

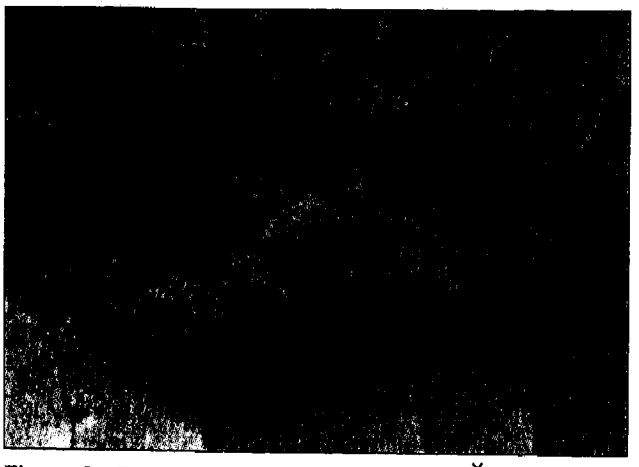

Figure 9. *Camponotus (Karavaievia) texens* ♀ holds a larva between her mandibles.

Figure 10. Pavilions of *Camponotus (Karavaievia) bel* attached at the underside of leaves.

Figure 11. *Camponotus (Karavaievia) belumensis* ☿☿ walking in a destroyed pavilion which was fully packed with larvae.

lions is covered with particles. *C. (K.) asli, C. gombaki, C. belumensis, C. micragyne* and *C. texens* were shown weaving additional nests between leaves. *C. (K.) striatipes* pavilions were found in folded leaves that are woven together with the aid of larval silk. The pavilions of most of the newly described species (*C. striatipes, C. melanus, C. gentingensis, C. belumensis, C. nigripes*) consist of merely one chamber like those of *C. asli* and *C. texens*. Only the pavilions of *C. micragyne* were found to consist of more than one chamber like those of *C. gombaki* and especially those of *C. orinus*. Nearly all hitherto investigated *Karavaievia* species contain in at least most of their pavilions scale insects as trophobionts. This is valid for *C. texens, C. gombaki, C. asli, C. orinus, C. melanus, C. belumensis, C. gentingensis*, and *C. nigripes*. Only the few (3) pavilions that were found as well of *C. micragyne* as of *C. striatipes* contained no trophobionts. Pavilions of *C. belumensis* were found to be fully packed with pupae of this species (Fig. 11). An extensive investigation on nest building of *C. texens, C. gombaki*, and *C. orinus* is in progress [9].

On the geographic and vertical distribution of the *Karavaievia* species nearly nothing can be said as well as on the supposed number of species in this subgenus. Any niche factors which would separate the different sympatric species are hitherto unknown. The reason is that there were found only very few colonies of the various species. The species that was found most often is *C. texens* from which 4 colonies were found in the Gombak valley (about 25 km north of Kuala Lumpur), 1 near Kuantan (eastern part of Peninsular Malaysia) and another one in Sumatra (Ketambe Park). *C. asli* was found in the Gombak valley (1 colony), in Belum (2 colonies) and in Pasoh Forest Reserve (1 colony); *C. gombaki* only in the Gombak valley (3 colonies); *C. orinus* in the Gombak valley at an elevation of about 700 m (3 colonies) and in the Cameron Highlands at an elevation of 900 m (3 colonies); and *C. melanus* is known from 1 colony in the Pasoh Forest Reserve (Peninsular Malaysia) and 1 from Borneo (Sarawak, Lambir Park). *C. gentingensis* is known only from 1 colony found in the Gombak valley, *C. striatipes* from Pasoh Forest Reserve with 1 colony, and additional as prey of *Aenictus laeviceps* [10] (there *C. striatipes* is called *Camponotus* sp. *19*), and from Borneo (Sabah, Poring Hot Springs). *C. belumensis* (2 colonies), *C. nigripes* (only 1 pavilion), and *C. micragyne* (3 pavilions) were only found in Belum.

Concerning the vertical distribution of the *Karavaievia* species, the few findings do not justify any conclusions. The *C. texens* colonies and those of *C. gombaki, C. asli, C. melanus, C. belumensis* and *C. orinus* were found on small trees (2-5 m in height). The findings of *C. striatipes* were made in heights of about 30 m, and those of *C. gentingensis, C. micragyne*, and *C. nigripes* were made on fallen branches. This means that *Karavaievia* spp. at most are canopy dwelling ants. So it is impossible to say, whether or not the crown regions of the rain forest trees contain *Karavaievia* colonies in a larger scale. From the fact, however, that the recent *Karavaievia* findings revealed more new colonies than of already known species, one can conclude that the number of species in this subgenus is probably still considerably higher than already known. The discovery of 12 new species (including a yet undescribed species already mentioned in the accompanying key) in addition to the 2 formerly known in this ant taxon demonstrates very convincingly how diverse rain forest canopy fauna can be and how little is known about it.

Acknowledgments We are grateful to the Deutsche Forschungsgemeinschaft (DFG) for financial support. We also thank the Malaysian Nature Society for organizing the Malaysian Heritage and Scientific Expedition to Belum in 1994.

REFERENCES

1 Hölldobler B. and Wilson E.O. (1977) Weaver ants. *Scient. Amer.* **237**: 146-154.

2 Schremmer F. (1979) Die nahezu unbekannte neotropische Weberameise *Camponotus (Myrmobrachys) senex* (Hymenoptera: Formicidae). *Entomol. Gen.* **5**: 363-378.
3 Emery C. (1901) Formiche racolte da elio Modigliano in Sumatra, Engano e Mentawei. *Ann. Mus. Stor. Nat. Genova* **40**: 709-743.
4 Forel A. (1911) Fourmis de Borneo, Singapore, Ceylon, etc. *Rev. Suisse Zool.* **19**: 23-62.
5 Viehmeyer H. (1915) Ameisen von Singapore, beobachtet und gesammelt von H. Overbeck, beschrieben von H. Viehmeyer. *Arch Naturgesch.* **81**: 108-169.
6 Dumpert K., Maschwitz U., Nässig W. and Dorow W. (1989) *Camponotus (Karavaievia) asli* sp.n. and *C. (K.) montanus* sp.n., two weaver ant species from Malaysia (Formicidae: Formicinae). *Zool. Beitr. N.F.* **32 (2)**: 217-231.
7 Emery C. (1925) Hymenoptera, Fam. Formicidae. In: *Genera Insectorum* (ed. P. Wytman). Louis Desmet-Verteneuil, Brussels.
8 Maschwitz U., K. Dumpert and Schmidt G. (1985) Silk pavilions of two *Camponotus (Karavaievia)* species from Malaysia: description of a new nesting type in ants (Formicidae: Formicinae). *Z. Tierpsychol.* **69**: 137-249.
9 Waldkircher G. and Maschwitz U. (unpublished).
10 Rościszewski K. (1995) *Die Ameisenfauna eines tropischen Tieflandregenwaldes in Südostasien: Eine faunistisch-ökologische Bestandsaufnahme.* Ph.D. thesis, Dept. Zoology, J. W. Goethe University Frankfurt am Main, Germany. 184 pp.

KEY TO THE HITHERTO KNOWN SPECIES OF *KARAVAIEVIA*

I Workers

1.	Head and alitrunk shining	2
	Head and alitrunk opaque	9
2.	Very slender animals; decumbent pubescence is lacking. Heads distinctly longer than wide (CI 90.4 ± 2.4)	*striatipes*
	Broader animals, showing decumbent pubescence	3
3.	Yellow or lightly yellowish brown in colour	4
	Darker in colour	7
4.	Heads wider than long (CI 107 ± 1.6)	5
	Heads longer than wide or at least as long as wide	6
5.	Occipital margin slightly concave	*micragyne*
	Occipital margin strongly concave, like the upper part of a heart	*spec.**
6.	Smaller animals (HL 1.06 ± 0.04; HW 1.08 ± 0.05)	*belumensis*
	Bigger animals (HL 1.21 ± 0.07; HW 1.21 ± 0.06)	*asli*
7.	Head wider than long (CI 104 ± 2)	*melanus*
	Head longer than wide or as long as wide	8
8.	Uniformly dirty yellow, anterior parts of head and gaster lighter; gaster with darker segment borders	*exsectus*
	Head, alitrunk and legs reddish brown, gaster blackish brown with lighter brown segment borders; apical flagellum and front of head yellow	*overbecki*
	Head, alitrunk, scapes and legs dark brown; gaster, petiole, apical antennal flagellum and front of head reddish	*texens*
9.	Big animals (HL and HW 1.4 - 1.5 on average)	10
	Smaller animals	11
10.	Head, gaster, and legs uniformly brown, alitrunk yellowish, scapes and basal antennal segments dark brown	*gentingensis*
	Head and gaster dark brown, alitrunk reddish to dark brown	*orinus*
11.	Legs uniformly dark to blackish brown	*nigripes*
	Legs of lighter colour	12
12.	Uniformly dirty yellowish brown; tarsi, apical antennal flagellum and front of head reddish	*dolichoderoides*
	Head and alitrunk reddish brown, gaster dark brown	*gombaki*

II Females

1.	Petiolar scale blunt in dorsal view	*exsectus*
	Petiolar scale acute in dorsal view	2

2.	Anterior clypeal margin with only a very small median excision; legs brown with 3 broad white bands	*striatipes*
	Anterior clypeal margin with strong semicircular excision	3
3.	Total length about 7 mm	*micragyne*
	Total length more than 9 mm	4
4.	Head and alitrunk more or less shining	7
	Head and alitrunk opaque	5
5.	Head middle brown, alitrunk yellowish brown, gaster dark brown; within the alitrunk, metanotum and borders of scutellum darker brown than the rest of alitrunk	*gentingensis*
	darker in colour	6
6.	Uniformly black or blackish brown in color	*orinus*
	Head, alitrunk and legs reddish brown, gaster darker	*gombaki*
7.	Head and alitrunk subopaque	*melanus*
	Head and alitrunk shining	8
8.	Alitrunk strongly sculptured showing stripe-like structures on pro- and mesonotum	*belumensis*
	Alitrunk not strongly sculptured but covered with very fine punctures	9
9.	Uniformly reddish brown, scutellum and metanotum darker	*asli*
	Different in colour	10
10	Head and alitrunk black with lighter front part of the head, gaster reddish brown	*texens*
	Head pale, occipital margin strongly concave like the upper part of a heart; alitrunk, legs and gaster darker (at least partly)	*spec.**

III Males

1.	Total length significantly less than 5 mm	2
	Total length more than 6 mm	4
2.	Head and alitrunk shining, two dark stripes on yellowish brown alitrunk; scutellum light brown	*striatipes*
	Head and alitrunk opaque, alitrunk dark brown; scutellum blackish brown	3
3.	Head longer than wide (CI ca. 90)	*asli*
	Head wider than long (CI ca. 115)	5
4.	Clypeus much wider than long (0.48 x 0,2 mm); clypeus and and mandibles much lighter than rest of head	*micragyne*
	Clypeus not as much wider than long (0.35 x 0.2 mm); not only clypeus and mandibles, but also the whole front head lighter than rest of head	*spec.**
5.	Body uniformly black - with the exception of the front parts of the head including antennae - and opaque	*orinus*
	Body lighter in colour	6
6.	Head and dorsal part of the alitrunk opaque, scutellum subopaque; uniformly reddish brown in colour	*gentingensis*
	Body more or less shining	7
7.	Petiolar scale with a slight median excision	8
	Petiolar scale with a deep median excision	9
8.	Body uniformly dirty yellow brown, gaster with indistinct narrow dark bands in front of the posterior segment borders	*overbecki*
	Body uniformly dark brown with light brown front parts of the head and prothorax and whitish segment borders of the gaster	*gombaki*
	Head and alitrunk dark brown, gaster lighter	*texens*

*: After finishing the manuscript this species was found by A. Weissflog in May 1995 in Peninsular Malaysia. Name and description of this species will be given in a separate paper in which behavioural characteristics will be reported as well.