



## ***Megasybacodes brevitarsis*, a new genus and species of Rhyparini (Coleoptera: Scarabaeidae: Aphodiinae) from Borneo**

SHOWTARO KAKIZOE<sup>1,2</sup>, MUNETOSHI MARUYAMA<sup>3</sup> & KIMIO MASUMOTO<sup>4</sup>

<sup>1</sup>Entomological Laboratory, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Motooka 744, Nishi-ku, Fukuoka, 819-0395 Japan. E-mail: [showtarok@gmail.com](mailto:showtarok@gmail.com)

<sup>2</sup>Research Fellow of Japan Society for the Promotion of Science (DC1), Tokyo, Japan

<sup>3</sup>The Kyushu University Museum, Hakozaki 6-10-1, Higashi-ku, Fukuoka, 812-8581 Japan. E-mail: [dendrolasius@gmail.com](mailto:dendrolasius@gmail.com)

<sup>4</sup>Kamezawa 3-chôme 14-13-1001, Sumida-ku, Tokyo, 130-0014 Japan. E-mail: [kimio\\_masumoto@yahoo.co.jp](mailto:kimio_masumoto@yahoo.co.jp)

### **Abstract**

*Megasybacodes brevitarsis* Kakizoe, Maruyama & Masumoto, a **new genus** and **new species** of the tribe Rhyparini, is described based on a single female from Borneo. It is allied to the genus *Sybacodes* Fairmaire, 1896, but easily distinguished by its short protarsi, broad flattened basal tarsomeres of the meso- and metatarsi, broad flattened tibiae, and wrinkled pronotal and elytral surfaces. Checklist of rhyparine species from Borneo is also provided.

**Key words:** *Sybacodes*, *Megasybacodes*, new genus, new species, Oriental region, Malaysia, Southeast Asia, taxonomy, termitophily, myrmecophily

### **Introduction**

The aphodiine tribe Rhyparini (Coleoptera: Scarabaeidae: Aphodiinae) was established by Schmidt (1910a) for the following genera: *Stereomera* Arrow, 1905; *Termitodius* Wasmann, 1894; *Rhyparus* Westwood, 1843 (*sic*) [*nunc Rhyparus* Westwood, 1845]; *Sybacodes* Fairmaire, 1896; and *Notocaulus* Quedenfeldt, 1884. *Stereomera* and *Notocaulus* are currently recognized in Stereomerini Howden & Storey, 1992 and Eupariini Schmidt, 1910 respectively (Howden & Storey 1992). The following 11 genera are currently recognized in Rhyparini: *Aschnarhyparus* Makhan, 2006 from the Neotropical region; *Hadrorhyparus* Howden, 1995 from the Australian region (Fiji); *Leptorhyparus* Howden, 2003 from the Neotropical region; *Lioglyptoxenus* Pittino, 2006 from the Oriental region (Nepal); *Microtermitodius* Pittino, 2006 from the Oriental region (Sumatra); *Monteitheolus* Howden & Storey, 2000 from the Australian region (Fiji); *Nanotermitodius* Howden, 2003 from the Neotropical region (Mexico); *Rhyparus* from all biogeographic regions; *Termitodiellus* Nakane, 1961 from the Oriental region; *Termitodius* from the Neotropical region; and *Sybacodes* from the Oriental region (Pittino 2006; Skelley 2007). We recently examined an extraordinary aphodiine from Borneo. Although the species is highly distinctive among known aphodiines, it has some synapomorphies with the genus *Sybacodes*. Therefore, the present study describes it as a new genus and species of Rhyparini.

### **Material and methods**

The specimen was dried and mounted for morphological observation, but dissected mouth parts were mounted in Euparal on a small glass plate (10×5 mm) and subsequently glued onto a paper card (6×5 mm) and pinned under the specimen (Maruyama 2004). Specimen photographs were taken using an Olympus OM-D E-M1 Mark II camera with a Canon MP-E 65 mm 1–5× macro lens and KIPON EF-MFT AF adapter or an Olympus BX43 microscope equipped with an Olympus E-5 camera and subsequently stacked using CombineZP software. Images

were edited using Adobe Photoshop CS6 (ver. 13.0.6 x64, Adobe Systems Inc.). Species description terminology followed Krikken & Huijbregts (1987), Skelley (2007), and Dellacasa *et al.* (2010). Because of obvious rarity of this new taxon, no additional specimens have been found. However, the collected female is quite different from all previously described taxa of Rhyparini. Therefore we describe here this new taxon on the basis of single female. It would probably be extremely difficult to collect additional specimens during next few years.

## Taxonomy

### Tribe Rhyparini Schmidt, 1910

“Gruppe” Rhyparina Schmidt, 1910a: 130 (diagnosis).

Tribus Rhyparina: Schmidt, 1922: 524 (diagnosis).

Rhyparini: Janssens, 1946: 8 (in key only); Janssens, 1949: 24 (in key only); Balthasar, 1964: 602 (diagnosis); Howden & Storey, 1992: 1811 (diagnosis); Stebnicka & Howden, 1996: 115 (diagnosis).

Type genus: *Rhyparus* Westwood, 1845.

See Howden & Storey (1992), Pittino (2006), and Skelley (2007) for detailed description.

### *Megasybacodes* Kakizoe, Maruyama & Masumoto, new genus

(Figs. 1–5)

**Type species.** *Megasybacodes brevitarsis* new species, here designated.

**Description.** Body (Figs. 1–3) elongate, strongly convex dorsally, color uniformly blackish-brown, matt, generally opaque. Head (Figs. 1–3) large, wide. Clypeus weakly rounded anteriorly, apically pointed and reflexed under head. Clypeocentral disc flat, sparsely punctate-microsetose, punctures weak. Vertex with two pairs of short, longitudinal ridges, densely punctate-microsetose, punctures strong. Genal tips strongly angular in dorsal view, slightly rounded anteriorly, straight posteriorly. Mouthparts small, except for elongate maxillary palpi. Eyes large, visible in dorsal view. Antennae 9-segmented with 3 lamellae, short, amber colored, pubescent. Pronotum (Figs. 1, 3) large and transverse, convex, with six longitudinal carinae, densely inconspicuously punctate-microsetose, inner carinae (paramedian) complete, slightly outwardly sinuate posterior 1/6, adjacent carinae (discolateral) distinctly interrupted anterior 1/4, outer carinae (submarginal) broad, slightly rounded, all carinae extending to anterior and posterior pronotal margin, inner surface of carinae distinctly wrinkled, anterior pronotal margin weakly rounded in dorsal view, lateral pronotal margins strongly protruding horizontally near posterior 1/5. Scutellum (Fig. 1) triangular, notably small, narrow, apically acute. Elytra (Figs. 1, 3) elongate, convex, with four distinctly elevated carinae and eight weak carinae, each topped with rows of inconspicuous setae, interrupted before apex, inner surface of carinae distinctly wrinkled. Macropterous. Mesosternum (Fig. 2) narrow, surface punctate with moderate setae. Metasternum (Fig. 2) slightly convex ventrally, lozenge-shaped, densely punctate-microsetose, distinctly grooved along midline. Abdomen (Fig. 2) with five visible sternites apparently fused, densely punctate-microsetose, first four narrow, wider laterally, apical sternite (anal sternite) notably broad, approximately as long as sum of first four sternites length in middle. Legs (Figs. 1–4) short with broad femora and tibiae. Femora with ventral surface densely punctate-setose. Profemora invisible in dorsal view. Protibiae flattend, broad, gradually widening from base to apex, strongly protruding apically, with a row of setae dorsally. Meso- and metatibiae flattend, broad, dorsal and ventral surface punctate-setose, gradually denser from base to apex. Protarsi pentamerous, short. Meso- and metatarsi pentamerous, short, basal tarsomere notably broad-flattened. All claws slightly weak, symmetric. Epipharynx (Fig. 5) small, vertically long, anterior margin weakly sinuate at middle, adapted mainly for saprophagy. Epitorma broad, pubescent. Pedia glabrous, with lateral elongate spines serially arranged. Chaetoparia short and dense. Acanthoparia short and weak.

**Diagnosis.** This genus is similar to the genus *Sybacodes* in general appearance but is easily distinguished. The combination of the following character states diagnoses of *Megasybacodes*: (1) large species (over 8.0 mm); (2) distinctly broad flattened basal tarsomere of the meso- and metatarsi; (3) broad flattened tibiae; and (4) densely wrinkled pronotal and elytral surfaces.

**Etymology.** A combination of the Greek word *megas* (μέγας) meaning “large” and *Sybacodes*, one of the genus of Rhyparini, in reference to synapomorphies between the two.

**Gender.** Masculine.

***Megasybacodes brevitarsis* Kakizoe, Maruyama & Masumoto, new species**

(Figs. 1–5)

**Type material.** Holotype, female, deposited in the Kyushu University Museum, Fukuoka, Japan: MALAYSIA, Borneo, Sabah, Near Keningau, IV 2003, local collector leg.

**Description of holotype female.** Head (Figs. 1–3) narrower than pronotum with a ratio of pronotal width to head width ca. 1.06; clypeus densely punctate-microsetose. Pronotum (Figs. 1, 3) distinctly shorter than elytra with a ratio of elytral length to pronotal length ca. 1.98, with surface strongly wrinkled except carinae. Elytra (Figs. 1, 3) with a ratio of length to width ca. 1.39; strongly wrinkled and almost glabrous except for microsetae at top of carinae. Protibiae (Fig. 1) densely setiferous near apex. Mesotibiae (Fig. 1) densely setiferous on anterior and lateral margins. Metatibiae (Fig. 1) with setae of similar densities to mesotibiae.

**Male.** Unknown.

**Measurements.** Body length 8.91 mm; maximum width of head 2.51 mm; median dorsal length of pronotum 2.66 mm, maximum width 3.71 mm; sutural length of elytra 5.27 mm, maximum width 3.79 mm; maximum width of epipharynx 0.52 mm.

**Diagnosis.** This species is similar to the members of the genus *Sybacodes* in general appearance but is easily distinguished by the generic diagnostic features described above.

**Etymology.** A combination of the Latin word *brevis* meaning “short” and *tarsi*, in reference to the short tarsi.

**Distribution.** Borneo.

**Checklist of rhyparine species known from Borneo:**

***Rhyparus* Westwood, 1845**

Type species. *Rhyparus desjardinsii* Westwood, 1845

= *Ryparus* Dejean, 1833 [*nomen nudum*]

= *Ryparus* Westwood, 1843 [incorrect publication year, see Dellacasa (1997)]

= *Ryparus* Westwood, 1845 [junior homonym of *Ryparus* Spinola, 1844 (Coleoptera: Cleridae)]

= *Rhyparus* Agassiz, 1846 [incorrect publication year, see Smith (2006)]

= *Rhyparus* Agassiz, 1847 [See note below]

= *Antrisis* Pascoe, 1866

Type species. *Antrisis saundersi* Pascoe, 1866

Note. Because *Rhyparus*, an unjustified emendation by Agassiz (1847) of *Ryparus* Westwood, 1845, is in prevailing use in the Coleoptera and attributed to Westwood (e.g. Schmidt 1910a, 1910b, 1922), it is deemed to be a **justified emendation** (ICZN 1999, Articles 19.2., 32.2.2., 33.2.3.1., 50.4.); the name *Rhyparus* Westwood, 1845 is to be maintained as the correct spelling (see also Dellacasa 1997; Smith 2006).

***Rhyparus accessoricostatus* Mencl, Rakovič & Král, 2013**

Type locality. “Borneo, Sabah, Crocker Mt., Gunung Emas, 500–1900 m a. s. l.”.

Distribution. Malaysia: Sabah.

***Rhyparus adebratti* Bordat, 1996**

Type locality. “Malaysia, Sabah, Sipitang, Mendolong”.

Distribution. Malaysia: Sabah.

***Rhyparus approximans* Fairmaire, 1893**

Type locality. “Bornéo occ., Sambas”.

Distribution. Indonesia: West Kalimantan (Fairmaire 1893); “Bornéo” (Bordat 1996).

***Rhyparus burckhardti* Paulian, 1989**

Type locality. “Sabah: Tambunan”.

Distribution. Malaysia: Sabah (Paulian 1989); “Bornéo” (Bordat 1996).

***Rhyparus danielssoni* Bordat, 1996**

Type locality. “Malaysia, Sabah, Sipitang, Mendolong”.

Distribution. Brunei; Malaysia: Sabah (Bordat 1996).

***Rhyparus dentatus* Fairmaire, 1896**

Type locality. “Bornéo”.

Distribution. “Bornéo”.

***Rhyparus denticollis* Fairmaire, 1893**

Type locality. “Java orient.: Mont Ardjoeno [= Mt. Arjuno]”.

Distribution. Indonesia: East Java (Fairmaire 1893); “Bornéo” (Bordat 1996).

***Rhyparus helophoroides* Fairmaire, 1893**

Type locality. “Bornéo occ.: Sambas; Java: Simpar et Kemanglen, rés. Tegal”. Distribution. Australia (introduced): New South Wales (Stebnicka 2009, Stebnicka & Howden 1996), Queensland (Lea 1923). Indonesia: Central Java, West Kalimantan (Fairmaire 1893), West Papua (Stebnicka 1998); Japan: Honshu, Kyushu, Shikoku, Ryukyus (Ochi 2001, Kawai *et al.* 2005); Malaysia: Sabah (Ochi 2001); Papua New Guinea: Central Province, Eastern Highlands, Morobe (Paulian 1984, Stebnicka 1998); The Philippines: Luzon (Paulian 1981), Negros Island (Ochi 2001); Vanuatu (Paulian, 1981); Taiwan (Ochi 2001); “Bornéo” (Bordat 1996).

= *Rhyparus helephoroides* [incorrect subsequent spelling]; Schmidt (1910b).

= *Rhyparus amamianus* Nakane, 1956.

Type locality. “Sumiyo, Amami-Oshima”.

Synonymised by Ishida & Fujioka (1988).

= *Rhyparus australiae* Lea, 1923.

Type locality. “Queensland: Cairns district”.

Synonymised by Stebnicka & Howden (1996).

= *Rhyparus orousseti* Paulian, 1981.

Type locality. “iles Philippines, Luzon, Mountain Prov., Baguio, 1500 m”.

Synonymised by Stebnicka (1998).

= *Rhyparus risbeci* Paulian, 1934.

Type locality. “Nouvelles-Hébrides”.

Synonymised by Stebnicka (1998).

***Rhyparus kinabalu* Paulian, 1989**

Type locality. “Sabah: Mt. Kinabalu, 1150 m route Ranau-Kota Kinabalu”.

Distribution. Malaysia: Sabah.

***Rhyparus magnus* A. Schmidt, 1911**

Type locality. “Banjoewangi [= Banyuwangi] (Java)”.

Distribution. Indonesia: East Java; “Bornéo” (Bordat 1996).

***Rhyparus micros* Bordat, 1996**

Type locality. “Malaysia, Sabah, Sipitang, Mendolong”.

Distribution. Malaysia: Sabah.

***Rhyparus minor* Paulian, 1989**

Type locality: “Sabah, E Mt. Kinabalu, 1180 m route Ranau-Kota, Kinabalu”.

Distribution. Malaysia: Sabah.

***Rhyparus peninsularis* Arrow, 1905**

Type locality. “Malay peninsula Penang, Perak”

Distribution. Malaysia: Penang, Perak (Arrow, 1905); Sabah (Paulian 1989); [?] Taiwan (Balthasar, 1964).

***Rhyparus pseudominor* Bordat, 1996**

Type locality. “Malaysia, Sabah, Sipitang, Mendolong”.

Distribution. Malaysia: Sabah.

***Rhyparus saundersii* (Pascoe, 1866) (*Antrisis*).**

Type locality. “Sarawak”.

Distribution. Malaysia: Sarawak.

***Rhyparus xanti* (Frivaldszky, 1883) (*Antrisis*).**

Type locality. “Borneo: m. Matang [= Gunung Matang]”.

Distribution. Malaysia: Sarawak (Frivaldszky 1883); Sabah (“N. Borneo, Sandakan”), “Bornéo” (Bordat 1996).

= *Rhyparus xanthi* [incorrect subsequent spelling]: Schmidt (1910b).

***Termitodiellus* Nakane, 1961**

Type species. *Termitodiellus esakii* Nomura, 1943

***Termitodiellus hammondi* Krikken & Huijbregts, 1987**

Type locality. “Sarawak: 4th Division: Gunung Mulu NP, Camp envs, 150–200 m”.

Distribution. Malaysia: Sarawak.

***Termitodiellus besucheti* (Paulian, 1983)**

Type locality. “Malaisie, Johor: env. de Dohol, Kota Tinggi”.

Distribution. Malaysia: Johor (Paulian 1983), Kuala Lumpur (Pittino 2006); “Bornéo” (Bordat 1996); Sumatra (Krikken & Huijbregts 1987).

= *Termitodiellus neglectus* Krikken & Huijbregts, 1987

Type locality. “Sumatra: Palembang”.

Synonymised by Bordat (1996).

***Sybacodes* Fairmaire, 1896**

Type species. *Sybacodes lutulentus* Fairmaire, 1896

***Sybacodes borneensis* Minkina, Mencl & Bellmann, 2018**

Type locality. “Borneo, Sabah Mt. Kinabalu Nat. Park, Poring Hot Spgs., 495m”.

Distribution. Borneo.

***Megasybacodes* Kakizoe, Maruyama & Masumoto, new genus**

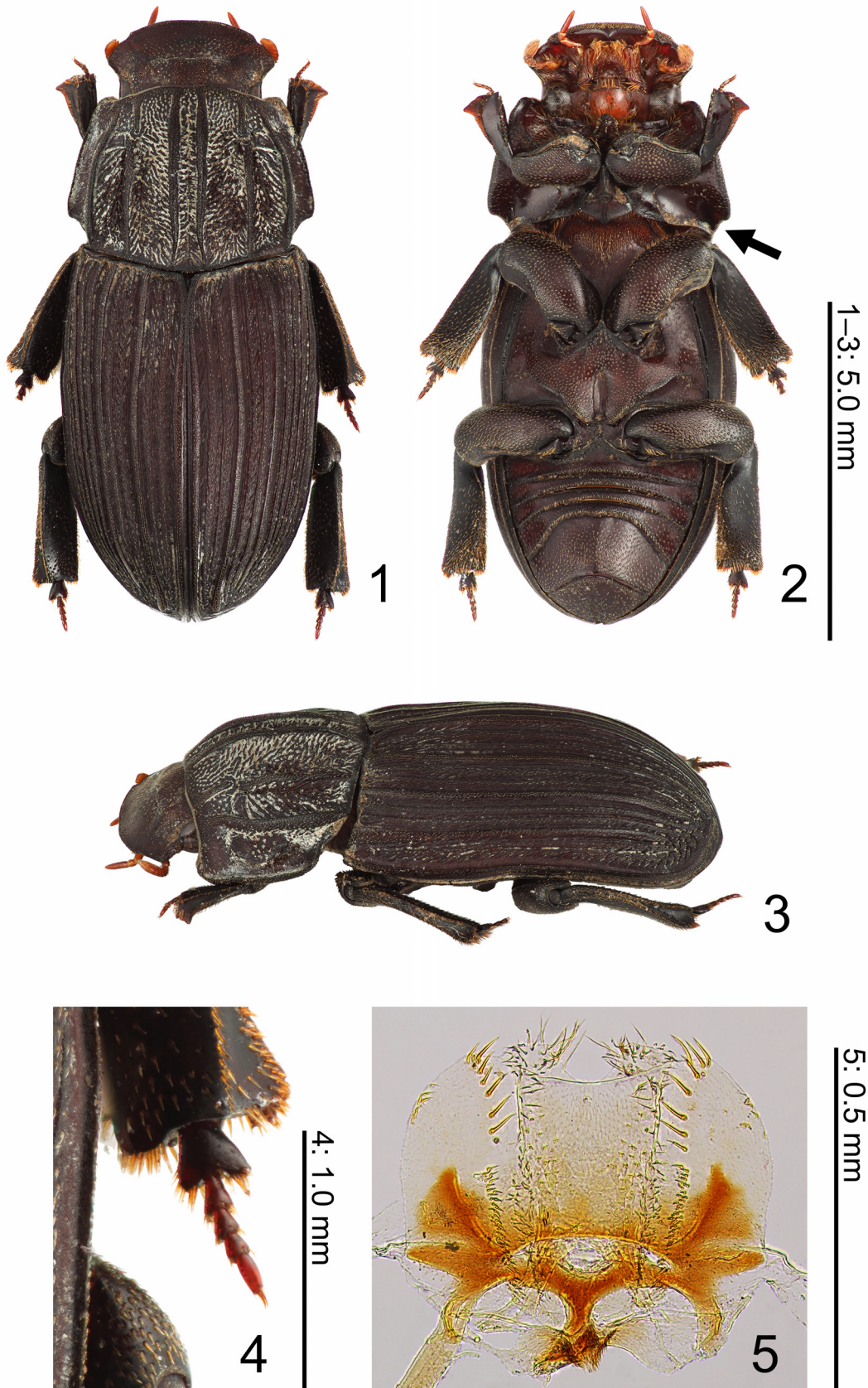
Type species. *Megasybacodes brevitarsis* Kakizoe, Maruyama & Masumoto, new species

***Megasybacodes brevitarsis* Kakizoe, Maruyama & Masumoto, new species**

Type locality. “Malaysia: Borneo, Sabah, Near Keningau”.

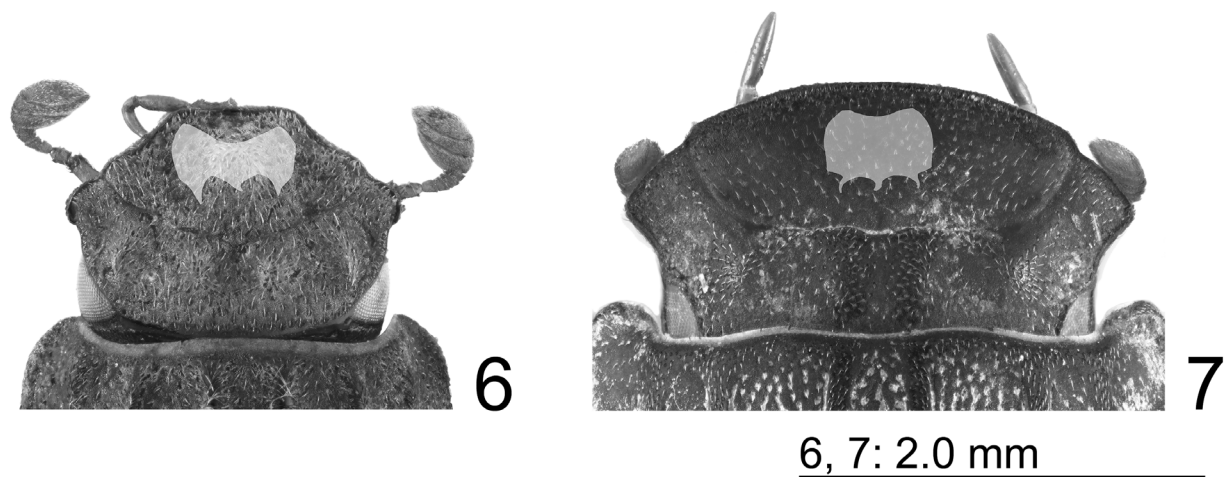
Distribution. Borneo.

See Dellacasa (1978), Krikken & Huijbregts (1987), Bordat (1996), Mencl *et al.* (2013) and Minkina *et al.* (2018) for details.



**FIGURES 1–5.** *Megasybacodes brevitarsis* Kakizoe, Maruyama & Masumoto, new genus and new species (holotype, female). 1, dorsal view; 2, ventral view; 3, dorso-lateral view; 4, right mesotarsus (dorsal view); 5, epipharynx. Scale bar = 5.0 mm for Figs. 1–3, 1.0 mm for Fig. 4 and 0.5 mm for Fig. 5.





**FIGURES 6–7.** Comparison of epipharyngeal size in the genus *Sybacodes* and *Megasybacodes* new genus. 6, head of *Sybacodes lutulentus alternatus* Fairmaire, 1897 (white part shows size of epipharynx); 7, head of *Megasybacodes brevitarsis* Kakizoe, Maruyama & Masumoto, new genus and new species (white part shows size of epipharynx). Scale bar = 2.0 mm.

## Discussion

**Relationship with other rhyparine genera.** The genus *Megasybacodes* new genus shares the following character states with the other rhyparine genera: presence of two antero–median lobes (Ochi, Kon & Kawahara 2018) and the completely broad (does not become a teardrop shape) epitorma of the epipharynx; presence of two pairs of longitudinal ridges of the vertex (in *Megasybacodes* new genus, the outer pair is very weak); presence of three pairs of longitudinal costae on the pronotum; a notably broad apical sternite; and truncate apical margins of all tibiae. These states are unique to Rhyparini within Aphodiinae. Therefore, it is clear that *Megasybacodes* new genus belongs to Rhyparini.

The relatively simple elytra (not strongly modified as in *Rhyparus* and its allies; caudal bulbs in elytral apex not developed; and lack of trichomes) and the clear margins of both pronotal sides are shared with *Sybacodes*. These character states are apparently plesiomorphic in Rhyparini, and the other rhyparine genera are clearly monophyletic in sharing the autapomorphies of the modified elytra. Therefore, *Megasybacodes* new genus and *Sybacodes* could have branched off from the other rhyparine genera. The monophyletic/paraphyletic relationships of *Megasybacodes* new genus and *Sybacodes* are unknown.

Although *Megasybacodes* new genus is quite similar to *Sybacodes*, it possesses several unique character states that distinguish it as a distinct genus, especially the strongly and widely furrowed anterior part of the prosternum (Fig. 2), broadly inflexed epipleura (Fig. 2), broad flattened basal tarsomere of the meso- and metatarsi (Figs. 1–4), notably small and simplified epipharynx (Figs. 5, 7), and wrinkled pronotal and elytral surfaces (Figs. 1, 3). These states are apparently apomorphic within Rhyparini.

**Possibility of myrmecophily or termitophily.** Some morphological states are commonly observed in myrmecophilous and termitophilous beetles (Parker 2016) and suggest these kinds of habitat in *Megasybacodes* new genus, *i.e.*, notably small simple mouthparts, short antennae (Figs. 1–3), short tarsi (Figs. 1–4), broad flattened basal tarsomere of the meso- and metatarsi (Figs. 1–4), short broad flattened tibiae (Figs. 1–2), broad hollows of the pro- and metasternum (Fig. 2), and broadly inflexed epipleura (Fig. 2). Certain defensive character states, such as short broad flattened legs and characteristic furrows on the pro- and metasternum (Fig. 2, arrow) are unique character states in this genus within Rhyparini and might contribute to leg storage. The short antennae may protect against attacks by ants or termites, as in other myrmecophilous beetles (Parker 2016). This suggests that *Megasybacodes* new genus are synechthrans (treated with hostility by its hosts) in the Wasmannian framework for inquiline insects (Wasmann 1894).

The structure of the epipharynx is quite simple, as in other myrmecophilous (e.g., the genus *Pterobius* Maruyama, 2010) and termitophilous (e.g., the genus *Termitotrox* Reichensperger, 1915, see Kakizoe & Maruyama

2015) aphodiines. This fact implies that the adult stage of *Megasybacodes* does not eat anything or is fed liquid food by social insects, such as ants or termites, as hypothesized in the obligatory termitophilous tribe Corythoderini (Tangelder & Krikken 1982). However, considering that it has defensive character states as mentioned above, it is unlikely that *Megasybacodes* new genus is fed liquid food by social insects.

In Rhyparini, termitophily has also been confirmed in the genera *Termitodius* and *Termitodiellus* (Nomura 1943; Reyes-Castillo & Martínez 1979). According to Nomura (1943, Fig. D), the epipharynx of *Termitodiellus esakii* (Nomura, 1943, originally *Termitodius esakii*) is simplified with no setae in the median portion compared with that of the genus *Rhyparus*. This epipharyngeal character state is similar to that of *Megasybacodes* new genus. However, because it is possible that this is a simplified diagram, it is necessary to review the morphology of the mouthparts of other termitophilous Rhyparini, including *Termitodiellus esakii*, in future studies.

In the tribe Stereomerini, closely related to Rhyparini, which has been recorded as termitophilous (Howden & Storey 1992; Maruyama & Nomura 2011) or myrmecophilous (Kráľ & Hájek 2015). The epipharynx of Stereomerini has been only described for *Australoxenella humptydooensis* Stebnicka & Howden 1996. According to Stebnicka & Howden (1996), the epipharynx of *A. humptydooensis* is extremely simple with absolutely no setae.

Therefore, epipharyngeal structures probably reflect a symphilic lifestyle. Examining the other structures of the mouthparts of myrmecophilous and termitophilous beetles may make it possible to understand the morphological changes associated with the evolution of myrmecophily or termitophily and estimate the ecology of a species based on morphological character states. Therefore, it is an important topic for future study.

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