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A new genus and species of flightless, microphthalmic Corythoderini (Coleoptera: Scarabaeidae: Aphodiinae) from Cambodia, associated with *Macrotermes* termites

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Abstract

Eocorythoderus incredibilis, a **new genus** and **new species**, of Corythoderini is described. This new species was found in fungus gardens of *Macrotermes gilvus* (Hagen, 1858) in Angkor Wat, Cambodia. The new taxon is a flightless, microphthalmic species and the first corythoderine associated with *Macrotermes* Holmgren, 1910. The beetles were observed being carried by worker termites. *Eocorythoderus* is probably closely related to the genera *Corythoderus* Klug, 1845 and *Paracorythoderus* Wasmann, 1918 (also Corythoderini). Some character states shared with the distantly-related termitophilous scarab genus *Termitotrox* Reichensperger, 1915 (Termitotrogini) are noted, and proposed as convergent.

Key words: Termitophile, fungus garden, *Odontotermes*, Oriental region, convergence

Introduction

Members of the tribe Corythoderini (Coleoptera: Scarabaeidae: Aphodiinae) are highly-modified, termitophilous scarabs associated with the fungus-growing termite genus *Odontotermes* Holmgren, 1912. In their comprehensive revision of the tribe, Tangelder & Krikken (1982) recognized five genera and 34 species from Africa through India, Sri Lanka, and Myanmar, namely, *Chaetopisthes* Westwood, 1847 (20 species from India), *Termitopisthes* Wasmann, 1918 (seven species from India, Sri Lanka, and Myanmar), *Corythoderus* Klug, 1845 (three species from Africa), *Paracorythoderus* Wasmann, 1918 (three species from Africa) and *Hemicorythoderus* Tangelder & Krikken, 1982 (one species from Africa). Recently, I collected an extraordinary flightless, microphthalmic scarab from fungus gardens of the genus *Macrotermes* Holmgren, 1910 in Angkor Wat, Cambodia. Although the species is distinctive among known termitophilous scarabs, it shares some synapomorphies with *Corythoderus* and *Paracorythoderus*. This paper describes it as a new genus and species of Corythoderini.

Material and methods

Fungus gardens of the host termite *Macrotermes gilvus* (Hagen, 1858) were dug out from 1–2m-high soil slopes alongside a road. When a fungus garden was uncovered on the slope, it was removed and carefully dissected on a white tray (25×40 cm) to find symbionts. More than 130 fist-sized fungus gardens were examined, but only 10 beetles were found. Habitus photographs of specimens were taken with a Canon EOS 60D and Canon MP-E65 2.8 1–5× macro lens and mounted using the automontage software CombineZM. Those of living specimens in the field were obtained with a Canon EOS 7D and EF-S60mm F2.8 Macro USM plus Kenko Extension Tubes. The terminology follows Tangelder & Krikken (1982), but “posterior impression” of the pronotum is used instead of “caudal impression”. The type series are deposited in my collection in the Kyushu University Museum, Fukuoka, Japan (KUM); Canadian Museum of Nature, Ottawa, Canada (CMN); and The Natural History Museum, London, United Kingdom (NHM).

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Tribe Corythoderini

See, Tangelder & Krikken (1982) for synonymies and detailed description.

Remarks. The new genus exhibits several unique character states that have not been seen before in Corythoderini. The new taxon therefore broadens the tribal diagnosis of Tangelder & Krikken (1982) to include: body cylindrical or panduriform (in *Eocorythoderus*); gena small or large (in *Eocorythoderus*); pronotum with or without (in *Eocorythoderus*) median sulcus; pronotal lateral lobes absent in one exception (in *Eocorythoderus*); legs rather slender or stout (in *Eocorythoderus*).

Eocorythoderus new genus

(Figs. 1–7)

Type species. *Eocorythoderus incredibilis* new species, here designated.

Etymology. A combination of *Eos,* the Greek goddess of the dawn, and *Corythoderus*, the type genus of Corythoderini, in reference to the new taxon having the eastern-most distribution of the genera in the tribe. Gender: masculine.

Diagnosis. The combination of the following character states diagnose *Eocorythoderus*: (1) body distinctly panduriform; (2) clypeal margin rounded; (3) eyes small, dorsally invisible; (4) pronotum with a pair of shallow depressions medially, (5) pronotum without median sulcus; (6) pronotum without trichome; (7) elytron with base of first and second intervals strongly elevated, to form a large median dorsal projection (Fig. 2: arrow); (8) elytron with basal knob-shaped protrusion; (9) elytron with 5 striae; (10) mesocoxal cavities widely separated; (11) mesolegs distinctly longer than others; (12, 13) mesofemora and metafemora broad, oval; (14, 15) mesotibiae and metatibiae narrowed apically.

Description. Body (Figs. 1–7) short, distinctly panduriform. Head (Figs. 1–3) slightly convex above; clypeus with gently broadened lateral margins; anterior margin rounded, slightly reflexed along anterior margin; eyes (Fig. 4) small, dorsally invisible. Pronotum (Figs. 1–3) strongly convex above, much higher than length; posterior impression shallow, short, extending from middle to base of median lobe; with a pair or shallow depressions medially; median lobe triangular, with dense setiferous punctures except for mesal area. Elytra (Figs. 1, 2) short, oval, strongly convex dorsally, but lower than pronotum; disc with 5 striae; each elytron with large basal elevation on intervals I and II to form median projection, which is densely covered with small trichomes at apex; base of intervals III-V with two rather low tubercles to form basal knob-shaped protrusion. Mesoventrite (Fig. 4) with intercoxal area broad, distinctly margined laterally. Metaventrite (Fig. 4) short, much shorter than mesoventrite. Proleg (Fig. 4) short; femur oblong oval; tibia short, bidentate near apex; tarsus slightly dilated apicad. Mesoleg (Fig. 4) stout, long, longer than metaleg; femur oval, broad, flattened, with posterior sulcus to hold tibia; tibia dilated apicad; tarsus narrowed apicad. Metaleg (Fig. 4) similar in shape to mesoleg, but shorter; femur slightly constricted near base. Pygidium (Fig. 4) with a pair of shallow depressions (perhaps this character is sexual dimorphic).

Eocorythoderus incredibilis new species

(Figs. 1–7)

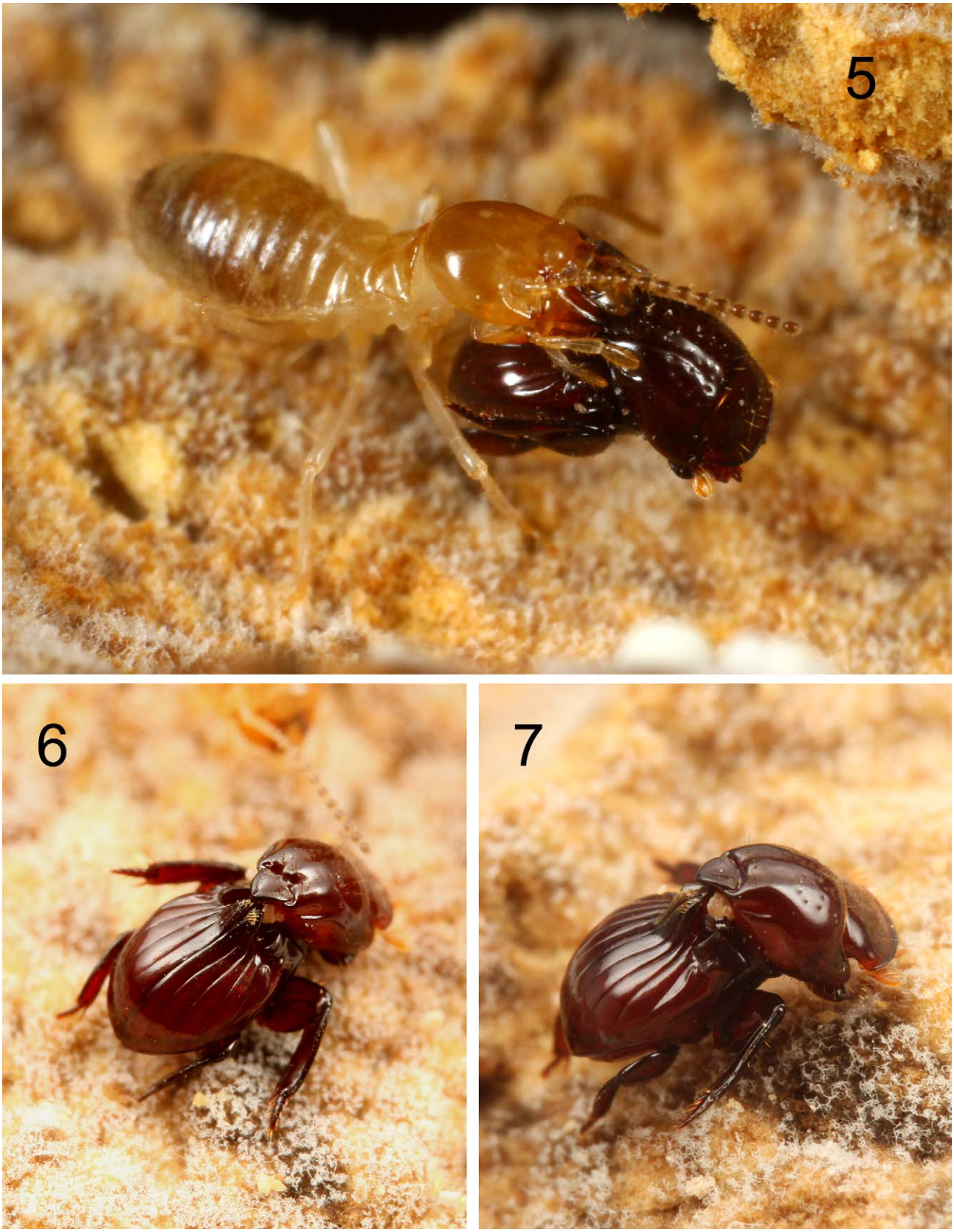
Type series. Holotype, female, 1.0 km southwest of Angkor Wat, Angkor, Siem Reap, Cambodia, 5 VI 2012, M. Maruyama leg. (KUM). Paratypes: 1 female, same data as holotype (KUM); 6 females, 1.0 km south of Angkor Wat, Angkor, Siem Reap, Cambodia, 18 VIII 2012, M. Maruyama leg. (CMN, KUM, NHM); 1 female, same data but 22 VIII 2012 (KUM); 1 female, north of Preah Khan, Angkor, Siem Reap, Cambodia, 18 VIII 2012, M. Maruyama leg. (KUM). In fungus gardens of *Macrotermes gilvus.*

Distribution. Northwestern Cambodia.

Etymology. The specific epithet means incredible, due to its extraordinary appearance and unexpected discovery in Cambodia.

Diagnosis. This species is readily distinguished from other Corythoderini by the genus diagnosis above, especially by the panduriform body shape and the stout, long mesolegs. Other corythoderine genera have more or less cyrindrical bodies and slender, short (shorter than metalegs) mesolegs.

FIGURES 1–4. *Eocorythoderus incredibilis* **new genus** and **new species**. 1, Holotype, dorsal view. 2, Paratype, lateral view. 3, Paratype, anterior view. 4, Paratype, ventral view.



FIGURES 5–7. *Eocorythoderus incredibilis* **new genus** and **new species**. 5, Adult beetle being carried by a worker termite. 6, 7, Adult beetle (holotype) walking on a fungus garden.

Description. Head (Figs. 1–3) slightly narrower than pronotum; clypeus densely punctured along anterior margin; surface with sparse, long setae. Pronotum (Figs. 1–3) slightly shorter than elytra, with surface almost impunctate, sparsely with long setae. Elytra (Figs. 1–3) almost glabrous except for trichomes at apex of median projection. Proleg (Fig. 4) with tibia densely setiferous near apex with small recumbent setae. Mesoleg (Fig. 4) with trochanter with 3 or 4 setae; femur with about 10 setae on anterior margin, 8–10 setae around posterior margin; tibia moderately setiferous along lateral margins with long setae. Metaleg (Fig. 4) with setae of similar densities to mesoleg.

Measurements. In mm: Body length, 2.81–2.96; head width, 1.01–1.04; pronotal length, 1.03–1.08; pronotal width, 1.20–1.25; elytral width, 1.35–1.38; mesotibial length, 0.86–0.88.

Discussion

Termite association. Ten *Eocorythoderus incredibilis* beetles were recovered from fungus gardens of *Macrotermes gilvus*, two were being carried by worker termites (Fig. 5). The beetle retracted all of its legs, and the termite worker grasped the beetle's elytral median projection in her maxillae, in the same way as workers carry their own nymphs. The pronotal median lobe and the elytral median projection form a handgrip-like structure that allows the termite to grab the beetle with ease. David Kistner and his wife Alzada Kistner (in Kistner 1982) observed another corythoderine, *Chaetopisthes assmuthi* Wasmann, 1903, being carried by a worker termite in the same way in India. In *Eocorythoderus incredibilis* the pronotal median lobe is covered with setiferous punctures, and the apex of the elytral median projection is covered with small trichomes. All other corythoderines bear trichomes on the posterior margin of pronotum, as well as at the bases or apices of elytra in some species. An exception might be *Hemicorythoderus vaneyeni* (Paulian, 1947); presently it is unclear whether the posterior pronotal margin of this species is completely glabrous or bears setiferous punctures as in *Eocorythoderus*. Wasmann (1903) found secretory tissue in *Chaetopisthes assmuthi* under the posterior part of the pronotum and apices of the elytra where the trichomes arise. It is probable that some kind of chemical substance, secreted from these punctures and trichomes, triggers the carrying behavior of the termite.

Eocorythoderus incredibilis beetles walked quickly between the termites in the fungus garden (Figs. 6, 7). They were very sensitive; when touched with forceps, they stopped moving and retracted their legs for several minutes.

All other corythoderines, as well as the closely related genus *Termitoderus* Mateu, 1966 (the only representative of the tribe Termitoderini known from Africa), are known to be associated with *Odontotermes* termites. Therefore, the finding of *Eocorythoderus incredibilis* from nests of *Macrotermes* termites is remarkable in being the first host record of a corythoderine from a nest of *Macrotermes*.

Phylogeny. Tangelder & Krikken (1982) performed a phylogenetic analysis of corythoderines using 30 morphological characters and showed the following intergeneric relationships: (*Chaetopisthes*, *Termitopisthes* (*Hemicorythoderus* (*Corythoderus*, *Paracorythoderus*))). However, many characters in their matrix, especially those of the pronotum and legs, are absent or ambiguous in *Eocorythoderus*, making it difficult to place the new taxon phylogenetically. Their "*Corythoderus* group"—the clade (*Hemicorythoderus* (*Corythoderus*, *Paracorythoderus*))—is composed wholly of African species (the other two genera are Oriental). Its monophyly is supported by the presence of the median lobe on the pronotum. Although the general appearance is very different, *Eocorythoderus* likely belongs to the *Corythoderus* group since it possesses the pronotal median lobe. *Eocorythoderus* is probably most closely related to *Corythoderus* and *Paracorythoderus* based on the following potential synapomorphies: the basal elevation of the first and second intervals of the elytra (well developed and forming a median projection in *Eocorythoderus*), and the basal knob-shaped protrusion of the elytra. The arrangement and shape of the elytral striae of *Eocorythoderus* are also similar to those in *Corythoderus* and *Paracorythoderus*, but the polarities of these characters are unknown. Therefore, following Tangelder & Krikken's (1982) tree, intergeneric relationships of the tribe may be: (*Chaetopisthes*, *Termitopisthes* (*Hemicorythoderus* (*Corythoderus*, *Paracorythoderus*, *Eocorythoderus*))). It is curious that *Eocorythoderus* is apparently more closely related to African rather than Oriental genera—a finding of critical importance when considering the evolution and biogeographic history of Corythoderini.

Interestingly, the morphology of the mesoleg of *Eocorythoderus* shares some similarity with *Termitotrox* Reichensperger, 1915, the only representative of the tribe Termitotrogini, which is associated with *Odontotermes* termites in Africa and India. The two genera also share flightlessness, microphthalmia (*Termitotrox* is blind) and panduriform body shape (probably related to flightlessness), and the two genera resemble each other in general appearance. Although the phylogenetic position of Termitotrogini is unknown, it likely only distantly related to Corythoderini (Vårdal & Forshage 2010). Hence, the shared character states are apparently due to convergence, suggesting that the two taxa may have similar behaviour and natural history. However, behavioral information for *Termitotrox* is not available at this time.

Distribution. Corythoderines are known mainly from the Ethiopian region and the Indian subregion of the Oriental region, and only a single species is known from western Myanmar, near India. Thus the present finding of *Eocorythoderus* from Cambodia is a geographically distant record in the tribe. I and my colleague have examined numerous nests of *Odontotermes* and *Macrotermes* termites in several localities in Thailand, which is situated between Myanmar and Cambodia. As of yet, no corythoderines have been found. Further investigations in Cambodia and other areas in Indochina, especially southern Vietnam, might yield additional, undescribed corythoderine species.

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