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Frist record of *Protohermes stigmosus* Liu, Hayashi & Yang (Megaloptera: Corydalidae: Corydalinae) in Thailand with the first description of female

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The dobsonfly genus *Protohermes* van der Weele, 1907 (Megaloptera: Corydalidae: Corydalinae) is the most species-rich group in the order Megaloptera with 89 species of the genus being known. The genus is mainly distributed in the Oriental region (87 spp.), and two species are distributed in the Palaearctic region (Martins *et al.* 2022). Adult *Protohermes* are morphologically characterized by the forewing with anterior branch of A2 vein partly fused with stem of A1 vein, and the presence of yellow or white round markings on wings in most species (Yang & Liu 2010).

Thailand is one of the most interesting regions for discovery of megalopterans, because it is a biodiversity hotspot due to its rich diversity and high endemism (Myers *et al.* 2000; Plant 2014; The Sustainability Consortium WRI 2019). The country is composed of Indochina and Sundaic subregions, which has been described as a zoogeographical crossroads or natural gateway from North to South (Luangjame *et al.* 1997). Recently, 21 species of Megaloptera were recorded in Thailand (Piraonapicha *et al.* 2021a). The previously reported Megaloptera fauna of Thailand includes five unidentified *Protohermes* and two named species: *Protohermes furcatus* Liu, Hayashi & Yang, 2008 from Chiang Mai Province, and *Protohermes triangulatus* Liu, Hayashi & Yang, 2007 from Chiang Rai, Chiang Mai, Nan Provinces (see also Liu *et al.* 2008, 2009; Piraonapicha *et al.* 2021a).

Protohermes stigmosus Liu, Hayashi & Yang, 2007 was previously known only from the type locality (Xishuangbanna, Yunnan Province, China) by a single male (Liu *et al.* 2007). The species was classified into the *Protohermes costalis* species group because it has widely separated ocelli and a subcylindrical male ectoproct bearing a ventral tuft (Liu *et al.* 2007). Our recent survey of Megaloptera from Bo Kluea District, Nan Province in northern Thailand found an interesting species of *Protohermes*. Having carefully compared the specimens of this species with the type material of closely related species, we concluded that this species is *P. stigmosus*, a new species record from Thailand. We used the standard DNA barcode from the mitochondrial COI gene to associate the male and female of this species successfully. The barcoding regions of related species with *P. stigmosus* i.e. *P. triangulatus* and *P. furcatus* were also sequenced to construct the tree. All examined non-type materials are deposited in the Thailand Natural History Museum of the National Science Museum, Pathum Thani (**THNHM**). In the present paper, the adult male is redescribed based on Thai specimen, and female of the species is described for the first time.

Taxonomy

Protohermes stigmosus Liu, Hayashi & Yang, 2007

(Figs 1–5)

Protohermes stigmosus Liu, Hayashi & Yang, 2007: 38 figs 20, 123–127; Yang & Liu, 2010: 180, fig. 78; Martins *et al*, 2022: 29.

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Types. Holotype. Male, China (Xishuangbanna Yunnan Province), 31.III.2004, reared from larva, Liang Tang leg., deposited in the Shanghai Normal University (SNU, examined), China.

Non-type material examined. Thailand. One male, Bo Kluea District, Nan Province, 19°11′13.35″N, 101°10′5.91″E, 1006 m a.s.l., 4.III.2020, K. Piraonapicha & L. Khaton leg. leg. (THNHM, THNHM-I-24146, pinned); 1 female, same locality, date, collectors (THNHM, THNHM-I-24147, in alcohol).

Diagnosis. Head without dark markings; pronotum with two pairs of blackish markings at anterolateral corner and three pairs of blackish markings near posterolateral corners; fused gonocoxites 10 medially with a pair of large subtriangular processes, and laterally with a pair of digitiform gonostyli 10, leaving very short lateral arms; female fused gonocoxites 8 with feebly convex posterior margin, medially without any notch; no lateral sac-like lobes between abdominal segments 8 and 9.

Description. Male (Figs 1–3). Measurements (n=1). Total body length 35.1 mm (including mouthparts); head width 6.2 mm, head length 4.8 mm (excluding labrum and mandibles); prothorax length 4.3 mm; prothorax width 4.4 mm; right forewing length 53.2 mm; right forewing width 16.7 mm; right hindwing length 47.6 mm; right hindwing width 18.3 mm; wing spans 101.5 mm.

FIGURE 1. *Protohermes stigmosus*, male in dorsal view. Scale bar: 1 cm.

Head yellow with obtuse postocular spine; compound eyes dark, located anterior to mid-length of head; ocelli located between compound eyes, close to antennal socket, inner margin brown; antennae subserrate, scapes and pedicel yellowish brown, scapes almost twice as long as pedicel, flagellum dark; labrum yellowish brown, subtriangular, shorter than broad, anterior margin distinctly convex, and covered with sparse short setae; mandibles yellow to reddish brown (anterior half reddish brown and posterior half yellow), with long and sharp apical tooth, followed by broad and subtriangular preapical tooth, small subtriangular prebasal tooth, and subtriangular basal tooth (denticles reddish brown); occiput subtriangular, yellow, posterior margin roundly convex in dorsal view.

Pronotum yellow, subquadrate, with two pairs of blackish markings at anterolateral corner and three pairs of blackish markings at posterolateral corner (Fig. 4); mesonotum and metanotum subrectangular, yellow, both clearly broader than long; legs yellow, covered with short dense setae; distal half of protibiae and all protarsi black, meso- and metatarsi with second to fifth tarsomeres black; tarsal claws reddish brown; forewing pale grayish brown, with a subtriangular yellowish brown marking near base, yellowish brown markings at basal 1/3, and with an irregular markings at apical 1/3 and several extremely small yellowish markings on crossveins on apical portion; costal cellules with distinct grayish brown stripes, hindwing entirely hyaline; veins yellow except veins in dark regions of forewing and apical portion of hindwing pale brown; RA 8-branched, with 9 crossveins between RA and RP, MP_{1+2} 4-branched, MP_{3+4} 2-branched. Abdomen yellowish brown.

Genitalia. Tergum 9 subrectangular, clearly broader than long, with anterior margin concave medially as U-shaped and slightly concave posteriorly. Sternum 9 in ventral view subrectangular, clearly broader than long, with median portion apparently inflated; posterior margin of sternum 9 in ventral view widely concave (as U-shaped), and with posterolateral corners forming short, acutely angled digitiform processes. Gonostylus 9 in ventral view slender, unguiform, and curved inward. Ectoproct subcylindrical, short; in ventral view with a feebly developed tufted tubercle located anterior to posterolateral corners on inner margin; tip of ectoproct slightly incised and covered with dense short setae. Callus cerci in dorsal view suboval, connected to posterolateral corners of tergum 9. Fused gonocoxites 10 medially with a pair of large subtriangular processes, and laterally with a pair of digitiform gonostyli 10, leaving very short lateral arms (Fig. 2).

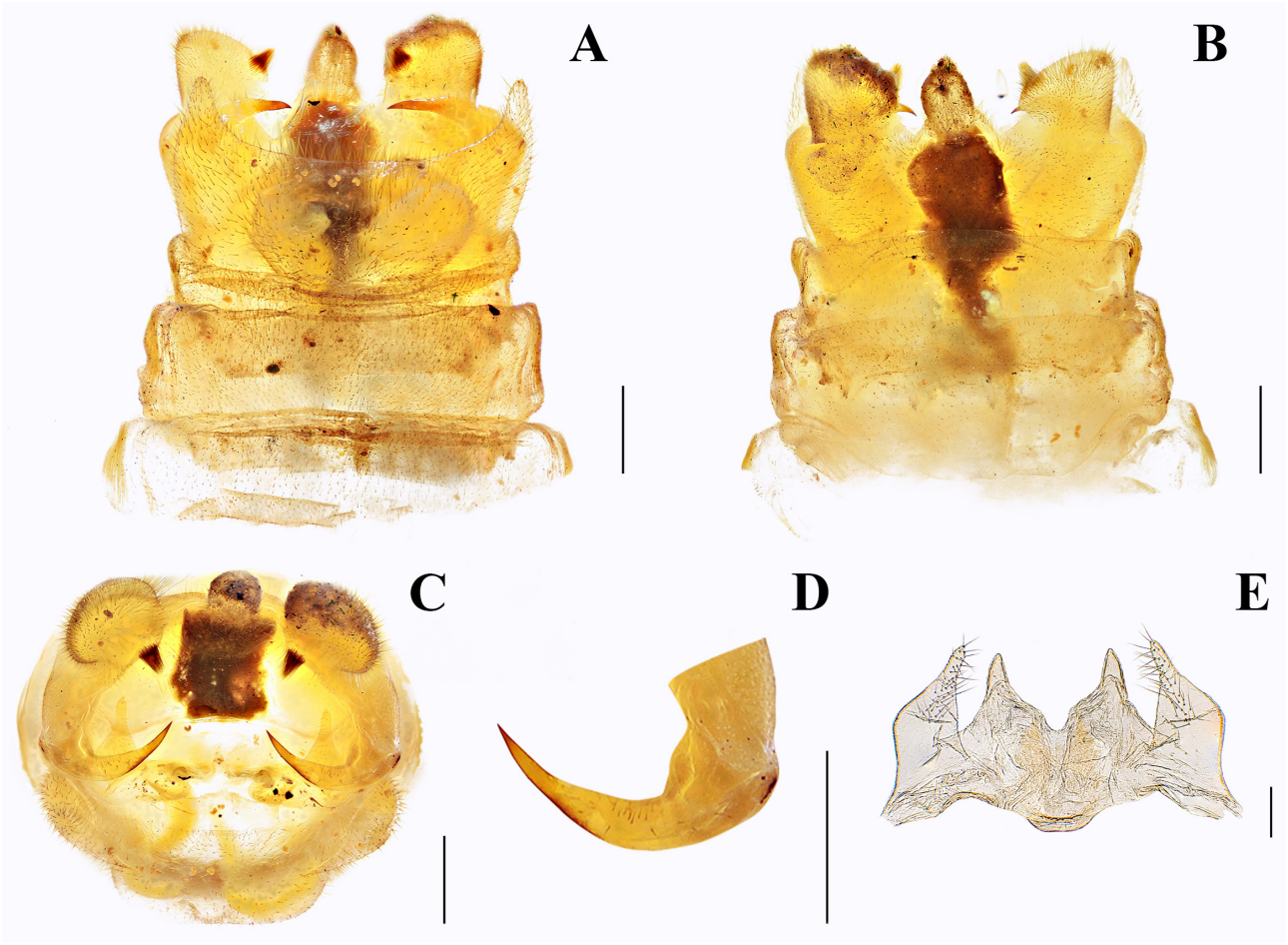

FIGURE 2. *Protohermes stigmosus*, male, **A**. abdominal apex in ventral view, **B**. abdominal apex in dorsal view, **C**. abdominal apex in caudal view, **D**. gonostylus 9, **E**. gonocoxites + gonostyli 10 (the gonocoxites + gonostyli 10 is placed on the slide and the cover glass placed over the specimen). Scale bars: 1 mm (A–D), 0.5 mm (E).

Female. (Figs 3–5). Measurements (n=1). Total body length 27.2 mm; head width 5.3 mm, head length 4.3 mm (excluding labrum and mandibles); prothorax length 3.3 mm; prothorax width 3.8 mm; right forewing length 41.1 mm; right forewing width 13.8 mm; right hindwing length 39.1 mm; right hindwing width 14.8 mm.

Morphologically similar to male, except these following characters: 1) fused gonocoxites 8 in lateral view subtrapezoid, slightly protruding posteriad, in ventral view subrectangular, posterior margin medially slightly convex, and covered with dense short setae; 2) gonocoxite 9 in lateral view broadly subtriangular, slightly incised posteroventrally near tip and with a rather small lobe at tip; 3) upper part of ectoproct in lateral view digitiform, and lower part suboval; 4) callus cerci in lateral view large and suboval, completely fused with ectoprocts (Fig. 5).

DNA barcode data. The mitochondrial COI sequences of our adult specimens are identical for both sexes showing genetic distance = 0. Phylogenetic analysis based on maximum likelihood estimation indicated that an unknown female specimen is conspecific with male adult of *P. stigmosus*. In addition, *P. stigmosus*, *P. triangulates*, and *P. furcatus* are genetically separated by high interspecific variations of COI sequences (Fig. 6).

Distribution. China (Yunnan); Thailand (Nan Province, **New record**).

FIGURE 3. *Protohermes stigmosus*, head and prothorax in dorsal view, **A**. male, **B**. female. Scale bars: 2 mm (A), 5 mm (B).

FIGURE 4. *Protohermes stigmosus*, live adult, female, **A**. habitus in dorsal view, **B**. habitus in lateral view. Scale bars: 1 cm.

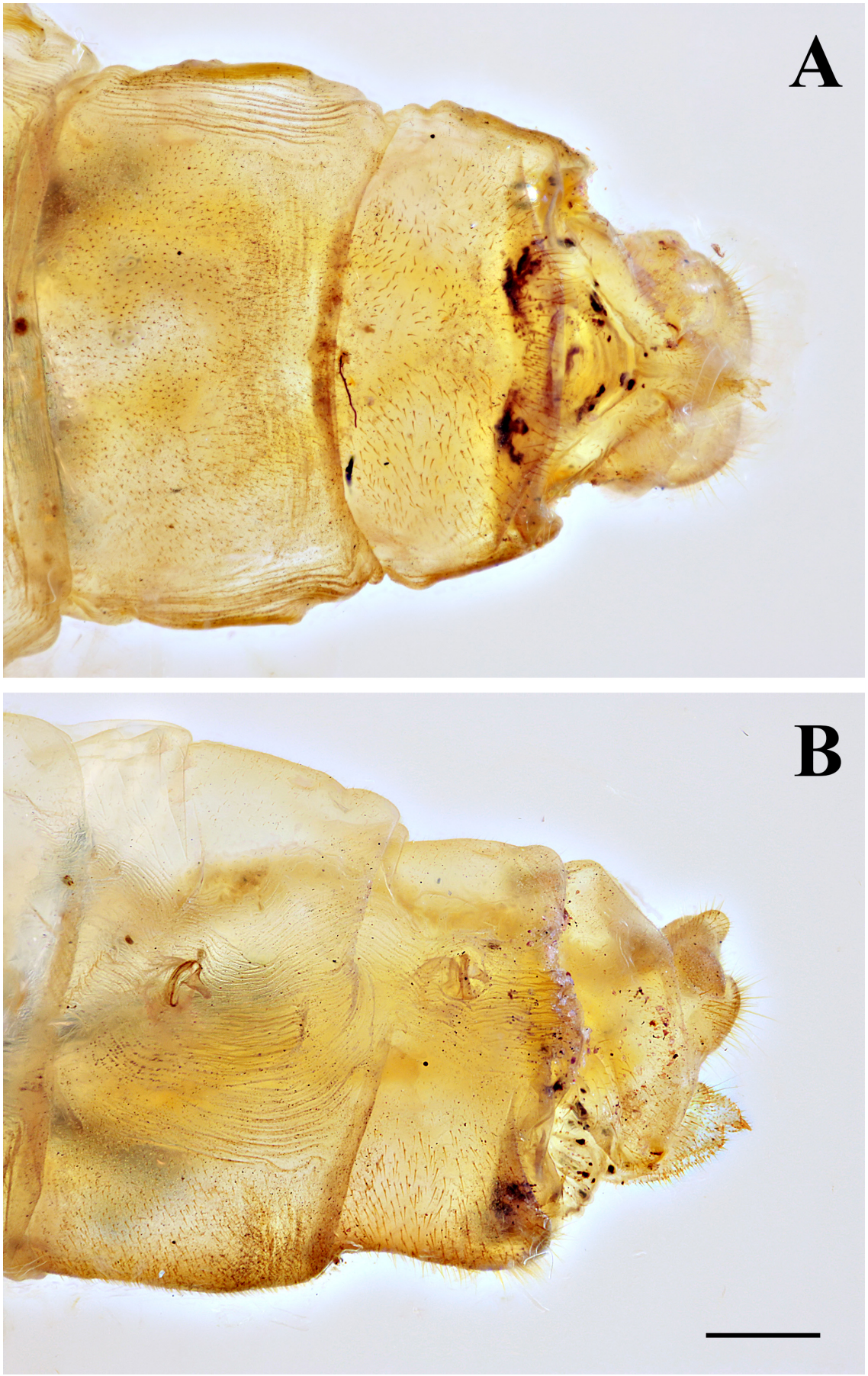

FIGURE 5. *Protohermes stigmosus*, female abdominal apex, **A**. ventral view, **B**. lateral view. Scale bar: 1 mm (A, B).

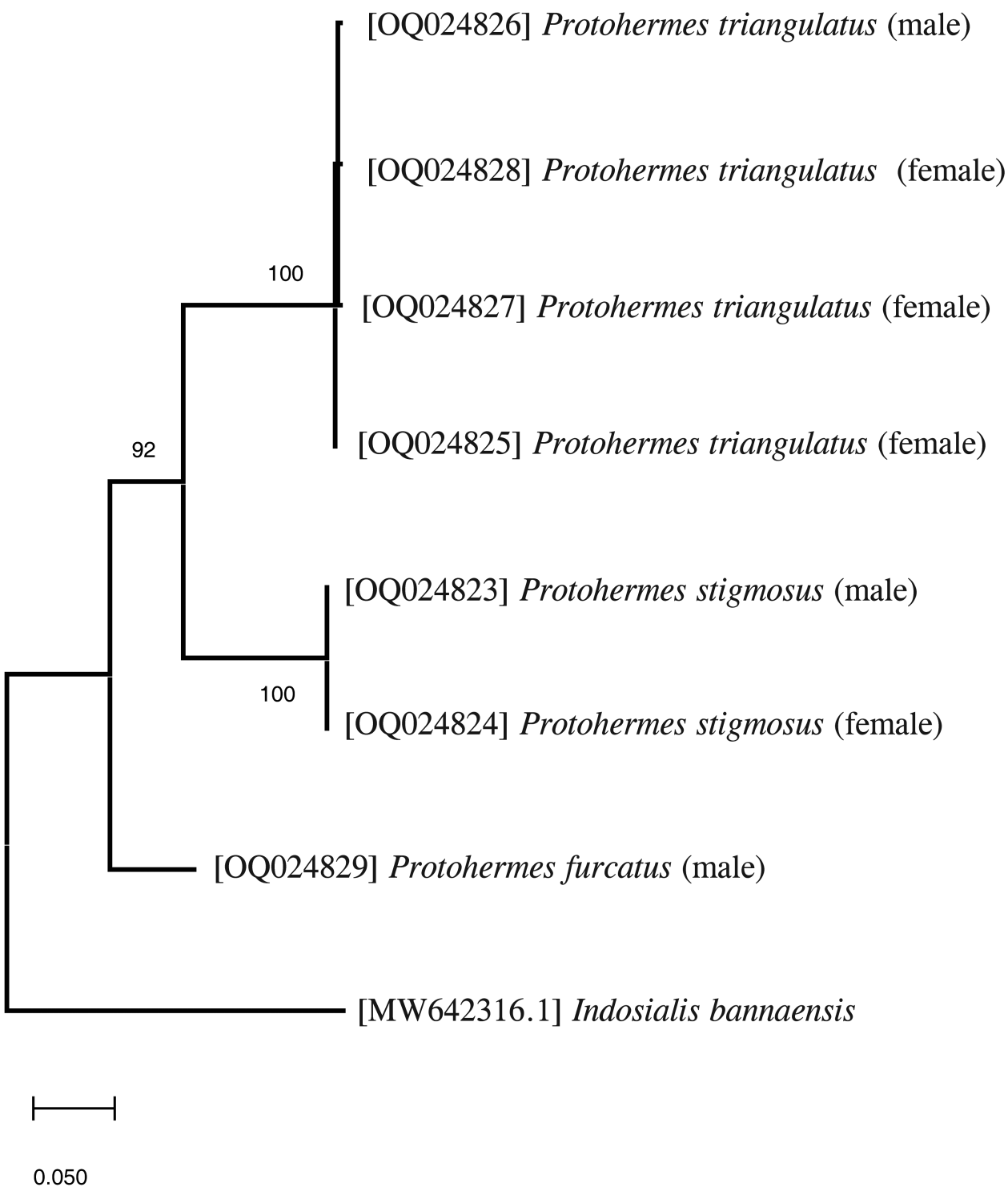

FIGURE 6. Resulting tree from Maximum likelihood analyses of 558 base pairs of the partial COI genes of the three *Protohermes* species recorded in Thailand, including the selected outgroup. Numbers at internodes are bootstrap values (1000 replicates, values < 70% not shown). Scale bar indicates 0.05 nucleotide substitutions.

Remarks. This species can be distinguished from the other members of the *P. costalis* group by the ten small dark spots (five pairs) on the pronotum in both sexes, and by the configuration of male fused gonocoxites 10 with a pair of large subtriangular lobes medially. Among the Thai species of *Protohermes*, *P. stigmosus* somewhat resembles *P. triangulatus* by the more complicated wing patterns. In this study, the female of *P. stigmosus* was collected and described for the first time. It is notable that the female genitalia of this species lacks the sac-like lateral lobes between abdominal segments 8

and 9. This trait is typical in the *P. costalis* group, although there are several species lacking this lobe, such as *Protohermes niger* Yang & Yang, 1988 and *Protohermes basimaculatus* Liu, Hayashi & Yang, 2007 (Liu *et al.* 2007; Chang *et al.* 2013). Whether the lack of the female sac-like lateral lobes indicates close relationships between above species (including *P. stigmosus*) or exclusion of these species from the *P. costalis* group needs further investigation.

Protohermes stigmosus was first described based on a single adult male (reared from a larva) from Yunnan, China (Liu *et al.* 2007). Prior to the current record, no additional specimen had been found since 2007, suggesting possible rareness of this species. The locality of the present record is approximately 1,000 kilometers far from the type locality. Based on the few specimens that have been collected, this species inhabits mountainous areas with elevations ca. 1000 m. The holotype as well as the two males and one female from Thailand were collected in March, thus mating flight of the species might be in the dry season.

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