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The Embiopteran Genus *Oligotoma* Westwood, 1837 (Embioptera: Oligotomidae), with Three New Recorded Species from Thailand

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ABSTRACT

Field sampling was performed at 17 locations within 14 provinces in Thailand by hand collection from January 2008 to July 2011 and resulted in the collection of three distinct species of *Oligotoma*—namely, *O. humbertiana* (Saussure, 1896), *O. nigra* (Hagen, 1885) and *O. saundersii* (Westwood, 1837)—that are new records for Thailand. Details of the important morphological characteristics of the female were added and illustrated. Identification keys to the three species, for both male and female adults, were compiled and the geographic distributions of the three species in this genus in Thailand were also mapped.

Keywords: new record, Embioptera, distribution, Thailand, *Oligotoma*

INTRODUCTION

Webspinners or embiids belong to the order Embiidina (Embioptera), a poorly characterized and often overlooked insect order with approximately 360 known species (Engel and Grimaldi, 2006; Szumik *et al*., 2008). However, Ross (2000a) speculated that the true number was probably nearer to 2,000 species worldwide. Typically, a few species live on remote islands, but some species have spread to several continents through anthropogenic intervention, especially through transport as a result of overseas trade (Ross, 2007). In particular, the genus *Oligotoma*, Westwood, 1837 (Oligotomidae), has expanded extensively by such anthropogenic-assisted colonization (Ross, 2000a, 2007). Oligotomids are readily recognized by their enlarged front tarsi, which contain about a hundred silk glands that are used for silk secretion (Nagashima *et al.*, 1991; Ross, 1955, 2000a) to spin a network of narrow hollow tubes, or galleries.

Because most species are very inconspicuous, spending most of their lives in silk galleries, webspinners are somewhat rarely observed by humans compared to the majority of the more conspicuous insects (Poolprasert and Edgerly, 2011), whilst they cause no economic or known ecological impact upon humans, because they feed on dead plant materials (Ross, 1991, 2007), removing much interest in them. Nonetheless, they are very interesting insects with a unique social behavior and ecology, and also have some primitive morphological characteristics and evolutionary biology.

The webspinner genus *Oligotoma*, initially established by Westwood (1837) and treated as a subgenus of *Embia* Latreille (1829), currently contains 13 recognized species worldwide (Table 2), but it is difficult to estimate the actual likely number of species of these embiids. Thus, many specimens are likely to be reclassified

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(Ross, 2007) for instance, analysis of embiopteran phylogeny to test the current classification (Szumik *et al*., 2008). However, the adult (imago) male species in the genus *Oligotoma*, which is closely related to the genera *Aposthonia* Krauss, 1911 and *Eosembia* Ross, 2007 (Poolprasert *et al*., 2011a, b), can be distinguished from members of the other genera by the presence of mesal lobing of the left cercus basipodite (LCB), which is free, prominent and ring-like, with an often pronounced and specialized mesad. The left cercus is two-segmented with the basal segment subcylindrical to strongly clavated, occasionally lobed on the inner side, but never echinulated.

In this study, involving field sampling from 17 locations within 14 provinces in Thailand, three species of *Oligotoma—O. humbertiana* (Saussure, 1896), *O. nigra* (Hagen, 1885) and *O. saundersii* (Westwood, 1837)—were found, which had not been previously reported in Thailand and are therefore considered as new records for the country. Furthermore, potential diagnostic characteristics of the adult females are noted between these three species based on the differences in the patterns of their sternites. The distribution localities in Thailand and keys to the species of both sexes of these three species are presented.

MATERIALS AND METHODS

Webspinner specimens were collected as found after searching the bark of trees, hollow twigs, lichen, moss patches and other suitable habitats within 17 locations in 14 of the 77 provinces in Thailand (Figure 1). At each location, trees with fissured bark, intermittent lichen or moss patches and hollow twigs among others locations, as appropriate, were examined and recorded for webspinners and habitat type. Webspinners were collected and kept in plastic boxes. The nymphal stages were brought back alive and reared in the laboratory, using the bark of trees, lichen and mosses from the area they were collected in as their food, until they developed into adults when they, along with adult collected specimens were preserved in 95% ethyl alcohol. Species identification and measurements were investigated using a stereomicroscope with an ocular micrometer. For those identified as belonging to the genus *Oligotoma*, the heads of the adult male and female, male genitalia and female sternite were illustrated using the stereomicroscope with the aid of a drawing attachment tube.

The terminology and symbols used in the study were the same as those employed by Poolprasert *et al.* (2011a, b). Samples (both those identified to the species level and those still

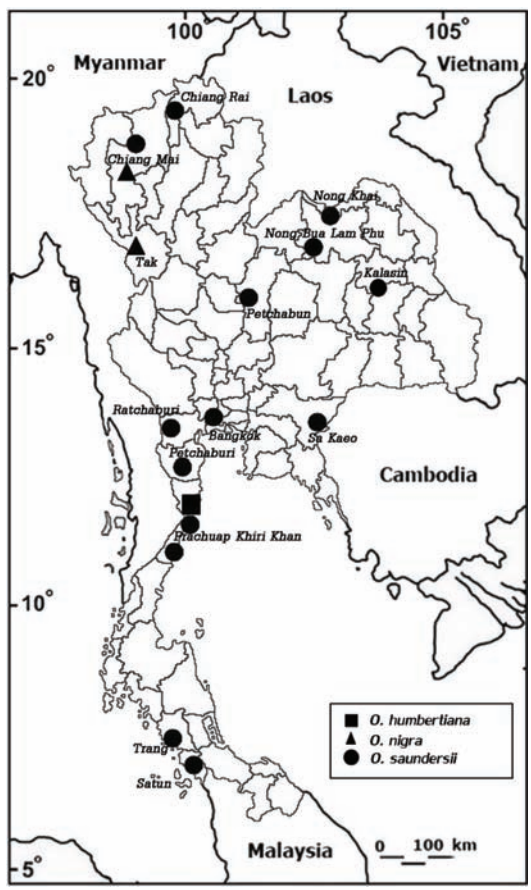

Figure 1 Distribution of the three collected species from the *Oligotoma* group in Thailand.

undergoing taxonomic investigation) were then deposited in the collection of the Chulalongkorn University Museum of Natural History, (CUMNH) Bangkok, Thailand.

RESULTS

Three species in the genus *Oligotoma* were found for the first time in Thailand—namely, *O. humbertiana*, *O. nigra* and *O. saundersii*. Comparative measurements of the character (head width, head length, body width, body length, forewing width, forewing length, hindwing width and hindwing length) of the three species are given in Table 1. The details of the important morphological characteristics of the adult female (apterous) are described in Figure 2.

***Oligotoma humbertiana* (Saussure, 1896)**
(Figures 2A, 3A&B, 4A&B)

Material examined Thailand, Prachuap Khiri Khan province, Mueang district, public park, 11°48.613'N, 098°47.329'E, 7 m, 10-24. VIII. 2009 (5 males, 5 females).

Adult male (alate) *Oligotoma humbertiana* is readily recognized by the minute, outer-apical process on the right tergal process of the tenth abdominal segment.

Adult female (apterous) differs from congeners by head capsule brown, longer than broad. Eyes small and less reniform. Mandibles massive. Antennae 19–20 segmented. Thorax brown throughout, meso- and metaterga smooth undivided. All legs darkish brown throughout. Hind leg with only one basitarsal papilla. Abdomen broad and cylindrical. Tenth sternum symmetrically divided longitudinally into two lateral plates. Sternite 8 divided with an unpigmented spot area at the center and on both lateral sides with a pattern of two unpigmented narrow convergent lines. Sternite 9 is without a distinct pattern.

***Oligotoma nigra* (Hagen, 1885)**
(Figures 2B, 3C&D, 4C&D)

Material examined Thailand, Tak province, Mae Sod district, plantation, 16°4.475'N, 098°34.291'E, 196 m, 04. IV. 2008 (1 male, 2

Table 1 Comparative measurements of three species of *Oligotoma* collected from Thailand.

Character	*O. humbertiana*	*O. nigra*	*O. saundersii*
Male	n=5, mean ± SD	n=4, mean ± SD	n=24, mean ± SD
Head width, mm	1.1 ± 0.02	1.1 ± 0.05	1.1 ± 0.13
Head length, mm	1.2 ± 0.05	1.2 ± 0.02	1.2 ± 0.11
Body width, mm	1.2 ± 0.03	1.2 ± 0.01	1.2 ± 0.06
Body length, mm	6.3 ± 0.29	6.5 ± 0.21	6.7 ± 0.35
Forewing width, mm	2.3 ± 0.02	2.1 ± 0.03	2.1 ± 0.22
Forewing length, mm	5.5 ± 0.14	6.3 ± 0.25	5.4 ± 0.43
Hindwing width, mm	2.1 ± 0.19	1.9 ± 0.12	2.1 ± 0.34
Hindwing length, mm	4.5 ± 0.13	5.4 ± 0.23	4.3 ± 0.44
Female	n=5, mean ± SD	n=6, mean ± SD	n=48, mean ± SD
Head width, mm	1.1 ± 0.06	1.2 ± 0.04	1.1 ± 0.11
Head length, mm	1.2 ± 0.04	1.2 ± 0.03	1.3 ± 0.09
Body width, mm	1.2 ± 0.03	1.3 ± 0.04	1.3 ± 0.09
Body length, mm	6.5 ± 0.05	6.7 ± 0.17	6.8 ± 0.57

females) and Chiang Mai province, Mueang district, Huay Kaeo Arboretum, 18°48.348'N, 098°57.585'E, 336 m, 01. III. 2008 (3 males, 4 females).

Adult male (alate) of *Oligotoma nigra* can be recognized by the hook-like process of LCB, directed ventrally, rather than horizontal as in *O. saundersii*.

Adult female (apterous) can be distinguished from congeners by head capsule somewhat lighter particularly in clypeus; rectangular-like small eyes. Thorax dark brown throughout. All legs dark throughout. Hind leg with only one basitarsal papilla. Abdomen very dark throughout, cylindrical. Sternite 8 with two indefinably outlined, broad, round, lateral pigmented areas separated medially by almost unpigmented areas. Sternite 9 deeply inset into the segment.

***Oligotoma saundersii* (Westwood, 1837)**
(Figures 2C, 3E&F, 4E&F)

Material examined.- Thailand, Bangkok province, Pathumwan district, Lumpini park, 13°45.575'N, 100°32.304'E, 7 m, 06. V. - 05. X. 2008 (2 males, 1 female); Chulalongkorn University 13°44.288'N, 100°31.824'E, 8 m, 10. VII. -08. IX 2009 (2 males, 4 females); Bangkhen district, Kasetsart University, 13°50.929'N, 100°34.239'E, 6 m, 31. VI. -14.XII.2008 (4 males, 6 females); Chiang Mai province, Mueang district, Huay Kaeo Arboretum, 18°48.348'N, 098°57.585'E, 336 m, 21. V. 2008 (1 male); Chiang Rai province, Mueang district, public park, 19°58.363'N, 099° 53.212'E, 383 m, 24. IX. 2009 (1 male, 2 females); Kalasin province, Khao Wong district, dry dipterocarp forest, 16°45.415'N, 104°07.526'E, 280 m, 21. V. 2008

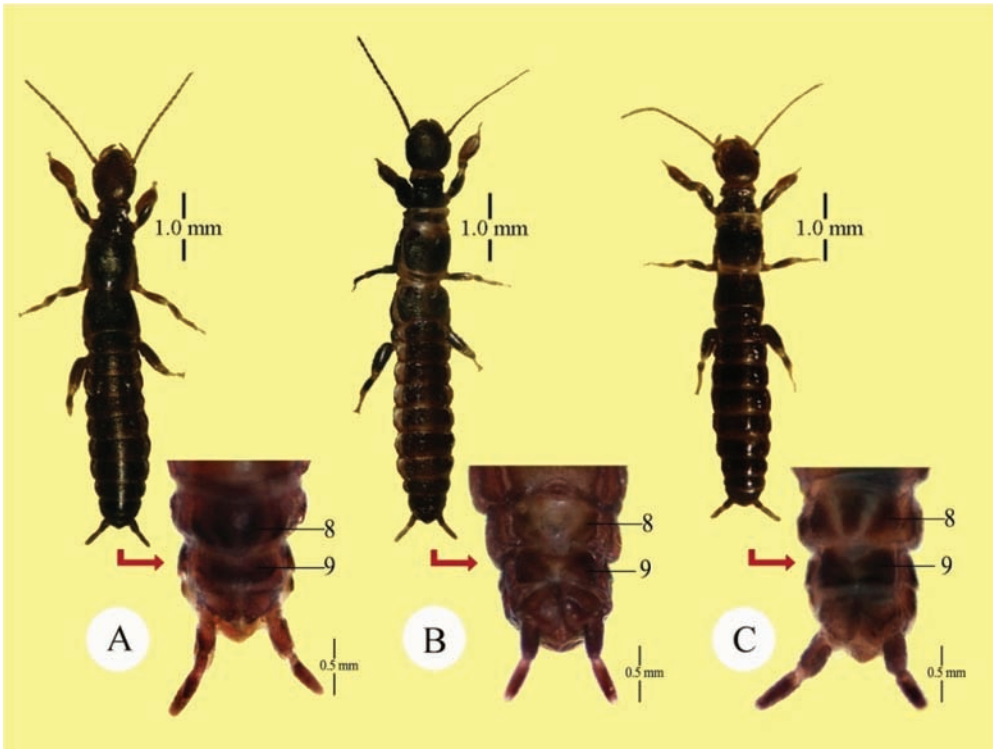

Figure 2 Light micrograph of females: A) *Oligotoma humbertiana*; B) *O. nigra*; C) *O. saundersii*. (8 = eighth abdominal sternite; 9 = ninth abdominal sternite.)

(1 female); Nong Kai province, Mueang district, public park, 14°58.160'N, 102°5.591'E, 182 m, 28. XI. 2009 (1 male, 1 female); Nong Bua Lam Phu province, Naklang district, dry dipterocarp forest, 17°12.839'N, 102°08.176'E, 293 m, 16. VII. 2010 (4 males, 7 females); botanical garden, 17°18.557'N, 102°11.198'E, 256 m, 17. VII. 2010 (2 males, 5 females); Prachuap Khiri Khan province, Bang Saphan district, botanical garden, 11°19.124'N 099°24.422'E, 80 m, 03. VIII. 2009 (3 females); Prachuap Khiri Khan province, Mueang district, plantation, 11°148.613'N 099°47.329'E, 7 m, 01. VIII. 2009 (1 male, 2 females); Petchabun province, Lom Sak district, plantation, 16°46.462'N, 101°14.323'E, 129 m, 27. X. 2010 (1 female); Petchaburi province, Ban Lad district, orchard, 13°02.428'N 099°53.043'E, 8 m, 12. VII. 2009 (2 females); Ratchaburi province, Suan Phueng district, botanical garden, 13°32.805'N, 099°20.126'E, 134 m, 22. VIII -18. IX. 2009 (5 males, 7 females); Sa Kaeo province, Aranyaprathet district, public park, 13°48.531'N, 102°04.193'E, 102 m, 15. VII. 2011 (2 females); Satun province, Mueang district, public park, 06°37.242'N, 100°4.021'E, 25 m, 22. X. 2008 (1 male, 3 females); Trang province, Mueang district, public park, 07°33.255'N, 099°36.831'E, 22 m, 02. XII. 2010 (1 female).

Adult male (alate) of *Oligotoma saundersii* is easily recognized by the horizontal sickle-shaped process beneath the hypandrium lobe.

Adult female (apterous) differs from congeners as head capsule darkish brown, longer than width. Eyes small. Antennae, 20 short segments. Thorax darkish brown throughout. All legs dark throughout. Hind leg with only one basitarsal papilla. Abdomen chocolate-brown throughout, broad and cylindrical. Sternite 8 is divided into a medial with two narrow, caudally convergent membranous lines. Sternite 9 is arrow headed in shape within the body.

Key to three Thai species of the genus *Oligotoma* (Adult males)

The identification key was modified from Ross (1940 and 1944).

Abbreviations used in the key are: 10LP = left tergal process; 10RP = right tergal process; H = hypandrium (sternite 9); LCB = left cercus-basipodite; LPPT = left paraproct.

1. 10LP broad, constricted basally thence broad subapically. 10RP long, gradually distended with smaller sharp projection at extremity. H broad, transverse basally with left apical angle-like narrow sickle spine. LCB broadest ventrally, produced mesad as narrow, simple, rounded lobe (Figures 3E&F). ...*O. saundersii* (Westwood)
- 10LP narrow (Figures 3A-D).....2
2. 10LP small, curved, slightly leftward with small outer hook. 10RP long subparallel sided with distinct subapical tooth on outer side. H broad basally gradually narrowed distally. LCB adjoins dorso-posterio-mesad with double lobe; basal portion blunt rounded (Figures 3A&B).....*O. humbertiana* (Saussure)
- 10LP gradually arced leftward, tapered to apex. 10RP long, gradually narrowed distally; LPPT with ventrally hook, slightly curved rightward. H broad, transverse basally, abruptly narrowed. LCB produced mesad, bilobed (Figures 3 C&D).....*O. nigra* (Hagen)

Key to the three Thai species of the genus *Oligotoma* (Adult females)

1. Head quadrated-oval. Sternite 8 with two indefinably outlined, broad, round, lateral pigmented areas separated medially by almost unpigmented areas. Sternite 9 deeply inset into segment (Figures 4C&D)..... *O. nigra* (Hagen)
- Head, longer than broad (Figures 4A&B, 4E &F).....2

2. Sternite 8 divided into a medial with two narrow, caudally convergent membranous lines. Sternite 9 is arrow headed in the shape within body (Figures 4E&F)..... *O. saundersii* (Westwood)
- Sternite 8 divided with unpigmented spot area at center and on both lateral sides with pattern of two unpigmented narrow convergent lines. Sternite 9 without distinct pattern (Figs. 4A&B). .....*O. humbertiana* (Saussure)

DISCUSSION AND CONCLUSION

The three species of *Oligotma* (Oligotomidae)—*O. humbertiana*, *O. nigra* and *O. saundersii*—are the first records from Thailand (Table 2).

The oligotomids are potentially one of the largest genera of Embiopteran and they are relatively common and cosmopolitan because of their rapid (anthropogenic) colonization and proliferation rates, being spread by humans throughout tropical Asia (Ross, 2007; Poolprasert *et al.*, 2011a). However, they have remained largely unrecorded. The results from the current study have increased the information on the distribution of the genus *Oligotoma* in Thailand.

All three of the species reported here predominately occur in northern India (Ross, 2000b), but *O. humbertiana* is very common in

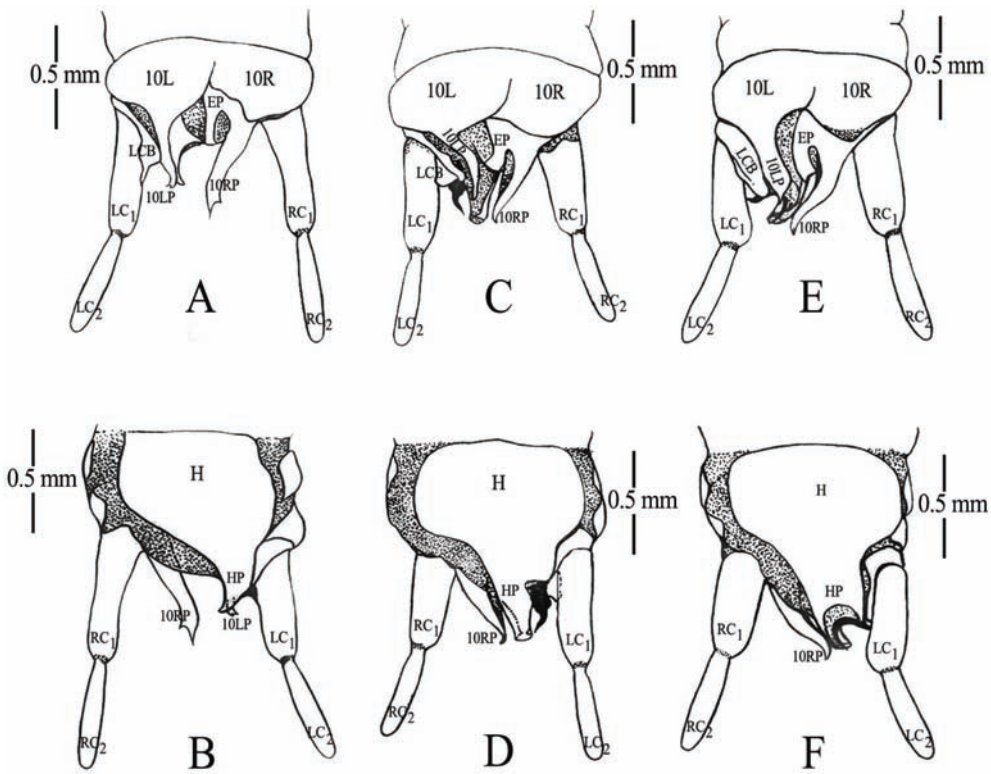

Figure 3 Important characters of males *Oligotoma humbertiana* (A&B), *O. nigra* (C&D) and *O. saundersii* (E&F). A, C, E) Dorsal views of terminalia. B, D, F) Ventral views of terminalia. (10LP and 10RP = left and right tergal processes; EP = epiproct (segment 11); H = hypandrium (sternite 9); HP = hypandrium process; LCB = left cercus-basipodite; LC_1 and LC_2 = first and second segments of left cercus; RC_1 and RC_2 = first and second segments of right circus.)

eastern and southern Asia, including now being recorded in Thailand, albeit thus far only at a single locality in Prachuap Khiri Khan province. *O. saundersii* is likely to be found in either tropical or temperate zones, and in this study in Thailand, it was the most common of the three species, being found in 13 provinces (Table 3). *O. nigra* is widely found in the Middle East and the Red Sea region (Ross, 2006), and now also extends into the southern United States as an introduced species (Ross, 1957), in addition to other localities where it can be found. Presently, it has been identified in western and northern Thailand.

These three Thai embiids within the genus *Oligotoma* can be found in various habitat types either in forests or in human exploited areas. The majority of habitats where the three oligotomids in this study were found was in the bark of shaded trees and near residential areas, such as in public parks and gardens, although some were also found in dry dipterocrap or dry evergreen forests. The habits of *O. humbertiana* have been rather extensively described (Ling, 1934a, 1934b; Ananthasubramanian, 1957; Edgerly, 1997), and the observations in the current survey have mostly concurred with them. *O. humbertiana* was present under the bark of *Cassia fistula* and inside the hollows of dry twigs (Table 3). It tends to be a solitary embiid being found alone in galleries.

Oligotoma nigra was found in ornamental trees (Table 3) located around villages and gardens. This genus appears to prefer dry areas (Ross, 2006), and was apparently introduced into the southern United States in date palm cuttings (Ross, 1957), but in western and northern Thailand (Tak and Chiang Mai provinces), it has not been reported to be occupying natural habitats.

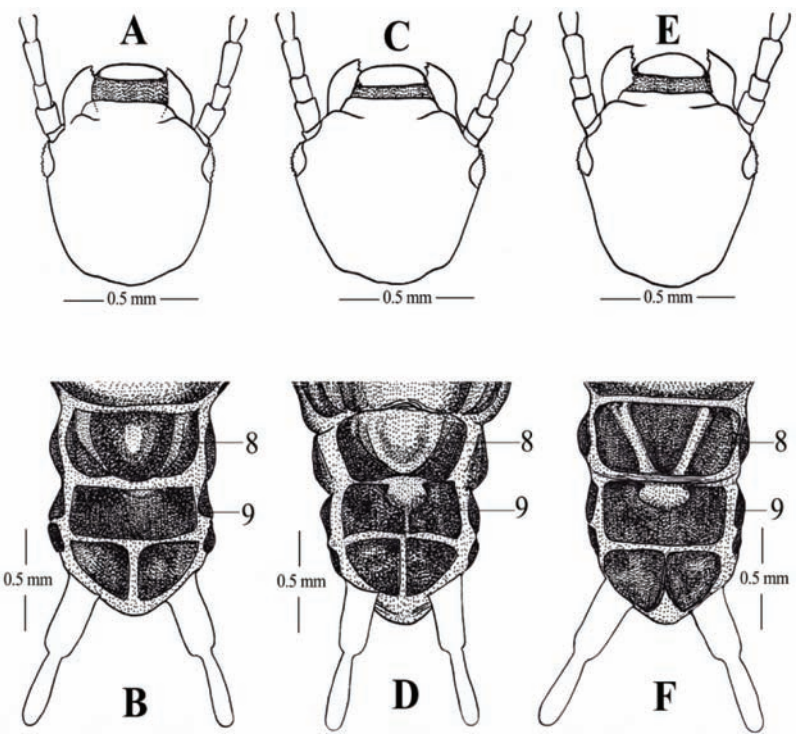

Figure 4 Important characters of females *Oligotoma humbertiana* (A&B), *O. nigra* (C&D) and *O. saundersii* (E&F). A, C, E) Head. B, D, F) Ventral views of terminalia. (8 = eighth abdominal sternite; 9 = ninth abdominal sternite.)

Table 2 List of worldwide *Oligotma* species currently known (recognized) and their distribution (countries).

No.	Species	Distribution
1.	*O. asymmetrica* Menon & George, 1936	India
2.	*O. burmana* Ross, 2007	Myanmar
3.	*O. dharwariana* Bradoo, 1971	India
4.	*O. dichroa* Navas, 1934	Vietnam
5.	*O. falcis* Ross, 1943	India
6.	*O. greeniana* Enderlein, 1912	China, Hong Kong, India, Malaysia, Philippines, Singapore, Sri Lanka, Taiwan
7.	*O. humbertiana* (Saussure, 1896)	China, Hong Kong, India, Indonesia, Madagascar, Mariana Islands, Mexico, Philippines, Sri Lanka, Taiwan, Thailand*
8.	*O. josephi* (Bradoo, 1971)	India
9.	*O. nigra* (Hagen, 1866)	Australia, Egypt, India, Iraq, Israel, Mexico, Thailand*, USA
10.	*O. pruthii* Kapur & Kripalani, 1957	India
11.	*O. saundersii* (Westwood, 1837)	Australia, Brazil, Cuba, India, Indonesia, Korea, Madagascar, Marcus Island, Mexico, New Caledonia, Taiwan, Thailand*, U.S.A, Venezuela, Virgin Islands.
12.	*O. termitophila* Wasmann, 1904	Sudan
13.	*O. ubicki* Ross, 2007	Myanmar

* = New record.

Table 3 *Oligotoma* species from Thailand associated with host plants.

Oligotoma spp.	Locality	Host plants	Site found
O. humbertiana	Prachuap Khiri Khan	*Cassia fistula* L.	Under bark
O. nigra	Chiang Mai, Tak	*Mascarena lagenicaulis* L., *Roystonea regia* (Kunth) Cook	Bark crevice
O. saundersii	Bangkok, Chiang Mai, Chiang Rai, Kalasin, Nong Bua Lam Phu, Nong Khai, Prachuap Khiri Khan, Petchabun, Petchaburi, Ratchaburi, Sa Kaeo, Satun, Trang	*Acacia auriculaeformis* A. Cunn. Ex Benth, *Cassia javanica* L., *Diospyios rhodcalyx* Kurz, *Eucalyptus camaldulensis* Dehnh, *Mangifera indica* L., *Pterocarpus indicus* Willd, *Pithecellobium dulce* (Roxb.) Benth, *Shorea roxburghii* G. Don, *Tamarindus indica* L.	Outer /under bark, bark crevice

In contrast, during the dry season, *Oligotoma saundersii* was never found inhabiting exposed places, but rather was hiding in crevices and under the bark of trees and in other humid and shady places. This probably shows its preference for a moist atmosphere. In addition, *Oligotoma saundersii* tended to inhabit the bark crevices of trees, the most common being *Acacia auriculaeformis, Cassia javanica, Mangifera indica, Pithecellobium dulce* and *Tamarindus indica* (Table 3). The social habits and maternal care of these insects, as observed during this study at collection sites and in laboratory rearing (data not shown), were consistent with the well-known habits that have been reported before for this species in other localities (Edgerly *et al.*, 2002; Lee *et al.*, 2002). Because they tend to live in groups that adopt shared breeding sites and cooperate in brooding care, they are considered as communal colonies.

From this survey alone, there are still 10 specimens that are unclassified to the species level; thus, further elaboration would likely further change the poorly known embiid fauna status in Thailand. In addition, this study did not cover a full geographic range of likely habitat in the country, so further surveys are still required and are likely to reveal more new records for Thailand.

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