

New records of Toxoderid Species (Dictyoptera: Mantodea: Toxoderidae) from Thailand

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Abstract

Seven species and two genera of the family Toxoderidae are reported from Thailand for the first time. *Heterochaetula tricolor* (Wood-Mason, 1876) is the 2nd species of the genus known from the country. *Toxomantis sinensis* Giglio-Tos, 1914 and *Toxoderopsis taurus* Wood-Mason, 1889 are the first records of the genus and species. *Paratoxodera cornicollis* Wood-Mason, 1889 and *Paratoxodera gigliotosi* Roy, 2009 are the 2nd and 3rd species of the genus, respectively. *Stenotoxodera pluto* (Rehn, 1909) is the 2nd species of the genus. *Toxodera maxima* Roy, 2009 is the 6th species of the genus. Photographs and diagnosis of all new record species are provided.

Keywords

praying mantis, predatory insect, taxonomy, Oriental region

Introduction

As we known, Mantodeans have several types of external morphology which support their hunting, camouflaging behaviors, such as: greenish leaf (*Choeradodis* spp.); dead leaf (*Parablepharis kuhlii*, *Deroplatys* spp.); bird poop (*Ceratomantis saussurii*); twig or branch (*Ambivia undata*, *Phyllothelys* spp.); grass (*Didymocorypha* spp.); lichen or bryophyte (*Majangella* spp., *Arria muscoamicta*); and flower (*Hymenopus coronatus*, *Helvia cardinalis*). Toxoderidae is one of the most fascinating families among the Mantodeans having an elongated body, almost have spine-like process on compound eye, almost have elongated and flatten cerci with various shapes of meso-, metathoracic femoral lobes. All these characteristics lead to branch, twig or even grass leaf appearances (Beier, 1934; Roy, 2009). The distributions have been reported in Afrotropic regions, Australia, Palearctic, and Oriental

regions. There are 12 genera in the Oriental region (Schwarz and Roy, 2019): *Oestomantis* Giglio-Tos, 1914 (Toxoderinae: Aethalochroini); *Toxodanuria* Uvarov, 1940 (Toxoderinae: Toxoderopsini); *Euthyphlebs* Wood-Mason, 1889 (Toxoderinae: Toxoderopsini); *Protoxodera* Werner, 1930 (Toxoderinae: Toxoderini); *Heterochaetula* Wood-Mason, 1889 (Oxyothespinae: Heterochaetulini); *Toxomantis* Giglio-Tos, 1914 (Toxoderinae: Calamothespini); *Aethalochroa* Wood-Mason, 1877 (Toxoderinae: Aethalochroini); *Toxoderopsis* Wood-Mason, 1889 (Toxoderinae: Toxoderopsini); *Stenotoxodera* Roy, 2009 (Toxoderinae: Toxoderini); *Paratoxodera* Wood-Mason, 1889 (Toxoderinae: Toxoderini); *Metatoxodera* Roy, 2009 (Toxoderinae: Toxoderini); *Toxodera* Audinet-Serville, 1837 (Toxoderinae: Toxoderini). Previously, five genera and nine species (Table 1) have been reported in Thailand (Roy, 2009; Mukherjee *et al.*, 2014; Unnahachote *et al.*, 2019). After the examination of many specimens of Toxoderids from several places throughout the country, the new record species were discovered and reported in the present work.

Materials and Methods

All specimens were collected from several localities in Thailand by searching at night and light trapping methods to attract adult specimens. The specimens were mounted and dried after the surveys. The material examined are deposited in the Thornthan Unnahachote personal collection, Thailand (TUPC), and the Natural History Museum, National Science Museum, Thailand (THNHM).

Morphological examinations were made with Optika microscope (Optika Microscope, Italy). All photographs of external morphology were taken with a Nikon AF-S Micro NIKKOR 60 mm lens attached to a Nikon D7200 camera. Scale bar is 1 cm for specimen photographs. Distribution map was made with SimpleMappr (Shorthouse, 2010). The classification system is according to Schwarz and Roy (2019).

Abbreviations. **DS** discoidal spine; **PvS** posteroventral spine; **TUPC** Thornthan Unnahachote personal collection; **THNHM** the Natural History Museum of the National Science Museum, Thailand.

Results

Taxonomy

Subfamily Oxyothespinae Giglio-Tos, 1916

Tribe Heterochaetulini Schwarz & Roy, 2019

Genus *Heterochaetula* Wood-Mason, 1889

Type species: *Heterochaeta tricolor* Wood-Mason, 1876.

Cheddikulama Henry, 1932 (Junior synonym of *Heterochaetula* by Ehrmann and Mukherjee, 2014).

***Heterochaetula tricolor* (Wood-Mason, 1876)**

(Figure 1A–D)

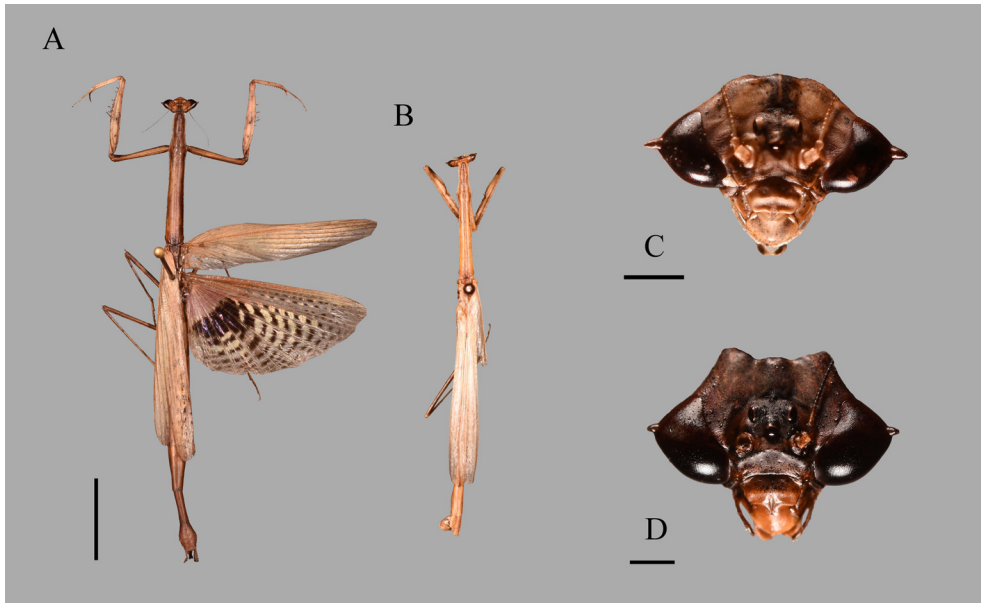
Heterochaeta tricolor Wood-Mason, 1876: 309. Type locality: India (Calcutta).*Heterochaeta tricolor*: Westwood, 1889: 20, 47.*Heterochaetula tricolor*: Kirby, 1904: 307; Giglio-Tos, 1927: 287–288; Ehrmann, 2002: 174, 376; Otte and Spearman, 2005: 241.**Material examined.** onemale, 1 female (TUPC), C Thailand, Suphan Buri, Doem Bang Nang Buat, 28.III.2018, T. Unnahachote leg.; 1 female (TUPC), NE Thailand, Nakhon Ratchasima, 2017, T. Unnahachote leg.; 1 female (THNHM-I-11226), Bangkok, H.S.A.C.T., 12.VII.1967, Pranee leg.

Figure 1. *Heterochaetula* spp. A–B, *Heterochaetula tricolor* female and male, respectively; C, Head of *H. tricolor* in dorsal view; D, Head of *H. fisispinis* in dorsal view (A–B scale bar 1 cm; C–D scale bar 1 mm).

Diagnosis. Head. Wider than long, flattens dorsoventrally; vertex without process; more or less triangular-shaped compound eye with spine-like process at apex; paramedian bulges more or less protrude; lower frons transverse (Figure 1C). Pronotum. Elongate; metazonal length more than twice as long as prozonal length, finely keeled; constricted prozone; supracoxal dilation indistinct; lateral margins granulate. Prothoracic leg. Coxa smooth; femur with four DS, four PvS, tibial spur groove locates near the middle of the length; tibia with eleven-twelve PvS. Meso-, metathoracic legs. Without lobe; genicular spur small. Flight organs. Both sexes brachypterous; forewing narrow; patterned hindwing especially in female (Figure 1A), with

large black patch at basal half of anal area. Abdomen. long, slender; cerci flatten, distinctly long in male and short in female.

Remarks. This species is the second species of the genus recorded in Thailand. This species can be easily distinguished from *H. fissispinis* Wood-Mason, 1889 by following characteristics: 1) smaller in size; 2) paramedian bulges less protrude (Figure 1C-D). this species can be found on dried grass stems or leaves near rural areas of Thailand.

Table 1. A checklist of the family Toxoderidae in Thailand.

| Genera | Species | References |
|---|--|----------------------------------|
| <i>Heterochaetula</i> Wood-Mason, 1889 | <i>Heterochaetula fissispinis</i> Wood-Mason, 1889 | Mukherjee <i>et al.</i> , 2014 |
| | <i>Heterochaetula tricolor</i> (Wood-Mason, 1876) | New record |
| <i>Toxomantis</i> Giglio-Tos, 1914 | <i>Toxomantis sinensis</i> Giglio-Tos, 1914 | New record |
| <i>Aethalochroa</i> Wood-Mason, 1877 | <i>Aethalochroa ashmoliana</i> (Westwood, 1841) | Mukherjee <i>et al.</i> , 2014 |
| <i>Toxoderopsis</i> Wood-Mason, 1889 | <i>Toxoderopsis taurus</i> Wood-Mason, 1889 | New record |
| <i>Paratoxodera</i> Wood-Mason, 1889 | <i>Paratoxodera cornicollis</i> Wood-Mason, 1889 | New record |
| | <i>Paratoxodera gigliotosi</i> Roy, 2009 | New record |
| | <i>Paratoxodera meggitti</i> Uvarov, 1927 | Unnahachote <i>et al.</i> , 2019 |
| <i>Stenotoxodera</i> Roy, 2009 | <i>Stenotoxodera porioni</i> Roy, 2009 | Unnahachote <i>et al.</i> , 2019 |
| | <i>Stenotoxodera pluto</i> (Rehn, 1909) | New record |
| <i>Toxodera</i> Audinet-Serville, 1837 | <i>Toxodera denticulata</i> Audinet-Serville, 1837 | Roy, 2009 |
| | <i>Toxodera hauseri</i> Roy, 2009 | Roy, 2009 |
| | <i>Toxodera integrifolia</i> Werner, 1925 | Roy, 2009 |
| | <i>Toxodera maculata</i> Ouwens, 1913 | Roy, 2009 |
| | <i>Toxodera fimbriata</i> Werner, 1930 | Unnahachote <i>et al.</i> , 2019 |
| | <i>Toxodera maxima</i> Roy, 2009 | New record |

Subfamily Toxoderinae Saussure, 1869**Tribe Calamothespini Giglio-Tos, 1914****Genus *Toxomantis* Giglio-Tos, 1914**

Type species: *Toxomantis sinensis* Giglio-Tos, 1914.

***Toxomantis sinensis* Giglio-Tos, 1914**

(Figure 2A–D)

Toxomantis sinensis Giglio-Tos, 1914: 11. Type locality: China.

Toxomantis sinensis: Beier, 1934: 7; Ehrmann, 2002: 361; Zhu *et al.*, 2012: 108.

Material examined. one female, N Thailand, Phayao Province; 1 female (THNHM-I-11232), NE Thailand, Nakhon Ratchasima, Sakaerat Environmental Research Station, 24.I.1968, S. Pongsa leg.

Diagnosis. Head. Longer than wide, slightly wider than pronotum width, V-shaped; vertex convex; conical-shaped compound eye with spine-like projection; lower frons transverse. Pronotum. Elongated, longer than forecoxal length, weakly curves; metazone with medial keel; indistinct supracoxal dilation; lateral margins serrate. Prothoracic leg. Anteroventral margin of forecoxa smooth, shorter than metazonal length; femur with pointed genicular lobes, dorsal margin with acute spine at apex, three DS, six PvS, tibial spur groove locates near base; tibia thin, straight with six PvS arrange in distal third. Meso-, metathoracic legs. Femur with small tubercles at posteroventral margin, genicular lobes elongate, pointed; tibia simple. Flight organs. Both sexes brachypterous; forewing narrow, subhyaline; hindwing hyaline. Abdomen. slender; supraanal plate semicircular, keeled; cerci long, flatten, distally wide, last cercomere truncate.

Remarks. This species is the first record genus and species in Thailand. Its camouflaging display look like a “dead grass leaf” by hanging under the leaf.

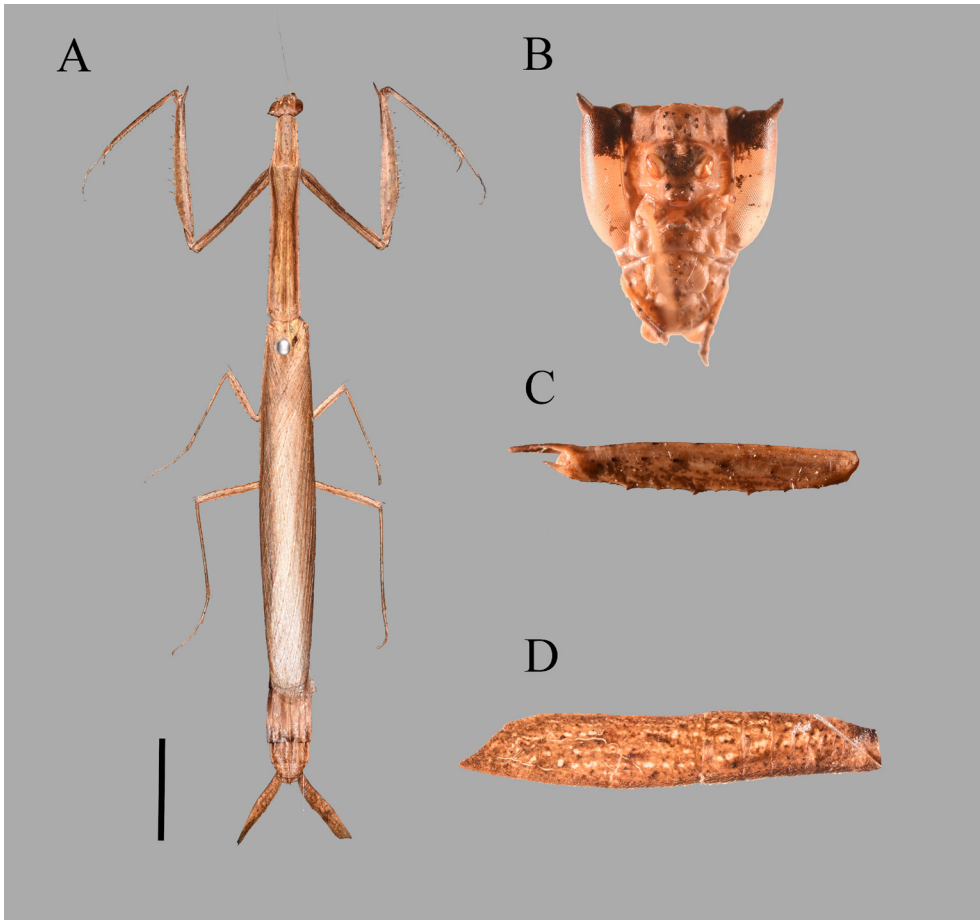


Figure 2. *Toxomantis sinensis*. A, Dorsal habitus; B, Head in frontal view; C, Mesothoracic femur; D, Cercus (A scale bar 1 cm; B–D no scale bar).

Subfamily Toxoderinae Saussure, 1869

Tribe Toxoderopsini Ehrmann and Roy, 2002

Genus *Toxoderopsis* Wood-Mason, 1889

Type species: *Toxoderopsis spinigera* Wood-Mason, 1889.

***Toxoderopsis taurus* Wood-Mason, 1889**

(Figure 3A–F)

Toxoderopsis taurus Wood-Mason, 1889: 320. Type locality: India (Lectotype), Pakistan (Paralectotype).

Toxoderopsis taurus: Mukherjee *et al.*, 1995: 325; Mukherjee *et al.*, 2014: 49; Ehrmann, 2002: 361.

Material examined. one male N Thailand, Phayao Province, Chiang Kham, Ang Thong, 380m, 9.X.2020, W. Khaikaew leg. (TUPC); 2 males, NE Thailand, Sakon Nakhon Province, 19.IX.2018, B. Kaewka leg. (TUPC).

Diagnosis. Head. Wider than long; vertex convex medially; more or less conical-shaped compound eye with spine-like process; ocular tubercle with median truncated spine-like projection; lower frons transverse. Pronotum. Elongate, metazonal length more than twice as long as prozonal length, strongly triangular-shaped in cross section with distinct medial keel; supracoxal dilation more or less distinct; lateral margin strongly denticulate; dorsal surface with numerous of spine-like tubercles. Prothoracic leg. Anteroventral margin of coxa with wavy lobe distally; dorsal margin with acute spine at apex, tibial spur groove locates near base, three DS, six PvS; tibia thin with spines distally. Meso-, metathoracic legs. All femoral lobes acute, spine-like distally, posteroventral lobe largest, distinctly trilobed, genicular spine long; tibia simple. Flight organs. Both sexes brachypterous; forewing narrow, marbled brown, subhyaline; hindwing hyaline. Abdomen. long, slightly distally wide; supraanal plate more or less triangular, keeled; cerci long, flatten, last cercomere with two pointed lobes.

Remarks. This species is the first record genus and species in Thailand.

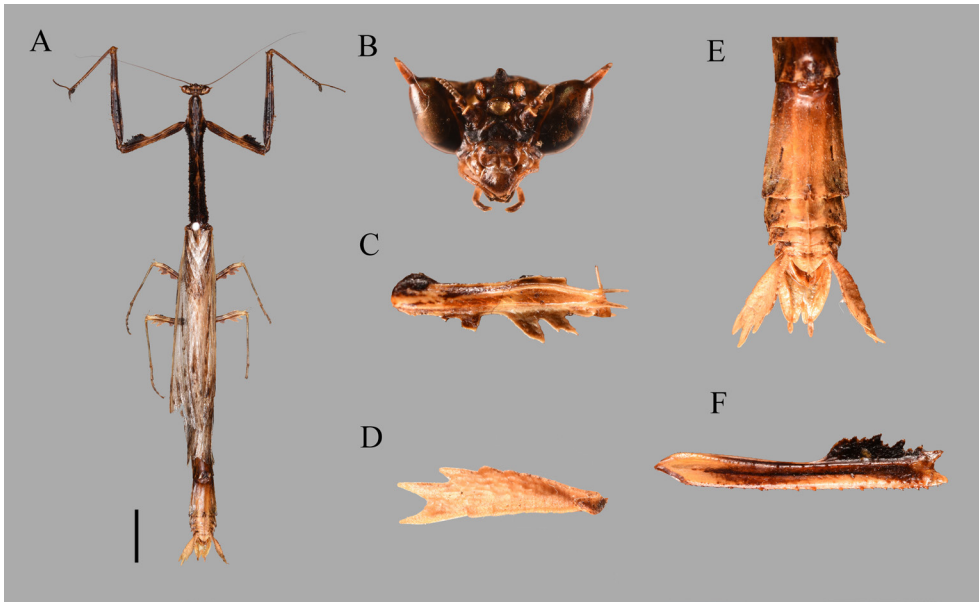


Figure 3. *Toxoderopsis taurus*. A, Dorsal habitus; B, Head in frontal view; C, Metathoracic femur; D, Cercus; E, Tip of abdomen in dorsal view; F, Prothoracic coxa in ventral view (A scale bar 1cm; B–F no scale bar).

Subfamily Toxoderinae Saussure, 1869**Tribe Toxoderini Saussure, 1869****Genus *Paratoxodera* Wood-Mason, 1889**

Type species: *Paratoxodera cornicollis* Wood-Mason, 1889.

***Paratoxodera cornicollis* Wood-Mason, 1889**

(Figure 4A–F)

Paratoxodera cornicollis borneana: Beier, 1931: 154 [as a variety by Roy, 2009]. Type locality: Indonesia (Java).

Paratoxodera borneana: Ehrmann, 2002: 272; Otte and Spearman, 2005: 394.

Paratoxodera cornicollis: Wood-Mason, 1889: 325; Kirby, 1904: 285; Giglio-Tos, 1914: 9 (in part); Giglio-Tos, 1927: 571 (in part); Werner, 1933a: 270; Werner, 1933b: 441; Beier, 1934: 7 (in part?), fig. P3; Ehrmann, 2002: 272 (in part); Otte and Spearman, 2005 (in part): 384; Roy, 2009: 143, Figs. 40–44; Schwarz and Konopik, 2014: 156.

Toxodera cornicollis Ouwens, 1913: 123, fig. 3.

Material examined. 1 male, S Thailand, Surat Thani Province, Phanom, Khlong Sok, 28.XI.2019, C. Hübner leg. (TUPC).

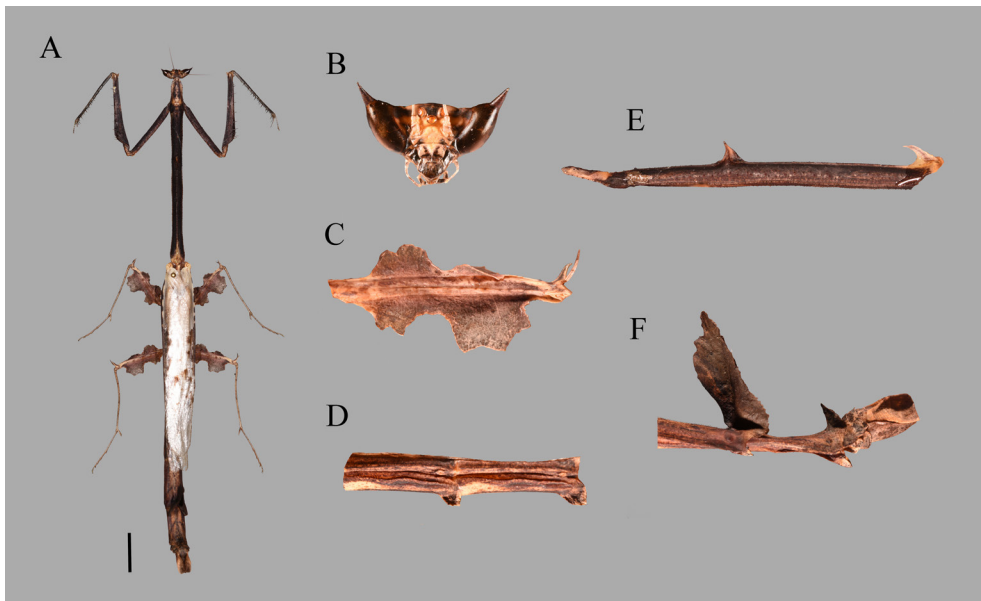


Figure 4. *Paratoxodera cornicollis*. A, Dorsal habitus; B, Head in frontal view; C, Metathoracic femur; D, Coxosternite IV–V in lateral view; E, Pronotum in lateral view; F, VI–VII tergal lobes and cerci (A scale bar 1cm; B–F no scale bar).

Diagnosis. Head. Wider than long, triangular-shaped; medial bulge of vertex slightly convex; conical-shaped compound eye with spine-like projection; lower frons transverse (Figure 4B). Pronotum. Elongate; metazonal length more than five times as long as prozonal length, more or less straight in lateral view, keeled with foliaceous lobe at posterior margin and smaller one or two lobes along the median keel (Figure 4E). Prothoracic leg. Anteroventral margin of coxa smooth; femur slender, keeled ventrally, dorsal margin with acute spine at apex, tibial spur groove locates near base, three DS, seven PvS; tibia thin with curved spines. Meso-, metathoracic legs. All femoral lobes acute, spine-like distally, posteroventral lobe strongly bilobed with more or less concavity on each lobe (Figure 4C), genicular spur curves up; tibia very long and thin. Flight organs. Both sexes brachypterous; forewing narrow, marbled brown, subhyaline; hindwing hyaline. Abdomen. long; tergite VI and VII with foliaceous lobes, VI lobe much larger, narrow (Figure 4F), coxosternite IV and V with distinct large lobes, more or less pointed apex (Figure 4D); supraanal plate transverse; cerci long, flatten, more or less pear-shaped, last cercomere more or less round (Figure 4F).

***Paratoxodera gigliotosi* Roy, 2009**

(Figure 5A–F)

Paratoxodera gigliotosi Roy, 2009: 149. Type locality: West Malaysia.

Paratoxodera cornicollis Giglio-Tos, 1914: 9 (in part?); Giglio-Tos, 1927: 571 (in part?); Beier, 1934: 7 (in part?); Ehrmann, 2002: 272 (in part); Otte and Spearman, 2005: 394 (in part).

Material examined. one male, S Thailand, Surat Thani Province, Phanom, Khlong Sok, 10.I.2020, C. Hübner leg. (TUPC).

Diagnosis. Head. Wider than long, triangular-shaped; medial bulge of vertex slightly convex; conical-shaped compound eye with spine-like projection; lower frons transverse. Pronotum. Elongate; metazonal length more than five times as long as prozonal length, more or less straight in lateral view, keeled with foliaceous lobe at posterior margin and smaller two lobes along the median keel. Prothoracic leg. Anteroventral margin of coxa smooth; femur slender, keeled ventrally, dorsal margin with acute spine at apex, tibial spur groove locates near base, three DS, seven PvS; tibia thin with curved spines. Meso-, metathoracic legs. All femoral lobes acute, spine-like distally, posteroventral lobe strongly bilobed, each lobe relatively round, genicular spur relatively long, curves up; tibia very long and thin. Flight organs. Both sexes brachypterous; forewing narrow, marbled brown, subhyaline; hindwing hyaline. Abdomen. long; tergite VI and VII with foliaceous lobes, VI lobe much larger, wide, coxosternite IV and V with distinct large lobes, round; supraanal plate transverse; cerci long, flatten, more or less pear-shaped, last cercomere more or less round.

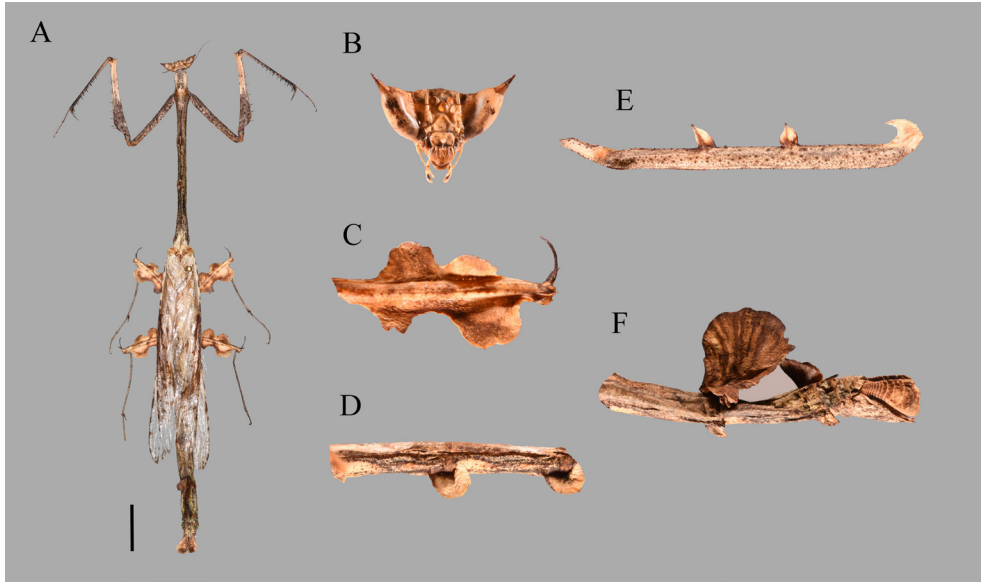


Figure 5. *Paratoxodera gigliotosi*. A, Dorsal habitus; B, Head in frontal view; C, Metathoracic femur; D, Coxosternite IV–V in lateral view; E, Pronotum in lateral view; F, VI–VII tergal lobes and cerci (A scale bar 1cm; B–F no scale bar).

Subfamily Toxoderinae Saussure, 1869

Tribe Toxoderini Saussure, 1869

Genus *Stenotoxodera* Roy, 2009

Type species: *Toxodera pluto* Rehn, 1909.

Stenotoxodera pluto (Rehn, 1909)

(Figure 6A–E)

Toxodera pluto Rehn, 1909: 182, figs. 5–7. Type locality: Indonesia (Sumatra).

Toxodera pluto: Karny, 1923: 66; Lieftinck, 1935: 174.

Paratoxodera pluto: Giglio-Tos, 1914: 9; Giglio-Tos, 1927: 572; Beier, 1934: 7; Beier, 1976: 395, Fig. 5; Ehrmann, 2002: 272; Otte and Spearman, 2005: 394; Schwarz and Konopik, 2014: 156

Material examined. one male, S Thailand, Surat Thani Province, Phanom, Khlong Sok, 5. II.2020, C. Hübner leg. (TUPC).

Diagnosis. Head. Wider than long, triangular-shaped; medial bulge of vertex slightly convex; conical-shaped compound eye with spine-like projection; lower frons transverse (Figure 6B). Pronotum. Elongate, very thin in lateral view; metazonal length more than four times as long as prozonal length, strongly curve upwards proximally, dorsal margin relatively denticulate with two distinct wavy projections, small curved thread-like projection at

posterior margin (Figure 6D). Prothoracic leg. Anteroventral margin of coxa smooth; femur slender, keeled ventrally, dorsal margin with acute spine at apex, tibial spur groove locates near base, three DS, six-seven PvS; tibia thin with curved spines. Meso-, metathoracic legs. All femoral lobes acute, very long spine-like distally, anterodorsal and anteroventral lobes moderately expand, posteroventral lobe largest, widely expands, more or less arched margin without concavity in the middle, genicular spur long and curve (Figure 6C); tibia very long and thin. Flight organs. Both sexes brachypterous; forewing narrow, marbled brown, subhyaline; hindwing hyaline. Abdomen. long, tergite VI and VII with foliaceous lobes, VI lobe much larger than VII lobe, more or less round anteriorly but angulated posteriorly; supraanal plate transverse; cerci long, flatten, last cercomere slightly concave dorsally (Figure 6E).

Remarks. This species can be easily distinguished from *S. porioni* Roy, 2009 by following characteristics: 1) posterolateral lobe without median concavity; 2) Meso-, metathoracic legs with genicular spur long and curve; 3) VII lobe more or less square-shaped; 4) last cercomere distinctly concave. This species is the second species of the genus to be recorded in Thailand.

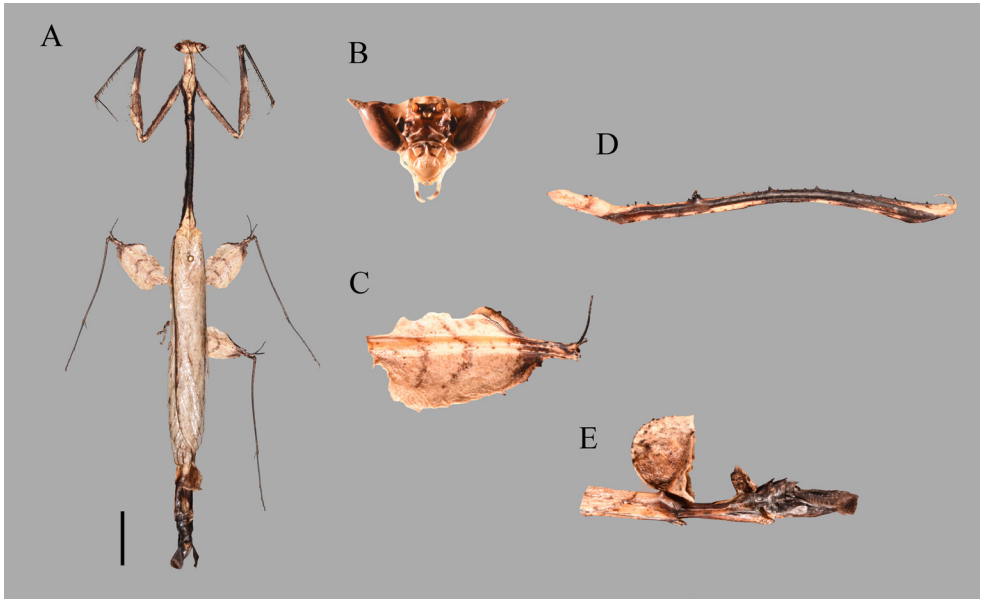


Figure 6. *Stenotoxodera pluto*. A, Dorsal habitus; B, Head in frontal view; C, Mesothoracic femur; D, Pronotum in lateral view; E, VI–VII tergal lobes and cerci (A scale bar 1cm; B–E no scale bar).

Subfamily Toxoderinae Saussure, 1869

Tribe Toxoderini Saussure, 1869

Genus *Toxodera* Audinet-Serville, 1837

Type species: *Toxodera denticulata* Audinet-Serville, 1837.

Eutoxodera Werner, 1930 [Junior synonym by Roy, 2009].

***Toxodera maxima* Roy, 2009**

(Figure. 7A–F)

Toxodera maxima: Roy, 2009: 104, figs. 5–12. Type locality: Malaysia (Kelantan: holotype), (Cameron Highlands: allotype and paratypes).

Toxodera denticulata: Werner, 1921: 134 (in part); Werner, 1925: 486 (in part).

Material examined. one male, S Thailand, Surat Thani Province, Tha Chana, Prasong, 27.X.2020, C. Bunyatikan leg. (TUPC).

Diagnosis. Head. Wider than long, triangular-shaped; medial bulge of vertex slightly convex; conical-shaped compound eye, lack of spine-like projection; lower frons transverse. Pronotum. Elongate; metazonal length approximately four times as long as prozonal length, more or less curve upwards, keeled with thread-like projection at posterior margin. Prothoracic leg. Anteroventral margin of coxa smooth; femur slender, keeled ventrally, dorsal margin with acute spine at apex, tibial spur groove locates near base, three DS, six PvS; tibia thin with curved spines. Meso-, metathoracic legs. All femoral lobes acute, very long spine-like distally, posteroventral lobe expands, concave medially, genicular spur more or less straight; tibia very long and thin. Flight organs. Both sexes brachypterous; forewing narrow, marbled brown, subhyaline; hindwing hyaline. Abdomen. long, tergite VI and VII with foliaceous lobes, pointed apically; supraanal plate transverse; cerci long, flatten, last cercomere bilobed, pointed.

Remark. This species is relatively large for the genus compared to other species; it is referred to by the specific name “maxima” which means “large”.

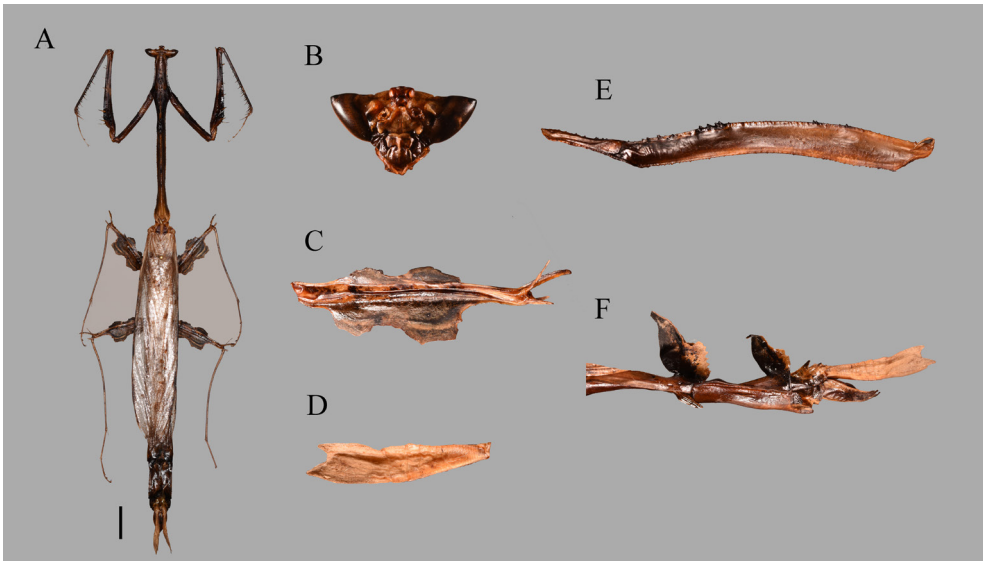


Figure 7. *Toxodera maxima*. A. Dorsal habitus; B. Head in frontal view; C. Metathoracic femur; D. Cercus in lateral view; E. Pronotum in lateral view; F. VI–VII tergal lobes and cerci (A scale bar 1 cm.; B–F no scale bar)



Figure 8. Distribution map of new records of the Toxoderid species from Thailand. Five-pointed star = *H. tricolor*; six-pointed star = *T. sinensis*; circle = *T. taurus*; rectangle = *P. cornicollis*; seven-pointed star = *P. gigliotosi*; eight-pointed star = *S. pluto*; triangle = *T. maxima*.

Conclusion

Previously, nine species belonging to five genera have been reported from Thailand: *Heterochaetula fissispinis*, *Aethalochroa ashmoliana*, *Paratoxodera meggitti*, *Stenotoxodera porioni*, *Toxodera denticulata*, *Toxodera hauseri*, *Toxodera integrifolia*, *Toxodera maculata* and *Toxodera fimbriata* (Roy, 2009; Mukherjee *et al.*, 2014; Unnahachote *et al.*, 2019). After intensively searching for many Toxoderid specimens from several localities in Thailand, several new recorded species were discovered. *Heterochaetula tricolor*, *Paratoxodera cornicollis*, *Paratoxodera gigliotosi*, *Stenotoxodera pluto* and *Toxodera maxima* are reported as additional species for the genus. In addition, *Toxomantis sinensis* and *Toxoderopsis taurus* are reported as new records of the genus and first species of the genus in Thailand. Presently, there are 15 Toxoderid species belong to seven genera in Thailand.

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