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New records of *Penthicodes* lanternfly species from Thailand and Malaysia and nomenclatural notes on the genus (Hemiptera: Fulgoromorpha: Fulgoridae)

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Abstract. *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801), *P.* (*Ereosoma*) *bimaculatus* (Schmidt, 1905) and *P.* (*Ereosoma*) *caja malayanus* Constant, 2010 are formally recorded from Thailand for the first time; the second one is also recorded from Peninsular Malaysia for the first time, based on photographs. Updated distribution maps and the first host plant records are provided for these species. The genus name *Penthicodes* Blanchard, 1845 must be treated as masculine in gender according to the International Code of Zoological Nomenclature and an updated list of the species-group names in *Penthicodes* is provided accordingly.

Key words. Aphaeninae, Fulgoroidea, new record, food plant, Indochina, Sunda.

INTRODUCTION

The lanternfly genus *Penthicodes* Blanchard, 1845 belongs to the subfamily Aphaeninae with *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801) as the type species. Members of the genus are widely distributed in Southeast Asia (Constant 2010; Bourgoin 2022). Although the article 30.1.4.4 of the International Code of Zoological Nomenclature (ICZN 1999) states that compound genus-group names ending in the suffix *-odes* are to be treated as masculine unless originally otherwise stated, *Penthicodes* was continuously treated as feminine in all previous studies (Metcalf 1947; Bourgoin 2022). Currently, 12 species are recognized in the genus, among which ten species belong to the subgenus *Ereosoma* Kirkaldy, 1906 and two species to the subgenus *Penthicodes* Blanchard, 1845 (Constant 2010; Bourgoin 2022). The species of the subgenus *Ereosoma* were reviewed by Constant (2010) who also provided an illustrated identification key to all species of the genus *Penthicodes*. Recently, five species of the genus were recorded from Thailand: *P.* (*Ereosoma*) *atomaria* (Weber, 1801), *P.* (*Ereosoma*) *caja* (Walker, 1851), *P.* (*Ereosoma*) *pulchellus* Guérin-Méneville, 1838, *P.* (*Ereosoma*) *variegatus* Guérin-Méneville, 1829, and *P.* (*Ereosoma*) *warleti* Constant, 2010 (Constant 2010; Jiaranaisakul et al. 2018). A sixth species, *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905) was mentioned from Thailand by Hutacharern et al. (2007) but this record was not substantiated by a reference or voucher specimen data. It was probably based on a misidentification of *P.* (*Ereosoma*) *variegatus*, a species closely resembling *P. quadrimaculatus* Lallemand, 1963, with the latter being erroneously treated by Nagai & Porion (1996) as a junior synonym of *P.* (*Ereosoma*) *bimaculatus* (Constant 2010). Hence the record of Hutacharern et al. (2007) was regarded as unreliable (Jiaranaisakul et al. 2018). All species so far recorded from Thailand belong to the subgenus *Ereosoma*. Recent surveys of the lanternfly fauna in Thailand led to the discovery of specimens of *P.* (*Ereosoma*) *bimaculatus* and *P.* (*Penthicodes*) *farinosus*, providing the first record in Thailand for these species, while photographic records additionally provided the first data of the former species in Peninsular Malaysia. Host plants are also recorded for the first time for these two species in Thailand, with an additional host plant record from Borneo for *P.* (*Penthicodes*) *farinosus*. In the present paper, we provide the first substantiated records of *P.* (*Ereosoma*) *bimaculatus* and *P.* (*Penthicodes*) *farinosus* in Thailand, the first records from Malaysia for the former species, and the first host plant data for both species as well as distribution maps and diagnostic characters to recognize both species. The

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distribution of these two species is discussed. An updated list of the species names in the genus is also provided.

MATERIAL AND METHODS

The male genitalia were removed from the tip of the abdomen, then soaked in 10% potassium hydroxide solution (KOH) for one day, and put in glycerin for detailed observation. The pygofer was separated from the abdomen and the aedeagus dissected with a needle blade for examination, then stored in glycerin for preservation. Photographs were taken with a Canon EF 100 mm f/2.8 Macro USM lens attached to a Canon EOS 7D mark II digital camera. The species were identified using the illustrated key in Constant (2010). The distribution maps were produced with SimpleMappr (Shorthouse 2010).

Institutional abbreviations

LTRS = Lam Takhong Research Station, Nakhon Ratchasima, Thailand
THNHM = Thailand Natural History Museum, Pathum Thani, Thailand

RESULTS

Taxonomy

Family Fulgoridae Duméril, 1820
Subfamily Aphaeninae Blanchard, 1847
Tribe Aphaenini Blanchard, 1847

Genus ***Penthicodes*** Blanchard, 1845

Blanchard (1845) did not give the gender of the genus name in the original description nor did he associate it to a species name from which the gender could be extrapolated. According to the International Code of Zoological Nomenclature (ICZN 1999), article 30.1.4.4 "A compound genus-group name ending in the suffix *-ites*, *-oides*, *-ides*, *-odes*, or *-istes* is to be treated as masculine unless its author, when establishing the name, stated that it had another gender or treated it as such by combining it with an adjectival species-group name in another gender form". Hence, the correct names of the 17 taxa in *Penthicodes* are as follows:

Penthicodes (*Ereosoma*) Kirkaldy, 1906
- *Penthicodes* (*Ereosoma*) *astraea* (Stål, 1864)
- *Penthicodes* (*Ereosoma*) *atomaria* (Weber, 1801)
- *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905)
- *Penthicodes* (*Ereosoma*) *caja* (Walker, 1851)
  - *Penthicodes* (*Ereosoma*) *caja caja* (Walker, 1851)
  - *Penthicodes* (*Ereosoma*) *caja malayanus* Constant, 2010
- *Penthicodes* (*Ereosoma*) *celebicus* Constant, 2010
- *Penthicodes* (*Ereosoma*) *pulchellus* Guérin-Méneville, 1838
- *Penthicodes* (*Ereosoma*) *quadrimaculatus* Lallemand, 1963
- *Penthicodes* (*Ereosoma*) *rugulosus* (Stål, 1870)
- *Penthicodes* (*Ereosoma*) *variegatus* Guérin-Méneville, 1829
- *Penthicodes (Ereosoma) warleti* Constant, 2010

Penthicodes (*Penthicodes*) Blanchard, 1845
- *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801)
  - *Penthicodes* (*Penthicodes*) *farinosus aerugineus* (Stål, 1870)
  - *Penthicodes* (*Penthicodes*) *farinosus farinosus* (Weber, 1801)
  - *Penthicodes* (*Penthicodes*) *farinosus leucosticticus* (White, 1845)
  - *Penthicodes* (*Penthicodes*) *farinosus niasensis* Schmidt, 1923
  - *Penthicodes* (*Penthicodes*) *farinosus tullia* (Breddin, 1901)
- *Penthicodes* (*Penthicodes*) *nicobaricus* (Stål, 1869)

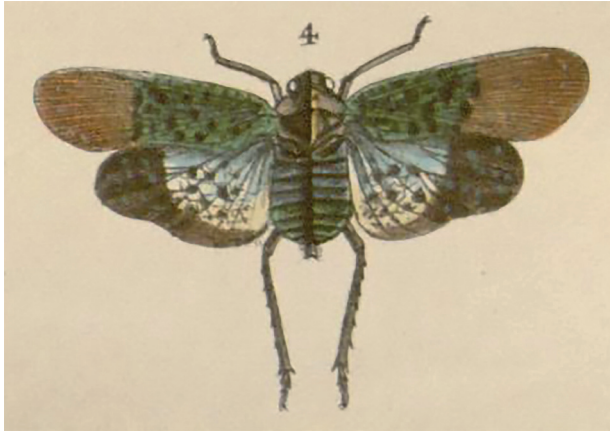

Fig. 1. Illustration of *Lystra dimidiata* in Hope (1843).

Notes. (1) The species-group epithets *astraea*, *atomaria*, *caja* and *tullia* are not adjectives and therefore indeclinable (D. Yanega pers. com., Sept. 2021).

(2) Hope (1843) described *Lystra dimidiata* Hope, 1843 from "Silhet" (currently Sylhet in Bangladesh, 24°54′N 91°52′E), which was later synonymized under *Penthicodes* (*Penthicodes*) *farinosus* by Nagai & Porion (1996). However, the specimen illustrated by Hope (1843) (Fig. 1) actually seems to be a specimen of *Penthicodes* (*Penthicodes*) *farinosus leucosticticus* (White, 1845) (see illustration in Nagai & Porion 1996: pl. 4, fig. 61). The latter subspecies is well characterized by its hind wings pale blue basally with numerous small black spots arranged in rows and is only known from the Philippines. There is no record of any *P. farinosus* specimen

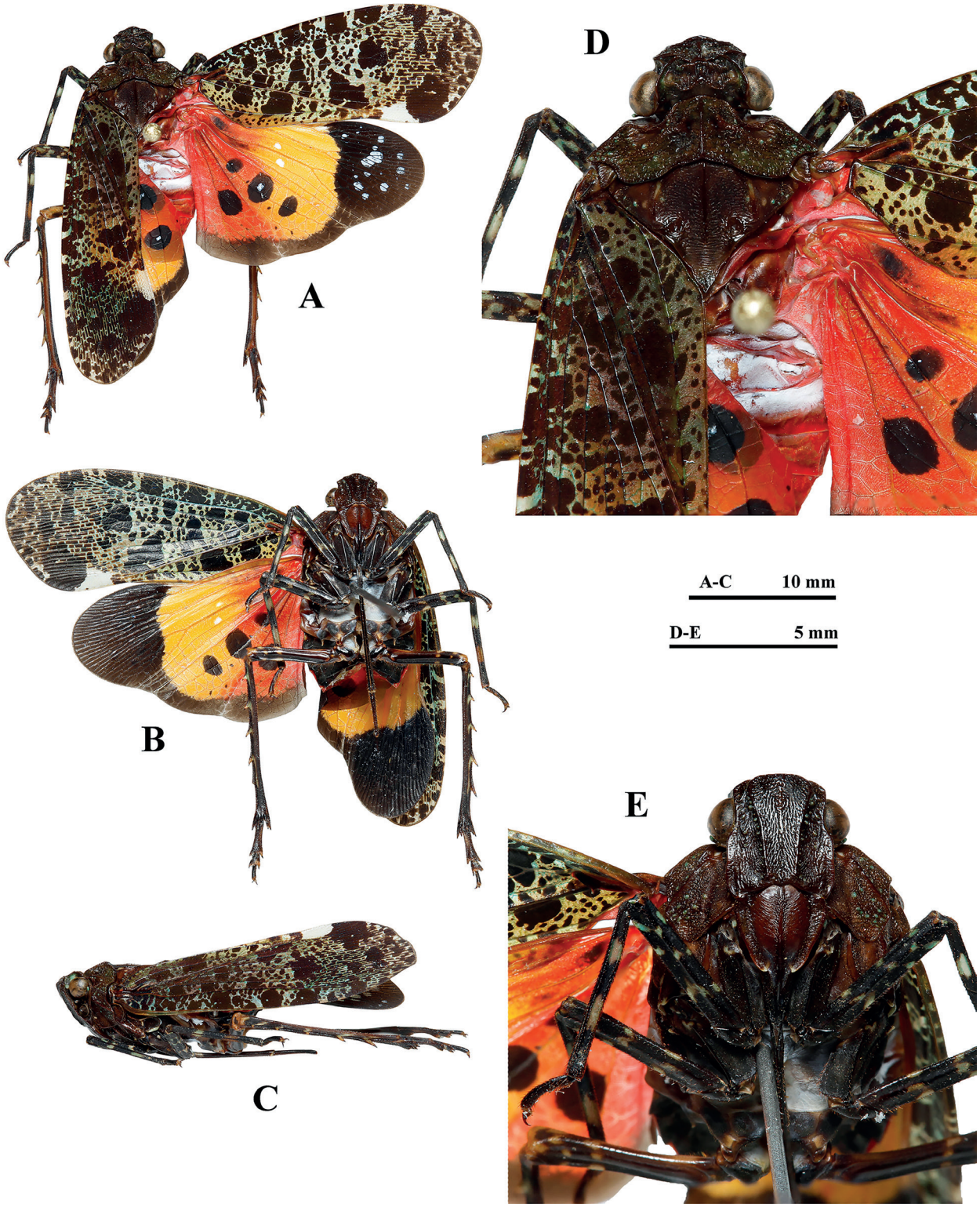

Fig. 2. *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905), ♂. **A**. Habitus, dorsal view. **B**. Habitus, ventral view. **C**. Habitus, lateral view. **D**. Head and thorax. **E**. Perpendicular view of frons.

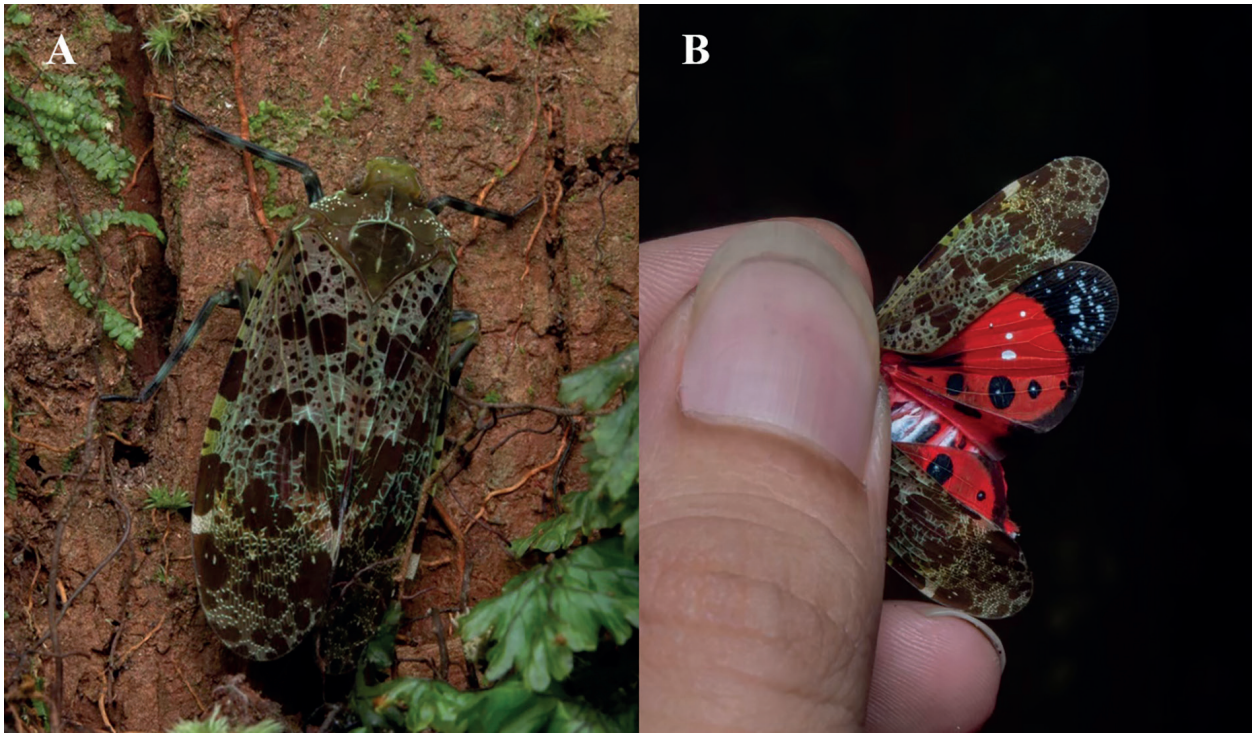

Fig. 3. *Penthicodes* (*Ereosoma*) *caja malayanus* Constant, 2010, ♀. **A**. On unidentified plant. **B**. Showing the disc of hind wing.

matching Hope's illustration from Sunda region or continental Southeast Asia, which represent the area between the Philippines and Bangladesh (Fig. 4; Nagai & Porion 1996: pl. 4, figs 62, 64, 67, 70); instead, all specimens examined from Sunda and the continent, lack the rows of black spots on the hind wings. Hence, we consider that the specimen collection data given by Hope is probably erroneous, and propose to remove *P.* (*Penthicodes*) *farinosus* from the fauna of Bangladesh.

(3) The subspecies given for *P.* (*Penthicodes*) *farinosus* follow Nagai & Porion (1996).

Penthicodes* (*Ereosoma*) *bimaculatus (Schmidt, 1905)
(Figs 2, 5A–D, 6A–C, 7A, 9A)

Diagnosis. The external morphology of the species is close to *P.* (*Ereosoma*) *celebicus* and *P.* (*Ereosoma*) *rugulosus* that are known from Indonesia (Sulawesi) and Philippines, respectively. They share the characters of a white patch along the sutural margin on nodal line of cross-veins and irregular black-brown markings on tegmina, but the disc of the hind wing is red with orange apically in *P.* (*Ereosoma*) *bimculatus*. The male genitalia of this species differ from other species by these characters: anal tube short with lateral curved expansion directed ventrally (Fig. 5B, D); gonostyli slightly elongated, round at apex in lateral view.

Material examined. Thailand: 2 ♀♀, Yala Prov., Betong Dist., 24.VIII 2018, M. Naiduangchan & P. Pawangkhanant leg., THNHM-I-24962 and THNHM-I-24963 (THNHM); 1 ♂, Yala Prov., Betong Dist., 3.VIII 2020, P. Pawangkhanant leg., THNHM-I-24961 (THNHM).

Material examined from photographs. Malaysia: 1 specimen (Fig. 6A), Selangor, Semenyih, 2.9474° N, 101.8451° E, 24.V.2020, T. Eng Wah; 1 specimen (Fig. 6B), Selangor, Sungai Tua, 3.25233° N, 101.67538° E, 10.XII.2016, T. Eng Wah; 1 specimen (Fig. 6C), Selangor, Ulu Yam, 3°25′59″ N, 101°39′27″ E, 9.VI.2012, H.P. Guek.

Distribution. Borneo, Indonesia (Sumatra), West Malaysia (new country record), Singapore and Thailand (Constant 2010; Bourgoin 2022).

Biology. Specimens (male and female) of *P.* (*Ereosoma*) *bimaculatus* have been confirmed from Thailand and Peninsular Malaysia. This species is confined to Sundaland. So far, the northern limit in its distribution range is in the southernmost part of Thailand. The male specimen was collected from southern Thailand on a trunk of *Shorea* cf. *curtisii* (Dipterocarpaceae) together with a cockroach (Fig. 7A).

Penthicodes* (*Ereosoma*) *caja malayanus Constant, 2010
(Figs 3, 8)

Diagnosis. The species differs from other species by its tegmina with large dark-brown markings, ground colour of tegmina and membrane brown; white patch along sutural margin and costal margin on nodal line of cross-

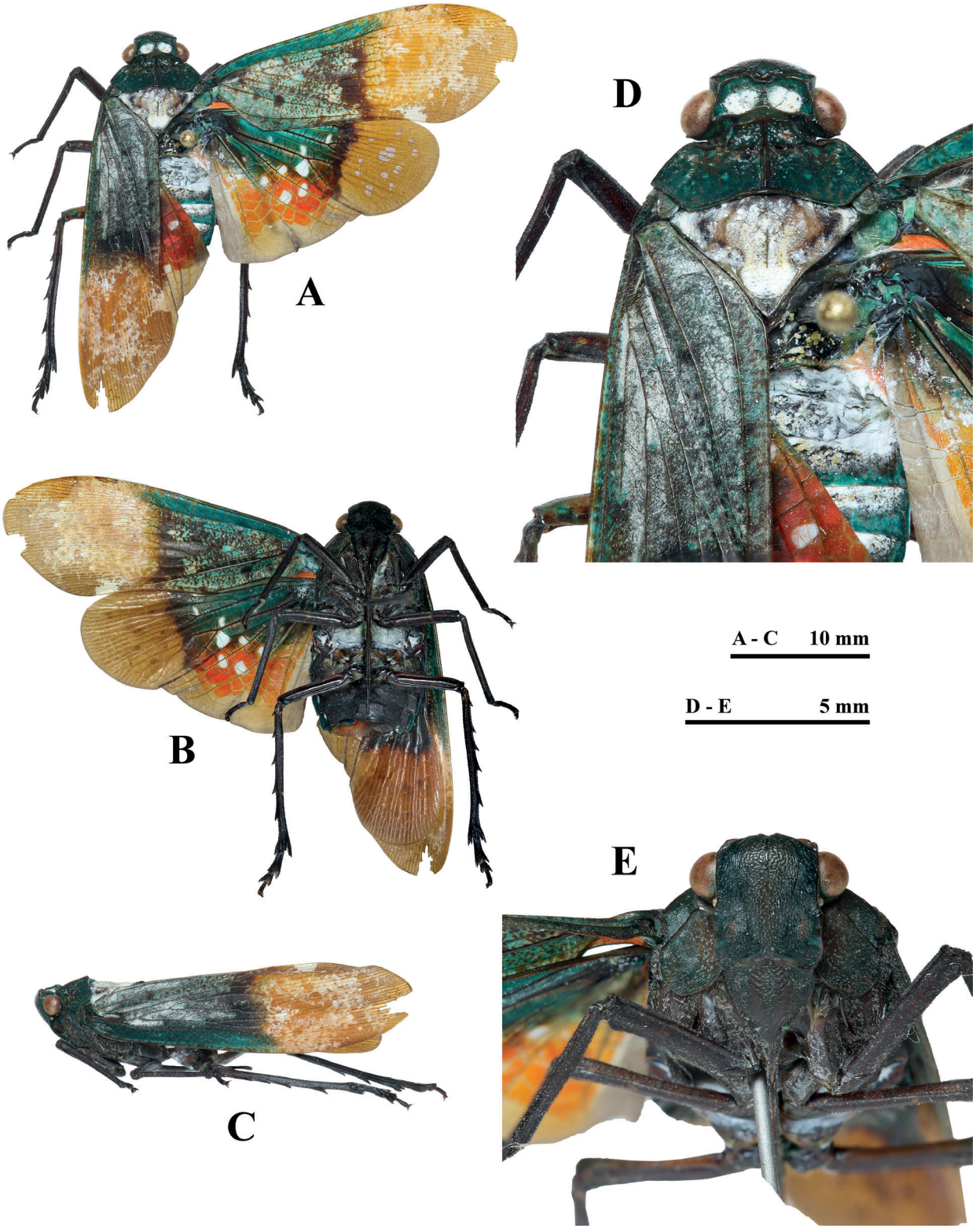

Fig. 4. *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801), ♂. **A**. Habitus, dorsal view. **B**. Habitus, ventral view. **C**. Habitus, lateral view. **D**. Head and thorax. **E**. Perpendicular view of frons.

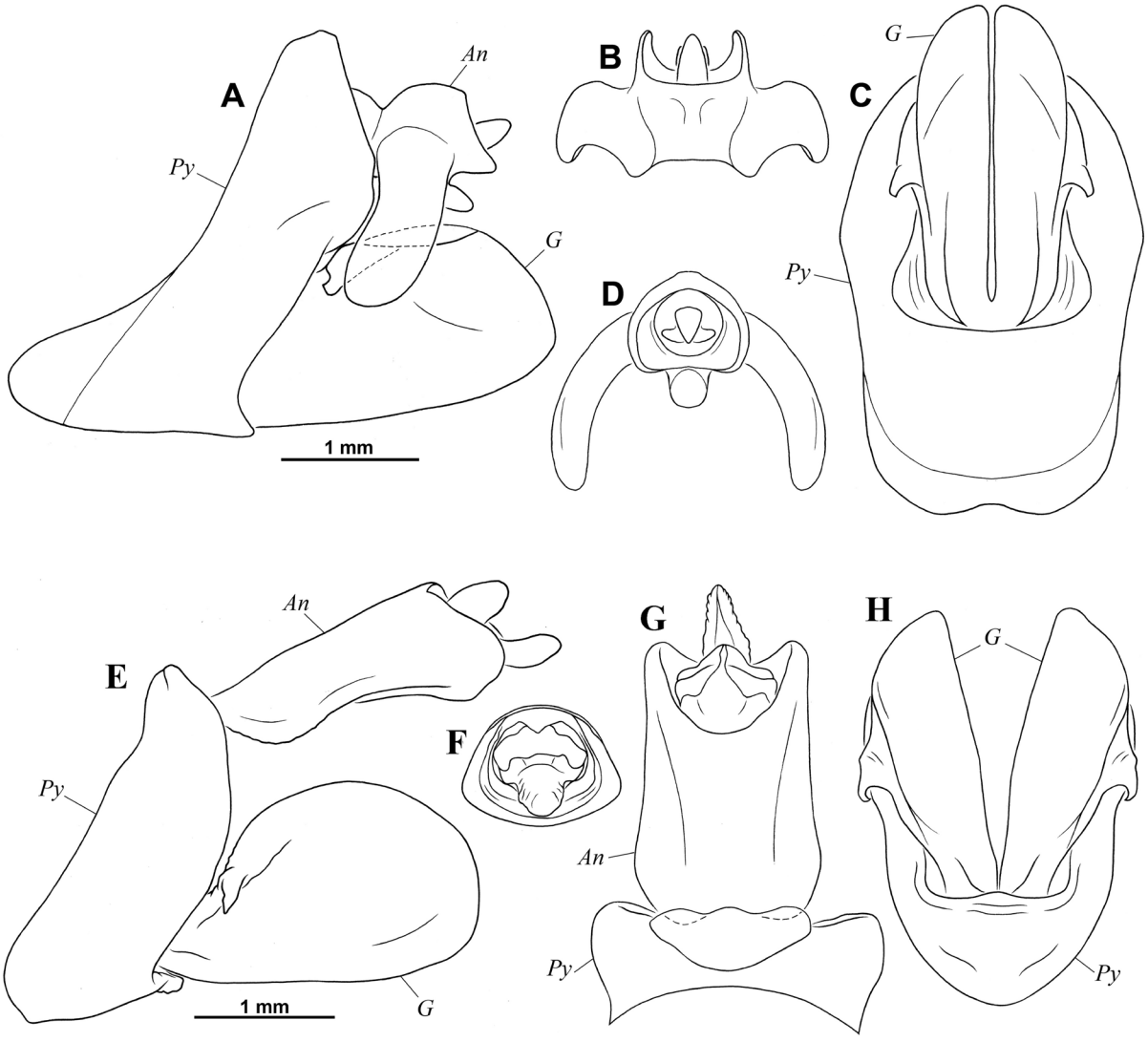

Fig. 5. Male genitalia. **A–D**. *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905) (modified from Constant 2010). **A**. Pygofer (*Py*), anal tube (*An*) and gonostyli (*G*), left lateral view. **B**. Anal tube, dorsal view. **C**. Pygofer and gonostyli, posteroventral view. **D**. Anal tube, posterior view. **E–H**. *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801). **E**. Pygofer, anal tube and gonostyli, left lateral view. **F**. Anal tube, posterior view. **G**. Pygofer and anal tube, dorsal view. **H**. Pygofer and gonostyli, posteroventral view.

veins. The subspecies *malayanus* is is very easy to recognize from *P. caja caja* by the disc of hind wings red as opposed to orange in *P. caja caja*.

Material examined. Thailand: 1 ♀, Nakhon Ratchasima Prov., Mu Si, 21.III.2020, W. Khaikaew leg. (LTRS).

Distribution. Malaysia (Constant 2010) and Thailand (new country record).

Biology. The specimen was found on an unidentified plant in dry evergreen forest.

Penthicodes* (*Penthicodes*) *farinosus (Weber, 1801)
(Figs 4, 5E–H, 6D, 7B–D, 9B)

Diagnosis. The species is easy to differentiate from the other *Penthicodes* species by the vertex wider than long in dorsal view with two patches of white waxy secretion. Only *P.* (*Penthicodes*) *nicobaricus* (Stål, 1869) from Andaman and Nicobar Islands shows waxy patches on the vertex but its vertex is as wide as long in dorsal view (Constant 2010; Constant & Mohan 2017).

Material examined. Thailand: 3 ♂♂, 2 ♀♀, Yala Prov., Betong Dist., 3.VIII.2020, A. Aksornneam, P. Pawangkhanant & T. Ruangsuwan leg., THNHM-I-24964–THNHM-I-24968 (THNHM); 1 ♀, Phang Nga Prov., Thai Mueang Dist., Khanim Waterfall, 8°29’48.7” N, 98°17’01.3” E, 50 m a.s.l., 20.X.2021, K. Jiaranaisakul leg. (THNHM).

Material examined from photographs. Malaysia (Borneo): 1 specimen (Fig. 6D), Sarawak, Mulu National

Fig. 6. Live specimens from Malaysia. **A**. *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905), Selangor, Semenyih, 24.V.2020. © T. Eng Wah. **B**. *Penthicodes* (*Ereosoma*) *bimaculatus*, Selangor, Sungai Tua, 10.XII.2016. © T. Eng Wah. **C**. *Penthicodes* (*Ereosoma*) *bimaculatus*, Selangor, Ulu Yam, 9.VI.2012. © H.P. Guek. **D**. *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801), Sarawak, Mulu National Park, 27.II 2009, on *Ailanthus integrifolia* Lam. (Simaroubaceae). © Fletcher & Baylis.

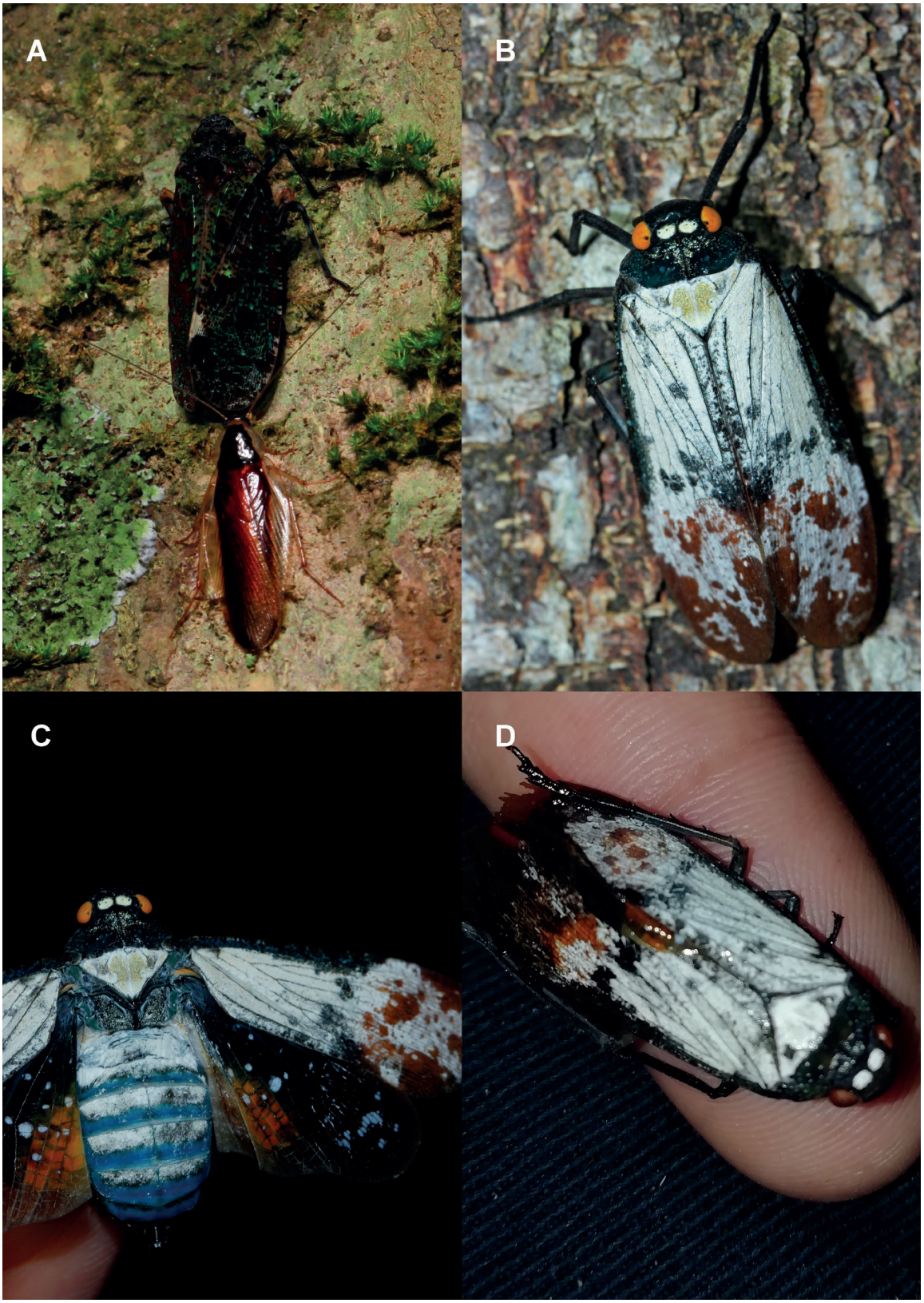

Fig. 7. Live specimens from Thailand. **A**. *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905), Yala, Betong, 3.VIII 2020, tended by cockroach. © P. Pawangkhanant. **B**. *P*. (*Penthicodes*) *farinosus* (Weber, 1801), Yala, Betong, 3.VIII 2020, on *Alstonia scholaris* (L.) R.Br. (Apocynaceae). © P. Pawangkhanant. **C**. *P*. (*Penthicodes*) *farinosus*, Yala, Betong, 3.VIII 2020, showing hind wings. © P. Pawangkhanant. **D**. *P*. (*Penthicodes*) *farinosus*, Yala, Betong, 31.III.2020. © K. Saechan.

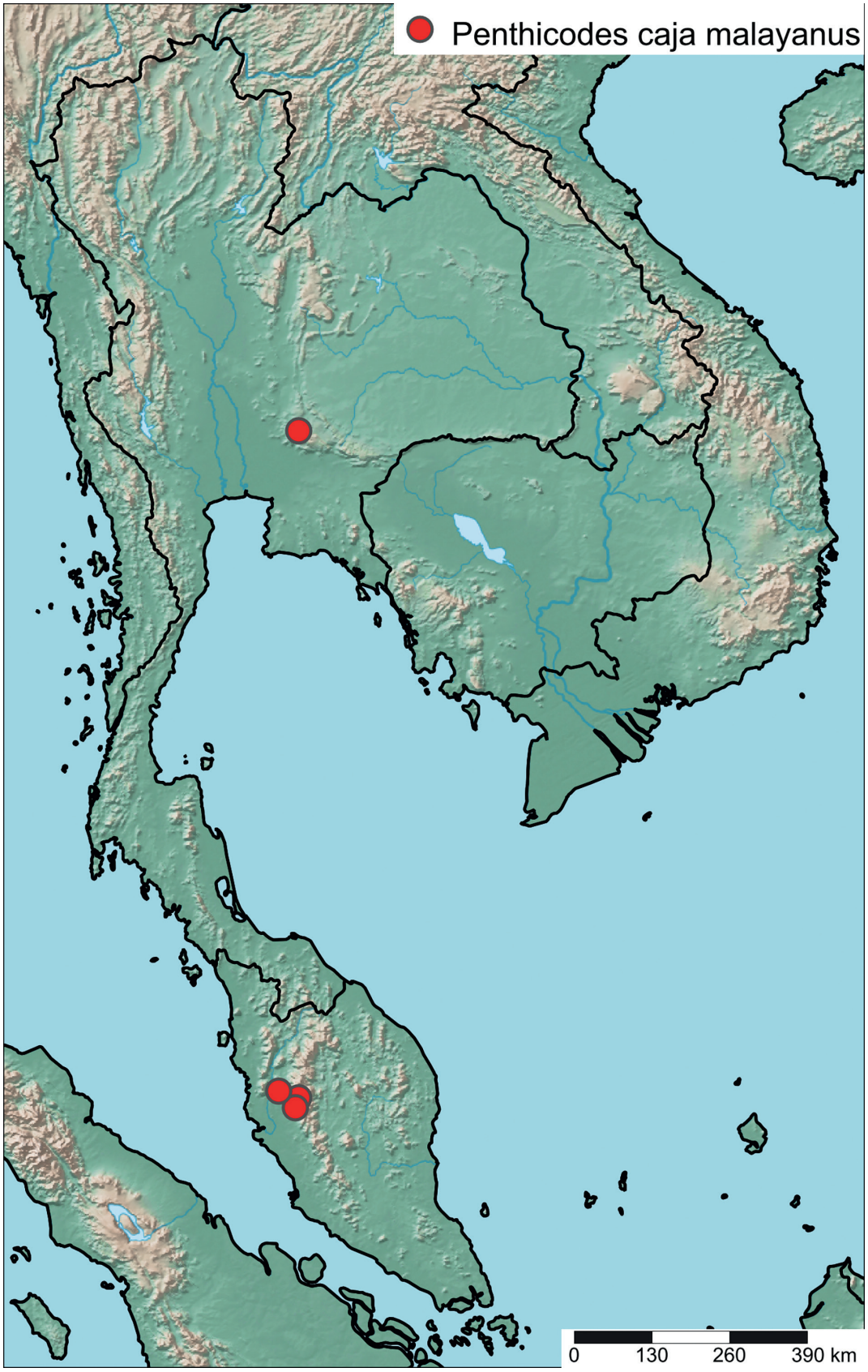

Fig. 8. Distribution map of *Penthicodes* (*Ereosoma*) *caja malayanus* Constant, 2010.

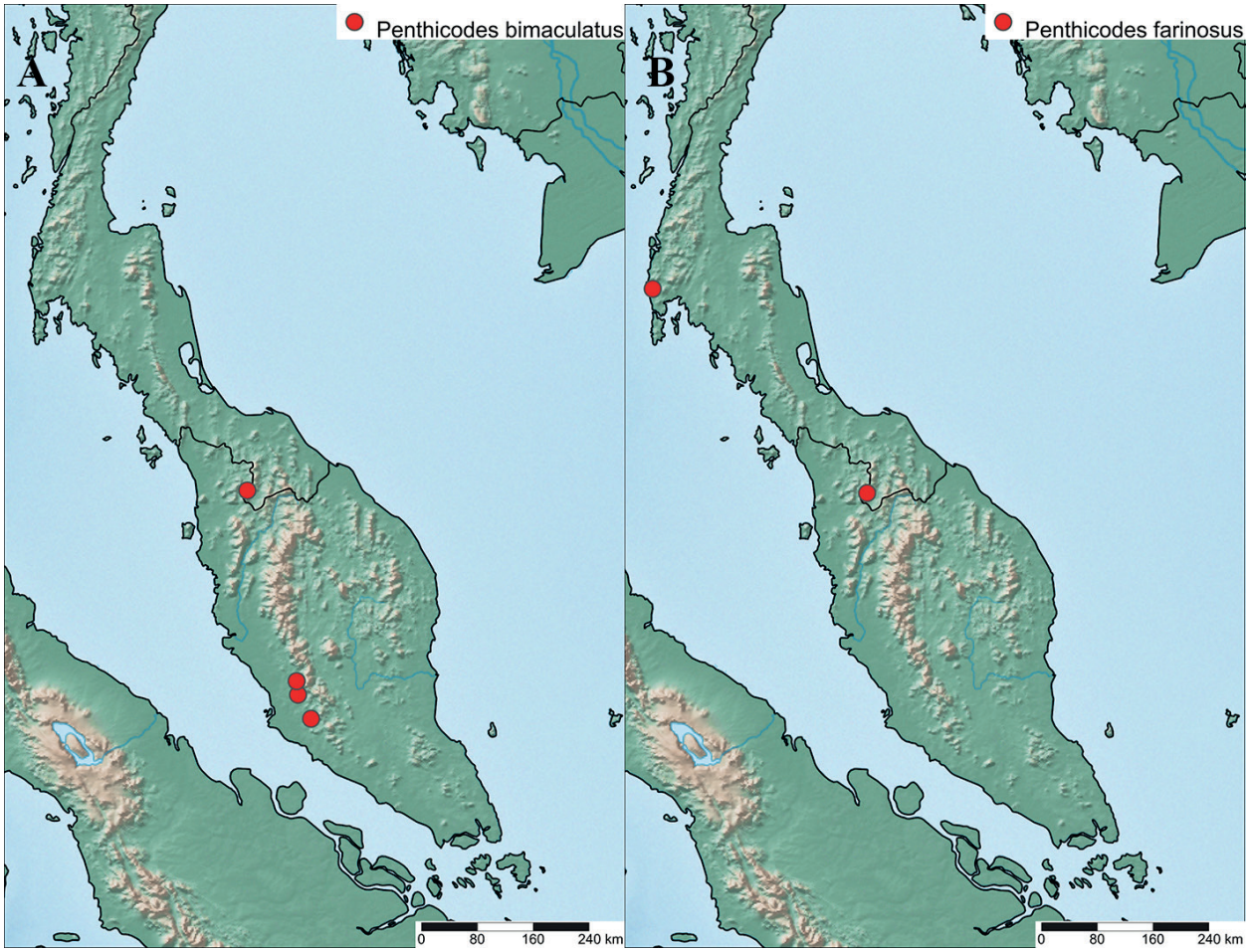

Fig. 9. Distribution map of *Penthicodes* Blanchard, 1845 spp. in the Malay Peninsula. **A**. *Penthicodes* (*Ereosoma*) *bimaculatus* (Schmidt, 1905). **B**. *Penthicodes* (*Penthicodes*) *farinosus* (Weber, 1801).

Park, 27.II.2009, on *Ailanthus integrifolia* Lam. (Simaroubaceae), W.K. Fletcher & D.M. Baylis.

Thailand: 1 specimen (Fig. 7D), Yala Province, Betong, 31.XII.2020, K. Saechan.

Distribution. Borneo, Indonesia (Java, Sumatra), West Malaysia, Myanmar, Philippines (Distant 1901; Lallemand 1963; Seidel & Wessel 2013; Bourgoin 2022) and Thailand (new country record).

Note. The record from Tavoy (currently Dawei, Myanmar), far north of the Isthmus of Kra, by Distant (1906) is regarded as doubtful and further studies are needed for confirmation.

Biology. *Penthicodes* (*Penthicodes*) *farinosus* has been found only in the southernmost part of Thailand. *Alstonia scholaris* (L.) R.Br. (Apocynaceae) is a host plant of *P.* (*Penthicodes*) *farinosus* in Thailand (Fig. 7B), while the species was recorded on *Ailanthus integrifolia* Lam. in Borneo (W.K. Fletcher & D.M. Baylis pers. com., 2020; Fig. 6D).

DISCUSSION

Three species and one subspecies of the genus *Penthicodes* were recently added to the fauna of Thailand, as well as several new host plant records (Jiaranaisakul et al. 2018; Jiaranaisakul & Constant 2021; present study). Additionally, the nomenclature of the genus had to be adapted to a correct masculine treatment of the genus instead of the feminine treatment erroneously applied by all authors for more than 150 years.

Seven species of the genus *Penthicodes* are now recorded from Thailand, representing 58.33% of the total number of species in the genus. Unfortunately, their life-history and biology remain still very poorly documented, for example, eggs and nymphs are still unknown. We hope that cooperation with citizen-scientists and local authorities will help fill those gaps in the knowledge of this iconic insect group.

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