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Remarks on the genus *Necroscia* (Phasmatodea, Diapheromeridae, Necrosciinae) from China, with two new records, one new synonym, and one new combination and key to the species

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Abstract

There are nine *Necroscia* species recognized in China, among which *N. inflata* (Redtenbacher) and *N. marginata* (Gray) are reported for the first time from China. One new synonym is discovered: *N. maculata* (Chen & He) is regarded as a junior synonym of *N. multicolor* (Redtenbacher) n. syn. First description is given for the female and egg of *N. hainanensis* (Chen & He) n. comb., which is transferred from *Sosibia* Stål. A list and key to all Chinese species are given.

Key words

Necroscia, *Necroscia inflata*, *Necroscia marginata*, *Necroscia hainanensis*, new records, new synonym, new combination, China

Introduction

Necroscia Audinet-Serville, 1838 is the second biggest genus of Necrosciinae Brunner von Wattenwyl, 1893 and contains 61 species in the tropical and warm subtropical regions of the Oriental region (Phasmida Species File Online by Brock). The number of *Necroscia* species is probably underestimated because of their canopy behavior, which causes difficulty collecting specimens.

In China, three *Necroscia* species are recognized in Hennemann *et al.* (2008: 17). Chen and He (2008) described several new taxa of *Necroscia* and *Aruanoidea* Brunner von Wattenwyl, 1893 in their monograph of Chinese phasmid. However, the latter one was a junior synonym to *Necroscia* (Hennemann 1998). Subsequently, eight species were recognized in Chen and He's monograph. There are also two other publications which involve the Chinese *Necroscia*, including a new species in Yunnan Province (Chen & Zhang 2008) and a newly discovered synonym (Ho 2010).

This study aims to provide taxonomic notes on the genus *Necroscia* in China, of which nine species are currently recognized in China. Two new species from China, *N. inflata* (Redtenbacher, 1908) and *N. marginata* (Gray, 1835), are reported for the first time. A new synonym and a new combination are proposed: *N. maculata* (Chen & He, 2000) is regarded as synonym of *N. multicolor* (Redtenbacher, 1908) n. syn.; and *N. hainanensis* (Chen & He, 2002) n. comb. is transferred from *Sosibia* Stål, 1875. The morphology of the female and structure of the egg of the latter species are firstly described and illustrated. A list and a key to *Necroscia* of China are provided in this paper to advance our understanding of this winged species in China.

Material and methods

The sequence of species account is alphabetical. Morphological terms largely follow Bragg (1997, 2001). Ootaxonomic description refers to Clark (1976a, 1976b, 1988, 1998) and Clark-Sellick (1997). Drawings of abdominal structure of *Necroscia inflata* (Redtenbacher) and *N. marginata* (Gray) are based on the Chinese specimens. Geographical distribution of each species provided in the checklist is based on Otte & Brock (2005), Chen & He (2008), Hennemann *et al.* (2008), and Phasmida Species File Online.

The materials mentioned in this paper are deposited in the following collections: Natural History Museum, London, England (BMNH); China Agricultural University, Beijing, China (CAU); Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium (ISNB); Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS); Naturhistorisches Museum, Vienna, Austria (NHMW); Shanghai Entomological Museum, China Academy of Sciences, Shanghai, China (SEM); Shanghai Normal University, Shanghai, China (SNU); Zoologisches Museum der Universität, Hamburg, Germany (ZMUH); Museum of Biology, Zhongshan (Sun Yat-Sen) University, Guangzhou, Guangdong, China (ZSU); and the private collection of Ho, G.W.C., Hong Kong, China (GH).

Taxonomy

Necroscia Audinet-Serville, 1838

Type species.— *Necroscia roseipennis* Audinet-Serville, 1838: 250, by subsequent designation of Kirby, 1904: 436.

= *Aruanoidea* Brunner von Wattenwyl, 1893 [Synonymised by Hennemann, 1998: 121].

Notes.— Nine species are currently recognized in China. Two newly described taxa, *Aruanoidea pseudocerca* Chen & He, 2008 [= *Necroscia pseudocerca*] and *Aruanoidea bidentata* Chen & He, 2008 [= *Necroscia bidentata*] are misplaced and not discussed in this study. A publication is in progress to deal with these species (Ho in prep.). The specimens of *Necroscia inflexipes* (Olivier, 1792) are believed lost (Hennemann *et al.* 2008) and, therefore, are not included in the key.

Species recorded in China.—
1. *Necroscia flavescens* (Chen & Wang, 1998) [China (Guangxi) & Vietnam].
2. *Necroscia hainanensis* (Chen & He, 2002) n. comb. [China (Hainan)].
3. *Necroscia inflata* (Redtenbacher, 1908) [China, Singapore, Peninsular Malaysia and Sumatra].

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4. *Necroscia inflexipes* (Olivier, 1792) [China].
= *Phasma curvipes* Stoll, 1813.
= *Phasma valgum* Lichtenstein, 1796.
5. *Necroscia marginata* (Gray, 1835) [China (Yunnan), Singapore, Peninsular Malaysia and India].
6. *Necroscia mista* (Chen & He, 2008) [China (Guangdong)].
7. *Necroscia multicolor* (Redtenbacher, 1908) [China (Guangxi & Guangdong) & Vietnam].
= *Necroscia maculata* (Chen & He, 2000) n. syn.
8. *Necroscia notata* (Chen & Zheng, 2008) [China (Yunnan)].
9. *Necroscia shukayi* (Bi, Zhang & Lau, 2001) [China (Guangdong & Hong Kong)].
= *Necroscia ovata* Chen & He, 2008.

Key to females of the Chinese *Necroscia*

1. Pronotum with spines . . . . . *N. notata*
- Pronotum lacking spine, only granulated or smooth 2

2. Anal region of alae with mottled spots 3
- Anal region of alae lacking mottled spots, uniformly colored 4

3. Metafemora and metatibiae armed with fin-like lamellae . . . . . *N. hainanensis*
- Metafemora and metatibiae lacking armature . . . . . *N. shukayi*

4. Body yellowish 5
- Body greenish 6

5. Head with ocelli . . . . . *N. flavescens*
- Head lacking ocellus . . . . . *N. multicolor*

6. Tegmina with narrow margin in green, length of cerci distinctly long than the anal segment, body length 62-80 mm . . . . *N. inflata*
- Tegmina with narrow margin in yellow, length of cerci as long as or shorter than the anal segment, body length 54-64 mm . . . . . *N. marginata*

Key to males of the Chinese *Necroscia*

1. Mesonotum with spine-like tubercles . . . . . *N. mista*
- Mesonotum lacking spine-like tubercle 2

2. Anal region of alae with mottled spots 3
- Anal region of alae lacking mottled spot, uniformly colored 4

3. Tegmina with narrow outer margin in creamy white . . . . . *N. shukayi*
- Tegmina with narrow outer margin in green . . . . . *N. hainanensis*

4. Body yellowish 5
- Body greenish 6

5. Body slender, head with ocelli . . . . . *N. flavescens*
- Body stout, head lacking ocellus . . . . . *N. multicolor*

6. Tegmina with narrow outer margin in yellow, body length 40-44 mm . . . . . *N. marginata*
- Tegmina with narrow outer margin in green, body length 50-59 mm . . . . . *N. inflata*

***Necroscia hainanensis* (Chen & He, 2002) n. comb.**
(Figs 1-4, 12)

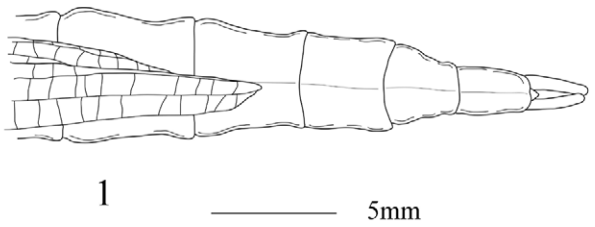
Sosibia hainanensis, Chen & He (in Chen *et al.*), 2002: 107, figs. 9 a-b. Holotype ♂, Jianfengling, Hainan Province, China, 29.VI.1981, Rao Shuqing (ZSU).
Hennemann *et al.*, 2008: 40.
Chen & He, 2008: 196, figs 161 a-b.

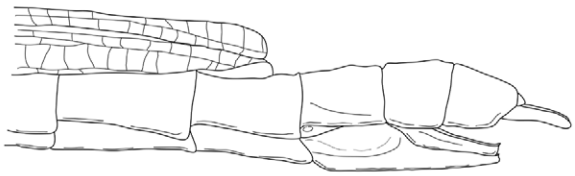
Further material.— ♂, Jianfengling, Hainan Province, China, 24.VII.1984, Hua Lizhong (ZSU); ♂♀ and 5 eggs, Jianfengling, Hainan Province, China, 7.VI.2008, Ho, G.W.C. (GH).

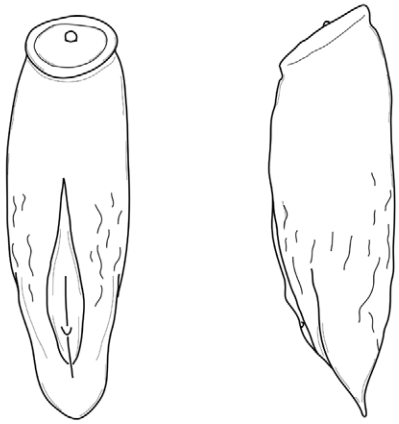
Diagnostic features.— The female is well distinguished from other species by antero-ventral carinae of metafemora and metatibia armed with fin-like lamellae. The male is generally similar to the female, but is lacking lamella on metafemora and mesofemora. Grayish to purplish green body with darker markings, which is distinctive from other *Necroscia*.

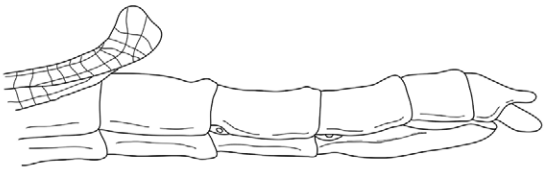
Description.— **Female:** (Figs 1, 2, 12) Grayish to purplish green with darker markings. Head and thorax covered with granules and tubercles. Larger and more robust than male.
Head: Oval, longer than wide, slightly shorter than pronotum. Vertex with two small oval elevations between eyes, anterior margin of the elevations black. Occiput gently convex, with yellowish tubercle-like granules. Median furrow distinct. Eyes big, oval and protruding, dark brown. Ocelli distinct, placed above eyes, green and oblong. Antennae very long, longer than forelegs; the first segment 1.5× longer than second segment.
Thorax: Pronotum with few granules, parallel-sided, slightly longer than head, hind margin rounded. Mesonotum 2.5× longer than pronotum, shorter than mesofemora, median carina distinct; surface sparsely covered with small granules and few tubercle-like granules with a short carina before half being laterad of lateral margins. Mesopleurum set with four to five short spine-like tubercles. Mesosternum with yellowish granules. Metapleurum with oblong granules.
Abdomen: Cylindrical and tapering posteriorly. Sixth to 8th tergites with two lateral carinae. Anal segment as long as 9th tergum, notched at hind margin. Supra-anal plate small, triangular. Subgenital plate boat-shaped, apex slightly notched, reaching end of the anal segment. Cerci long and straight, apices rounded, slightly shorter than anal segment.
Legs: Brownish to grayish green, with irregular sizes of black mottling. Hindlegs as long as forelegs. All carinae of profemora, mesofemora, protibiae and mesotibiae smooth and unarmed. Antero-ventral carina of metafemora and metatibiae with irregular sizes of fin-like lamellae. Postero-ventral carina of metafemora smooth. Postero-ventral carina of metatibiae slightly waved.
Wings: Tegmina dull green, oval, with blunt elevation, margin with a blackish stripe. Alae very long, reaching 7th tergum, costal region dull green to grayish green, with pale or green mottling, anal region buff with blackish spots.
Measurements (mm): Body length 79, head 5, antennae 65, pronotum 5, mesonotum 10, metanotum 5, median segment 7, profemora 21, mesofemora 14, metafemora 23, protibiae 22.5, mesotibiae 15, metatibiae 24, tegmina 10.5, alae 46.
Eggs (Figs 3, 4)**:** Capsule bluish green to dull green, bullet-shape, with wrinkles. Narrowing moderately towards posterior end, apex obtuse in dorsal view. Operculum flat, blackish green surrounded by dull green with wrinkles as capsule, central area elevated with a

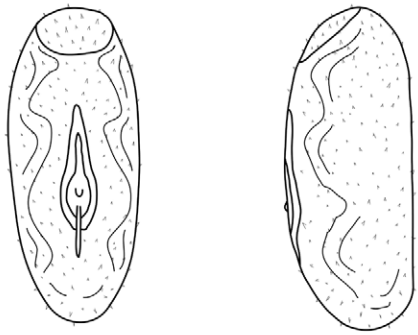
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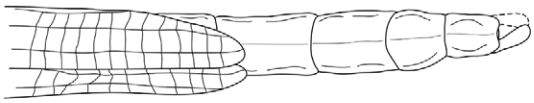




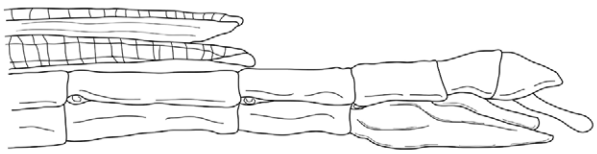


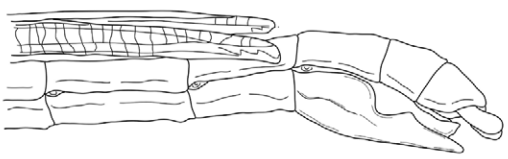












Figs 1-11. *Necroscia* spp. and *Sosibia truncata*. 1. *N. hainanensis*: ♀, end of abdomen, dorsal view. 2. *N. hainanensis*: ♀, end of abdomen, lateral view. 3. *N. hainanensis*: egg, dorsal view. 4. *N. hainanensis*: egg, lateral view. 5. *Sosibia truncata*: ♀, end of abdomen, lateral view. 6. *S. truncata*: egg, dorsal view (after Ho 2012: 39, figs 4). 7. *S. truncata*: egg, lateral view (after Ho 2012: 39, figs 5). 8. *N. inflata*: ♀, end of abdomen, dorsal view. 9. *N. inflata*: ♀, end of abdomen, lateral view. 10. *N. marginata*: ♀, end of abdomen, dorsal view. 11. *N. marginata*: ♀, end of abdomen, lateral view.

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small granule-like capitulum, same coloration as capsule. Opercular collar thick and smooth. Micropylar plate oblong, anterior apex pointed while posterior apex slightly rounded.
Measurements (mm): Length 5.4, width 1.7, height 1.5.

Notes.— Chen and He (in Chen *et al*. 2002) originally placed this species in *Sosibia* Stål, 1875. However, the curved inward hind margin of the anal segment in the female and the bullet-shaped egg capsule of this species match with the features of *Necroscia* rather than *Sosibia* (rounded hind margin of the anal segment in female and oval egg capsule, see Figs 5-7) and should, therefore, be transferred. The female and eggs are described for the first time.

Distribution.— Hainan (Jianfengling), China. Probably an endemic species to Hainan.

Necroscia inflata (Redtenbacher, 1908)
(Figs 8-9, 13)

Aruanoidea inflata, Redtenbacher, 1908: 526. Syntypes 2♂♂, Palembang, Sumatra, G. Wölber leg. ded., 11.IX.1891, 163-164 (ZMUH); Syntypes 2♀♀, Palembang, Sumatra, G. Wölber leg. ded., 11.IX.1891, 166-167 (ZMUH); Syntype ♀, Deli, Palembang, Sumatra (ZMUH); Syntype ♂, Nias Island, Sumatra, 1897, U.Raap, 'Mus. Genova' (NHMW); Syntype ♀, Palambang, Sumatra (NHMW); Syntypes 2♂♂, Perak, Peninsular Malaysia, Staudinger (NHMW); Syntypes 1♂, 5♀♀, Kuala Kangsar, Perak, Peninsular Malaysia, 1902, Grubauer (NHMW); Syntypes ♂♀, Perak, Peninsular Malaysia, Jachau (NHMW); Syntype ♂, Kelantan, Peninsular Malaysia, Rolle (NHMW). [Assessed by Phasmid Species File Online's images]
Necroscia inflata, Seow-Choen *et al.*, 1994a: 11.
Seow-Choen *et al.*, 1994b: 8.
Seow-Choen *et al.*, 1994c: 394. [Note on food-plants].
Brock, 1995: 91.
Seow-Choen, 1997: 92. [Illustration].
Brock, 1998: 35.
Brock, 1999: 99. [Redescription and egg illustrations].
Seow-Choen, 1999: 299.
Seow-Choen, 2000: 23. [Illustration].
Zompro, 2002: 190.
Otte & Brock, 2005: 212.
Seow-Choen, 2005: 60. [Illustration].

Further material.— ♀, 12000391 (SEM).

Diagnostic features.— The dark green thorax and costal region of alae lacking marking is separated from other similar species.

Description of both sexes.— Dark green species. Both sexes similar. Male smaller and slimmer than the female. Head square, almost as long as wide. Eyes dark brown. Mesonotum with small granulations. Female anal segment slightly longer than 9th tergum, slightly incised in center at hind margin. Female cerci stout and long (lacking right cercus in SEM specimen), cylindrical, apex rounded. Male cerci small, hidden beneath anal segment. Legs green as body. Tegmina green as body, elevated angle blunt and brown. Margin of costal region of alae light green, anal region pinkish with dusky areas, usually reaching 6th tergum or 7th tergum.

Distribution.—China, Singapore, Peninsular Malaysia (Perak and Kelantan) and Sumatra (Palembang and Nias Islands).

Notes.—The specimen in SEM was not labeled and was presumably collected from Yunnan or Guangxi among the neighboring Chinese specimens in the collection. With the similar distribution and occurrence in China of *N. marginata* [described in this study] and *Trachythorax atrosignatus* (Brunner von Wattenwyl, 1893) [recently reported from China in Chen & He 2008: 179], segregated distributions of this species between China and Peninsular Malaysia reflect the potential populations in Vietnam, Myanmar and Thailand. Redescription and egg illustrations were provided by Brock (1999: 99). The description is based on Brock (1999: 99) and the Chinese specimen.

Necroscia marginata (Gray, 1835)
(Figs 10-11, 14)

Phasma marginatum, Gray, 1835: 23. Holotype ♀, Malabar, India, catalog no 844793 (BMNH). [Assessed by Phasmid Species File Online's images].
Necroscia marginata, Westwood, 1859: 148.
Kirby, 1904: 375.
Brock, 1995: 90.
Brock, 1999: 93. [Egg illustration].
Seow-Choen, 2000: 22. [Illustration].
Otte & Brock, 2005: 213.
Seow-Choen, 2005: 54. [Illustration].
Aruanoidea marginata, Redtenbacher, 1908: 525.

Further material.— 2♀♀, Xishuangbanna, Yunnan Province, China, 8.VII.2003, Hu Jiayao & Tang Liang (SNU).

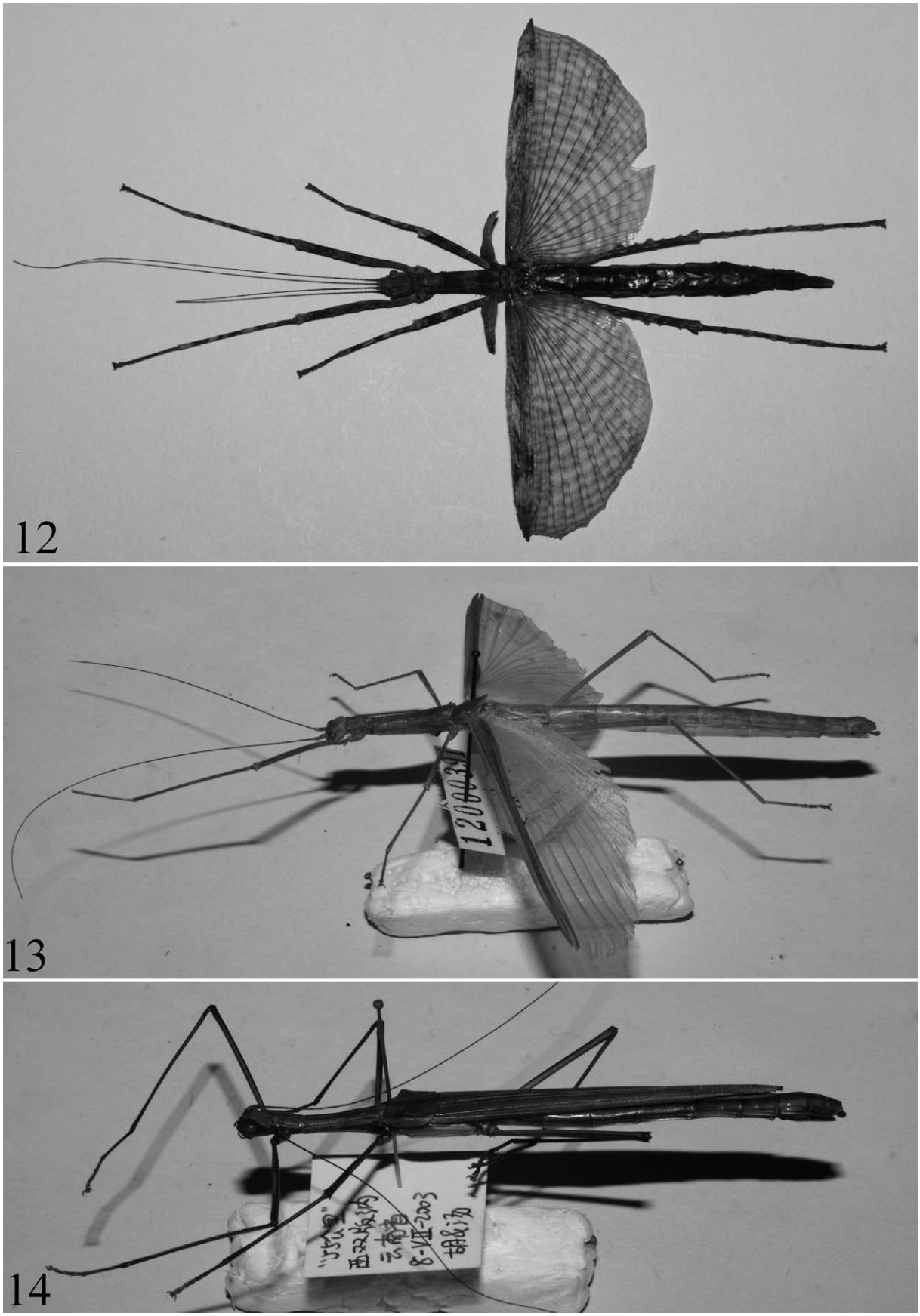
Diagnostic features.— This species is separated from other *Necroscia* by tegmina, and costal region of alae green with narrow margin in yellowish or reddish brown and anal region of alae rosy pink.

Description of both sexes.— Female body robust, male smaller than female. Head, thorax and wings green, abdomen brown. Head as wide as long. Genae with yellowish postocular band. Pronotum rectangular with yellowish or reddish brown margins. Mesonotum with small granules. Female anal segment truncate at hind margin. Female subgenital plate boat-shaped, apex notched and reaching end of the anal segment. Male anal segment incised in center. Cerci broadened at apex in both sexes. Legs reddish brown with dark stripes on all femora. Tegmina and costal region of alae green with narrow margin in yellowish brown (Chinese specimens) or reddish brown, followed by narrow white margin (indistinct in Chinese specimens). Alae usually reaching 7th tergum, anal region rosy pink.

Distribution.— Yunnan (Xishuangbanna), China. India [Type locality] and Peninsular Malaysia (Kedah, Pahang and Perak).

Notes.— This species is new to China and only found in Xishuangbanna of Yunnan. With the similar distribution and occurrence in China of *N. inflata* (described in this study) and *Trachythorax atrosignatus* (Brunner von Wattenwyl, 1893) (recently reported from China in Chen & He 2008: 179), segregated distributions of this species between the southwestern China and Peninsular Malaysia probably reflect the potential populations in Vietnam, Myanmar and Thailand. The description is based on Brock (1999: 93) and the two Chinese specimens. Coloration is assessed by the illustrations in Seow-Choen (2000: 22; 2005: 54). The coloration of the Chinese specimen is slightly different from the type, and

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Figs 12-14. Habitus of *Necroscia* spp. 12. *N. hainanensis*: ♀ (GH). 13. *N. inflata*: ♀ (SEM). 14. *N. marginata*: ♀ (SNU).

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the Malaysian specimen differs by its yellowish-brown margins of pronotum, mesonotum, tegmina and alae. Generally, the Chinese specimen is morphologically matched with this species.

***Necroscia multicolor* (Redtenbacher, 1908)**

Aruanoidea multicolor, Redtenbacher, 1908: 523. Syntypes 5♂♂, 2♀♀, Than-Moi, Tonkin (Vietnam), Juni-Juli, Fruhstorfer, H. (NHMW); Syntypes 3♂♂, Than-Moi, Tonkin (Vietnam), Fruhstorfer, H. (ISNB). [Assessed by Phasmid Species File Online's images]
Brock, 1998: 44.
Necroscia multicolor, Otte & Brock, 2005: 213.

= *Aruanoidea incerta*, Carl, 1913: 54 [Synonymised by Günther, 1935: 140].
= *Aruanoidea maculata*, Chen & He, 2000: 396, fig. 2 [Holotype ♂, 240 m., Longgang, Longzhou Country, Guangxi Autonomous Region, China, 5.V.1982, Yang Chikun (CAU).] **n. syn.**
Necroscia maculata, Otte & Brock, 2005: 213.
Hennemann *et al.*, 2008: 17.
Chen & He, 2008: 114, figs. 79 a-b.

Further material.—♀, Xiangshuichangcun, Longzhou, Guangxi Autonomous Region, China, 11.VI.1980, Xi Fusheng (ZSU); ♂♀, Nankunshan, Guangdong Province, China, 7.VI.1983, Weng Yong (ZSU); 2♂♂, Heishiding, Fengkai, Guangdong Province, China, 5.VII.1986, Tao Hong (ZSU); ♂, Nankunshan, Guangdong Province, China, 9-14.VI.1987, Lu Yongjun (ZSU); 4♂♂, 330-350 m., Longzhou, Guangxi Autonomous Region, China, 13-15.VI.2000, Li Wenzhu (IZCAS); 3♂♂, 2♀♀, Wuming, Guangxi Autonomous Region, China, 30-31.VII.2012, Ho, G.W.C. (GH).

Diagnostic features.—Yellowish green with bright yellow maculations and purple stripe on costal region of alae is distinctive from other species.

Description of both sexes.—Medium species. Both sexes similar, with charming coloration, eyes dark brown. Antennae bluish green, sparsely covered with long hairs, some segments with dark blue coloration ventrally. Mouthparts pale. Thorax with yellowish green granules and spine-like tubercles. Pronotum with two small spine-like tubercles. Mesonotum 3× longer than pronotum, lateral margins with seven to nine small spine-like tubercles. Abdomen dorsal surface yellowish green with bright yellow longitudinal stripe, and a purple spot medio-posteriorly. Ventral surface white. Female anal segment broadly emarginated at hind margin, lateral angles pointed. Female supra-anal plate semi-circular, median carina distinct. Female subgenital plate boat-shaped, incurved at end, slightly incised in center, projecting over the half of anal segment. Male poculum pointed at apex. Cerci very long, longer than anal segment, cylindrical and straight, apices rounded. Legs unarmed, with short setae, yellowish green. Metafemora with a purple band near apex. Metatibiae with two purple bands, one at base, another near apex. Tegmina oval, yellowish green with bright yellow maculations, elevated near middle, with u-shape purple marking and bright yellow spot laterad of the elevation. Alae reaching 6th tergum, yellowish green with bright yellow maculations, anal region pale white.

Notes.— *Necroscia maculata* (Chen & He, 2000), originally from Guangxi, is perfectly matched with Vietnamese *Necroscia multicolor* (Redtenbacher, 1908) and is no doubt a junior synonym of the latter species. Guangdong is a new distribution record for this species in China.

Distribution.— Guangxi (Longzhou and Wuming) and Guangdong (Nankunshan and Heishiding), China. Also Vietnam [Type locality].

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