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Cover photograph: Mass *Curtos fulvocapitalis*, photo by Yiu Vor.

Contribution to the knowledge of Chinese Phasmatodea VI: New taxa and new nomenclature of the subfamily Necrosciinae from the Phasmatodea of China

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ABSTRACT

This study provides the descriptions of one new genus, eight new species and two new subspecies from the Necrosciinae of China, including *Oedohirasea* **gen. nov.**, *Acanthophasma brevicercum* **sp. nov.**, *Acanthophasma dilatatum* **sp. nov.**, *Cheniphasma parvidentatum* **sp. nov.**, *Oedohirasea huanglianshanensis* **sp. nov.**, *Oxyartes densigranulatus* **sp. nov.**, *Oxyartes nigrigranulatus* **sp. nov.**, *Oxyartes sparsispinosus* **sp. nov.**, *Oxyartes xishuangbannaensis* **sp. nov.**, *Oxyartes despectus yingjiangensis* **subsp. nov.** and *Oxyartes rubris distinctus* **subsp. nov.**; four new combinations are suggested including *Cheniphasma fruhstorferi* (Brunner von Wattenwyl, 1907) **comb. nov.** from *Neohirasea* Rehn, 1904, *Oedohirasea fenshuilingensis* (Ho, 2017) **comb. nov.** from *Neohirasea*, *Oedohirasea pengzhongi* (Ho, 2017) **comb. nov.** from *Neohirasea* and *Oedohirasea wangpengi* (Ho, 2017) **comb. nov.** from *Neohirasea*; the first descriptions of the male of *Neointerphasma minutigranulatum* Ho, 2017 and *O. fenshuilingensis* (Ho, 2017) **comb. nov.** are provided; the taxonomic position of *Neointerphasma* Ho, 2017 is redefined, transferred from subfamily Clitumninae Brunner von Wattenwyl, 1893 to Necrosciinae; *Marmessoidea casignetus* (Westwood, 1859) and *Oxyartes despectus* (Westwood, 1848) are for the first time recorded from China. Keys to the species and a species list for *Acanthophasma* Chen & He, 2000, *Cheniphasma* Ho, 2012, *Oedohirasea* **gen. nov.** and *Oxyartes* Stål, 1875 are provided.

Key words: Stick insects, China, taxonomy, new genus, new species, new subspecies, new combinations

中國螳目之新知VI:中國螳目長角枝螳亞科新分類群及新分類命名

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摘要:本文記述中國長角枝螳亞科一新屬八新種及二新亞種: 膨胸棘螳屬 *Oedohirasea* **gen. nov.**, 短尾棘螳 *Acanthophasma brevicercum* **sp. nov.**, 膨股棘螳 *Acanthophasma dilatatum* **sp. nov.**, 細齒陳螳 *Cheniphasma parvidentatum* **sp. nov.**, 黃連山膨胸棘螳 *Oedohirasea huanglianshanensis* **sp. nov.**, 密粒刺異螳 *Oxyartes densigranulatus* **sp. nov.**, 黑粒刺異螳 *Oxyartes nigrigranulatus* **sp. nov.**, 疏刺刺異螳 *Oxyartes sparsispinosus* **sp. nov.**, 西雙版納刺異螳 *Oxyartes xishuangbannaensis* **sp. nov.**, 褐刺異螳 盈江亞種 *Oxyartes despectus yingjiangensis* **subsp. nov.** 及赤刺異螳 顯刺亞種 *Oxyartes rubris distinctus* **subsp. nov.**; 建立四新組合: 弗氏陳螳 *Cheniphasma fruhstorferi* (Brunner von Wattenwyl, 1907) **comb. nov.**, 分水嶺膨胸棘螳 *Oedohirasea fenshuilingensis* (Ho, 2017) **comb. nov.**, 彭氏膨胸棘螳 *Oedohirasea pengzhongi* (Ho, 2017) **comb. nov.**及王氏膨胸棘螳 *Oedohirasea wangpengi* (Ho, 2017) **comb. nov.**; 對新介螳屬 *Neointerphasma* Ho, 2017進行了修定, 並對微粒新介螳 *Neointerphasma minutigranulatum* Ho, 2017雄蟲進行首次描述; 報告二新紀錄種: 翅突瑪異螳 *Marmessoidea casignetus* (Westwood, 1859)及褐刺異螳 *Oxyartes despectus* (Westwood, 1848); 以及制定棘螳屬 *Acanthophasma* Chen & He, 2000, 陳螳屬 *Cheniphasma* Ho, 2012, 膨胸棘螳屬 *Oedohirasea* **gen. nov.**及刺異螳屬 *Oxyartes* Stål, 1875的分類檢索表。

關鍵字: 竹節蟲, 中國, 分類, 新屬, 新種, 新亞種, 新組合

INTRODUCTION

In China, more than 150 species are recognised in the subfamily Necrosciinae Brunner von Wattenwyl, 1893 (Chen and He, 2008; Hennemann et al., 2008; Ho, 2016, 2017a, unpubl. data; Brock et al., 2020). The diversity of Chinese Necrosciinae is apparently high and most of the taxa are found in the tropical and subtropical forests in the southern parts (Guangdong, Guangxi and Yunnan Provinces) of China.

This study is the sixth of the series on the Contribution to the knowledge of Chinese Phasmatodea. The previous contributions I-V contain descriptions of 65 new taxa (six new genera, 48 new species and 11 new subspecies) and suggestions of 13 new nomenclatures (13 new combinations) from the subfamilies Clitumninae, Dataminae, Necrosciinae and Lonchodinae (Ho, 2013a, 2013b, 2016, 2017a, 2017b). The present paper describes 11 new taxa and suggests four new combinations for the Chinese Necrosciinae.

MATERIALS & METHODS

The systematic treatment is according to Otte and Brock (2005), Bradler et al. (2014), Robertson et al. (2018), Simon et al. (2019) and Brock et al. (2020). Morphological terms follow Rehn and Rehn (1939), Bragg (2001), Zompro (2004) and Bradler (2009). Ootaxonomic description refers to Clark (1976a, 1976b, 1979, 1988, 1998), Clark-Sellick (1997) and Zompro (2004). Measurements are given in millimeters (mm). The abbreviations used for collections are: HKES: Hong Kong Entomological Society, Hong Kong, China; SEM: Shanghai Entomological Museum, Chinese Academy of Sciences, Shanghai, China; UMO: Hope Entomological Collections, University Museum, Oxford, UK; and GH:

Private collection of George Ho Wai-Chun, Hong Kong, China.

RESULTS

Lonchodidae Brunner von Wattenwyl, 1893

Necrosciinae Brunner von Wattenwyl, 1893

Acanthophasma Chen & He, 2000

Acanthophasma, Chen and He, 2000: 33; Zompro, 2004: 304; Otte and Brock, 2005: 38; Chen and He, 2008: 158; Hennemann et al., 2008: 8.

Type-species: *Oxyartes varius* Chen & He, 1992: 44, by original designation.

Distribution: China (Hunan and Yunnan).

Notes: This genus consists of three species and is reported for the first time from Yunnan in southwestern China. A key is only given to males because adult females of all species are unknown.

Species included:

1. *Acanthophasma brevicercum* **sp. nov.**
Distribution: China (Yunnan)

2. *Acanthophasma dilatatum* **sp. nov.**
Distribution: China (Yunnan)

3. *Acanthophasma varium* (Chen & He, 1992: 44, figs. 124a-b). [*Oxyartes varius*]
Distribution: China (Hunan)

Key to the species of *Acanthophasma*

Male:

1. Fourth and fifth abdominal tergites with a spine posteromedially. . . *A. varium*
- Fourth and fifth abdominal tergites with a hump posteromedially. **2**

2. Metanotum with a pair of posterior medial spines, alae tegmina-like. . *A. brevicercum* **sp. nov.**
- Metanotum lacking posterior medial spines, alae scale-like. . . *A. dilatatum* **sp. nov.**

***Acanthophasma brevicercum* sp. nov.** (Figs. 1-2, 32, 35)

Type: Holotype, 1♂, 2000m, Longchuan, Dehong, Yunnan, China, 10.VI.2017, Bi Wen-Xuan (SEM).

Differentiation: *Acanthophasma brevicercum* **sp. nov.** is related to *A. dilatatum* **sp. nov.**, but can be separated by its larger size, the presence of paired posterior medial spines on the metanotum, the tegmina-like alae and the indistinct roundly expanded posterolateral angles on the abdominal tergites.

Description of male (Figs. 1-2, 32, 35): Small size. Body stout and short. General colouration of body and legs dark brown, with blackish markings.

Head: Oval, sparsely covered with small granules. Vertex flat, with a pair of supra-antennal spines. Occiput conically raised, with two pairs of medial spines along median longitudinal furrow, also with a pair of supra-orbital spines. Compound eyes small and rounded, its length about three times length of genae. Antennae long, apices surpassing apices of protarsi, sparsely covered with short bristles; scapus basally flattened, longer than pedicellus; and pedicellus as long as third segment.

Thorax: Rough, sparsely covered with small granules. Pronotum rectangular, longer than wide, anterior margin incurved, posterior margin truncate, transverse and longitudinal sulci crossing before middle point; with a pair of posterior medial spines and posterolateral spines. Mesonotum moderately expanded posteriorly, with paired pre-median and post-median spines, also with a bi-spinose hump on the posteromedian area. Mesopleurae with a median spine and a supra-coxal spine. Metanotum square, shorter than median segment, with paired posterior medial spines. Metapleurae with a supra-coxal spine.

Abdomen: Sparsely covered with small granules, with indistinct roundly expanded posterolateral angles from second to eighth tergites. Median segment rectangular, about two times wider than long. Second and third tergites with a pair of posterior medial spines. Second to fifth tergites with a small hump posteromedially. Ninth tergum with a small crest posteromedially, also with elongated posterolateral angles, apices rounded. Anal segment shorter than ninth tergum, posterior margin truncate. Poculum cup-shaped, posterior margin rounded and reaching anterior area of anal segment. Cerci cylindrical, short, apices weakly curved upwards, rounded and surpassing posterior margin of anal segment.

Legs: Slender, sparsely covered with short bristles. Unarmed. Procoxae and mesocoxae with a short spine. Femora thicker than corresponding tibiae, subapical area of anterodorsal and posterodorsal carinae dilated as a small lamella. Profemora curved basally. Tibiae roughly as long as corresponding femora.

Wings: Tegmina indistinct. Alae short, tegmina-like, as long as pronotum.

Measurements: See Table 1.

Distribution: China (Yunnan).

Notes: The female is unknown.

Etymology: The specific epithet of this new species is derived from the short cerci in the male.

***Acanthophasma dilatatum* sp. nov.** (Figs. 3-4, 33-34, 36)

Types: Holotype, ♂, 2000m, Nanjian, Dali, Yunnan, China, 2.VI.2018, George Ho Wai-Chun (HKES); Paratype, 1 immature ♀, same data as holotype ♂ (HKES).

Differentiation: *Acanthophasma dilatatum* **sp. nov.** is related to *A. brevicercum* **sp. nov.**, but can be separated by its smaller size, the unarmed metanotum, the scale-like alae and the distinctly and roundly expanded posterolateral angles on the abdominal tergites in the male.

Description of male (Figs. 3-4, 33, 36): Small size. Body stout and short. General colouration of body and legs dark brown, with blackish markings.

Head: Oval, sparsely covered with small granules. Vertex flat, with a pair of supra-antennal spines. Occiput conically raised, with three pairs of medial spines along median longitudinal furrow, also with a pair of short supra-orbital spines. Compound eyes small and rounded, its length about three times length of genae. Antennae long, surpassing apices of protarsi, sparsely covered with short bristles; scapus basally flattened, longer than third segment; and pedicellus shorter than third segment.

Thorax: Rough, sparsely covered with small granules. Pronotum rectangular, longer than wide, anterior margin weakly incurved, posterior margin truncate, transverse and longitudinal sulci crossing before middle point; with a pair of posterior medial spines and posterolateral tubercles. Mesonotum moderately expanded posteriorly, with paired pre-median and post-median spines, also with a small bi-tuberculate hump on posteromedian area. Mesopleurae with a median spine-like tubercle and a supra-coxal spine. Metanotum square, shorter than median segment. Metapleurae with a supra-coxal spine.

Abdomen: Sparsely covered with small granules. Median segment rectangular, about two times wider than long. Second to eighth tergites with a small hump posteromedially, also with roundly expanded posterolateral angles. Ninth tergum with a small crest posteromedially, also with elongated posterolateral angles, apices obtuse. Anal segment roughly as long as ninth tergum, posterior margin truncate. Poculum cup-shaped, posterior margin rounded and reaching posterior area of anal segment. Cerci cylindrical, short, straight, apices rounded and surpassing posterior margin of anal segment.

Legs: Slender, sparsely covered with short bristles. Unarmed. Procoxae and mesocoxae with a short spine-like tubercle. Femora thicker than corresponding tibiae, subapical area of anterodorsal and posterodorsal carinae dilated, lamella-like. Profemora curved basally. Tibiae roughly as long as corresponding femora.

Wings: Tegmina indistinct. Alae small, reduced, scale-like.

Description of female (Fig. 34): Generally similar to male. Body stout, sparsely covered small granules. General colour of body and legs brown, with blackish markings.

Head: As in male, occiput conically raised, with one pair of supra-antennal, one pair of supra-orbital and three pairs of occipital medial spines.

Thorax: As in male. Pronotum rectangular, with a pair of posterior medial spines. Mesonotum moderately expanded posteriorly, with paired pre-median and post-median spines, also with a bi-tuberculate hump on posteromedian area. Metanotum unarmed, shorter than median segment. Mesopleurae with a median tubercle and a supra-coxal spine, also with a few enlarged granules on lower margin.

Abdomen: Second to ninth tergites with more distinct roundly expanded posterolateral angles than male, also with distinct lateral and median longitudinal carinae and a small posteromedian hump. Posterior margin of anal segment rounded. Subgenital plate short and flattened. Cerci as in male.

Legs: As in male, unarmed. Femora thicker than corresponding tibiae, with dilated subapical area on anterodorsal and posterodorsal carinae.

Wings: Tegmina indistinct. Alae small, scale-like.

Measurements: See Table 1.

Distribution: China (Yunnan).

Notes: The description of the female is based on an immature individual. Measurements are only given to the holotype male. Further material especially of the adult female and its eggs are needed for knowing the complete morphological characters of this species.

Etymology: The specific epithet of this new species is derived from the dilated subapical area on the anterodorsal and posterodorsal carinae of the femora in the both sexes.

Cheniphasma Ho, 2012

Cheniphasma, Ho, 2012: 217; Ho, 2013c: 528.

Type-species: *Cheniphasma serrifemoralis* Ho, 2012: 217, by original designation.

Description: Small size. Apterous. Dull colouration, brown to greenish brown or dark brown. Body cylindrical,

rugose and granulose. Head oval, dorsoventrally flattened. Vertex and occiput flat, unarmed. Antennae long and filiform. Thorax tuberculate and granulose in female, spinose in male. Pronotum rectangular, with two anterior medial spines. Mesonotum elongate, moderately expanded posteriorly; medially armed with a pair of tuberculate or spinose lamellae in female, only with a pair of median medial spines in male. Metanotum with a pair of posterior medial spines. Abdomen granulated and wrinkled, narrowing posteriorly. Second to eighth tergites with a granule or tubercle posteromedially. Female praeopercular organ distinct on posteromedian area of seventh sternum. Subgenital plate of female scoop-shaped, reaching or surpassing posterior margin of anal segment. Anal segment of male posteriorly emarginated. Poculum of male cup-shaped. Cerci of both sexes with rounded apices, male with longer cerci. Female anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with serrations or dentations, dentations indistinct in male. Tibiae with indistinct dentations. Egg capsule oval. Micropylar plate rounded.

Distribution: China (Guangdong and Yunnan) and Vietnam.

Notes: The description of genus is amended because new taxa are added. Changes of the description focus on the variation of armature on thorax and legs. Other description largely follows the original description. Currently four species are recognised, including *Cheniphasma granulatum* Ho, 2013, *C. fruhstorferi* (Brunner von Wattenwyl, 1907) **comb. nov.** [transferred from *Neohirasea* Rehn, 1904; type-locality from Vietnam, not occurring in China], *C. parvidentatum* **sp. nov.** and *C. serrifemoralis* Ho, 2012. This genus is substantially known only from southern China (Guangdong and Yunnan) and northern Vietnam (Hoa Binh and Lang Son). Only two species are present in China. Yunnan (China) and Hoa Binh (Vietnam) are the new locations for *Cheniphasma*. Based on the currently recognised distribution of *Cheniphasma* in China, the floristic habitat in the southwestern and northwestern parts of Guangxi is similar to southwestern Guangdong and southeastern Yunnan. Although there is no record of *Cheniphasma* from Guangxi, further collecting of specimens in the region could discover certain populations.

Species included from China:

1. *Cheniphasma parvidentatum* **sp. nov.**
Distribution: China (Yunnan)

2. *Cheniphasma serrifemoralis* Ho, 2012: 217, figs. 1a-g, 2a-b
Distribution: China (Guangdong)

Key to the species of *Cheniphasma* from China:

Female:

1. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with small and rounded dentations. . *C. parvidentatum* **sp. nov.**
- Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with distinct serrations. . . . *C. serrifemoralis*

Male:

1. Posterior margin of anal abdominal segment weakly emarginated, posterolateral angles not elongated and not curved inwards. . . . . *C. parvidentatum* **sp. nov.**
- Posterior margin of anal abdominal segment deeply emarginated, posterolateral angles elongated and curved inwards. . . *A. serrifemoralis*

***Cheniphasma parvidentatum* sp. nov.** (Figs. 5-8, 37-42)

Types: Holotype, ♀, 1500m, Jinping, Honghe, Yunnan, China, 28.VIII.2019, George Ho Wai-Chun (HKES); Paratypes, 10♀, 14♂ & 47 eggs (naturally laid by paratypes ♀), same data as holotype ♀, George Ho Wai-Chun (HKES).

Differentiation: *Cheniphasma parvidentatum* **sp. nov.** is closely related to *C. serrifemoralis* Ho, 2012, but can be separated by the more robust body, the presence of spine-like tubercles on the lateral margins of mesonotum and the indistinct armature on legs in the female and the presence of enlarged granules on the lateral margins of mesonotum and the weakly emarginated posterior margin of the anal abdominal segment in the male.

Description of female (Figs. 5-6, 37, 41): Small size. Body robust, distinctly larger than male. General colouration of body and legs brown or dark brown.

Head: Oval, longer than wide, sparsely granulated. Vertex flattened. Occiput gently convex, posterior margin with six small swellings, median longitudinal furrow distinct, lateral longitudinal furrows indistinct. Compound eyes oval and small, its lengths about four times length of genae. Antennae filiform, not surpassing apices of protarsi, sparsely covered with short bristles; scapus flattened basally, roughly as long as third segment, longer than pedicellus.

Thorax: Rough, granulated and wrinkled. Pronotum rectangular, longer than wide, roughly as long as head; anterior margin incurved, with a pair of short spine-like tubercles, apices weakly pointing forwards, posterior margin rounded, transverse and longitudinal sulci crossing at middle point. Mesonotum moderately expanded posteriorly, mediolongitudinally not carinate; medially elevated with a pair of tuberculate lamellae, dorsally bearing a few short tubercles; anterior, pre-median and posterior area with paired, short spine-like medial tubercles, lateral margins interspersed with a few spine-like tubercles. Metanotum with a pair of

spine-like medial tubercles posteriorly, apices pointing posteriorly. Mesopleurae and metapleurae with a few spine-like tubercles on lower margin. Mesosternum and metasternum with indistinct granulations. Metapleurae with a short supra-coxal tubercle.

Abdomen: Cylindrical, tapering posteriorly. Wrinkled and sparsely granulated. Median segment broader than long, shorter than metanotum, longer than second tergum, with a pair of short spine-like medial tubercles posteriorly. Median segment to seventh tergites with a short tubercle posteromedially, apex curved posteriorly. Posteromedian area of seventh sternum with distinct praeopercular organ, formed by two tubercle-like structures, apices pointing posteriorly. Eighth and ninth tergites with a small crest posteromedially, apex obtuse. Anal segment longer than ninth tergum, with two small emarginations on posterior margin, posterolateral angles pointed. Subgenital plate scoop-shaped, median longitudinal carina distinct, apex rounded and surpassing posterior margin of anal segment. Cerci short, flattened, apices rounded and not surpassing posterior margin of anal segment.

Legs: Slender and long, sparsely covered with short bristles. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with weakly developed dentations. Profemora incurved basally. Tibiae lacking noticeable armature, roughly as long as corresponding femora.

Description of male (Figs. 7-8, 38, 42): Small size. Body slender and slim, distinctly smaller and more slender than female. General colouration of body and legs brown.

Head: Obscurely granulated. Oval, gently constricted behind compound eyes, as long as pronotum. Vertex flat. Posterior margin of occiput with six small and indistinct swellings, median and lateral longitudinal furrows indistinct. Compound eyes rounded and small, its lengths about three times length of genae. Antennae long and filiform, sparsely covered with short bristles, apices of antennae surpassing apices of protarsi; scapus flattened basally, longer than pedicellus, shorter than third segment.

Thorax: Inconspicuously covered with small granules, also interspersed with a few enlarged granules. Pronotum rectangular, longer than wide, transverse and longitudinal sulci crossing at middle point; anterior margin gently curved inwards, posterior margin rounded, with a pair of anterior medial spines, apices pointing forwards. Mesonotum elongated, broadly emarginated medially, with paired medial spines medially, lateral margins with a few minute pits and enlarged granules, median longitudinal carina indistinct. Metanotum trapezoidal, constricted posteriorly, longer than median segment, with a pair of medial spines posteriorly. Mesopleurae and metapleurae with a supra-coxal spine.

Abdomen: Slender, with short wrinkles and inconspicuous granulations. Median segment rectangular, longer than wide, shorter than metanotum. Second to eighth tergites with a short tubercle posteromedially. Second to seventh tergites parallel-sided. Eighth tergum gently expanded posteriorly, roughly as long as ninth tergum. Anal segment as long as eighth tergum, laterally swollen, with a small emargination on posterior margin. Poculum cup-shaped, posterior margin rounded, reaching anterior area of anal segment, median elevation indistinct. Cerci long, cylindrical, distinctly curved inwards, apices swollen, rounded and not surpassing posterior margin of anal segment.

Legs: Slender and long, sparsely covered with short bristles. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with small and inconspicuous dentations, subapical area of anteroventral and posteroventral carinae with a minute tooth. Profemora incurved basally. Tibiae lacking noticeable armature, roughly as long as corresponding femora.

Vomer: Very minute, length about 1.0 mm, oblong, symmetrical, apex obtuse.

Measurements: See Table 2.

Description of egg (Figs. 39-40): Capsule brown, oval, densely granulated, interspersed with a few enlarged granules, posterior pole rounded. Micropylar plate rounded, with a short median longitudinal carina. Micropylar cup placed at posterior margin of micropylar plate. Median line short, about one-third of micropylar plate. Operculum brown, densely granulated, with a small dish-like capitulum, marginally thickened.

Measurements: Length, 2.2 mm; width, 1.6 mm; height 2.0 mm.

Distribution: China (Yunnan).

Etymology: The specific epithet of this new species is derived from the small dentations on the carinae of the femora in the both sexes.

Marmessoidea Brunner von Wattenwyl, 1893

Marmessoidea, Brunner von Wattenwyl, 1893: 85; Rehn, 1904: 73; Kirby, 1904: 371; Redtenbacher, 1908: 509; Brock, 1999: 89, 175; Bragg, 2001: 565; Zompro, 2004: 314; Otte and Brock, 2005: 192; Chen and He, 2008: 156; Hennemann et al., 2008: 14; Mandal and Yadav, 2010: 9; Ho, 2016: 318, 2018a: 182.

Type-species: *Necroscia marmessus* Westwood, 1859: 49, by original designation (= *Trigonophasma* Kirby, 1904: 436, synonymised by Brock, 1999: 175].

Distribution: China, India, Indonesia, Malaysia, Philippines, Singapore and Vietnam.

Notes: Currently five species and two subspecies are

recognised in China (Ho, 2016: 318, 2018a: 182).

***Marmessoidea casignetus* (Westwood, 1859)** (Fig. 43)

Necroscia casignetus, Westwood, 1859: 147, pl. 20: 5.
Trigonophasma casignetus, Kirby, 1904: 373.
Sipyloidea casignetus, Redtenbacher, 1908: 544.
Marmessoidea casignetus, Otte and Brock, 2005: 193.

Type: Holotype, ♀, Assam, India, Major Jenkins, no. 665 (UMO).

Other material examined: 1♀, Yingjiang, Dehong, Yunnan, China, 5.VII.2019, George Ho Wai-Chun (GH).

Differentiation: This species is related to *Marmessoidea bispina* (Redtenbacher, 1908), but can be easily separated by the brown colouration, the more slender body and the brown granulations on the mesonotum.

Distribution: China (Yunnan) and India (Assam).

Notes: This species is firstly reported from China.

***Neointerphasma* Ho, 2017**

Neointerphasma, Ho, 2017: 519.

Type-species: *Neointerphasma minutigranulatum* Ho, 2017b: 520, by original designation.

Description: Small size. Apterous. Body short, robust and dorsoventrally flattened, unarmed. Head oval, inconspicuously covered with sparse and minute granules. Vertex and occiput flat. Compound eyes small and rounded. Antennae segmented, surpassing apices of protibiae. Thorax sparsely covered with minute and inconspicuous granules. Pronotum square in both sexes. Mesonotum distinctly pre-medially swollen in female, indistinctly swollen pre-medially in male. Abdomen inconspicuously and sparsely granulated, medially swollen in female, tapering posteriorly in male. Female seventh sternum lacking noticeable praeopercular organ. Anal segment with rounded posterior margin in female, weakly emarginated in male. Supra-anal plate small and indistinct in both sexes. Female subgenital plate scoop-shaped, tapering posteriorly, apex pointed. Male poculum cup-shaped. Cerci flattened and apically pointed in both sexes. Legs slender, unarmed. Egg capsule oval, with rounded micropylar plate.

Distribution: China (Yunnan).

Notes: Ho (2017b: 519) originally placed *Neointerphasma* Ho, 2017 in the tribe Medaurini Hennemann & Conle, 2008 [Family Phasmatidae Gray, 1835, Subfamily Clitumninae Brunner von Wattenwyl, 1893] based on a single female specimen. However, the present author recently discovered the corresponding male of *N. minutigranulatum* Ho, 2017 [type-species of *Neointerphasma*] and considered it to be a member of Necrosciinae. In fact, *Neointerphasma* matches the features of Necrosciinae including the long and filiform antennae in the both sexes, the short supra-anal plate and the short subgenital plate in the female and the non-spilt anal abdominal segment and the well-developed vomer in the male. *Neointerphasma* obviously violates the main features of Medaurini and even the 'Lanceocercata' group in Phasmatidae by the robust body structure in the female and the non-spilt anal abdominal segment and the well-developed vomer in the male (Hennemann and Conle, 2008; Bradler et al., 2014; Simon et al., 2019). Undoubtedly, *Neointerphasma* is a member of Necrosciinae. *Neointerphasma* is closely related to *Neohirasea* Rehn, 1904, but can be easily separated by the small size, the flattened body, the pre-medially swollen mesonotum and the unarmed legs in the both sexes. Therefore, the new material provides further information for understanding the appropriate taxonomic position for this genus. This genus only consists of one species and the male is firstly described.

Species included:

1. *Neointerphasma minutigranulatum* Ho, 2017b: 520, figs. 29-30, 108-110, 162-163.
Distribution: China (Yunnan)

***Neointerphasma minutigranulatum* Ho, 2017** (Figs. 9-11, 44)

Neointerphasma minutigranulatum, Ho, 2017b: 520, figs. 29-30, 108-110, 162-163.

Types: Holotype, ♀, 2400-2500m, Weibaoshan, Weishan, Dali, Yunnan, China, 16.VIII.2015, Bi Wen-Xuan (SEM); Paratypes, 11 eggs, same data as holotype ♀ (SEM); 3♀, 2450-2580m, Weibaoshan, Weishan, Dali, Yunnan, China, 7.VII.2017, Bi Wen-Xuan (HKES & SEM).

Other material examined: 2♂, 3♀, 2300m, Weishan, Dali, Yunnan, China, 3.VI.2018, George Ho Wai-Chun (GH).

Description of male (Figs. 9-11, 44): Small size. Body short, shout and dorsoventrally flattened, distinctly smaller and more slender than female. Unarmed and apterous. General colouration of body and legs brown, with sparse and small blackish markings.

Head: Oval, sparsely and inconspicuously covered with minute granules. Vertex and occiput flat. Median longitudinal furrow distinct, lateral longitudinal furrows indistinct. Genae with one short and thin postocular carina behind compound eyes. Compound eyes small and rounded, its length about three times of genae. Antennae long and filiform, distinctly segmented, with 22 segments, sparsely covered with short bristles; scapus basally flattened, as long as third segment, longer than pedicellus.

Thorax: Wrinkled and sparsely covered with minute and inconspicuous granules. Pronotum square, roughly as long as head, anterior margin weakly incurved, posterior margin truncate, transverse and longitudinal sulci crossing at middle point. Mesonotum pre-medially swollen weakly. Metanotum rectangular, wider than long, longer than median segment.

Abdomen: Sparsely covered with minute and inconspicuous granules, laterally carinate. Dorsoventrally flattened. Median segment narrow, about two times wider than long. Anal segment longer than ninth tergum, posterior margin with a small emargination. Poculum cup-shaped, posterior margin rounded and reaching anterior area of anal segment. Cerci long and straight, tapering apically, apices pointed and surpassing posterior margin of anal segment.

Legs: Slender, sparsely covered with short bristles. Unarmed. All femora thicker than corresponding tibiae. Profemora curved basally. Tibiae roughly as long as corresponding femora.

Vomer: Apical part symmetrical, gradually constricted apically, apex pointed.

Measurements: See Table 3.

Distribution: China (Yunnan).

Notes: The male is described and illustrated for the first time. The measurements of females are also provided.

***Oedohirasea* gen. nov.**

Type-species: *Neohirasea fenshuilingensis* Ho, 2017a: 16, by present designation.

Differentiation: *Oedohirasea* **gen. nov.** is similar to *Neohirasea* Rehn, 1904, but can be separated by its smaller size, the robust body and the thick-built thorax in the both sexes, the medially swollen mesonotum in the female and the comparatively short mesonotum (not more than three times length of pronotum) in the male.

Description: Small size. Apterous. Dull colouration, brown to dark brown. Body stout, robust, cylindrical; rough, with wrinkles and granules. Head oval, lacking spines. Occiput gently convex or elevated with a hump. Thorax rough, wrinkled and granulated, unarmed or with spines and/or tubercle-like spines. Pronotum rectangular, with two anterior medial spines or tubercles. Mesonotum granulated, with spines or spine-like tubercles, distinctly swollen medially in female, indistinctly swollen medially or expanded posteriorly in male. Mesopleurae and metapleurae with a short supra-coxal tubercle. Abdomen cylindrical, wrinkled and granulated, tapering posteriorly. Female seventh sternum with indistinct praeopercular organ posteromedially, usually formed by carina- or tubercle-like structure. Female subgenital plate short, scoop-shaped. Male poculum small, cup-shaped. Supra-anal plate indistinct. Cerci short and flattened in both sexes. Legs thick-built, with distinct or indistinct dentations or serrations. Egg capsule oval. Micropylar plate oval.

Distribution: China (Guizhou and Yunnan).

Notes: This new genus consists of four species. *Oedohirasea* **gen. nov.** matches the features of Necrosciinae including the long and filiform antennae in the both sexes, the short supra-anal plate and the short subgenital plate in the female and the non-spilt anal abdominal segment and the well-developed vomer in the male. *Oedohirasea* **gen. nov.** is closely related to *Neohirasea* Rehn, 1904 and shares the features including the absence of wings, spinose thorax and the absence of capitulum on the egg operculum. The diagnostic character of *Oedohirasea* **gen. nov.** is the robust body and thick-built thorax in the both sexes. Based on a recent molecular work (Bradler et al., 2014), *Neohirasea* is related to *Sipyloidea* Brunner von Wattenwyl, 1893 and both genera are the members of Necrosciinae. Therefore, *Oedohirasea* **gen. nov.** is considered to be a member of Necrosciinae.

Etymology: Feminine. The specific epithet of this new genus is derived from the words 'Oedo' (= swollen) referring the distinct medially swollen mesonotum in the female) and 'hirasea' referring to the close relationship with *Neohirasea* Rehn, 1904.

Species included:

1. *Oedohirasea fenshuilingensis* (Ho, 2017a: 16, figs. 40-41, 70-74, 274-275). [*Neohirasea*] **comb. nov.**
Distribution: China (Yunnan)

2. *Oedohirasea huanglianshanensis* **sp. nov.**
Distribution: China (Yunnan)

3. *Oedohirasea pengzhongi* (Ho, 2017a: 22, figs. 53-56, 67, 95-103). [*Neohirasea*] **comb. nov.**
Distribution: China (Guizhou)

4. *Oedohirasea wangpengi* (Ho, 2017a: 26, figs. 62-64, 69, 115-123, 280-281). [*Neohirasea*] **comb. nov.**
Distribution: China (Yunnan)

Key to the species of *Oedohirasea* gen. nov.

Male:

1. Thorax unarmed. . *O. pengzhongi* **comb. nov.**
- Thorax with spines or tubercle-like spines. **2**

2. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with rounded elevations. . *O. wangpengi* **comb. nov.**
- Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with serrations. **3**

3. Post-median area of pronotum with a pair of tubercle-like spines. . . . . *O. huanglianshanensis* **sp. nov.**
- Post-median area of pronotum unarmed. . . . . *A. dilatatum* **sp. nov.**

Female:

1. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with serrations. . . . . *O. fenshuilingensis* **comb. nov.**
- Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with rounded elevations. **2**

2. Mesonotum with one tuberculate hump on mesonotum medially. *O. pengzhongi* **comb. nov.**
- Mesonotum with two tuberculate humps on mesonotum pre-medially and medially. . . . . *O. pengzhongi* **comb. nov.**

***Oedohirasea fenshuilingensis* (Ho, 2017) comb. nov.** (Figs. 12-14, 45, 47)

Neohirasea fenshuilingensis, Ho, 2017a: 16, figs. 40-41, 70-74, 274-275.

Types: Holotype, ♀, 1300-1400m, Fenshuiling, Jinping, Yunnan, China, 4.IX.2016, George Ho Wai-Chun (HKES); Paratypes, 8 eggs (naturally laid by holotype ♀), same data as holotype ♀ (HKES).

Other material examined: 4♀, 6♂, 1800-2000m, Jinping, Honghe, Yunnan, China, 25-26.VIII.2019, George Ho Wai-Chun (GH).

Description of male (Figs. 12-14, 45, 47): Small size. Body slender, distinctly smaller and more slender than female. General colouration of body and legs dark brown.

Head: Covered with sparse and small granulations. Oval, longer than wide. Vertex flat. Occiput distinctly elevated with a hump, dorsally bearing a few granules. Posterior margin of occiput with indistinct swellings. Median and lateral longitudinal furrows indistinct. Compound eyes oval and small, its lengths about three times length of genae. Antennae filiform, not reaching apices of protarsi, covered with sparse long and dense short bristles; scapus flattened basally, shorter than third segment, longer than pedicellus.

Thorax: Rough, granulated and wrinkled. Pronotum rectangular, longer than wide, roughly as long as head, with a pair of anterior medial spines; anterior margin incurved, posterior margin rounded, transverse and longitudinal sulci crossing at middle point. Mesonotum constricted pre-medially, gently swollen medially, median longitudinal carina indistinct; medially with a spinose hump, also with paired posterior medial and median spines. Metanotum centrally with a pair of medial spines. Mesopleurae and metapleurae with a spine-like supra-coxal tubercle.

Abdomen: Cylindrical, tapering posteriorly. Wrinkled and granulated. Median segment broader than long, shorter than metanotum. Median segment to sixth tergites with a curved spine posteromedially, apex pointing posteriorly. Seventh to ninth tergites with a pair of small humps posteromedially. Anal segment as long as ninth tergum, with a small V-shaped emargination on posterior margin, posterolateral angles rounded. Poculum cup-shaped, medially elevated, posterior margin rounded and reaching anterior area of anal segment. Cerci short, flattened, apices pointed and not surpassing posterior margin of anal segment.

Legs: Slender and long, sparsely covered with short bristles. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with two to three distinct serrations, serrations on ventral carinae smaller than serrations on dorsal carinae. Profemora curved basally. Anterodorsal and posterodorsal carinae of tibiae with indistinct serrations, anteroventral and posteroventral carinae unarmed.

Vomer: Apical part symmetrical, gradually constricted apically, apex pointed.

Measurements: See Table 4.

Distribution: China (Yunnan).

Notes: The male is described and illustrated for the first time. The measurements of females are also provided.

***Oedohirasea huanglianshanensis* sp. nov.** (Figs. 15-17, 46, 48)

Type: Holotype, 1♂, 1300-1400m, Huanglianshan, Luchun, Honghe, Yunnan, China, 7.IX.2016, George Ho Wai-Chun (HKES).

Differentiation: *Oedohirasea huanglianshanensis* **sp. nov.** is similar to *O. fenshuilingensis* (Ho, 2017) **comb. nov.**, but can be easily separated by the presence of paired tubercle-like medial spines on the anterior margin and post-median area of pronotum, the bi-laminate armature on the pre-median area of mesonotum and the distinct armature on the dorsal carinae of tibiae in the male.

Description of male (Figs. 15-17, 46, 48): Small size. Body stout and slender. General colouration of body and legs brown.

Head: Covered with sparse and small granulations. Oval, longer than wide. Vertex flat. Occiput distinctly elevated with a small hump, dorsally bearing a few enlarged granules. Lacking noticeable swellings on posterior margin of occiput. Median and lateral longitudinal furrows indistinct. Compound eyes oval and small, its lengths about three times length of genae. Antennae filiform, not reaching apices of protarsi, covered with

sparse long and sparse short bristles; scapus flattened basally, longer than third segment; and pedicellus as long as third segment.

Thorax: Rough, granulated and wrinkled. Pronotum rectangular, longer than wide, roughly as long as head, with paired tubercle-like medial spines anteriorly and post-medially; anterior margin incurved, posterior margin rounded, transverse and longitudinal sulci crossing at middle point. Mesonotum constricted pre-medially, indistinctly swollen medially, median longitudinal carina weakly elevated; pre-median area obscurely elevated, bearing a pair of tubercle-like spines anteriorly and a pair of lamellae posteriorly; also with paired tubercle-like posterior medial and median spines, lateral margins with a few tubercle-like spines. Metanotum centrally with a pair of tuberculate lamellae. Mesopleurae and metapleurae with a tubercle-like supra-coxal spine.

Abdomen: Cylindrical, tapering posteriorly. Wrinkled and granulated. Median segment broader than long, shorter than metanotum. Second and third tergites with paired tubercle-like post-median medial spines. Second to sixth tergites with a curved tubercle-like spine posteromedially, apex pointing posteriorly. Seventh to ninth tergites with a pair of small humps posteromedially. Anal segment as long as ninth tergum, with a small V-shaped emargination on posterior margin, posterolateral angles rounded. Poculum cup-shaped, medially elevated, posterior margin rounded and reaching anterior area of anal segment. Cerci short, flattened, apices obtuse and not surpassing posterior margin of anal segment.

Legs: Slender and long, sparsely covered with short bristles. Anterodorsal, posterodorsal, anteroventral and posteroventral carinae of femora with two to three distinct serrations, serrations on ventral carinae smaller than serrations on dorsal carinae. Profemora curved basally. Tibiae longer than corresponding femora, anterodorsal and posterodorsal carinae with indistinct serrations, anteroventral and posteroventral carinae lacking noticeable armature.

Vomer: Apical part symmetrical, gradually constricted apically, apex truncate.

Measurements: See Table 5.

Distribution: China (Yunnan).

Notes: The female is unknown.

Etymology: The specific epithet of this new species is derived from the type-locality, Huanglianshan, Yunnan.

Oxyartes Stål, 1875

Oxyartes, Stål, 1875: 18; Kirby, 1904: 324; Redtenbacher, 1908: 474; Bragg, 2001: 316; Zompro, 2004: 316; Otte and Brock, 2005: 242; Chen and He, 2008: 184; Hennemann et al., 2008: 18; Mandal and Yadav, 2010: 12; Ho, 2017a: 28, 2018b: 3.

Type-species: *Phasma* (*Acanthoderus*) *despectum*, Westwood, 1848: 80, pl. 39, by subsequent designation of Kirby, 1904: 324.

Description: Medium-sized. Mainly brown. Body slender and elongate, female more robust than male. Head oval. Mesonotum usually granulated and wrinkled, unarmed or armed with a few tubercles and/or spines. Abdomen wrinkled, unarmed or with spines and/or crest-like structures, also with longitudinal carinae. Female seventh sternum rarely with praeopercular organ. Female subgenital plate scoop-shaped, flattened, tapering posteriorly, posterior apex pointed. Male poculum small, cup-shaped. Anal segment with two to four emarginations on posterior margin in female, weakly emarginated medially in male. Cerci cylindrical, straight or weakly curved inwards in both sexes. Legs lacking noticeable armature, usually with small spines near apices of anteroventral and posteroventral carinae of femora in both sexes. Tegmina indistinct. Alae scale-like or tegmina-like. Egg capsule oval. Micropylar plate oval.

Distribution: China (Guangdong, Guangxi and Yunnan), Bangladesh, India, Laos, Thailand and Vietnam.

Notes: Currently 15 species and four subspecies are recognised from this Oriental genus and 11 species and three subspecies are recognised from China.

Species included:

1. *Oxyartes densigranulatus* **sp. nov.**
Distribution: China (Yunnan)

2. *Oxyartes despectus* (Westwood, 1848: 80, pl. 39: 5).
Distribution: Bangladesh (Silhet), China (Yunnan) and India (Assam, Arunachal Pradesh, Meghalaya and Nagaland)

2.1. *Oxyartes despectus despectus* (Westwood, 1848: 80, pl. 39: 5).
Distribution: Bangladesh (Silhet) and India (Assam, Arunachal Pradesh, Meghalaya and Nagaland)

2.2. *Oxyartes despectus yingjiangensis* **subsp. nov.**
Distribution: China (Yunnan)

3. *Oxyartes dorsalis* Chen & He, 2008: 185, figs. 150a-d.
Distribution: China (Yunnan)

4. *Oxyartes guangdongensis* Chen & He, 2008: 186, figs. 151a-c.
Distribution: China (Yunnan)

5. *Oxyartes jinpingensis* Ho, 2017a: 29, figs. 124-127, 156163.
Distribution: China (Yunnan)

6. *Oxyartes lamellatus* Kirby, 1904: 374. [= *Oxyartes honestus* Redtenbacher, 1908: 475; = *Oxyartes spinosissimus* Carl, 1913: 46]
Distribution: China (Guangxi) and Vietnam

7. *Oxyartes nigrigranulatus* **sp. nov.**
Distribution: China (Yunnan)

8. *Oxyartes rubris* Ho, 2017a: 31, figs. 128-131, 164-171, 282-283.
Distribution: China (Yunnan)

8.1. *Oxyartes rubris distinctus* **subsp. nov.**
Distribution: China (Yunnan)

8.2. *Oxyartes rubris rubris* Ho, 2017a: 31, figs. 128-131, 164-171, 282-283.
Distribution: China (Yunnan)

9. *Oxyartes sparsispinosus* **sp. nov.**
Distribution: China (Yunnan)

10. *Oxyartes xishuangbannaensis* **sp. nov.**
Distribution: China (Yunnan)

11. *Oxyartes yunnanus* Chen & He, 2008: 184, figs. 149a-c.
Distribution: China (Yunnan)

Key to the species of *Oxyartes* from China:

Female:

1. Mesonotum with spines. . . . **2**
- Mesonotum with granules or tubercle-like granules. **5**

2. Fifth and seventh abdominal tergites lacking posteromedian lamella. . . . **3**
- Fifth or seventh abdominal tergites with a posteromedian lamella. . . . **4**

3. Fifth abdominal tergum with posterior humps. . . . . *O. despectus yingjiangensis* **subsp. nov.**
- Fifth abdominal tergum lacking posterior humps. . . . . *O. guangdongensis*

4. Pronotum unarmed. *O. sparsispinosus* **sp. nov.**
- Pronotum with spines on pre-median area. . . . . *O. lamellatus*

5. Eighth and ninth abdominal tergites with a posteromedian tubercle. . . . **6**
- Eighth and ninth abdominal tergites lacking posteromedian tubercle. . . . **10**

6. Sixth abdominal tergum with a hump-like structure. **7**
- Sixth abdominal tergum lacking hump-like structure. **8**

7. Anterior area of mesonotum with a spinose hump. . . . . *O. rubris distinctus* **subsp. nov.**
- Anterior area of mesonotum with a tuberculate hump. . . . . *O. rubris rubris*

8. Mesonotum densely granulated. . . . . *O. densigranulatus* **sp. nov.**
- Mesonotum sparsely granulated. . **9**

9. Alae shorter than pronotum. . *O. dorsalis*
- Alae longer than pronotum. . . . . *O. xishuangbannaensis* **sp. nov.**

10. Alae distinct, tegmina-like. . *O. jinpingensis*
- Alae indistinct, scale-like. . . **11**

11. Eighth and ninth abdominal tergites with a crest-like structure. . *O. densigranulatus* **sp. nov.**
- Eighth and ninth abdominal tergites lacking crest-like structure. . . . *O. yunnanus*

Male:

1. Median segment to ninth tergum lacking posteromedian granule. . . . **2**
- Median segment to ninth tergum with a posteromedian granule or tubercle. . **4**

2. Alae distinct, tegmina-like. . *O. jinpingensis*
- Alae indistinct, scale-like. . . **3**

3. Ninth abdominal tergum parallel-sided. . . . . *O. sparsispinosus* **sp. nov.**
- Ninth abdominal tergum laterally swollen. . . . . *O. yunnanus*

4. Mesonotum unarmed. . . . **5**
- Mesonotum with spines. . . . **7**

5. Posterior apex of alae pointed. . . . . *O. xishuangbannaensis* **sp. nov.**
- Posterior apex of alae obtuse. . . **6**

6. Anterior area of mesonotum with spines. . . . . *O. rubris distinctus* **subsp. nov.**
- Anterior area of mesonotum with granules. . . . . *O. rubris rubris*

7. Pronotum with spines on pre-median area. . . . . *O. lamellatus*
- Pronotum unarmed. . . . **8**

8. Poculum medially elevated, apically pointed. . . . . *O. densigranulatus* **sp. nov.**
- Poculum medially rounded, not elevated medially. **9**

9. Ninth abdominal tergum parallel-sided. . . . . *O. despectus yingjiangensis* **subsp. nov.**

- Ninth abdominal tergum laterally swollen. . . . . *O. dorsalis*

***Oxyartes densigranulatus* sp. nov.** (Figs. 18-21, 49-52, 59-60)

Types: Holotype, ♀, 1500m, Baoshan, Yunnan, China, 1.VII.2019, George Ho Wai-Chun (HKES); Paratypes, 4♀, 5♂ & 19 eggs (naturally laid by holotype ♀ & paratypes ♀), same data as holotype ♀, George Ho Wai-Chun (HKES).

Differentiation: *Oxyartes densigranulatus* **sp. nov.** is closely related to *O. yunnanus* Chen & He, 2008, but can be separated by the presence of a small hump on the posteromedian area of second to seventh abdominal tergites and the tegmina-like alae in the female and the medially elevated poculum in the male.

Description of female (Figs. 18-19, 49, 51): Medium-sized. General colour of body and legs brown. Body slender and elongate, larger and more robust than male.

Head: Oval, roughly as long as pronotum, densely covered with small granules. Vertex and occiput flat, with six small swellings on posterior margin, median and lateral longitudinal furrows distinct. Compound eyes small and oval, its lengths about three times length of genae. Antennae long and filiform, surpassing apices of protarsi, sparsely covered with short bristles; scapus basally flattened, as long as third segment, longer than pedicellus.

Thorax: Rough, densely covered with small granules. Pronotum rectangular, anterior margin weakly curved inwards, posterior margin rounded, transverse and longitudinal sulci crossing before middle area. Mesonotum parallel-sided, median longitudinal carina indistinct, densely granulated, interspersed with a few enlarged granules. Metanotum longer than median segment. Metapleurae with a few acute granules on lower margin.

Abdomen: Densely covered with small and obscure granules and interspersed with a few enlarged granules, median and lateral carinae distinct. Median segment to seventh tergites with a small hump posteromedially. Third tergum to anal segment with longitudinal carinae. Eighth and ninth tergites with a small crest posteromedially. Seventh sternum with a pair of spine-like praeopercular organ on posteromedian area. Eighth tergum longer than ninth tergum. Anal segment as long as ninth tergum, posterior margin with distinct posterolateral angles and posteromedian elevations, forming four small posterior emarginations. Subgenital plate scoop-shaped, flattened, mediolongitudinally carinate, posterior margin rounded and reaching posterior margin of anal segment. Cerci short, straight, apices obtuse and not surpassing end of abdomen.

Legs: Slender and long. Unarmed. Sparsely covered with short bristles. Anteroventral and posteroventral carinae of femora with two to four small spines subapically. Profemora incurved basally. Tibiae roughly as long as corresponding femora, medioventral carina elevated basally.

Wings: Alae short and tegmina-like.

Description of male (Figs. 20-21, 50, 52): Medium-sized. Body slender, distinctly smaller and more slender than female. General colour of body and legs greenish brown.

Head: Oval, with sparse and inconspicuous granulations. Vertex and occiput flat, posterior margin with six small swellings. Compound eyes oval, its lengths about two-and-a-half times length of genae. Antennae long and filiform, surpassing apices of protarsi; scapus flattened basally, as long as third segment, longer than pedicellus.

Thorax: Sparsely covered with small and inconspicuous granules. Pronotum rectangular, transverse and longitudinal sulci crossing before middle point, anterior margin weakly curved inwards, posterior margin rounded. Mesonotum broadly emarginated medially, median longitudinal line indistinct, with two rows of spines placed between median longitudinal line and lateral margins, each row with five to eight spines varied in different individuals; lateral margins with a very few enlarged granules. Metanotum longer than median segment.

Abdomen: Slender, with sparse and inconspicuous granulations. Second to seventh tergites parallel-sided. Eighth tergum expanded posteriorly, longer than ninth tergum. Anal segment as long as ninth tergum, posterior margin thickened and weakly emarginated. Poculum cup-shaped, medially elevated distinctly, apically pointed, posterior margin rounded and reaching middle area of anal segment. Cerci cylindrical, long, gently curved inwards, apices rounded and not surpassing posterior margin of anal segment.

Legs: Slender and long. Sparsely covered with short bristles. Anteroventral and posteroventral carinae of femora with two to three small spines subapically. Profemora distinctly curved at base. Tibiae roughly as long as corresponding femora.

Wings: Alae short and tegmina-like.

Measurements: See Table 6.

Description of egg (Figs. 59-60): Capsule brown, oval, posterior pole rounded, sparsely granulated. Micropylar plate oval, anterior and posterior margins rounded. Micropylar cup placed near posterior area of micropylar plate. Median line long, almost as long as micropylar plate. Operculum blackish brown, centrally elevated with a small and closed-stalked capitulum, apically rounded.

Measurements: Length, 3.5 mm; width, 2.0 mm; height

3.0 mm.

Distribution: China (Yunnan).

Etymology: The specific epithet of this new species is derived from the dense granulations on the mesonotum in the female.

***Oxyartes despectus yingjiangensis* subsp. nov.** (Figs. 53-56)

Types: Holotype, ♀, 1000m, Yingjiang, Dehong, Yunnan, China, 3.VII.2019, George Ho Wai-Chun (HKES); Paratypes, 1♀, 2♂, 6 eggs (naturally laid by holotype & paratype ♀), same data as holotype ♀ (HKES); 2♂, 570m, Nabang, Yingjiang, Dehong, Yunnan, China,19. VI.2017, Bi Wen-Xuan (HKES & SEM).

Differentiation: *Oxyartes despectus yingjiangensis* **subsp. nov.** is closely related to the nominate *O. despectus despectus* (Westwood, 1848), but can be separated by the smaller size in the both sexes, the more robust body, the short tubercles on the lateral margins of mesonotum and the unarmed metanotum in the female and the presence of five pairs of spines on the mesonotum in the male.

Description of female (Figs. 53, 55): Generally as in nominate race. Medium-sized. General colour of body and legs brown. Head as in nominate race, with small and sparse granules. Vertex flat and unarmed. Occiput with six small swellings on posterior margin. Antennae as in nominate race. Thorax generally as in nominate race, rough, with wrinkles and obscure granulations. Mesonotum as in nominate race, with one paired anterior medial, two paired posterior medial spines, two paired pre-median, one paired post-median and one paired posterior spines, but less developed, comparatively smaller in size, lateral margins interspersed with a few short tubercles (distinctly spine-like in nominate race). Metanotum distinctly unarmed. Abdomen generally as in nominate race, with small granules and wrinkles. Median segment to seventh tergites with less developed hump posteromedially. Eighth and ninth tergites with a small crest posteromedially. Seventh sternum lacking noticeable praeopercular organ. Anal segment with four small posterior emarginations on posterior margin. Subgenital plate and cerci as in nominate race. Legs as in nominate race, anteroventral and posteroventral carinae of femora with three to six small spines subapically. Alae as in nominate race.

Description of male (Figs. 54, 56): Generally as in nominate race, but body more robust. Head as in nominate race, with sparse and inconspicuous granulations. Vertex flat and unarmed. Occiput with six small swellings on posterior margin. Antennae long and filiform. Thorax as in nominate race, small and inconspicuous granules. Mesonotum generally as in nominate race, broadly emarginated medially, but only with ten spines including one paired anterior medial, one paired posterior medial, two paired pre-median and one paired post-median spines; lateral margins with a very few enlarged granules (with tubercle-like granules in nominate race). Abdomen as in nominate race. Anal segment as long as ninth tergum, posterior margin thickened and weakly emarginated. Poculum cup-shaped, posterior margin rounded, reaching posterior area of anal segment. Cerci cylindrical, long, straight, apices rounded and not surpassing posterior margin of anal segment. Legs as in nominate race, anteroventral and posteroventral carinae of femora with one to four small spines subapically. Alae as in nominate race.

Measurements: See Table 7.

Distribution: China (Yunnan).

Notes: The nominate race *Oxyartes despectus despectus* (Westwood, 1848) is not occurred in China and only found in Bangladesh and India.

Etymology: The specific epithet of this new subspecies is derived from the type-locality, Yingjiang, Yunnan, China.

***Oxyartes nigrigranulatus* sp. nov.** (Figs. 22-23, 57-58, 61-62)

Types: Holotype, ♀, 2000m, Xiping, Yuxi, Yunnan, China, 23.VI.2019, George Ho Wai-Chun (HKES); Paratypes, 2♀, 21 eggs (naturally laid by paratypes ♀), same data as holotype ♀, George Ho Wai-Chun (HKES).

Differentiation: *Oxyartes nigrigranulatus* **sp. nov.** is related to *O. yunnanus* Chen & He, 2008, but can be separated by its smaller size, the comparatively more robust body, the presence of sparse and black granules on the mesonotum and the crest-like structure on the posteromedian area of eighth and ninth abdominal tergites in the female.

Description of female (Figs. 22-23, 57-58): Medium-sized. General colour of body and legs brown to dark brown. Body slender and elongate.

Head: Oval, roughly as long as pronotum, sparsely covered with small granules. Vertex and occiput flat, with six small swellings on posterior margin, median longitudinal furrow distinct, lateral longitudinal furrows indistinct. Compound eyes small and oval, its lengths about three times length of genae. Antennae long and filiform, surpassing apices of protarsi, sparsely covered with short bristles; scapus basally flattened, longer than pedicellus; and third segment as long as combined length of scapus and second segment.

Thorax: Sparsely covered with small granules. Pronotum rectangular, anterior margin curved inwards, posterior margin rounded, transverse and longitudinal sulci crossing before middle area. Mesonotum parallel-sided, median longitudinal carina indistinct, interspersed with a few small and black granules, posteromedian area

with a small hump. Mesosternum interspersed with a few small and black granules. Metanotum longer than median segment. Metapleurae with a few small and black granules on lower margin.

Abdomen: Sparsely covered with small granules, also with longitudinal carinae. Median segment to seventh tergites with a small horn-like tubercle posteromedially. Eighth and ninth tergites with a small crest posteromedially. Seventh sternum lacking noticeable praeopercular organ. Eighth tergum longer than ninth tergum. Anal segment as long as ninth tergum, posterior margin with distinct posterolateral angles and posteromedian elevation, forming four posterior emarginations. Subgenital plate scoop-shaped, posterior margin rounded and reaching posterior margin of anal segment. Cerci short, straight, apices obtuse and not surpassing end of abdomen.

Legs: Slender and long. Unarmed. Sparsely covered with short bristles. Anteroventral and posteroventral carinae of femora with one to three small spines subapically. Profemora incurved basally. Medioventral carina of tibiae elevated basally.

Wings: Alae reduced and scale-like.

Measurements: See Table 8.

Description of egg (Figs. 61-62): Capsule olive brown, oval, posterior pole rounded, smooth. Micropylar plate oval, anterior margin rounded, posterior margin slightly pointed. Micropylar cup placed near posterior margin of micropylar plate. Median line long, almost as long as micropylar plate. Operculum blackish brown, centrally elevated with a small and closed-stalked capitulum, apically flattened.

Measurements: Length, 3.0 mm; width, 2.0 mm; height 2.2 mm.

Distribution: China (Yunnan).

Notes: The male is unknown.

Etymology: The specific epithet of this new species is derived from the black granulations on the thorax in the female.

***Oxyartes rubris distinctus* subsp. nov.** (Figs. 63-66)

Types: Holotype, ♀, 1500m, Jinping, Honghe, Yunnan, China, 28.VIII.2019, George Ho Wai-Chun (HKES); Paratypes, 3♀, 2♂, 27 eggs (naturally laid by holotype & paratypes ♀), same data as holotype ♀ (HKES).

Differentiation: *Oxyartes rubris distinctus* **subsp. nov.** is similar to the nominate *O. rubris rubris* Ho, 2017, but can be separated by its larger size and more elongate and slender body in the both sexes, the distinct spinose hump on the anteromedian area of mesonotum, more distinct granulations on thorax and abdomen in the female and the presence of well-developed anterior medial spines on the pronotum in the male.

Description of female (Figs. 63, 65): Medium-sized. General colour of body and legs greenish brown to brown, with light brown markings. Body slender and elongate. Head as in nominate race. Pronotum as in nominate race. Mesonotum rough, elevated with a spinose hump on anteromedian area, bearing four to six spines; lateral margins with more developed and enlarged acute granules. Metanotum with more distinct granulations. Abdomen generally as in nominate race, but with more distinct granulations. Legs and alae as in nominate race.

Description of male (Figs. 64, 66): Medium-sized. Body slender, smaller and more slender than female. General colour of body and legs brown. Head and thorax generally as in nominate race. Mesonotum lacking noticeable wrinkles, less rough, with granulations, anteromedian area with paired well-developed medial spines. Abdomen, legs and alae as in nominate race.

Measurements: See Table 9.

Description of egg: As in nominate race.

Distribution: China (Yunnan).

Etymology: The specific epithet of this new subspecies is derived from the distinct spinations on the anteromedian area of mesonotum in the both sexes.

***Oxyartes sparsispinosus* sp. nov.** (Figs. 24-27, 67-70)

Types: Holotype, ♀, 2000m, Baoshan, Yunnan, China, 30.VI.2019, George Ho Wai-Chun (HKES); Paratypes, 4♂, same data as holotype ♀, George Ho Wai-Chun (HKES).

Differentiation: *Oxyartes sparsispinosus* **sp. nov.** is related to *O. rubris* Ho, 2017, but can be easily separated by the more slender body and the presence of two rows of spines on the mesonotum in the both sexes, the presence of a crest on the posteromedian area of fifth abdominal tergum in the female and the scale-like alae in the male.

Description of female (Figs. 24-25, 67, 69): Medium-sized. General colour of body and legs dark brown. Body slender, distinctly larger and more robust than male.

Head: Oval, roughly as long as pronotum, sparsely covered with small granules. Vertex flat. Occiput gently convex, with six distinct swellings on posterior margin, median and lateral longitudinal furrows distinct. Compound eyes small and oval, its lengths about four times length of genae. Antennae long and filiform, surpassing apices of protarsi, sparsely covered with short bristles; scapus longer than pedicellus, as long as

third segment.

Thorax: Sparsely covered with small granules. Pronotum rectangular, longer than wide, anterior margin weakly curved inwards, posterior margin rounded, transverse and longitudinal sulci crossing at middle area. Mesonotum parallel-sided, with weak median longitudinal carina, with one paired anterior medial spines; also with two rows of spines placed between median longitudinal carina and lateral margins, each row of spines with four spines, lateral margins with a few tubercle-like granules. Metanotum longer than median segment, lateral margins with a few tubercle-like granules.

Abdomen: Sparsely covered with small granules and with short wrinkles. Third to fifth and seventh to eighth tergites with a horn-like spine posteromedially, spine enlarged on fourth tergum. Fifth tergum with a lamella-like crest posteromedially. Seventh sternum with bifurcated praeopercular organ posteromedially. Eighth tergum longer than ninth tergum. Anal segment as long as ninth tergum, median and lateral longitudinal carinae distinct, posterior margin with four small emarginations. Subgenital plate scoop-shaped, posterior margin rounded and surpassing posterior margin of anal segment. Cerci short, straight, apices pointed and not surpassing end of abdomen.

Legs: Slender and long. Unarmed. Sparsely covered with short bristles. Anteroventral and posteroventral carinae of femora with one to three small spines subapically. Profemora incurved basally. Tibiae as long as corresponding femora, medioventral carina elevated basally.

Wings: Alae reduced and scale-like.

Description of male (Figs. 26-27, 68, 70): Medium-sized. Body slender, smaller and more slender than female. General colour of body and legs brown, with blackish markings.

Head: Oval, with sparse and inconspicuous granulations. Vertex flat, unarmed. Occiput flat, posterior margin with six small swellings. Compound eyes oval. Antennae long and filiform; scapus flattened basally, longer than third segment; and pedicellus shorter than third segment.

Thorax: Sparsely covered with small granules. Pronotum rectangular, transverse and longitudinal sulci crossing before middle point, anterior margin curved inwards, posterior margin nearly truncate. Mesonotum broadly emarginated medially, median longitudinal line distinct, with one pair of anterior medial spines, also with two rows of spines placed between median longitudinal line and lateral margins, each row of spines with three to four spines, lateral margins with a few enlarged granules. Metanotum longer than median segment.

Abdomen: Slender and wrinkled. Second to seventh tergites parallel-sided. Eighth tergum expanded posteriorly, as long as ninth tergum. Anal segment shorter than ninth tergum, posterior margin thickened and with an indistinct and broad emargination. Poculum cup-shaped, posterior margin rounded and reaching anterior area of anal segment. Cerci cylindrical, apices rounded and not surpassing posterior margin of anal segment.

Legs: Slender and long. Sparsely covered with short bristles. Femora roughly as long as corresponding tibiae, posteroventral carina of femora with three small spines subapically. Profemora distinctly curved at base.

Wings: Alae reduced and scale-like.

Measurements: See Table 10.

Distribution: China (Yunnan).

Etymology: The specific epithet of this new species is derived from the sparse spinations on the mesonotum in the both sexes.

***Oxyartes xishuangbannaensis* sp. nov.** (Figs. 28-31, 71-74)

Types: Holotype, ♀, 500-600m, Menglun, Xishuangbanna, Yunnan, China, 6.IX.2015, George Ho Wai-Chun (HKES); Paratypes, 2♀, 2♂, same data as holotype ♀, George Ho Wai-Chun (HKES).

Differentiation: *Oxyartes xishuangbannaensis* **sp. nov.** is similar to *O. densigranulatus* **sp. nov.**, but can be easily separated by its larger size and more slender body in the both sexes, lacking crest-like structure on the ninth abdominal tergum in the female and the unarmed mesonotum in the male.

Description of female (Figs. 28-29, 71, 73): Medium-sized. General colour of body and legs brown, with blackish markings. Body very slender and elongate, more robust than male.

Head: Oval, as long as pronotum, sparsely covered with small granules. Vertex and occiput flat, with six distinct and small swellings on posterior margin, median longitudinal and lateral longitudinal furrows distinct. Compound eyes small and oval, its lengths about four times length of genae. Antennae long and filiform, surpassing apices of protarsi, sparsely covered with short bristles; scapus basally flattened, as long as third segment, longer than pedicellus.

Thorax: Rough, wrinkled, sparsely covered with small granules, interspersed with a few enlarged granules. Pronotum rectangular, longer than wide, anterior margin weakly curved inwards, posterior margin rounded, transverse and longitudinal sulci crossing before middle area. Mesonotum parallel-sided, median longitudinal line distinct; sparsely granulated, lateral margins interspersed with a few enlarged granules. Metanotum as long as median segment. Metapleurae with a few

enlarged granules on lower margin.

Abdomen: Wrinkled, with longitudinal carinae, also sparsely covered with a few small granules. Median segment to ninth tergites with a small granule-like hump posteromedially. Seventh sternum with a carina-like praeopercular organ, bifurcated posteriorly. Eighth tergum longer than ninth tergum. Anal segment as long as ninth tergum, posterior margin with distinct posterolateral angles and posteromedian elevations, forming four small posterior emarginations. Subgenital plate scoop-shaped, flattened, mediolongitudinally carinate, posterior margin rounded and reaching posterior margin of anal segment. Cerci short, straight, apices obtuse and not surpassing end of abdomen.

Legs: Slender and long. Unarmed. Sparsely covered with short bristles. Anteroventral and posteroventral carinae of femora with three to five small spines subapically. Profemora incurved basally. Protibiae and mesotibiae roughly as long as corresponding femora, metatibiae longer than corresponding femora, medioventral carina elevated basally.

Wings: Alae distinct, short and tegmina-like.

Description of male (Figs. 30-31, 72, 74): Medium-sized. Body slender, distinctly smaller and more slender than female. General colour of body and legs brown, with blackish markings.

Head: Oval, with sparse and inconspicuous granulations. Vertex and occiput flat, posterior margin with four small swellings. Compound eyes oval, its lengths about three times length of genae. Antennae long and filiform, surpassing apices of protarsi; scapus flattened basally, as long as third segment, longer than pedicellus.

Thorax: Sparsely covered with small and inconspicuous granules. Pronotum rectangular, longer than wide, transverse and longitudinal sulci crossing before middle point, anterior margin weakly curved inwards, posterior margin nearly truncate. Mesonotum rough, winkled, broadly emarginated medially, median longitudinal line indistinct; unarmed, lateral margins with a few enlarged granules. Metanotum as long as median segment.

Abdomen: Slender, with sparse and inconspicuous granulations, with indistinct longitudinal carinae. Second to seventh tergites parallel-sided. Eighth tergum expanded posteriorly, longer than ninth tergum. Anal segment shorter than ninth tergum, posterior margin thickened and emarginated. Poculum cup-shaped, posterior margin rounded, reaching posterior area of anal segment. Cerci cylindrical, long, weakly incurved, apices rounded and surpassing posterior margin of anal segment.

Legs: Slender and long. Sparsely covered with short bristles. Anteroventral and posteroventral carinae of femora with two to six small spines subapically. Profemora distinctly curved at base. Mesotibiae roughly as long as corresponding femora, protibiae and metatibiae longer than corresponding femora.

Wings: Alae distinct, short and tegmina-like.

Measurements: See Table 11.

Distribution: China (Yunnan).

Etymology: The specific epithet of this new species is derived from the type-locality, Xishuangbanna, Yunnan, China.

CONCLUSION

In this paper, 11 new taxa including one new genus, eight new species and two new subspecies are described and four new combinations are suggested. Necrosciinae is a speciose subfamily in China and more than 150 species are described (Chen and He, 2008; Hennemann et al., 2008; Ho, unpubl. data). Most taxa are endemic to China. However, some described species are only known from single male or female specimen. This needs further specimen collecting and research to study their taxonomic status and to achieve a comprehensive faunal documentary.

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TABLES & FIGURES

	Acanthophasma brevicercum **sp. nov.** **Holotype Male**	*Parapachymorpha apicalis* **sp. nov.** **Holotype Male**
Body	33.5	29.0
Head	3.5	3.0
Antennae	28.0	25.0
Pronotum	2.0	2.0
Mesonotum	7.5	6.5
Metanotum	1.5	1.5
Median segment	2.5	2.0
Profemora	7.5	8.0
Mesofemora	6.5	6.0
Metafemora	9.0	8.0
Protibiae	7.5	8.0
Mesotibiae	6.5	6.0
Metatibiae	9.0	9.0
Alae	2.0	-

Table 1. Measurements of *Acanthophasma* spp.

	Holotype Female	**Paratype Females**	**Paratype Males**
Body	49.0	42.0-51.0	39.0-45.0
Head	4.5	4.0-4.5	3.0
Antennae	27.0	23.0-26.0	26.0-33.0
Pronotum	4.0	4.0	3.0
Mesonotum	10.0	9.0-11.0	9.0-11.0
Metanotum	3.0	3.0-3.5	3.0
Median segment	2.5	2.0-2.5	2.0
Profemora	13.5	11.5-14.0	13.0-15.0
Mesofemora	11.0	9.0-11.0	10.0-12.0
Metafemora	15.5	13.0-16.0	14.0-17.0
Protibiae	13.5	12.0-15.0	13.5-17.0
Mesotibiae	11.0	10.0-12.0	11.0-13.5
Metatibiae	17.0	15.0-19.0	16.5-17.0

Table 2. Measurements of *Cheniphasma parvidentatum* **sp. nov.**

	Holotype Female	**Females**	**Males**
Body	34.0	29.0-32.0	24.0-28.0
Head	3.5	3.0	2.0
Antennae	12.0	12.0	16.0-18.0
Pronotum	3.0	2.5-3.0	1.5-2.0
Mesonotum	6.0	5.0-6.0	4.5-5.5
Metanotum	2.5	2.0	1.5-2.0
Median segment	1.0	1.5	1.0
Profemora	6.5	6.5-7.0	6.0-7.5
Mesofemora	5.0	5.0	5.0-6.0
Metafemora	7.5	8.0	7.0-8.5
Protibiae	7.0	7.5-8.0	6.5-8.5
Mesotibiae	5.0	5.5-6.0	5.0-6.0
Metatibiae	8.0	8.5-9.0	8.0-10.0

Table 3. Measurements of *Neointerphasma minutigranulatum* Ho, 2017

	Holotype Female	Females	Males
Body	40.0	37.0-41.0	31.0-35.0
Head	4.0	4.0	2.5
Antennae	22.0	20.0-22.0	22.0-27.0
Pronotum	3.0	3.0-3.5	3.0
Mesonotum	7.0	7.0-7.5	6.5-7.0
Metanotum	2.0	2.0	2.5
Median segment	2.0	2.0	1.5
Profemora	11.0	10.0-11.0	10.0-12.0
Mesofemora	9.0	9.0	8.5-10
Metafemora	14.0	12.0-13.0	11.0-14.0
Protibiae	12.0	12.0-13.0	11.0-14.0
Mesotibiae	10.0	9.5-10.5	9.0-11.0
Metatibiae	15.0	14.0-16.0	13.0-16.0

Table 4. Measurements of *Oedohirasea fenshuilingensis* (Ho, 2017) **gen. & comb. nov.**

	Holotype Male
Body	31.0
Head	2.5
Antennae	24.0
Pronotum	3.0
Mesonotum	6.0
Metanotum	2.5
Median segment	1.5
Profemora	11.5
Mesofemora	9.0
Metafemora	13.0
Protibiae	13.0
Mesotibiae	11.0
Metatibiae	16.0

Table 5. Measurements of *Oedohirasea huanglianshanensis* **gen. & sp. nov.**

	Holotype Female	Paratype Females	Paratype Males
Body	90.0	87.0-91.0	67.0-75.0
Head	5.0	5.0	3.5
Antennae	56.0	50.0-52.0	46.0-55.0
Pronotum	4.5	4.5-5.0	3.0-3.5
Mesonotum	23.0	21.0-24.0	16.5-20.0
Metanotum	7.5	6.5-8.0	6.0-6.5
Median segment	5.0	5.0	3.5-4.0
Profemora	19.0	18.0-20.0	19.0-21.0
Mesofemora	14.0	14.0-15.0	13.0-14.0
Metafemora	21.0	20.0-22.0	19.0-20.0
Protibiae	19.0	18.0-20.0	20.0-22.0
Mesotibiae	14.0	13.0-14.0	13.0-14.0
Metatibiae	24.0	22.0-24.0	21.0-23.0
Alae	4.0	3.5-4.0	1.0

Table 6. Measurements of *Oxyartes densigranulatus* **sp. nov.**

	Holotype Female	Paratype Female	Paratype Males
Body	80.0	85.0	56.0-62.0
Head	5.0	5.0	4.0
Antennae	49.0	50.0	47.0-50.0
Pronotum	5.0	5.0	3.5-4.0
Mesonotum	18.0	20.0	13.0-14.5
Metanotum	6.0	6.0	4.0-5.0
Median segment	4.5	5.0	3.5
Profemora	18.0	17.0	15.0-17.0
Mesofemora	13.0	13.0	10.5-12.0
Metafemora	20.0	19.0	15.0-17.0
Protibiae	19.0	17.5	17.0-18.0
Mesotibiae	13.0	13.0	11.0-13.0
Metatibiae	21.0	20.0	17.0-20.0
Alae	4.0	4.0	2.5

Table 7. Measurements of *Oxyartes despectus yingjiangensis* **subsp. nov.**

	Holotype Female	Paratype Females
Body	94.0	86.0-90.0
Head	5.0	4.5-5.0
Antennae	52.0	45.0-50.0
Pronotum	4.5	4.0-4.5
Mesonotum	21.0	21.0
Metanotum	7.5	7.0
Median segment	6.5	5.5-6.0
Profemora	17.0	16.0-17.0
Mesofemora	14.0	13.0-14.0
Metafemora	19.0	17.0-19.0
Protibiae	16.0	15.0-16.0
Mesotibiae	12.0	12.0
Metatibiae	19.0	19.0-20.0

Table 8. Measurements of *Oxyartes nigrigranulatus* **sp. nov.**

	Holotype Female	Paratype Females	Paratype Males
Body	80	84.0-87.0	68.0-70.0
Head	5.5	5.5-6.0	3.5
Antennae	53.0	42.0-60.0	60.0
Pronotum	5.0	5.0	3.5
Mesonotum	18.0	19.0-21.0	16.0-17.5
Metanotum	6.0	6.0	5.0
Median segment	5.5	6.0	4.0
Profemora	19.0	19.0-21.0	19.0-20.0
Mesofemora	13.0	14.0-15.0	12.0-13.0
Metafemora	19.0	19.0-21.0	18.0-20.0
Protibiae	19.0	19.0-21.0	20.0
Mesotibiae	12.0	12.5-13.0	13.0
Metatibiae	20.0	20.0-23.0	21.0
Alae	4.5	4.5	2.5

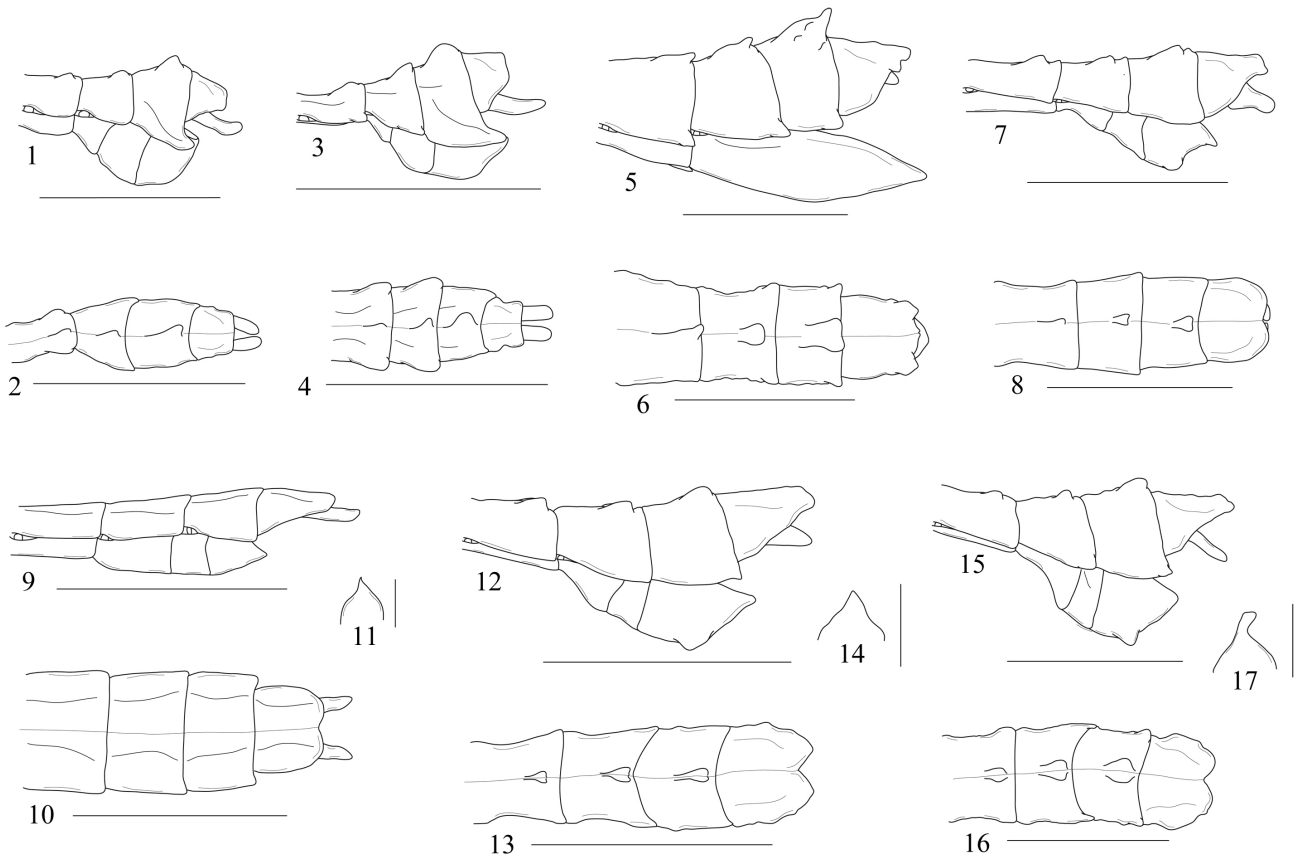
Table 9. Measurements of *Oxyartes rubris distinctus* **subsp. nov.**

	Holotype Female	Paratype Males
Body	80.0	55.0-57.0
Head	5.0	3.0-3.5
Antennae	50.0	43.0-45.0
Pronotum	4.5	3.0
Mesonotum	17.5	13.0-14.0
Metanotum	6.0	4.0-4.5
Median segment	5.0	3.5
Profemora	18.5	15.0-16.0
Mesofemora	13.0	10.0-11.0
Metafemora	19.0	15.0-15.5
Protibiae	18.5	16.0-17.0
Mesotibiae	13.0	10.5-12.0
Metatibiae	20.0	16.5-18.0

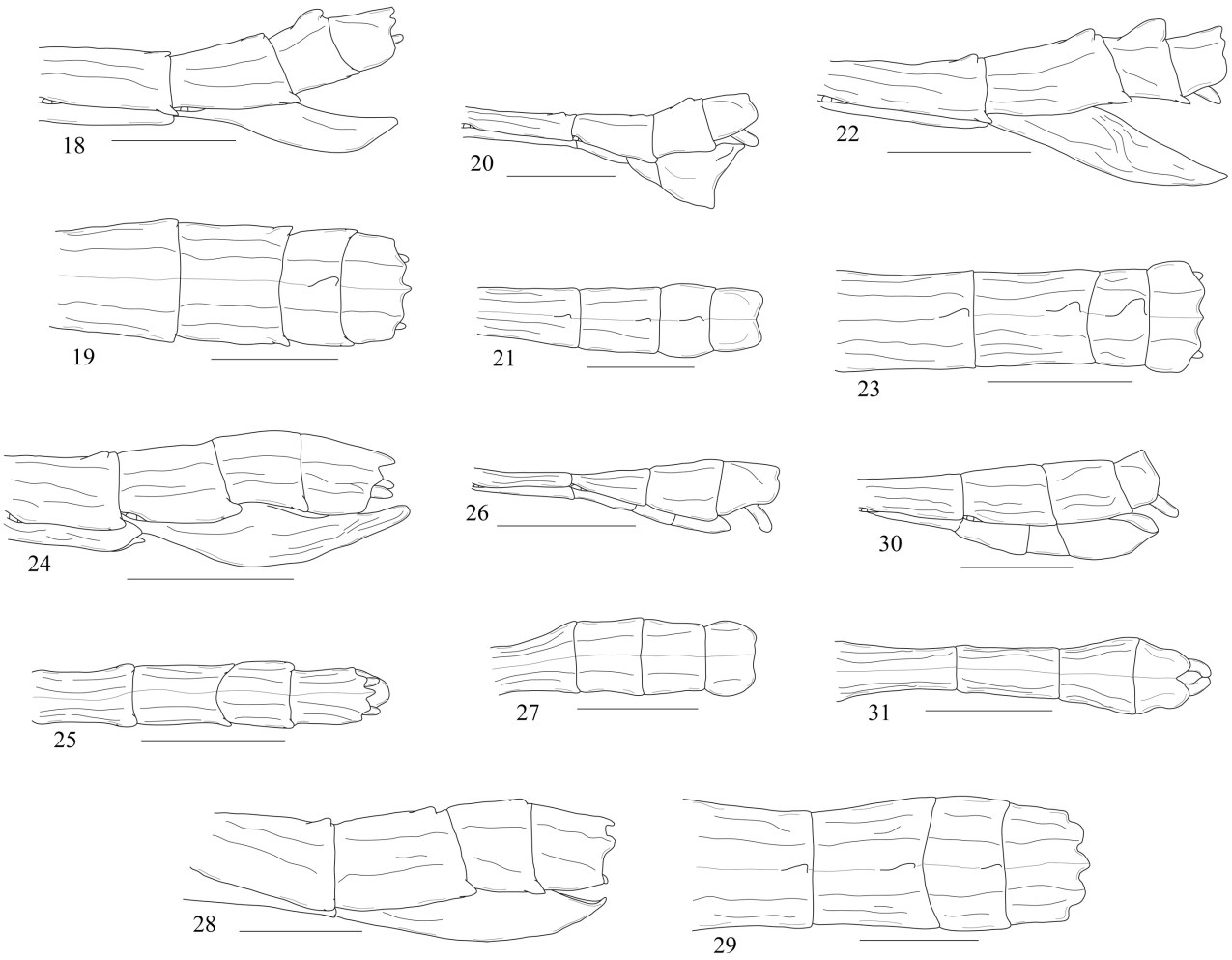
Table 10. Measurements of *Oxyartes sparsispinosus* **sp. nov.**

	Holotype Female	Paratype Females	Paratype Males
Body	103.0	100.0-105.0	78.0-80.0
Head	6.0	6.0	4.5
Antennae	70.0	63.0-65.0	70.0
Pronotum	6.0	6.0	4.0
Mesonotum	24.0	24.0	19.0
Metanotum	7.0	7.0	5.0
Median segment	7.0	6.5-7.0	5.0
Profemora	25.0	24.0-25.0	24.0-25.0
Mesofemora	18.0	17.0-18.0	17.0
Metafemora	25.0	24.0-25.0	23.0
Protibiae	25.0	25.0	27.0
Mesotibiae	17.0	16.0-17.0	17.0-18.0
Metatibiae	28.0	28.0-29.0	27.0-29.0
Alae	8.0	8.0	4.0

Table 11. Measurements of *Oxyartes xishuangbannaensis* **sp. nov.**



Figures 1-17. 1. *Acanthophasma brevicercum* **sp. nov.**, male, apex of abdomen, lateral view. 2. *Acanthophasma brevicercum* **sp. nov.**, male, apex of abdomen, dorsal view. 3. *Acanthophasma dilatatum* **sp. nov.**, male, apex of abdomen, lateral view. 4. *Acanthophasma dilatatum* **sp. nov.**, male, apex of abdomen, dorsal view. 5. *Cheniphasma parvidentatum* **sp. nov.**, female, apex of abdomen, lateral view. 6. *Cheniphasma parvidentatum* **sp. nov.**, female, apex of abdomen, dorsal view. 7. *Cheniphasma parvidentatum* **sp. nov.**, male, apex of abdomen, lateral view. 8. *Cheniphasma parvidentatum* **sp. nov.**, male, apex of abdomen, dorsal view. 9. *Neointerphasma minutigranulatum* Ho, 2017, male, apex of abdomen, lateral view. 10. *Neointerphasma minutigranulatum* Ho, 2017, male, apex of abdomen, dorsal view. 11. *Neointerphasma minutigranulatum* Ho, 2017, male, vomer, ventral view. 12. *Oedohirasea fenshuilingensis* (Ho, 2017) **gen. & comb. nov.**, male, apex of abdomen, lateral view. 13. *Oedohirasea fenshuilingensis* (Ho, 2017) **gen. & comb. nov.**, male, apex of abdomen, dorsal view. 14. *Oedohirasea fenshuilingensis* (Ho, 2017) **gen. & comb. nov.**, male, vomer, ventral view. 15. *Oedohirasea huanglianshanensis* **gen. & sp. nov.**, male, apex of abdomen, lateral view. 16. *Oedohirasea huanglianshanensis* **gen. & sp. nov.**, male, apex of abdomen, dorsal view. 17. *Oedohirasea huanglianshanensis* **gen. & sp. nov.**, male, vomer, ventral view. [Scale bars: apex of abdomen = 5 mm; vomer = 1 mm; Drawings by author]



Figures 18-31. 18. *Oxyartes densigranulatus* **sp. nov.**, female, apex of abdomen, lateral view. 19. *Oxyartes densigranulatus* **sp. nov.**, female, apex of abdomen, dorsal view. 20. *Oxyartes densigranulatus* **sp. nov.**, male, apex of abdomen, lateral view. 21. *Oxyartes densigranulatus* **sp. nov.**, male, apex of abdomen, dorsal view. 22. *Oxyartes nigrigranulatus* **sp. nov.**, female, apex of abdomen, lateral view. 23. *Oxyartes nigrigranulatus* **sp. nov.**, female, apex of abdomen, dorsal view. 24. *Oxyartes sparsispinosus* **sp. nov.**, female, apex of abdomen, lateral view. 25. *Oxyartes sparsispinosus* **sp. nov.**, female, apex of abdomen, dorsal view. 26. *Oxyartes sparsispinosus* **sp. nov.**, male, apex of abdomen, lateral view. 27. *Oxyartes sparsispinosus* **sp. nov.**, male, apex of abdomen, dorsal view. 28. *Oxyartes xishuangbannaensis* **sp. nov.**, female, apex of abdomen, lateral view. 29. *Oxyartes xishuangbannaensis* **sp. nov.**, female, apex of abdomen, dorsal view. 30. *Oxyartes xishuangbannaensis* **sp. nov.**, male, apex of abdomen, lateral view. 31. *Oxyartes xishuangbannaensis* **sp. nov.**, male, apex of abdomen, dorsal view. [Scale bars = 5 mm; Drawings by author]

Figures 32-36. 32. *Acanthophasma brevicercum* **sp. nov.**, habitus of male. 33. *Acanthophasma dilatatum* **sp. nov.**, habitus of male. 34. *Acanthophasma dilatatum* **sp. nov.**, habitus of female (immature). 35. *Acanthophasma brevicercum* **sp. nov.**, male, head and thorax, dorsolateral view. 36. *Acanthophasma dilatatum* **sp. nov.**, male, head and thorax, dorsolateral view. [Scale bars = 5 mm; Photos by author]

Figures 37-42. 37. *Cheniphasma parvidentatum* **sp. nov.**, habitus of female. 38. *Cheniphasma parvidentatum* **sp. nov.**, habitus of male. 39. *Cheniphasma parvidentatum* **sp. nov.**, egg, lateral view. 40. *Cheniphasma parvidentatum* **sp. nov.**, egg, dorsal view. 41. *Cheniphasma parvidentatum* **sp. nov.**, female, head and thorax, dorsolateral view. 42. *Cheniphasma parvidentatum* **sp. nov.**, male, head and thorax, dorsolateral view. [Scale bars: habitus, head and thorax = 5 mm; egg = 1 mm; Photos by author]

Figure 43. *Marmessoidea casignetus* (Westwood, 1859), habitus of female. [Scale bar = 5 mm; Photo by author]

Figure 44. *Neointerphasma minutigranulatum* Ho, 2017, habitus of male. [Scale bar = 5 mm; Photo by author].

Figures 45-48. 45. *Oedohirasea fenshuilingensis* (Ho, 2017) **gen. & comb. nov.**, habitus of male. 46. *Oedohirasea huanglianshanensis* **gen. & sp. nov.**, habitus of male. 47. *Oedohirasea fenshuilingensis* (Ho, 2017) **gen. & comb. nov.**, male, head and thorax, dorsolateral view. 48. *Oedohirasea huanglianshanensis* **gen. & sp. nov.**, male, head and thorax, dorsolateral view. [Scale bars = 5 mm; Photos by author].

Figures 49-52. 49. *Oxyartes densigranulatus* **sp. nov.**, habitus of female. 50. *Oxyartes densigranulatus* **sp. nov.**, habitus of male. 51. *Oxyartes densigranulatus* **sp. nov.**, female, head and thorax, dorsolateral view. 52. *Oxyartes densigranulatus* **sp. nov.**, male, head and thorax, dorsolateral view. [Scale bars = 5 mm; Photos by author].

Figures 53-56. 53. *Oxyartes despectus yingjiangensis* **subsp. nov.**, habitus of female. 54. *Oxyartes despectus yingjiangensis* **subsp. nov.**, habitus of male. 55. *Oxyartes despectus yingjiangensis* **subsp. nov.**, female, head and thorax, dorsolateral view. 56. *Oxyartes despectus yingjiangensis* **subsp. nov.**, male, head and thorax, dorsolateral view. [Scale bars = 5 mm; Photos by author].

Figures 57-62. 57. *Oxyartes nigrigranulatus* **sp. nov.**, habitus of female. 58. *Oxyartes nigrigranulatus* **sp. nov.**, female, head and thorax, dorsolateral view. 59. *Oxyartes densigranulatus* **sp. nov.**, egg, lateral view. 60. *Oxyartes densigranulatus* **sp. nov.**, egg, dorsal view. 61. *Oxyartes nigrigranulatus* **sp. nov.**, egg, lateral view. 62. *Oxyartes nigrigranulatus* **sp. nov.**, egg, dorsal view. [Scale bars: habitus, head and thorax = 5 mm; egg = 1 mm; Photos by author]

Figures 63-66. 63. *Oxyartes rubris distinctus* **subsp. nov.**, habitus of female. 64. *Oxyartes rubris distinctus* **subsp. nov.**, habitus of male. 65. *Oxyartes rubris distinctus* **subsp. nov.**, female, head and thorax, dorsolateral view. 66. *Oxyartes rubris distinctus* **subsp. nov.**, male, head and thorax, dorsolateral view. [Scale bars = 5 mm; Photos by author]

Figures 67-70. 67. *Oxyartes sparsispinosus* **sp. nov.**, habitus of female. 68. *Oxyartes sparsispinosus* **sp. nov.**, habitus of male. 69. *Oxyartes sparsispinosus* **sp. nov.**, female, head and thorax, dorsolateral view. 70. *Oxyartes sparsispinosus* **sp. nov.**, male, head and thorax, dorsolateral view. [Scale bars = 5 mm; Photos by author]

Figures 71-74. 71. *Oxyartes xishuangbannaensis* **sp. nov.**, habitus of female. 72. *Oxyartes xishuangbannaensis* **sp. nov.**, habitus of male. 73. *Oxyartes xishuangbannaensis* **sp. nov.**, female, head and thorax, dorsal view. 74. *Oxyartes xishuangbannaensis* **sp. nov.**, male, head and thorax, dorsal view. [Scale bars = 5 mm; Photos by author]

What can be found from the observation records of Hong Kong Odonata over the past decade? (Part 1)

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ABSTRACT

A brief account on the 13 Odonata species new to Hong Kong recorded or reported after 2011 is given. The known sightings in the territory are described. Comparing with the new-to-Hong Kong discoveries between 2002 and 2011, it is shown that citizen's observation records increasingly contribute to our understanding to the local Odonata fauna. Residential status of the 13 new species needs continuous observation to confirm. Citizen participation in a long term survey on Odonata over the territory would complement the work of professionals in closing this knowledge gap.

Key words: New record, citizen science, Odonata, Hong Kong

INTRODUCTION

Establishing an ecological survey database through public participation is nothing new around the world, not even in Hong Kong. Since 2016, the Hong Kong Bird Watching Society (HKBWS) has been organizing yearly Hong Kong Sparrow Census, recruiting members of the public to conduct surveys over the city, not to mention the Society's long history of collecting bird observation records from members since its establishment (see HKBWS website: https://cms.hkbws.org.hk/cms/resource-tw/bird-report-tw). Green Power also engages citizens to participate in the "Butterfly Surveyor" programme from 2008 onwards (see Green Power website: https://www.greenpower.org.hk/butterfly/eng/surveyor.shtml). This type of "citizen science" is found to be a vital part in many ecology-related studies (Silvertown, 2009; Kullenberg and Kasperowski, 2016).

Among Hong Kong's local insect fauna, Odonata is a relatively well studied (e.g. works of Syoziro Asahina and Keith Wilson) and monitored order. The Dragonfly Working Group under Agriculture, Fisheries and Conservation Department (AFCD) of Hong Kong Government conducts regular surveys of local Odonata fauna since its inauguration in 2002. It is stated in the AFCD website (https://www.afcd.gov.hk/english/conservation/hkbiodiversity/aboutus/aboutus.html) that the survey results would be available to public after detailed analysis. As of today, the findings are yet to be publicized in full.

Odonata is also a more frequently observed insect group by both practitioners and enthusiasts in Hong Kong. Environmental Impact Assessment (EIA) Study Briefs issued by Environmental Protection Department (EPD) of Hong Kong Government in the past two decades usually specify the need for an Odonata survey (among surveys of other taxa, but Odonata and butterflies are the only two named terrestrial macroinvertebrates), in case an ecological impact assessment is required for the particular project's EIA (all Study Briefs are uploaded to EPD EIAO website sorted by the year of issuance: https://www.epd.gov.hk/eia/english/register/index4/all_2020.html). To the author's observation, the number of dedicated photographers focused on Odonata is second only to that on butterflies, and many of them are capable of accurate species identification.

The sizeable population of Odonata observers implies the potential for a comprehensive database of local Odonata fauna in terms of spatial and temporal distribution, if the observation records are gathered systematically. This would not only enrich our knowledge on Odonata but also provide a basis for future studies, for example EIA or population variations due to climate change. While the official surveys are conducted regularly following scientific approaches, a citizen survey would certainly complement the dataset by a wider spectrum of locality and observation timing. Indeed, several observations of Odonata species new to Hong Kong in recent years were from enthusiasts.

MATERIALS & METHODS

In this article, the observation records of Hong Kong Odonata fauna over the past decade (2011 to 2020) by several enthusiasts are reviewed to see whether trends can be seen from a long-term survey dataset. The method and the content of recording are also discussed in order to establish a suitable template for a citizen survey. Part 1 covers the Odonata species firstly recorded / reported in Hong Kong since 2011. Part 2 describes findings on the spatial and temporal distribution of all other extant and previously recorded species.

RESULTS

Part 1: New Odonata Records of Hong Kong Since 2011

The book *The Dragonflies of Hong Kong* by AFCD describes 116 species recorded up to 2011 (Tam et al., 2011). In the following 10 years, a total of 13 new species were added to the Hong Kong list. Some of them are recorded prior to 2011, but the discoveries were publicized after the book was published. Leung and Tam (2016) and the website *A Checklist of Dragonflies (Odonata) of Hong Kong* (Ka, 2020) have outlined these

findings. A brief account of the Hong Kong records of these 13 species are given below.

Zygoptera: Lestidae

Sympecma paedisca (Brauer 1877)

A single male sub-adult was found on 9.II.2009 in Shing Mun South by Sum Lam-Po as described in Ka (2020). For unknown reason this record was not mentioned in Leung and Tam (2016). This species is widespread throughout Palearctic region, with distribution stretching from France to Japan (Battisti and Pavesi, 2017). In China it is confined to northern provinces (Zhang, 2018). Given the lower dispersal ability of damselflies (Watts et al., 2006), it is possible that the individual was transported to Hong Kong with aquarium plants.

Zygoptera: Calopterygidae

Matrona basilaris Selys 1853

Seehausen (2014) described the discovery of specimens in the Übersee-Museum, Bremen, Germany. The two male and two female specimens are mounted with the label stating “Hongkong” as the collection locality, probably during the late 19th / early 20th Century. It is widely distributed in China (Zhang, 2018) but there is no sighting reported in Hong Kong other than the specimens in Germany.

Epiprocta: Aeshnidae

Anax indicus Lieftinck, 1942

Yam (2012) described the only reported sighting of this species in Hong Kong. A male was spotted at Yuen Tun Ha on 25.IX.2010 and it occurred for a few minutes. Zhang (2018) mentions its occurrence in Vietnam and Yunnan, China in addition to the distribution between Pakistan and Thailand as stated by Yam. It is not sure whether it is a vagrant individual, or just that the presence of this species is overlooked, as locally common species *Anax guttatus* and *Anax parthenope* tend to fly continuously above ponds without rest when occur, and it is challenging to identify similarly coloured *Anax* species during rapid flight.

Gynacantha ryukyuensis Asahina, 1962

The occurrence of this species in Hong Kong was announced by AFCD (2014), based on records in northeast New Territories (in 2004 and May 2014) and Tai Lam Country Park (April 2013 and June 2014), as detailed in Leung, Hui and Fung (2016). Subsequently the species is recorded in a wide range of localities over Hong Kong. An earlier photo record dated 26.VII.2011 taken at Sha Lo Tung by the author was later identified as *G. ryukyuensis*. Below are the personal observation records of the author and Cheung Che-Man (pers. comm.) showing the locality and the dates, among other records posted in the internet:

1. Sha Lo Tung - Dates recorded: 26.VII.2011, 21.VI.2014, 12.VII.2014, 6.VI.2020
2. Wu Kau Tang - Dates recorded: 29.VI.2014, 27.VII.2014
3. Luk Keng - Dates recorded: 16.V.2015
4. Ping Nam Stream - Dates recorded: 13.V.2019

On iNaturalist website, sightings of *G. ryukyuensis* were reported at Shui Hau, Lantau Island on 26.IV.2019, Sha Lo Tung on 15.VI.2019 and Lamma Island on 26.IV.2020, illustrating that its range spans over a large part of the territory from north to south.

Hong Kong is within the distribution range of *G. ryukyuensis* which spans between Guangxi, China and Tanegashima, Japan (Ozono et al., 2012; Zhang, 2018). It was first reported in Taiwan in the early 1990s (Yeh, 2006). There is no clue on whether the species only expands its range to Hong Kong in recent years, but because of their cryptic, crepuscular behaviour and similarity with other *Gynacantha* spp., it may well be a resident species that has just been overlooked. The many recent records by enthusiasts indicate that a steady community may have been established in Hong Kong.

Polycanthagyna ornithocephala (McLachlan, 1896)

Up to date there are two reported sightings of this species in Hong Kong. A female was found in northeast New Territories by Sum Lam-Po on 13.VII.2017 as illustrated in Ka (2020). A male was recorded at Tai Po Kau Outdoor Study Centre on 23.VIII.2018 by Ernest Chiu as described in a post on the “HK Dragonfly” Facebook page (https://www.facebook.com/groups/hkdragonfly/permalink/917793205376318). According to Wong et al. (2012), it usually occurs near woodland pools that are small in area, sharing the same habitat type with *P. erythromelas* which is locally a widespread and well recorded species (Tam et al., 2011). Although Hong Kong is within the reported range of its distribution from India to the Ryukyu (Wong et al., 2012), more observation record is needed to confirm its status in the territory.

Epiprocta: Gomphidae

Stylurus annulatus (Djakonov, 1926) and *Stylurus clathratus* (Needham, 1930)

Wilson (2019) gives a comprehensive account of the discovery of these two species in Hong Kong: *S. annulatus* was first recorded in the eastern water outside Sai Kung on 13.VIII.2008 by Samson So. It was identified as *S. kreyenbergi* but this name is synonymized with *S. annulatus* now as explained in the same article by Wilson. It was also recorded by AFCD on 15.IX.2014 (one female) and 27.VI.2017 (one male) in Ma On Shan. All three records occurred in the eastern

side of the city. A female *S. clathratus* was recorded at Tai O, Lantau Island by Ernest Chiu on 19.VI.2018. Both species are recorded from Guangdong province, but again additional records are required to confirm whether they breed in Hong Kong.

Epiprocta: Cordulegastridae

Anotogaster cf. *klossi* Fraser, 1919

AFCD (2015) reported the first record of Cordulegastridae in Hong Kong in May 2015. It was found in central New Territories and subsequently identified as *Anotogaster* sp., close to *A. klossi*. On and on there have been sightings of *Anotogaster* sp. at different localities in central and northeastern New Territories. A Japanese visitor photographed a flying adult in Wu Kau Tang on 5.VI.2016 (Bergman Ng, pers. comm.). Teneral individuals were photographed in April 2018 and on 7.V. 2020 in Shing Mun, where an ovipositing female (on 20.VII.2017) and a larva have also been recorded at various locations within the country park (Mahler Ka, pers. comm.). A male was recorded at Sha Lo Tung by Cheung Che-Man on 15.VII.2020 (pers. comm.). Apparently there are breeding communities of *Anotogaster* sp. in Hong Kong. Species under this genus closely resemble each other and correct identification may require dissection of genitalia (Zhang, 2018).

Epiprocta: Libellulidae

Indothemis carnatica (Fabricius, 1798)

The first reporting of this species was by AFCD (2018a), describing the discovery at a pond in northwest New Territories, where both sexes occurred between 4.IV.2018 and 9.IV.2018 and mating was recorded. It was later checked that a male was photographed in Luk Keng on 28.X.2017 by Cheung Che-Man (pers. comm.; Ka, 2020). In the following two years, this species has been recorded in various sites as west as in Castle Peak and as east as in Tsiu Hang and Ngong Wo, both in Sai Kung (Bergman Ng, pers. comm.).

Von Ellenrieder et al. (2015) mentioned that *I. carnatica* was only recorded in limited sites in India, Sri Lanka, Thailand and Malaysia, and reported the first record in northern Vietnam. Later Zhang (2018) mentioned its occurrence in Yunnan, Guangxi and Guangdong provinces of China. The first Singaporean record was seen in 2018 (Soh et al., 2019). Whether it is spreading its range over the past years remains in question, although sighting in Hong Kong is getting more common.

Orthetrum albistylum (Selys, 1848)

A species widely spread across the Palearctic region from Europe to Japan. It is also said to occur throughout China (Zhang, 2018). The first local record (a male) was found in Hong Kong Wetland Park on 26.IX.2018 reported by AFCD (2018b). On 16.IX.2020 a female was photographed by M Y Lai, also in Hong Kong Wetland Park (pers. comm.).

Rhyothemis fuliginosa Selys, 1883

On 11.X.2014, a species resembling *Rhyothemis triangularis* but with a bigger size was spotted by Bergman Ng at an abandoned fish pond in Luk Keng. It was later identified by Mahler Ka as *Rhyothemis fuliginosa*, with larger and darker metallic blue patches on the wings. This is the first reported sighting in Hong Kong. At least two males were observed on that day. One individual was observed each day on 12.X.2014, 14.X.2014 and 17.X.2014. It rested on the leaf tips of pond-side weeds, but was frequently disturbed by dominant species there such as *Anax guttatus*, *Pantala flavescens*, *Tramea virginia* etc. No more sighting of this species was recorded in Hong Kong after October 2014.

Upon checking the records, it was found that a male *R. fuliginosa* was photographed by Truman Kwok at the same pond on 1.X.2014. The colour pattern on the hindwings of this earlier individual is clearly different from the ones photographed on later days in the month. According to records in Japan, there can be significant variation in shape and shade among communities in different regions (Ozono et al., 2012; Futahashi, 2013).

R. fuliginosa inhabits vegetated freshwater ponds in East Asia, spanning between Korean Peninsula to the north and Guangdong, China to the south. Wilson (2009) cast doubt on the authenticity of reports on its occurrence in Hainan province. Records from Cambodia are believed to be *R. plutonia* (Kosterin, 2010; Kosterin et al., 2012). *R. fuliginosa* was first reported in Taiwan in 2006 (Yeh et al., 2007). As of today Hong Kong is near the southernmost part of its distribution range.

Sympetrum darwinianum (Selys, 1883)

The only reported sighting of this small reddish species in Hong Kong was at Wu Kau Tang on 14.XII.2014 by Bergman Ng and Cheung Che-Man with identification help from Mahler Ka. It rested on a concrete footpath for a few hours on a sunny day with temperature around 16°C. It has not been reported in Hong Kong afterwards.

Sympetrum spp. are mostly Holarctic species, living in the temperate areas of Eurasia and North America. *S. darwinianum* is found in Korea, Japan and most provinces of China other than the northwest regions (Zhang, 2018). Wilson (2013) mentioned that the species has not been recorded at locations below Latitude 23°N, but the current record rebuts this statement. The author has recorded this species in northern Guangdong. This individual may be vagrant and arrive at Hong Kong together with the winter monsoon.

Sympetrum fonscolombii (Selys, 1840)

The first record of this species in Hong Kong was from Moody Au who discovered a male at Pak Nai on 5.X.2017 (pers. comm.). A few days afterwards, a

female was found in southern part of Hong Kong by Denis Wong, Ernest Chiu, Yuet Yin Ling and Ken Cheng (AFCD, 2017). Two years later, Moody Au recorded a female in Tai Lam Country Park on 9.XI.2019 (pers. comm.). Not long later the author found a few males and females (about two to three for each gender) at Mount Davis on 10.XI.2019, upon earlier sightings by Tom Li. This later group of individuals lasted for a week more before disappearing from the site (Cheung Che-Man, pers. comm.).

S. fonscolombii has an extensive range of distribution in Asia, Europe and Africa (Clausnitzer, 2013). Its seasonal migratory behaviour have been widely reported (e.g. Campbell and Reimer, 2011; Borisov et al., 2020). The first sighting in Taiwan was recorded in 2006 (Tsou and Yeh, 2007) and the species has since been observed visiting the island in autumn every year (Tang et al., 2013). The Hong Kong sightings in the autumns of 2017 and 2019 and the occurrence pattern observed at Mount Davis may imply that the city is on its regular migration path, though persistent and more extensive monitoring is needed to confirm so.

DISCUSSION

Table 1 summarizes the 13 species new to Hong Kong described above. Only two of them are damselflies (Zygoptera), and one of these are just historical records from a museum collection. All others are dragonflies (Epiprocta: Anisoptera) that are usually considered as more capable of dispersal (Heiser and Schmitt, 2010).

Four out of these were discovered by AFCD, while the other nine are by other researchers and enthusiasts. In the previously reported new-to-Hong Kong records between 2002 (after AFCD Working Group was established) and 2011 as listed in Table 2, five were first recorded by AFCD and four were by researchers. Comparing these, it can be seen that citizen observations play an increasingly important role in contributing to the knowledge of the evolving Odonata fauna in Hong Kong. With the strength in numbers and diversity of sites visited, a publicly participated observation scheme would definitely complement the regular survey and monitoring schemes by the authority.

Fundamental knowledge of the Hong Kong Odonata fauna has been well established with the effort of previous researchers and field workers. New records in recent years may be attributed to the following reasons:

1. Resident species with a very cryptic life cycle: the seldomly seen but breeding *Anotogaster* cf. *klossi* may be an example.

2. Species that naturally expand their range to Hong Kong due to environmental factors like climate change: the originally more southerly distribution of *Indothemis carnatica* in Asia and its recent discovery in locations closer to Hong Kong may reflect a northerly spread colonization.

3. Species accidentally introduced into Hong Kong by human activities, e.g. shipment with aquarium plants: For occasionally recorded Zygoptera (*Sympecma paedisca*) this reason may be of higher possibility than others, as they are weaker fliers with lower dispersal range (Purse et al.,2003; Watts et al., 2006).

4. Seasonal migrants that have been previously overlooked or have recently chosen Hong Kong as a stopover location: The repeated visit of *Sympetrum fonscolombii* in a group in 2019 and its seasonal appearance in Taiwan may be a cue for its migrating through Hong Kong.

5. Vagrant: The single occurrence of *Sympetrum darwinianum* may belong to this category.

After all, these are only speculations that require verification. Without sufficiently long and widespread observations, it would be hard to determine whether these new species are regular migrants, occasional visitors or residents. Again, citizen participation through extensive survey and continuous monitoring would help close the knowledge gap more efficiently than solely relying on the hard work of professionals.

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TABLES & FIGURES

Species	Year of first record in HK	First record by
Gynacantha ryukyuensis	2004, reported in 2014	AFCD
Stylurus annulatus	2008	Samson So
Sympecma paedisca	2009	Sum Lam-Po
Anax indicus	2010, reported in 2012	Eddie Yam
Matrona basilaris	Historical, reported in 2014	Malte Seehausen from museum collection
Rhyothemis fuliginosa	2014	Bergman Ng; an earlier record retrospectively checked by Truman Kwok
Sympetrum darwinianum	2014	Bergman Ng, Cheung Che-Man
Anotogaster cf. klossi	2015	AFCD
Polycanthagyna ornithocephala	2017	Sum Lam-Po
Indothemis carnatica	2017	First reported by AFCD in 2018; an earlier record retrospectively checked by Cheung Che-Man
Sympetrum fonscolombii	2017	Moody Au
Stylurus clathratus	2018	Ernest Chiu
Orthetrum albistylum	2018	AFCD

Table 1. Summary of new Odonata records in Hong Kong since 2011 in chronological order of discovery discussed in this article.

Species	Year of first record in HK	First record by
Pseudagrion pruinosum frasei	2003	AFCD
Anax nigrofasciatus	2003	AFCD
Cephalaeschna klotsae	2003	AFCD
Trithemis pallidinervis	2003	Graham Reels
Fukienogomphus choifongae	2004	AFCD
Planaeschna skiaperipola	2005	Keith Wilson
Sieboldius deflexus *	2007	Samson So, Dickson Wong
Aethriamanta brevipennis	2008	AFCD
Heliogomphus retroflexus	2009	Mahler Ka

Table 2. Summary of new Odonata records in Hong Kong between 2002 and 2011 in chronological order of discovery, based on information in Tam et al. (2008) and Ka (2020). [* = exuviae only]

Figure 1. Comparison of the dorsal markings of three *Gynacantha* species recorded in Hong Kong: (a) *G. japonica*; (b) *G. ryukyuensis*; (c) *G. subinterrupta*. All three insects shown here are male. Photos by: (a), (c), Eric Tse; (b), Cheung Che-Man.

Figure 2. A male *Anotogaster* sp. recorded at Sha Lo Tung in 2020. Photo by Cheung Che-Man.

Figure 3. An *Anotogaster* sp. larva found at a stream in Hong Kong. Photo by author.

Figure 4. *Indothemis carnatica* has been observed in many localities in Hong Kong. Shown here a male recorded at Tsiu Hang, Sai Kung. Photo by author.

Figure 5. A female *Orthetrum albistylum* recorded at the Hong Kong Wetland Park in 2020. Photo by M Y Lai.

Figure 6. Different male *Rhyothemis fuliginosa* individuals recorded at Luk Keng. Note the difference in the colour pattern on their hind wings. (a) observed on 1.X.2014, photo by Truman Kwok); (b) observed on 11.X.2014, photo by author.

Figure 7. *Sympetrum darwinianum* recorded at Wu Kau Tang. Photo by Bergman Ng.

Figure 8. A male *Sympetrum fonscolombii* found at Pak Nai. Photo by Moody Au.

Methodologies for monitoring fireflies in Hong Kong

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ABSTRACT

In total 241 field visits to 47 different sites in Hong Kong were conducted specifically for firefly survey, from 2009 to 2020. Various methods were used to record fireflies qualitatively and quantitatively. Local restrictedness of 29 species of Hong Kong fireflies are listed. Methods for accessing the population of different firefly species are discussed and recommended according to their distribution characteristic, flash and flight, and habitat. Using photography and videography to assist counting fireflies is introduced. Current limitations and further actions are proposed.

Key words: Fireflies, Lampyridae, Rhagophthalmidae, Hong Kong, local restrictedness, accessing population

INTRODUCTION

Fireflies are one of the most flashy and spectacular animal groups. IUCN SSC Firefly Specialist Group are working on assessing extinction risk of the 2000 and more firefly species of the world (Lewis and Wong, 2018). Fireflies are also proposed as potential flagship species and bio indicators for photo pollution (Hagen et al., 2015).

There are 29 species of fireflies (Lampyridae & Rhagophthalmidae) known in Hong Kong (Yiu, 2017), 26% of which are regarded as locally restricted or highly restricted (Yiu, 2013). 10 species are endemic to Hong Kong (Yiu, 2017). Hong Kong is densely populated with 7.5 millions of citizens (Census and Statistics Department, 2020) living in 1107 km² of land, of which 25% is developed and 40% is Country Parks and Nature Reserves (HKSAR Government, 2020). Demands on land development for housing have been major public concern for years (Task Force on Land Supply, 2018). Without a standardized and systematic methods for assessing Hong Kong fireflies, it would be hard to know the actual change of firefly populations over time.

MATERIALS & METHODS

Starting from 2009, intensive and extensive surveys specifically for fireflies have been conducted. More specifically, 241 field visits were conducted specifically for firefly survey, of which 220 visits were done at night and 21 were done in the day time. In total 47 different sites were visited in the 11 years of study, of which 4 sites have been visited yearly since 2009. Location of the sites and visiting frequency are shown in figure 4. In addition to site visits, various methods were used to record fireflies qualitatively and quantitatively, including:

a. Malaise traps. Ten traps were set for a general insects study in 2014 and small quantity of fireflies were collected;

b. Quadrat count and point count. Used in high visibility areas with concentration of flying fireflies displaying light at night. Area of the quadrats was measured by visual estimation, measuring tape or a Leica DISTO DXT Laser Distance meter. The observer stand along the margins of the quadrat to counts the number of fireflies displaying light ; or stand at the centre of the quadrat and count the number of fireflies displaying light in a 360 degree perspective – point count.

c. Transect count. This was usually done by walking slowly along a road, a trail or a path; fireflies occurring on both sides of the path were counted. Flying fireflies displaying light could be clearly visible from a distance up to 25m, depending on size of light spots, brightness of the light spots and the brightness of the ambient light. Stationary fireflies on low vegetation or on the ground could be visible up to 5m, depending on size of light spots, brightness of the light spots and the brightness of the ambient light.

d. Visiting permanent “bright light traps”. Wherever available, public toilets emitting light at night in remote area would be visited to check the fireflies trapped inside.

Identification and records of fireflies were done by direct observation, photography and videography. Olympus E3, E620 digital camera with a Olympus ZUIKO DIGITAL ED 50mm F2.0 Macro lens; a canon 550D are 5D Mark III camera with either a Canon EF-S 60mm f/2.8 Macro lens, a SIGMA MACRO 70mm F2.8 DG HSM lens or a EF 100mm f/2.8 Macro lens were used for photography. Videography was done by a Canon 5D Mark III camera with a Canon EF 17-40mm f/4.0L USM zoom lens or EF 100mm f/2.8 Macro lens; and a Sony A7S camera with a Mitakon Speedmaster 50mm f/0.95 lens. Sensitivity rating (ISO speed) of the cameras for videography of firefly flashes was set between ISO 12800 to ISO 102400.

Photo records on iNaturalist until Sept 30, 2020 were also considered. 453 observations with 17 species were checked.

For Local restrictedness assessment, the method proposed by Fellowes et al. (2002) defined local restrictedness as a measure of dependence of wild animals on particular locality, versus other localities of comparable size in Hong Kong. A locality is taken to measure 1 km². A highly restricted species is most vulnerable to local extinction through habitat loss or damage, and its very restrictedness is a reflection of high habitat specificity. Local restrictedness was simplified and assigned according to the following coding:

A = known to occur in this locality alone
B = know to occur in two localities
C = known to occur in three to four localities
D = known to occur in five to eight localities
E = known to occur in nine to 16 localities
F = known to occur in 17-32 localities.

Their proposition is that the threshold for local restrictedness is about 4% of area surveyed. Thus if about 100 km² have been surveyed for a given group, a species will only be considered highly restricted if the area of occupancy is 4 km² or less. B is used as the restrictedness threshold for all insect groups. To be consistent, the same is adopted here.

RESULTS

Local Restrictedness of Hong Kong Fireflies

Yiu (2013) listed the Local Restrictedness of 27 species of firefly, based on 152 field visits from 2009 to 2013. With 89 additional field visits and verified records on iNaturalist, the updated Local Restrictedness of 29 species of Hong Kong Fireflies is listed in Table 1.

Distribution characteristics (Table 2)

Populations of 17 species are usually confined or restricted to particular area(s), more or less a margin can be drawn to encompass the fireflies. Distribution of 9 species, on the contrary, are more diffused, this may be attributable to their comparatively higher mobility or of being less dependent to a particular habitat.

Flash & Flight (Table 2)

Yiu (2013) catergorized Hong Kong fireflies into 4 groups according to their flash patterns and sexual communication. For the purpose of applying suitable sampling methods, the same categorization can be used with slight modifications, in terms of visibility and detection of the different firefly species by human observers:

Mode 1: Diurnal fireflies fly during daylight (there may be weak luminescent signal). Male flies, female may or may not fly. Frequency of encountering theses fireflies in the daytime is comparatively low. *Cyphonocerus longicornus*, *Drilaster* sp., *Pyrocoelia sanguiniventer*, *Vesta sinuata* belong to this category.

Mode 2: Nocturnal fireflies with **flightless females emitting continuous glow** in unsheltered condition, could be directly visible in the dark from a distance of few meters. **Flying male is either non-luminous or produces only very weak light**, almost invisible in the field at night. *Rhagophthalmus hiemalis*, *R. motschulskyi*, *Diplocladon atripennis*, *Oculogryphus chenghoiyanae*, *Stenocladius bicoloripes*, *Lamprigera taimoshana* belongs to this group. *Stenocladius* sp. is presumed to be this category but female of which is not known yet. Male of *L. taimoshana* is more readily seen in the field because of its very large size and strong tendency of staying on open ground surface.

Mode 3: Nocturnal fireflies with **flightless females emitting continuous glow** in unsheltered condition, could be directly visible in the dark from a distance of few meters. However, frequency of encountering female of theses fireflies is extremely low. **Flying male produces prominent continuous glow**, clearly visible in the dark from a distance of up to 25 meters. Density of flying male displaying glow is high to moderately high. *Diaphanes citrinus*, *D. lampyroides*, *Pyrocoelia analis*, *P. lunata* belong to this category.

Mode 4: Nocturnal fireflies with **male displays distinctive flash patterns**, female also produces flashing light. Female flies, except *Luciola* nr. *nicollieri*. Male is often more numerous and active than the female of the same species. Density of flying male displaying light could be very high, up to hundreds per hectare. All members of Luciolinae belong to this category.

Habitat (Table 2)

Habitat for members of the Luciolinae is generally homogeneous (Fig. 1). *Abscondita terminalis* and *Curtos fulvocapitalis* are found in lowland grasslands and grassy abandoned farmlands; *Pygoluciola qingyu* is found along hill streams and *Pteroptyx maipo* is found along riversides in mangroves; *Aquatica* spp. are found in stagnant or slow running, shallow freshwater wetlands; other species in mature woodlands. Habitat for members of Rhagophthalmidae, Cyphonocerinae, Lampyrinae are generally heterogenous, usually involve closely connected woodlands, scrublands and grasslands (Fig. 2). Exceptions are *Diplocladon atripennis*, *Stenocladius bicoloripes* and *Vesta sinuata*. They are found in woodlands only.

DISCUSSION

Local Restrictedness of the fireflies

There are 5 species - 17% of all known species, are known to occur in only one locality; One species is known to occur in two localities; and 5 species are known to occur in three to four localities. Amongst the 10 endemic species, *Cyphonocerus longicornus* and *Luciola tuberculata* are only know in one locality; *Oculogryphus chenghoiyanae* is only know in 2 localities; *Rhagophthalmus hiemalis*, *Diplocladon atripennis* and

Medeopteryx hongkongensis are known to occur in 3 to 4 localities. These should draw our attention to the sustainability of these firefly species and the possibility of losing one or more species forever.

Concerning coverage, locations of the surveys are more inclined to Central New Territories, North East New Territories, and places around Ma On Shan. East, West and North New Territories were less visited. Except the 2 largest islands - Lantau Island and Hong Kong Island, all other Islands are not studied yet. Moreover, there could be more sites on Lantau Island and Hong Kong Island to be explored.

The survey sites are also heavily inclined to more natural environment with less human disturbance. However, some species are actually more frequently seen in human disturbed areas. For example, *Abscondita terminalis* and *Curtos fulvocapitalis* are often seen occurring in mass number in abandoned farmland or near villages, but seldom seen in any Nature Reserve or Country Park. Majority of the records of *Rhagophthalmus motschulskyi* are obtained in villages or farmlands, instead of less disturbed natural habitats. It was also very recently recorded in urban area. *Pyrocoelia analis* was also occasionally recorded in urban area. More surveys could be done in urban and sub-urban areas, as well as in villages in the New Territories.

Concerning frequency and season of visits. Total of 241 visits to 47 sites were conducted in the past 11 years. In average, 22 visits per year, only 1.8 per month. In average, each site was visited 5.1 times. Only 5 sites (10.6%) were visited in all months of the year; 16 sites (34.0%) were visited in both wet season and dry season; 20 sites (42.5%) were visited in wet season only; 7 sites (14.9%) were visited in dry season only. Apart from finding more new sites, visiting the existing sites more frequency could also provide more comprehensive data.

Daytime visits are also very limited and the number of records of diurnal fireflies is particularly scarce.

Much more work is needed. Hong Kong Firefly Survey Team was established in July, 2020. After training, the team would conduct about 150 firefly surveys in one year.

Methods for assessing the populations of fireflies with observable light emitting in the dark

There is no other living organisms emitting light at night like fireflies. In Hong Kong, only in rare cases, two or more species could be found displaying light in the same location at the same time. Even if this happens, different species can be easily distinguished by their different flash patterns. Therefore counting the number of light spots would tell the population of a particular firefly species quantitatively. Less mobile species can be counted by simple counting - Lewis and Wang, 1991; Yuma, 2007; De Cock and Guzmán-Álvarez, 2013; Firebaugh and Haynes, 2016; Atkins et al., 2017. For surveying and counting the high density of individuals giving the synchronous light display such as the congregating *Pteroptyx* spp. found on the mangrove trees in Malaysia and Thailand, Jusoh and Ibrahim (2011) proposed to compare the appearance of light spots of the fireflies with a series of percentage charts, ranging from 1% to 50%. Kirton et al. (2012) and Khoo et al. (2012) used digital night photography and image analysis to obtain an index of abundance.

There is no high density congregating firefly species in Hong Kong. Light emitting wingless female (Flash & Flight Mode 2) can be counted directly to get population data. Yet surveying female density of glow-worm firefly type of species by counting number of individuals is tricky. In European species of glow-worm fireflies like *Lampyris noctiluca* and *Lamprohiza splendidula* and also in the North American *Phausis reticulata* density of females is directly related to male densities, and at high male densities females are almost directly found by males and stop glowing immediately at mating; This could give observer the wrong impression that female densities are low or that the species is event absent at localities whereas in reality it might be a very good and dense population (Raphael De Cock, pers. comm.). For Flash & Flight Mode 3, light emitting females are often too scarce to be found. Flying males of such species occur sparse to moderately high densities. As the slowly flying males display with a continuous glow, it could be easy to separate different individuals in flight. The flying males of *Diaphanes citrinus* and *D. lampyroides* are only active for about 45 minutes each night during their flight period. It is important to count at the right time - the peak within the 45 minutes of active period.

For medium density of light displaying flying males, the recording by video for later playback and assessment enables future counting is also possible by using a camera and lens specialized for low night videography. Sensitivity rating (ISO speed) of the cameras should be set between ISO 12800 to ISO 102400, and aperature f/4 or larger.

For Flash & Flight Mode 4. If the density of flying males displaying flashes is low, direct count can be used. If the density is medium, for species displaying simple pulsations, including *Aquatica ficta*, *A. leii*, *Luciola kagiana*, *L.* nr. *laticollis*, *L.* nr. *nicollieri*, *L. tuberculata*, *Medeopteryx hongkongensis* and Species inquirenda 1, the path of movement of different individuals can be traced just like those showing continuous glow (Mode 3). However, for species showing flash train, including *Abscondita terminalis*, *Curtos fulvocapitalis*, *L. curtithorax*, and *Pteroptyx maipo*, distinguishing different individuals of this type could be more challenging since inter-flash intervals lasts for up to 4s. That is to say, the light signal disappears for 4s in the dark. To distinguish between different individuals of this type, one also needs to know how to distinguish the flash pattern of the species, together with sufficient training and practice. Taking high quality video records for future counting on playing back the video is also a good option. Another

alternative is taking long exposure photos. Divide the exposure time by duration of one flash cycle, times the number of flash train units recorded in the photo, can be regarded as the actual number of flying individuals in the study area during the period of recording (Fig. 3): N = Duration of 1 flash cycle/ photo exposure time x flash units detected on photo.

Pygoluciola qingyu is perhaps the easiest species to count since the flashing males tends to keep stationary during the whole night.

For any particular species, the population numbers will vary across the flight period. It is important to record repeatedly in different dates in order to find the peak population and the population density change during the flight period. The majority of the fireflies are only active for a short period of time, usually less than one hour at night, and the (visible) population also varies during the short period of time. It is also important to record at the right time or the recording duration should cover the peak time of light display.

Methods for assessing the populations of fireflies with inconspicuous or no light emitting in the dark

For male of Flash & Flight Mode 2. Chen and Cheng (2009) founded that flight interception trap is a very effective method to collect fireflies, better than using Malasie trap. Ho et al. (2012) used Malaise traps and sex-attraction by collected female to collect male *Rhagophthalmus* spp.. De Cock and Guzmán-Álvarez (2013) used lures and traps to attract nocturnal flying male glow-worm fireflies. The lures include LED lures, Phosphorescent light Lures, breaklight lures and betalight lures. This methodology is also used in behavioral and ecological studies on *Lampyris noctiluca* in Finland by Hopkins et. al. (2015). *Diplocladon atripennis*, *Stenocladius bicoloripes*, *Stenocladius* sp., *Pyrocoelia analis* are occasionally found in public toilets in remote areas, presumably be attracted by the bright light in the toilets. Using bright light trap is possible a method for finding these species, but this is not tested yet. Males of “glow-worm-type” firefly species react very differently to light lures depending on spectral and intensity characteristics, where some are only attracted to weak glowing lures of specific wavelength composition (color of light) while others are not so “choosy” - so the best option is to use several types of glow and light lure traps (Raphael De Cock, pers. comm.).

Compared with other methods, flight interception traps and Malaise traps are most destructive because all the collected fireflies would be inevitably killed, and occasionally very large number of individuals from a single species could be caught at the same time in a single trap. Additionally all other caught insects would be killed. If the population dynamics and local survival of a particular firefly species is not clearly understood, repeated and continuous use of a destructive method should be avoided.

Bright light traps, although not necessarily lethal to the collected insects, may also cause certain disturbance to the fireflies as well as the whole nocturnal insect community. Repeated or continuous use should be avoided.

Light lure traps or glow lure traps induce less disturbance to the firefly community on the condition that the caught fireflies are released immediately after examination.

It is not clear whether sweep netting is useful because the non-luminous males may be actively flying and searching for luminous females instead of staying on the vegetation. “Blind” sweeping in the air at different heights from vegetation or ground is a possible easy and cheap method to be tested.

For male of Flash & Flight Mode 1 - diurnal fireflies fly during daylight. Frequency of encountering theses fireflies in the daytime is comparatively low. The most frequently encountered *Vesta sinuata*, only has a few records per year; other species have one record for few years. Effectiveness of sweep netting is not tested. An alternative is to recruit more volunteers to greatly increase the number of field visits. This type of survey method also depends on training, expertise and development of a “search image” for these often less conspicuous diurnal fireflies by observers.

Transect or Quadrat?

Accessibility to the habitat, visibility of the habitat, as well as distribution pattern of the firefly species should be considered. For luminous species densely confined to homogeneous habitat with high visibility (e.g. grasslands and farmlands), no matter the accessibility, quadrat method is recommended, as their population can be assessed by direct counting of the light spots in the area. The assessor may stand in the middle of the quadrat (point count) or at the sides of the quadrat. To ensure clear visibility to the flash pattern, longest distance between the assessor and the firefly should not exceed 25m. A laser distance meter is a quick and accurate equipment to check distances in the dark.

For diffused and/or sparsely spaced, luminous species in homogeneous habitat, transect method (Fig. 4) is recommended to extend the sampling area. For luminous species in heterogenous habitat with low accessibility and low visibility, transect (walk along paths) method is also recommended.

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TABLES & FIGURES

Family, Sub-family	Species	Local Restrictedness #
Rhagophthalmidae	*Rhagophthalmus hiemalis* *	C
Rhagophthalmidae	*Rhagophthalmus motschulskyi* *	E
Rhagophthalmidae	*Diplocladon atripennis* *	C
Lampyridae, Cyphonocerinae	*Cyphonocerus longicornus* *	A
Lampyridae, Cyphonocerinae	*Drilaster sp.*	A
Lampyridae, Cyphonocerinae	*Oculogryphus chenghoiyanae* *	B
Lampyridae, Cyphonocerinae	*Stenocladius bicoloripes*	E
Lampyridae, Cyphonocerinae	*Stenocladius sp.*	D
Lampyridae, Lampyrinae	*Diaphanes citrinus*	E
Lampyridae, Lampyrinae	*Diaphanes lampyroides*	D
Lampyridae, Lampyrinae	*Pyrocoelia analis*	F
Lampyridae, Lampyrinae	*Pyrocoelia lunata* *	E
Lampyridae, Lampyrinae	*Pyrocoelia sanguiniventer*	D
Lampyridae, Lampyrinae	*Vesta sinuata* *	E
Lampyridae, Lampyrinae	*Lamprigera taimoshana* *	D
Lampyridae, Luciolinae	*Abscondita terminalis*	D
Lampyridae, Luciolinae	*Aquatica ficta*	No info.
Lampyridae, Luciolinae	*Aquatica leii*	D
Lampyridae, Luciolinae	*Asymmetricata circumdata*	A
Lampyridae, Luciolinae	*Curtos fulvocapitalis*	C
Lampyridae, Luciolinae	*Luciola curtithorax*	D
Lampyridae, Luciolinae	*Luciola kagiana*	A
Lampyridae, Luciolinae	*Luciola nr. laticollis*	C
Lampyridae, Luciolinae	*Luciola nr. nicollieri*	D
Lampyridae, Luciolinae	*Luciola tuberculata* *	A
Lampyridae, Luciolinae	*Medeopteryx hongkongensis* *	C
Lampyridae, Luciolinae	*Pteroptyx maipo*	C
Lampyridae, Luciolinae	*Pygoluciola qingyu*	F
Lampyridae, Luciolinae	Species inquirenda 1	D

Table 1. Local Restrictedness of Hong Kong Fireflies. [* = Endemic to Hong Kong; # = Local restrictedness: A = known to occur in this locality alone; B = know to occur in two localities; C = known to occur in three to four localities D = known to occur in five to eight localities; E = known to occur in nine to 16 localities; F = known to occur in 17-32 localities]

Species	Distribution	Flash & Flight #	Habitat	Recommended method(s)
*Rhagophthalmus hiemalis**	Confined, sparse	Mode 2	Heterogeneous; females often seen laying on the surface of sparsely vegetated slopes near woodland margins & road sides	Transect count, glow lures
Rhagophthalmus motschulskyi *	Confined, sparse	Mode 2	Heterogeneous; females often seen laying on the ground of open areas & sparsely vegetated road sides	Transect count, glow lures
Diplocladon atripennis *	Confined, sparse	Mode 2	Homogenous; well vegetated natural woodlands, male may be attracted to bight light	Transect count, glow lures
Cyphonocerus longicornus *	Confined, sparse	Mode 1	Heterogeneous; woodlands and scrubland around hill top	Transect count
Drilaster sp.	Confined, sparse	Mode 1	Heterogeneous; woodlands and scrubland around hill top	Transect count
Oculogryphus chenghoiyanae *	Confined, sparse	Mode 2	Heterogeneous; females often seen laying on the surface of sparsely vegetated slopes near woodland margins & road sides	Transect count, glow lures
Stenocladius bicoloripes	Diffused, sparse	Mode 2	Homogeneous; females often seen laying on the surface of sparsely vegetated slopes in woodlands	Transect count, glow lures
Stenocladius sp.	Diffused, sparse	Possibly mode 2	Heterogeneous; woodlands, and scrublands, occasionally found in public toilets, presumably attracted to bright light	Transect count, glow lures
Diaphanes citrinus	Diffused, moderately dense	Mode 3	Heterogenous, woodlands, scrublands and grasslands	Transect count
Diaphanes lampyroides	Confined, moderately dense	Mode 3	Heterogenous, woodlands, scrublands	Quadrat count, transect
Pyrocoelia analis	Diffused, sparse	Mode 3	Heterogenous, woodlands, farmlands, abandoned farmlands, mangrove, grasslands, occasionally found in public toilets, presumably attracted to bright light	Transect count
Pyrocoelia lunata *	Diffused, moderately dense	Mode 3	Heterogenous, woodlands, scrubland grasslands near hill top	Transect count
Pyrocoelia sanguiniventer	Diffused, sparse	Mode 1	Heterogenous, woodlands, scrublands	Transect count
Vesta sinuata *	Diffused, sparse	Mode 1	Homogenous, woodlands	Transect count
	Homogenous, woodlands	Transect count	Heterogenous, woodlands, scrubland and grassland near hill top	Transect count
Lamprigera taimoshana *	Confined, sparse	Mode 2	Heterogenous, woodlands, scrubland and grassland near hill top	Transect count
Abscondita terminalis	Confined, dense	Mode 4	Homogeneous. Lowland grasslands and abandoned farmlands	Quadrat count
Aquatica ficta	No local live record	Mode 4	Presumably similar to *Aquatica leii*	N.A.
Aquatica leii	Confined, sparse	Mode 4	Homogenous, stagnant or slow running, shallow freshwater wetlands	Quadrat count
Asymmetricata circumdata	No local live record	Mode 4	No information	N.A.
Curtos fulvocapitalis	Confined, dense	Mode 4	Homogenous, lowland grassland, abandoned farmland	Quadrat count
Luciola curtithorax	Diffused, dense	Mode 4	Homogeneous, mature woodland	Quadrat count

Luciola kagiana	Confined, moderately dense	Mode 4	Homogeneous, mature woodland	Quadrat count
Luciola nr. laticollis	Diffused, dense	Mode 4	Homogeneous, mature woodland	Quadrat count
Luciola nr. nicollieri	Diffused, dense	Mode 4	Homogeneous, mature woodland	Quadrat count
Luciola tuberculata *	Confined, moderately dense	Mode 4	Homogeneous, mature woodland	Quadrat count
Medeopteryx hongkongensis *	Confined, dense	Mode 4	Homogeneous, mature woodland	Quadrat count
Pteroptyx maipo	Confined, dense	Mode 4	Homogeneous, riversides in mangrove	Transect count, quadrat count
Species inquirenda 1	Confined, dense	Mode 4	Homogeneous, mature woodland	Quadrat count

Table 2. Distribution characteristic, flash & flight characteristic, habitat characteristic and recommended methods for assessing populations. [* = Endemic to Hong Kong; # = Modes of flash & flight: Mode 1, diurnal fireflies; Mode 2, flightless females emitting continuous glow, flying male is either non-luminous or produces only very weak light; Mode 3, flightless females emitting continuous glow, flying male produces prominent continuous glow; Mode 4, male displays distinctive flash patterns]

Figure 1. Homogenous habitat – grassy abandoned farmland. Photo by author.

Figure 2. Heterogenous habitat involving closely connected woodlands, scrublands and grasslands. Photo by author.

Figure 3. This photo is formed by overlapping a series of 10 photos taken at the same place, total exposure time is 50s. 365 flash units are found on the photo, each contains 2 closely connected light spots. Average duration of each flash cycle of this Curtos fulvocapitalis in Hong Kong is 2520 ms. Number of flashing male fireflies occurring = 2520/50000 x 365 = 18.3. Photo by author.

Figure 4. A typical woodland trail for transect count of firefly population. Photo by author.

Figure 5. Location of visited sites in Hong Kong and frequency of visits for firefly survey from 2009 to 2020.