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# Revision of the family Metarbelidae (Lepidoptera) of the Oriental Region. I. Introduction and genera *Encaumaptera* Hampson 1893, *Orgyarbela* gen. nov., and *Hollowarbela* gen. nov.

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## Abstract

In the first part of the revision of the family Metarbelidae (Lepidoptera) of the south-eastern Asia, a complete literature review of the previously described taxa and biology of the Asian group members is given. The images of the adults and male genitalia of all known Metarbelidae genera of the Oriental region are illustrated. Two genera are described as new for the science: *Orgyarbela* Yakovlev & Zolotuhin, **gen. nov.** (type species *Arbela millemaculata* Hampson, 1897, by original designation here) and *Hollowarbela* Yakovlev & Zolotuhin, **gen. nov.** (type species *Indarbela kinabalua* Holloway, 1976, by original designation). The genus *Encaumaptera* Hampson, 1893 is revised. The following new species are described here: *Encaumaptera aurora* Yakovlev & Zolotuhin, **sp. nov.** (type locality: Thailand, Changwat Nan, 5 km N of Bo Luang), *E. devyatkini* Yakovlev & Zolotuhin, **sp. nov.** (type locality: C. Vietnam, Kon Tum Prov., Sa Thay Distr., Bargok, Chu Mot Ray NP), *Orgyarbela kerri* Yakovlev & Zolotuhin, **sp. nov.** (type locality: Laos, Nam Guak [Yuak river Valley, Wiengchau]), and *O. mackwoodi* Yakovlev & Zolotuhin, **sp. nov.** (type locality: Burma, Kawkerait [Kawkarike, Karen Prov., Myanmar]). The new combinations are established: *Orgyarbela millemaculata* (Hampson, 1897), **comb.nov.** and *Hollowarbela kinabalua* (Holloway, 1976), **comb. nov.**

**Key words:** biodiversity, Cossoidea, entomology, Asia, Africa, Palearctica, Metarbelidae, taxonomy, new genus, new species.

## Introduction

Metarbelidae Strand, 1909 (=Arbelidae Hampson, [1893], Holandiidae Karsch, 1896, Teragridae Hampson, 1920, Squamuridae Roepke, 1957) is a relatively small family of Lepidoptera belonging to the superfamily Cossoidea (Hampson 1893, 1920; Karsch 1896; Roepke 1957; Regier *et al.* 2009; Mutanen *et al.* 2010; van Nieuwerkerken *et al.* 2011; Wahlberg *et al.* 2013; Heikkilä *et al.* 2015). As of 2019 (Lehmann 2019a), the family included 237 species of 27 genera (most of which, 218 species of 24 genera, are known from Africa). The family is widely spread in the tropics of the Old World: in Africa south of Sahara, on Madagascar, on Arabian Peninsula; in the Asian tropics they are known from India and southern China to

Sulawesi (Lehmann 2019a). Most species of Asian Metarbelidae are accumulated in Hindustan, Sri-Lanka, Indochina and the island of Borneo. Only one species is known south of Borneo (*Squamura celebensis* Roepke, 1957) – from the island of Sulawesi. Thus, according to the modern publications, the representatives of the family were not recorded eastwards the Wallace Line (Wallace 1860).

In the recent years, African Metarbelidae were actively revised by I. Lehmann, who published a series of significant works (several as a co-author) (Lehmann 1997–2014; Lehmann & Rajaei 2013; Lehmann *et al.* 2018). The Lehmann's research was resulted in his Doctorate dissertation (Lehmann 2019a), where he made a phylogenetic analysis and outlined several new genera. The author noted that according to his preliminary data no less than 570 Metarbelidae species should met in the Afrotropics (Lehmann 2019a: 14).

While the African Metarbelidae were actively revised, the level of our knowledge on Asian representatives of the family remains extremely low, with very poor bionomics data. We are going to fill this gap by a series of publications.

Firstly we briefly dwell on the previously described taxa as representatives of the oriental fauna. The first species of the family were described by the classics of British entomology from various regions of British India (India, Burma, Bangladesh), Ceylon and a number of other regions (here we give the original combinations of the primary descriptions): *Cossus 4-notatus* Walker, 1856 (type locality: Ceylon), *Cossus abruptus* Walker, 1865 (type locality: Hindostan) (Walker 1856, 1865), *Cossus tessellatus* Moore, 1879 (type locality: Calcutta), *Arbela tetraonis* Moore, 1879 (type locality: Bombay) (Moore 1879a, b); *Arbela ? dea* Swinhoe, 1890 (type locality: Rangoon [Myanmar]); *Arbela phaga* Swinhoe, 1894 (type locality: Cherra Punji); *Arbela disciplaga*

Swinhoe, 1901 (type locality: Sarawak, Borneo and Singapore) (Swinhoe 1890, 1894, 1901); *Brachylia stigmata* Hampson, 1892 (type locality: Nilgiri District), *Arbela millemaculata* Hampson, 1897 (type locality: Khásis), *Arbela watsoni* Hampson, 1900 (type locality: Madras), *Arbela minima* Hampson, 1910 (type locality: Ceylon, Galle), *Arbela theivora* Hampson, 1910 (type locality: Assam, Sylhet, Gazipur (Antram) [central Bangladesh]), *Arbela campbelli* Hampson, 1910 (type locality: Madras, Horsleyhonda) (Hampson 1892, 1897, 1900, 1910). Additionally, several new Metarbelidae were described from Indonesia, South-east China, Taiwan, Vietnam and the Philippines: *Squamura maculata* Heylaerts, 1890 (type locality: Sumatra, Fort de Kock) (Heylaerts 1890), *Squamicapilla arenata* W. Schultze, 1908 (type locality: Manila, P.[ilippines] I.[slands]) (Schultze 1908), *Arbela discipuncta* Wileman, 1915 (type locality: Kanshirei [Taiwan]) (Wileman 1915), *Arbela flavina* Mell, 1923 (type locality: W. Sumatra, Padang), *Arbela obliquifasciata grisescens* Mell, 1923 (type locality: North East Sumatra), *Arbela obliquifasciata* Mell, 1923 (type locality: Guandong, China), *Arbela acutistriata* Mell, 1923 (type locality: Java, Malang) (Mell 1923), *Arbela baibarana* Matsumura, 1927 (type locality: Formosa (Horisha) (Matsumura 1927), *Arbela magma* de Joannis, 1929 (type locality: Tonkin) (de Joannis 1929). Three new species were found in Indonesia (Sumatra, Java and Sulawesi) (Roepke 1957): *Squamura celebensis* Roepke, 1957 (type locality: Makassar “ex branch of Ceibapentandra”), *Squamura sumatrana* Roepke, 1957 (type locality: Bonan Dolok, Sibolga [Indonesia, Sumatra]), and *Squamura tenera* Roepke, 1957 (type locality: Telawa, Central Java). From Malaysia, Holloway (Holloway 1976; Holloway in Barlow 1982) described two new species: *Squamura roepkei* Holloway in Barlow, 1982 (type locality: Malaysia, Sumatra), *Indarbela kinabalu* Holloway, 1976 (type locality: Borneo, Kinabalu). Inoue (1988) proposed a new combination as *Squamura discipuncta* (Wileman). Lehmann (2019b) described new species within two new genera: *Lutzkobesia* Lehmann, 2019 (type species: *L. hollowayi* Lehmann, 2019 from Aek Tarum III [Asahan District, North Sumatra province, Indonesia]) and *Stueningeria* Lehmann, 2019 (type species: *S. nepalensis* Lehmann, 2019 from Nepal, Kathmandu Valley, Godavari [Lalitpur District, Bagmati Zone, Central Region]). Quite recently Kishida (2020) described *Squamura jucunda* Kishida, 2020 from Laos, basing only on the external characters (Xieng Khouang, Ban Phonsaranh).

It is worth noting that these were rather random descriptions of individual species, not related to the common goal of revising this group or its individual lineages. Moreover, the nomenclature work with the group was often hampered by the fact that certain species were described as Cossidae, their types were stored with Cossidae, often in non-examined materials, which took time and effort to find and understand the real status of a taxon.

In addition to the mentioned above taxa of the species group from South-east Asia, several genera have been described. Moore (1879) erected the genus *Arbela* Moore, 1879 for *Arbela tetraonis* Moore, 1879 (is a junior homonym of *Arbela* Stål, 1865 (Hemiptera) (Fletcher & Nye 1982). *Squamura* Heylaerts, 1890

was allocated for *Squamura maculata* Heylaerts, 1890. Hampson (1893) erected the genus *Encaumaptera* Hampson, 1893 for *Brachylia stigmata* Hampson, 1892 originally being established in the Hepialidae. Schultze (1908) established the genus *Squamicapilla* (type species: *S. arenata*). Fletcher (1922) suggested the epithet *Indarbela* as a replacement name for *Arbela* Moore, 1879.

Thus, at present 30 species united into six genera are known from the territory of the Oriental Region. The status of the group is still debatable – from an independent family to a separate subfamily within Cossidae. We will cover this issue in the final part of this revision.

### Brief morphological characteristics of the family

All species cossoid in appearance, wingspan from 18 to 40 mm. Most species have minor sexual dimorphism, although in some genera females much larger and more robust; contrary, in *Squamura* females often smaller than males, and in *Orgyarbela* they are differently colored and patterned. Sometimes sex identification is very difficult in intact specimens – both sexes have the same shape and length of antennae and similar long and rather slender abdomen with anal hair pencil.

Antennae in both sexes bipectinate with short rami, without basal widening; eyes large and occupy larger part of the head lateral side, without setae; galea absent.

Epiphysis roughly from middle of foretibia, presents in both sexes; spur formula is 0-2-2.

Wings slightly elongated, with concave outer margin and reticulate patterning on a pale background as in some tropical Cossidae but modified by a presence of distinct discal spot and often, distinct postmedial fascia and basal longitudinal stroke. In some species hair-like scale occupy define fields on the fore wing being probably androconias in males.

Retinaculum and frenulum usually absent (present in some *Salagena* and *Teragra* (Janse 1932)).

Venation: accessory cell absent; anterior branch of M in cell absent; Rs2 to Rs4 stalked; CuP in forewing obsolete. The family resembles the Ratardidae in having a single strong anal vein in the forewing. A1 completely absent (no trace) whereas A2 fused with A3 on the larger distance but with presence of a short but distinct basal fork.

Tergum of anal segment with modified scales with very long base in both sexes; these scales are situated in two dorso-lateral tufts those diagnostically protrude in a resting moth.

The male genitalia symmetric, with broad, flattened beak-like uncus, tip sometimes bifid (*Squamura*) or wide and bilobed (*Marshalliana*), and separate or fused rather drumstick-like appendages from it, possibly gnathi, basally fused with robust subanal plate embracing anal cone as gutter. Socii very small or absent; bulla present or absent; valvae small, rather rounded, with some modification to sacculus and often with fields of strong grouped setae (maybe also with pheromone activity) and different degree of basal-costal field sclerotization. Aedeagus usually short, slender, tube-like, often apically narrowed, with basal widening; vesica membranous, sometimes with short numerous cornuti. Pregenital segments not modified.

The female genitalia with short, telescopic ovipositor lobes and expanded membrane between T7 and T8. By the shape of 8, they resemble Ratardidae, the following several features may indicate close relationship: the deep, narrow ovipositor lobes that have dorsal rounded expansions; the reduced ductus and corpus bursae; the expanded membrane between tergite 7 and the genitalia.

Thus, there is a base for uniting the two families, with Ratardidae having priority, but examination of the Ratardidae male genitalia (at present known only for *Shiza excellens* Strand, 1917 (Owada 1993) and *Sumatratardea diehli* Kobes & Ronkay, 1990 (Kobes & Ronkay 1990)) is needed to confirm this (Holloway 1986). The 8-shaped ovipositor lobes are apomorphic. The male genitalia of both Ratardidae species have the such synapomorphy with Metarbelidae as harpes of various shapes forming by the modified abdominal edge of the valve. However, in our opinion, the most significant distinctive characteristic between Ratardidae and Metarbelidae is expressed sex dimorphism and complete reduction of a gnathos in Ratardidae. Unfortunately, it is impossible to conduct a more detailed analysis because males are known only for two Ratardidae species so far (from ten known in three genera) (Yakovlev 2018).

Margins of ostium often with reticulated lobes, antrum cup-like, ductus poorly sclerotized, bursa elongated.

## Biology

The bionomics of Asian Metarbelidae is poorly studied. Roepke (1916) was the first to describe the larva and pupa of Metarbelidae from Java. He indicated several species of trees damaged by *Squamura maculata* Heylaerts: *Deguila*, *Delonix* and *Albizzia* (Fabaceae), *Theobroma* (Sterculiaceae), *Citrus* (Rutaceae), *Mangifera* (Anacardiaceae), *Nephelium* (Sapindaceae) and by the representatives of the family Guttiferae. Gardner (1945) described the larva of *Indarbela quadrinotata* (Walker, 1856) from Sri Lanka. Kalshoven (1965) indicated several south-eastern Asian Metarbelidae species and their biological peculiarities. Among them *Squamura maculata* is very common on lowlands and plains of Java. Its larvae make thin and long tunnels on the trunks of feed plants. In the evening, the caterpillar leaves this tunnel and builds its continuation on the tree bark nearby, gnawing only the epidermis and superficial tissues, not going deeper than 3-4 mm and not using lignified parts for nutrition, thus not damaging the tree greatly. Copulation of butterflies is noted between 9 and 10 pm; the general development of the pre-imaginal stages takes about a year; the larvae growing is possible only on live young shoots and was successful on the species of the genus *Ceiba* (Malvaceae), though in the wild the caterpillars are also found on *Erythrina*, *Cassia siamea*, *Pithecolobium lobatum* (Fabaceae). However, it is assumed that all smooth-barked plants are potential forage. At the same time, solitary trees are willingly populated, but not the trees under the canopy of a forest or in a group. In the mountains higher than 1000 m similar damage is caused by *S. flavina*. This species, previously defined (probably, mistakenly) as *S. magma*, is found on the bark of *Citrus* (Rutaceae) in Bogor. *S. acutistriata* causes hard damage of the bark and surface tissues of *Citrus* in the east of Java; contrary to other species, this one prefers to inhabit the crowns of trees; also found on *Albizzia lebbeck* (Fabaceae). The caterpillar penetrates into the bark deeper than the others, up to 5 mm, willingly eats dead wood, which often leads to drying out of the shoot tops; the infected shoots are repeatedly colonized and covered with deep superficial lesions. Caterpillars reach 32 mm and pupate in early September, producing butterflies in the first week of October, hatching between 5 and 7 pm. Females actively lure males, who arrive from 3 to 9 pm; the copulation is short-term. The female lays eggs the next day, in small clutches covered with mucus and single scales from the abdomen. The caterpillars hatch on the 10<sup>th</sup> day.

There are data about a damage of cacao by this species in central Java. The caterpillar of *S. tenera* is up to 20 mm in length, builds horizontal galleries about 1 m above the ground, on *Manihot* (Euphorbiaceae). The pupae stage lasts three weeks. *S. celebensis* found on the branches of *Ceiba pentandra* (Malvaceae). The old trees are more willingly damages, the older shoots are more often chosen for dwelling.

The caterpillar thought to be *Indarbela quadrinotata* from *Annona* from Sri Lanka is said to bore into the trunk, and it also eats the bark and makes channels in it.

Markku Pellinen (pers. comm.) noticed that caterpillar of any Thai *Squamura* could bore the shelter way quite deeply (several cm.s) in the sound wood of *Cleistocalyx* (*Syzygium*) *nervosum* (Myrtaceae), but always in the place where a branch had fallen. Caterpillars were found at a height of two to three meters, and they could bore holes in a sound tree, as well as in the place where a branch had been cut out, the depth is about two to three cm, the caterpillars were seriously not easy to be taken out. It looked like the caterpillars were not very close to the surface, at least more than a few cm. Just a knife was not enough to take them out. He thinks that caterpillars also eat the tree bark, probably in places where there is lichen or fungus part of lichen. Three tunnels were seen on one tree.

## Material and methods

The materials for the study were the adult Metarbelidae specimens deposited in various collections:

MWM – Museum of Thomas Witt (Munich, Germany) – nowadays a part of ZSM since 2020;

NHMUK – National Museum of Natural History (formerly: The Natural History Museum, London, U.K.);

RYB – collection of Roman Yakovlev (Barnaul, Russia);

ZSM – Zoologische Staatssammlung der Bayerischen Staaten (Munich, Germany).

Male and female genitalia were mounted in euparal on slides following Lafontain and Mikkola (1987) and examined with an Olympus SZX16 microscope. The images were taken with the digital camera CMOS 20.7 megapixels and processed using Corel Photo-Paint 2017 software.

## Taxonomical part

As said previously, there are only six Metarbelidae genera known from the Oriental region (here they are given alphabetically). For some of them (*Encaumaptera*, *Indarbela*, and *Squamicapilla*) the genital structures have never been studied and illustrated. Thus it is necessary to compensate at the beginning of our revision for the correct argumentation of our further taxonomic decisions.

### Genus *Encaumaptera* Hampson, 1893

Hampson, 1893, Fauna Brit. India, Moths 1: 314.

Type species (by monotypy): *Brachylia stigmata* Hampson, 1891.

### Genus *Indarbela* Fletcher, 1922

Fletcher, 1922, Entomologist, 55: 231

= *Arbela* Moore, 1879. Proc. zool. Soc. Lond. 1879: 411 (type species – *Arbela tetraonis* Moore, 1879) (Figs 1–2, 16) by subsequent designation by Moore, 1883, Lepid. Ceylon 2: 155. A junior homonym of *Arbela* Stål, 1865, Hemiptera Afr. 3: 42 – Insecta, Hemiptera. The objective replacement name is *Indarbela* Fletcher, 1922.

= *Lepidarbela* von Dalla Torre in Strand, 1923, Lepid. Cat. 28: 3. Unnecessary replacement name.

### Genus *Lutzkobesia* Lehmann, 2019

Lehmann, 2019b, Heterocera Sumatrana 13(2): 58, Figs 7–11.

Type species (by original designation): *Lutzkobesia hollowayi* Lehmann, 2019

### Genus *Squamicapilla* W. Schultze, 1908

Schultze, 1908, Philippine journ. science, A. Gen. Science 3 (1): 29.

Type species (by original designation): *Squamicapilla arenata* W. Schultze, 1908 (Figs 3, 18).

### Genus *Squamura* Heylaerts, 1890

Heylaerts, 1890, Ann. Soc. Entomol. Belg. 34: xxvi.

Type species (by monotypy): *Squamura maculata* Heylaerts, 1890 (Figs 4, 19).

### Genus *Stueningeria* Lehmann, 2019

Lehmann, 2019b, Heterocera Sumatrana 13(2): 52, Figs 1–6.

Type species (by original designation): *Stueningeria nepalensis* Lehmann, 2019.

In the first part of our revision of the Oriental Metarbelidae we are revising one of the known genera and describing two genera new to science.

### Genus *Encaumaptera* Hampson, 1893

Type genus (by original designation) *Brachylia stigmata* Hampson, 1891.

**Redescription.** Adults of medium size, similar to the representatives of the cossid genera *Roerichiora* Yakovlev & Witt, 2009 (type species *Zeuzera stigmatica* Moore, 1879). Antenna bipectinate along all length, antenna processes about two times longer than antenna rod diameter in its medium third. Fore wing with poorly expressed pattern, hind wing without pattern, noticeably shorter. Abdomen apically without modified scales collected in a brush.

Male genitalia. Uncus robust, tapered, apically rounded; tegumen large; gnathos arms thick, relatively long, large leaf-like processes at bases of gnathos arms (more dorsally) on tegumen; gnathos massive; valve narrow, slightly narrowing from base to apex, with small notch on border between medium and distal thirds of costal edge, with small triangle harpe; juxta small cup-like; saccus tiny; aedeagus robust, short, straight, with small paired linear-shaped cornuti along lateral surfaces of vesica.

Females unknown.

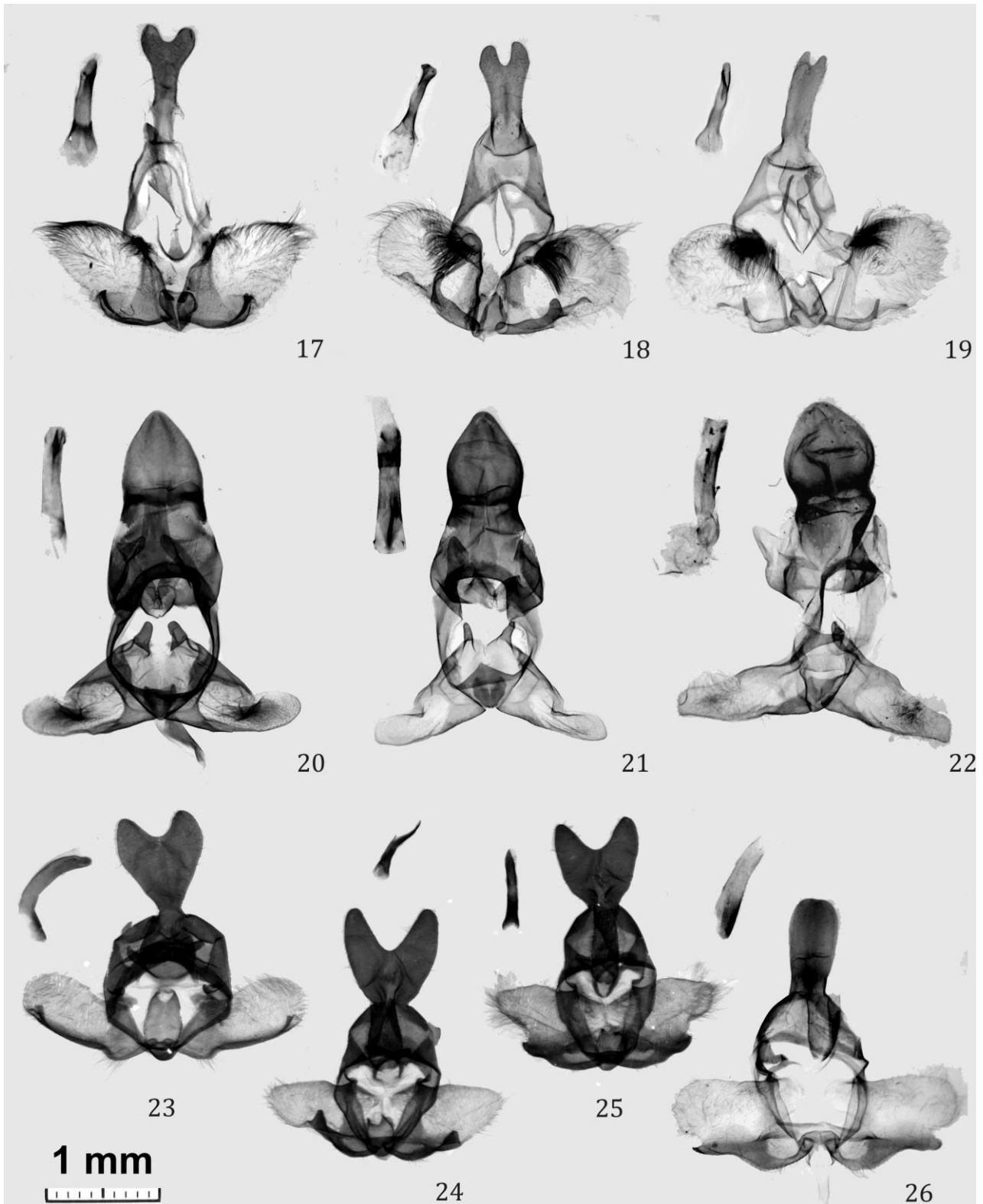
**Diagnosis.** The new genus is distinguished in the weak wing pattern, the absence of modified abdomen scales, large tapered uncus, big leaf-like processes at bases of gnathos arms, narrow valve with a small harpe, straight thick phallus with small paired linear-shaped cornuti along the lateral surface of the vesica.

**Composition.** The genus *Encaumaptera* includes three species so far: *E. stigmata* (Hampson, 1891), *E. aurora* **sp. nov.**, and *E. devyatkini* **sp. nov.**

**Distribution.** Indochina (Vietnam and Thailand), south-eastern or Southern India (Tamil Nadu), Sri Lanka (Fig. 27); its range strongly disjunct and incompletely known.



**Figures 1–16. Adult specimens of Oriental Metarbelidae:** 1. *Indarbela tetraonis* (Moore, 1879), male, S. India, Madurai, 18.vii.1985, leg. M. Eckrich (ZSM); 2. *Indarbela tetraonis* (Moore, 1879), female, S. India, Madurai, 2.vii.1985, leg. M. Eckrich (ZSM); 3. *Squamicapilla arenata* W. Schultze, 1908, male, the Philippines, E. Luzon, Aurora Prov., Sra Madre, 14 km S of Dilalongan, Dapalan river, 50 m, 16°02.709N / 121°42.667E, 11/12 Feb 2008, J.H. Lourens/K. Knoblich leg. (MWM); 4. *Squamura maculata* Heylaerts, 1890, male, Indonesia, East Java, Mt. Argopuro, 1200 m, 7–12.x.2004, leg. Jäkl (MWM); 5. *Encaumaptera stigmata* (Hampson, 1891), male, type (from Hampson 1891); 6. *E. stigmata*, male, Sri Lanka (Ceylon), Prov. Uva (Yala Nat. Park), Monaragalla/Gelge, 100 m, 29–30.v.1995, leg. Schnitzler (MWM); 7. *E. stigmata*, male, Sri Lanka (Ceylon), Prov. Uva (Yala Nat. Park), Monaragalla distr., Gelge, 100 m, 2–4.vi.1995, leg. Schnitzler (MWM); 8. *E. devyatkini* **sp. nov.**, male, holotype (MWM); 9. *E. aurora* **sp. nov.**, male, holotype (MWM); 10. *E. aurora* **sp. nov.**, male, paratype, Thailand, Isthmus of Kra, Ranong [9°57' N 98°38' E], TV-station, 500 ms, Mitte April 2002, leg. loc. coll., ex coll. S. Loeffler (RYB); 11. *Hollowarbela kinabalua* (Holloway, 1976), male, holotype (from Holloway 1980); 12. *H. kinabalua*, male, Malaysia, Sabah, Trus Madi, 1100 m, 4–24.iv.2002, Martini leg. (MWM); 13. *Orgyarbela millemaculata* (Hampson, 1897), male, syntype (NHMUK); 14. *O. millemaculata* (Hampson, 1897), female, Khasis, May 1894 (NHMUK); 15. *O. kerri* **sp. nov.**, male, holotype (NHMUK); 16. *O. mackwoodi* **sp. nov.**, male, holotype (NHMUK). Scale bar 1 cm.



**Figures 17–26. Male genitalia of Oriental Metarbelidae:** 17. *Indarbela tetraonis* (Moore, 1879), S. India, Madurai (slide ZSSM 2016/4 Coss); 18. *Squamicapilla arenata* W. Schultze, 1908, the Philippines, E. Luzon, Aurora Prov. (slide Genitalpräparat Heterocera MWM Nr. 27.981); 19. *Squamura maculata* Heylaerts, 1890, Indonesia, East Java (slide Genitalpräparat Heterocera MWM Nr. 27.983); 20. *Encaumaptera stigmata* (Hampson, 1891), Sri Lanka (Ceylon) (GenPr MWM: 26.649); 21. *E. devyatkini* **sp. nov.**, holotype (Genitalpräparat Heterocera MWM Nr. 27.986); 22. *E. aurora* **sp. nov.**, holotype (slide Genitalpräparat Heterocera MWM Nr. 26.648); 23. *Orgyarbela millemaculata* (Hampson, 1897), Khasis (slide NHMUK010315538); 24. *O. kerri* **sp. nov.**, holotype (slide NHMUK 010315534); 25. *O. mackwoodi* **sp. nov.**, holotype (slide NHMUK 010315536); 26. *Hollowarbela kinabalua* (Holloway, 1976), Malaysia, Sabah, Trus Madi (Genitalpräparat Heterocera MWM Nr. 28.047).

***Encaumaptera stigmata* (Hampson, 1891)**

Figs 5–7, 20

Originally described in the family Hepialidae.

*Brachylia stigmata* Hampson, 1891, Ill. Typ. Spec. Lepid. Heterocera coll. Brit. Mus., 8: 66, pl. 144 (CXLIV), fig. 1

Type locality: [Nilgiri district of Southern India, Tamil Nadu Province].

Type material: holotype (male) in NHMUK. Holotype was not found in the collection of NHMUK in spite of special search though the image was given at the description from the specimen kept here.

**Material examined:** 1 male, Sri Lanka, Uva Prov., Monoragalla Distr., Galge, 100 m, Yala Park, 29–31.i.–3–4.iv.1995, leg. H. Schnitzler (MWM, slide Genitalpräparat Heterocera Nr. 26.649); 2 males, same locality, 29–30.v.1995, leg. H. Schnitzler (MWM, slide Genitalpräparat Heterocera Nr. 28.030).

**Re-description.** Length of fore wing 13–14 mm. Fore wing light-brown, blurred wide brown spot in radial area postdiscally, bright dark-brown spot cubitally (in medium part of wing), fringe light-brown. Hind wing light-brown without pattern, fringe light-brown.

Male genitalia. Uncus very large, tapered, apically rounded, basally strongly sclerotized; tegumen massive, with wide leaf-like processes at bases of gnathos arms; gnathos arms thick, relatively long; gnathos large; valve narrow, slightly narrowing from base to apex, with small semicircular notch on border between medium and distal thirds of costal edge, small leaf-like processes at valve base (on costal edge), small triangle harpe on inner surface of valve at base of notch on costal edge, medium third of costal and abdominal edges strongly sclerotized, wide sclerotized bridge from costal to abdominal edge of valve; juxta small, cup-like; saccus tiny; phallus thick, short, straight, with long longitudinal linear sclerite on abdominal surface and small paired linear-shaped cornuti along lateral surfaces of vesica.

**Diagnosis.** The species is well differentiated externally: the fore wing has a more modified pattern in comparison to other species of the genus: a light-brown background with a blurred wide brown spot in radial area postdiscally and a bright dark-brown spot cubitally (in the medial part of the wing), the phallus has the same thickness throughout its length. The hind wing color matches that of the fore wing. The species is probably an endemic of southern India and Sri-Lanka.

**Distribution.** Southern India, Sri Lanka.

**Comments.** We does not exclude the possibility that southern India and Sri Lanka are inhabited by two closely related species similar externally. This phenomenon is widely known in different groups of Lepidoptera (Zolotuhin 2009; Yakovlev 2015), but not having at our disposal a type specimen or at least a topotypical specimen, and being guided only by its image, taking into account the very close zoogeographic connections between southern India and the island, at this stage we treat both populations as conspecific.

***Encaumaptera aurora* sp. nov.**

Figs 9–10, 22

**Material.** Holotype: male, Thailand, Changwat Nan, 5 km N of Bo Luang, 1000 m, 4.ii.2000, leg. Hreblay & Szabó (MWM, slide Genitalpräparat Heterocera Nr. 26.648). Paratypes: 1 male, Thailand, Changwat Nan, 25 km N of Bo Luang, 1150 m, 29.iii.1998, leg. Tibor Csövényi & Pál Stéger (MWM); 1 male, Thailand, Isthmus of Kra, Ranong [9°57' N 98°38' E], TV-station, 500 ms, Mitte April 2002, leg. loc. coll., ex coll. S. Loeffler (RYB, slide RYB 2017/6).

**Description.** Length of fore wing 12–14 mm (holotype – 13 mm). Thorax covered with dark-brown scales, abdomen – with light-pink scales. Antenna pale brown, bipectinate along all length, crest processes about twice longer than antenna rod diameter in its medium third. Fore wing light-brown with poorly expressed pattern of darker blurred spots and thin orange rim along outer edge, fringe brown. Hind wing pink, without pattern, fringe light-brown.

Male genitalia. Uncus very robust, tapered, apically rounded, basally strongly sclerotized; tegumen massive, with wide leaf-like processes at gnathos arms bases; gnathos arms thick, relatively long; gnathos massive; valve narrow, slightly narrowing from base to apex, with small semi-oval cut on border between medium and distal third of costal edge, valve basally (on costal edge) with small narrow leaf-like processes, small triangle harpe on inner surface of valve at base of cut on costal edge, medium third of costal and abdominal edges strongly sclerotized, narrow sclerotized bridge from costal to abdominal edge of valve; juxta small, cup-like; saccus tiny; phallus thick, short, straight, slightly widening apically, with long longitudinal linear **sclerite** on abdominal surface and small paired linear-shaped cornuti on lateral surfaces of vesica.

**Diagnosis.** The new species differs from the other species of the genus in the pink scales on the abdomen, the bright pink hind wing and the phallus slightly widening to the apex.

**Distribution.** Thailand (Nan and Ranong Provinces).

**Etimology.** Aurora – Goddess of Dawn because of hind wings colored as rising Sun.

***Encaumaptera devyatkini* sp. nov.**

Figs 8, 21

**Material.** Holotype: male, C. Vietnam, Kon Tum Prov., Sa Thay Distr., Bargok, Chu Mot Ray NP, 14°25'N / 107°43'E, 680 m, 20–23.iii.2012, leg. V. Zolotuhin (MWM, slide Genitalpräparat Heterocera Nr. 27.986).

**Description.** Length of fore wing 15 mm. Thorax and abdomen densely covered with dark-brown scales. Fore wing dark-brown, with poorly expressed pattern of lighter brown bands: postdiscally transverse, medially longitudinal, and rare black transverse strokes throughout all wing area. Hind wing dark-brown without pattern.

Male genitalia. Uncus relatively short, robust, apically rounded, basally strongly sclerotized; tegumen massive, with wide leaf-like processes at gnathos arms bases; gnathos arms thick, long; gnathos massive; valve narrow, slightly narrowing from base to apex, with very small cut on border between medial and distal third of costal edge, long leaf-like process at base of costal edge of valve, costal and abdominal edges strongly sclerotized, in medium third connected with narrow bridge, tip of abdominal edge slightly drawn, small triangle harpe on inner surface of valve closer to costal edge; juxta scaphoid; saccus semicircular, tiny; phallus thick, short, almost straight, with small paired cornuti on lateral surfaces of vesica.

**Diagnosis.** The new species differs externally from *E. aurora* sp. n. in the dark hind wings, from *E. stigmata* in the poorly modified pattern on the fore wing. From both species it clearly differs in the genital structure: the shorter uncus, the thin sclerotized bridge between the costal and abdominal margins of the valve, the poorly expressed cut on the costal edge of the valve.

**Habitat and details of biology** (Fig. 29). The species was collected in the rainy season in an undisturbed very dense tropical mountain forest, attracted to the light, near a sheer rock wall cut along a mountain road above a mountain stream. At rest, folds its wings and sits like a Cossid moth without lifting the abdomen up.

**Etymology.** The species is named after Alexey L. Devyatkin (1957–2012) (Fig. 31), who worked at the Department of Entomology, Faculty of Biology, the Moscow University. He was one of the largest specialists in Oriental Hesperidae, Lepidoptera of Vietnam, and also in metalmarks of the genera *Melitaea* and *Mellicta*. He is the author of more than 60 taxa of Rhopalocera from the Palaearctic and Oriental region, first of all of the fauna of Vietnam.

**Distribution.** Central Vietnam.

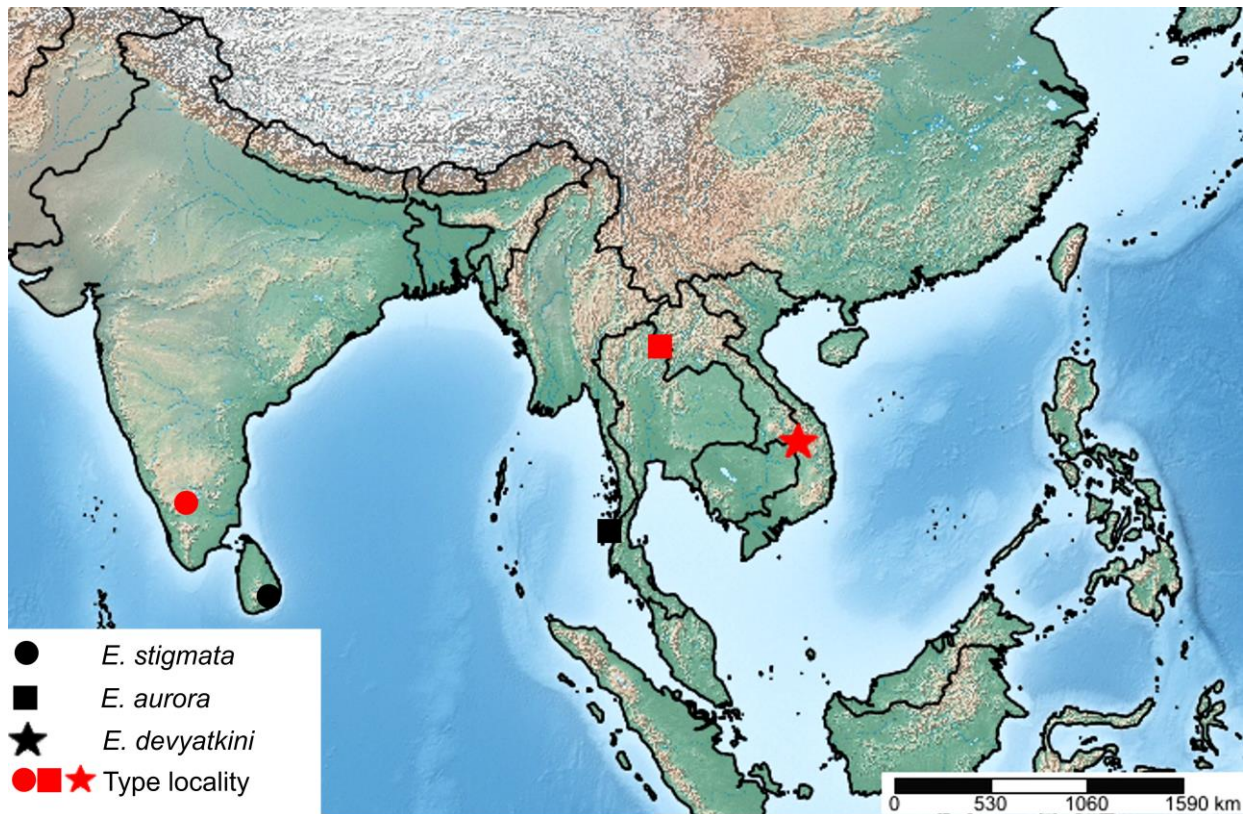


Figure 27. Distributional map of genus *Encaumaptera* Hampson, 1893.

### Genus *Orgyarbela* gen. nov.

Type species (**here designated**): *Arbela millemaculata* Hampson, 1897.

**Description.** Basing on the known material, the genus is strongly sexually dimorphic.

Male. Small species, male fore wing length 9–10 mm. Antenna bipectinate, crest processes three times longer than antenna rod diameter in its medium third. Fore wing narrow, often with fine spotty pattern, hind wing smaller, without pattern. Bunch of very long hairs on tip of abdomen.

Male genitalia. Uncus very robust, strongly expanded towards top, apically with deep semicircular bifurcation; tegumen robust; gnathos arms of medium length; gnathos small; valve short, abdominal edge hypertrophied, strongly sclerotized, small dentate harpe on abdominal edge; juxta cup-like; saccus tiny; phallus short, slightly sharpened apically.

Female (only the female of *O. millemaculata* is known). Slightly larger than male, colored brightly and lighter. Antenna bipectinate, crest processes approximately equal to antenna rod diameter in its medium third. Pattern of fore wing mottled. Hind wing with longitudinal dark band. Bunch of very long hairs on tip of abdomen. Genitalia not examined.

**Diagnosis.** The new genus differs from the known Metarbelidae genera in the gracility, dimorphism in color and size, relatively bright coloration of females, the presence of a bundle of very long scales at the apex of the abdomen in both sexes, a very powerful split uncus. The split uncus, the reduced hind wing size and the dimorphism may be considered the autapomorphies of the genus.

The bright color and the extreme rarity of both sexes in collections suggest their daily activity and this may be also a unique autapomorphic feature of this group / genus.

**Composition.** The new genus includes three species: *O. millemaculata* (Hampson, 1897) **comb. nov.**, *O. kerri* **sp. nov.** and *O. mackwoodi* **sp. nov.**

**Distribution.** Eastern India, Myanmar and Laos (Fig. 28).

***Orgyarbela millemaculata* (Hampson, 1897) comb.nov.**

Figs 13–14, 23

*Arbela millemaculata* Hampson, 1897: 286.

Type locality: Khásis [Khasi Hills, Meghalaya, Eastern India].

Type material: syntypes in BMNH.

**Material examined.** 1 male, 1 female, Khasis (NHMUK, individual number 012832507; slide NHMUK 010315538).

**Re-description.** Male. Length of fore wing 9–10 mm. Thorax and abdomen densely covered with brown scales, bunch of long dark-brown scales on tip of abdomen. Fore wing light-brown with very dense spotty pattern of dark-brown spots arranged in transverse rows, fringe mottled, dark at veins, light between veins. Hind wing brown, without pattern, fringe yellow unicolorous.

Male genitalia. Uncus very robust, strongly expended from base to apex, with small semicircular incision (for quarter of uncus length); tegumen robust; gnathos arms of medium length; gnathos small; valve short, poorly sclerotized, apex wide semicircular, costal edge smooth, abdominal edge strongly sclerotized, small cut in basal third of abdominal edge, small dentate harpe on abdominal edge (closer to apex); juxta cup-like; saccus tiny; phallus short, strongly bent along all length, apically slightly sharpened.

Female. Length of fore 13–14 mm. Thorax covered with dark-brown scales, abdomen – with bright orange scales, bunch of very long dark scales on tip of abdomen. Fore wing bright orange, with black large basal spot, wide band discally, more narrow band postdiscally, small black spots submarginally, marginally and between discal and postdiscal bands (in radial area)

Female genitalia not examined.

**Diagnosis.** The new species is externally closer to *O. kerri*, from which it differs in the smaller incision on the uncus, and in the harpe on the abdominal edge of the valve strongly moved to its apex.

***Orgyarbela kerri* sp. nov.**

Figs 15, 24

**Material.** Holotype: male, Laos, Nam Guak [Yuak river Valley, Wiengchau], 300 m, 25.iv.1932. French Ind. China, Dr. A. Kerr (NHMUK, individual number 012832503; slide NHMUK 010315534).

**Description.** Male. Length of fore wing 10 mm. Thorax and abdomen densely covered with brown scales, bunch of long dark-brown scales on tip of abdomen. Fore wing light-brown with dense spotty dark-brown pattern of strokes throughout all wing, fringe mottled: dark at veins, light between veins. Hind wing dark-brown with yellow costal edge and yellow fringe.

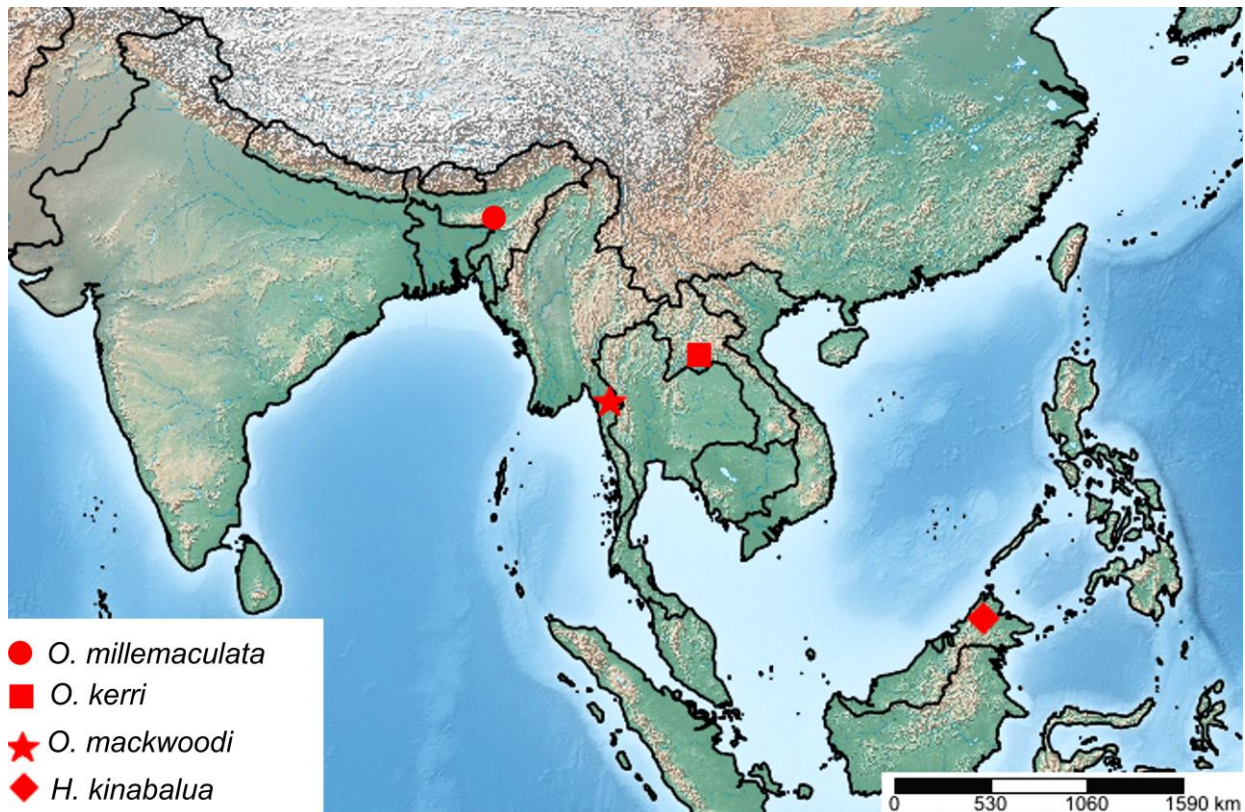
Male genitalia. Uncus very robust, strongly extended from base to apex, with deep triangle incision (for half of uncus length); tegumen robust; gnathos arms of medium length; gnathos small; valve short, poorly sclerotized, lanceolate, costal edge almost smooth, abdominal edge hypertrophied, strongly sclerotized, small dentate harpe on abdominal edge (in medium third); juxta cup-like; saccus tiny; phallus short, curved in medium third, gradually narrowing from middle to top.

Female unknown.

**Diagnosis.** Externally, the new species is closer to *O. millemaculata*, from which it differs in the darker color, more split uncus and the harpe situated closer to the abdominal edge of the valve.

**Distribution.** Northern Laos (Kerr 1933; Jacobs 1962).

**Etymology.** The new species is named after its collector – the most active researcher of the Indo-China fauna, the Irish doctor A.F.G. Kerr (1877–1942) (Fig. 32), who made a trip to the highest point of Laos in 1932 and collected insects along the way.



**Figure 28.** Distributional map of genera *Orgyarbela* gen. n. & *Hollowarbela* gen. n.

***Orgyarbela mackwoodi* sp. nov.**

Figs 16, 25

**Material.** Holotype: male, Burma, Kawkerait [16°33'20"N 98°14'24"E, Kawkarike, Karen Prov., Myanmar], v.1912, F.M. Mackwood (NHMUK, individual number 012832505; slide NHMUK 010315536).

**Description.** Male. Length of fore wing 9 mm. Thorax and abdomen densely covered with brown scales, bunch of long dark-brown scales on tip of abdomen. Fore wing dark-brown, without pattern, fringe mottled: dark at veins, light between veins. Hind wing dark-brown without pattern, fringe pale brown.

Male genitalia. Uncus very robust, strongly extended from base to apex, with deep semicircular incision (for one third of uncus length); tegumen robust; gnathos arms of medium length; gnathos small; valve short, poorly sclerotized, with slightly sharpened apex, costal edge curved, abdominal edge hypertrophied, strongly sclerotized, small dentate harpe on abdominal edge (in medium third); juxta cup-like; saccus tiny; phallus short, straight, apically slightly sharpened.

Female unknown.

**Diagnosis.** The new species differs from both other species of the genus in the poorly modified coloring (the fore wing is dark-brown, without pattern), an important diagnostic feature in the genitals is the lanceolate narrowing distal tip of the valve.

**Etymology.** The new species is named after F. M. Mackwood (1843–1931) (Fig. 33), a businessman (one of the founders of the tea house Mackwood's Limited) in Colombo, a keen amateur lepidopterist. His specimens are kept at the Natural History Museum, London and the National Museum, Colombo (Wijesekara & Wijesinghe, 2003).

**Distribution.** Myanmar: Karen Province.



**Figures 29–30. Habitats of Metarbelidae:** 29. *E. devyatkini* **sp. nov.** (photo by Vadim Zolotuhin); 30. *H. kinabalua* (Holloway, 1976) (photo by Alexey Yakovlev).



**Figures 31–33.** Portraits of Entomologists: 31. Alexey L. Devyatkin (photo from private archive of Anatoliy Krupitsky); 32. A.F.G. Kerr (photo from <http://www.nationaalherbarium.nl/>); 33. F.M. Mackwood (photo from <http://www.mackply.com/history-of-mackwoods.html>)

### **Genus *Hollowarbela* gen. nov.**

Type species (here designated): *Indarbela kinabalua* Holloway, 1976.

**Description.** Medium sized, firmly built species with wide thorax. Antenna bipectinate, crest processes twice longer than antenna rod diameter in medium part. Antenna equal to  $\frac{1}{2}$  of fore wing costal edge length. Fore wing pale brown, narrow, with dense dotted dark-brown pattern, more developed at costal edge and cubitally, apex sharp. Hind wing light-brown, with poorly developed reticulated pattern throughout all wing.

Male genitalia. Uncus large, long, slightly extending apically, apex rounded; tegumen of medium size; gnathos arms very short, not fused, gnathos reduced; costal edge of valve smooth, abdominal edge slightly curved in medium third, strongly sclerotized, small dentate process on border between proximal and medium third of abdominal edge, outer edge of valve semicircular; juxta small, with small slightly curved lateral processes. Phallus simple, tabulate, vesica without cornuti.

Female unknown.

**Diagnosis.** The genus has the following distinctive features: the robust thorax, the fore wing with a specific fine spotty pattern and a sharp apex, the non-split clavately expanding robust uncus, the sclerotized abdominal edge of the valve and the vesica without cornuti.

**Composition.** A monotypic genus.

**Etymology.** The new Genus is named after Dr. Jeremy D. Holloway, a well-known British entomologist – specialist in Oriental Fauna.

**Distribution.** Known only from Northern Borneo (Fig. 27).

### ***Hollowarbela kinabalua* (Holloway, 1976) comb. nov.**

Figs 11–12, 28

*Indarbela kinabalua* Holloway, 1976, *Moths of Borneo with Special Reference to Mount Kinabalu*: 88

Type locality: Borneo, Kinabalu.

Type material: holotype (male) in NHMUK.

**Material examined:** 2 males, Borneo, Sabah, Mt. Trus Madi, 4–24.04.2002, leg. Martini (MWM); 1 male, Nordborneo, Trus Madi, 1150 m, 9–14.04.1996, leg. Martini (MWM); 1 male, 1 male, Borneo, Sabah, Trus Madi, 1200 m, 4.2004, Martini (MWM).

**Habitat.** Montane forests between 1500–2000 m (Holloway 1986) (Fig. 30).

The species probably has a daily activity, as the robust thorax allows a strong and complicated search flight.

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