

## A new and remarkable species of *Eupterote* from the mountains of West Sumatra (Lepidoptera: Eupterotidae)

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**Abstract:** A new species of *Eupterote* (*sensu stricto*) is described from West Sumatra: *Eupterote* (*Eupterote*) ***kalliesi* n. sp.**, locus typicus: Mt. Singgalang, 2100 m (Indonesia: Sumatera Barat). It is remarkable for its diurnal flight behaviour, the extraordinarily small eyes, and the hyaline wings with a sparse black and white pattern, derived from the usual yellow ground colour and pattern of the species-group.

### Eine neue und bemerkenswerte *Eupterote*-Art aus den Gebirgen Westsumatras (Lepidoptera: Eupterotidae)

**Zusammenfassung:** Eine neue Art der Gattung *Eupterote* (*sensu stricto*) aus Westsumatra wird beschrieben: *Eupterote* (*Eupterote*) ***kalliesi* n. sp.**, locus typicus: Mt. Singgalang, 2100 m (Indonesien: Sumatera Barat); ♂ Holotypus (und einzig bekanntes Exemplar) zur Zeit in coll. Senckenberg-Museum, Frankfurt am Main. Sie zeichnet sich durch einige Besonderheiten aus: die Männchen sind tagaktiv, die Augen sind kleiner als bei verwandten Arten, und die Flügel sind größtenteils hyalin, mit einer spärlichen schwarzen und weißen Beschuppung und einer ungewöhnlich kurzen Diskoidalzelle. Die reliktiäre Zeichnung der Flügel und die Genitalmorphologie stimmen mit dem Standardgrundmuster verwandter Arten völlig überein. Eine gelbe Behaarung, besonders auf der Ventralseite, weist auf nahe Verwandtschaft mit den „gelben“, nachtaktiven Arten der Untergattung hin. Das ♀ und die Präimaginalstadien sind bisher unbekannt.

## Introduction

The moth genus *Eupterote* Hübner [1820]<sup>2</sup> *sensu stricto* consists of some number between approximately 30 and 80 species, which are generally more or less yellowish to reddish or sometimes brownish to greyish, medium-sized to large (length of forewing ca. 20–60 mm in ♂♂), and living in South and South East Asia. It is still unrevised (see comments in Holloway, 1982, 1987 and Nässig, 1989, 1995). As far as their behaviour

- 1 Studies in Eupterotidae (Eupterotiden-Studien) no. 3. (No. 2: Nässig, W. A., 1995: Revisional notes on Philippine Eupterotidae: *Sarmalia* Walker 1866 another new synonym of *Eupterote* Hübner [1822] (Lepidoptera: Eupterotidae). – *Nachr. entomol. Ver. Apollo*, Frankfurt am Main, **Suppl. 14**: 119–124.)
- 2 Date [1820] according to Fletcher & Nye (1982).

has been reported at all, eupterotid moths exhibit predominantly nocturnal flight activity. Diurnal members of SE Asian Eupterotidae are thus far only known in the genus *Melanothrix* Felder 1874 (see Holloway, 1987), females of which were repeatedly collected during the daytime. The existence of a new species of *Eupterote* (*sensu stricto*) with diurnal males is therefore a remarkable discovery.

The new species was discovered by Axel KALLIES in the Barisan range of West Sumatra at elevations of ca. 2100–2600 m in the Mt. Singgalang area (ca. 0° 22' S, 100° 16' E; interpolated coordinates, not measured) near Bukittinggi in 1996. In 1997, most likely the same species was also observed, though not collected, in the Mt. Kerinci area at approximately equal elevation. The species does not appear to be very rare (A. Kallies, *in litt.*); flying specimens were encountered quite often. However, ♂♂ fly very fast and in an erratic manner during the daytime through the dense mossy cloud forest on very steep and slippery slopes, so that it is nearly impossible to net them. All attempts to collect the species during daytime have been thus far futile. The only specimen available for study appeared at dusk on the screen of a light collecting unit at the moment when the light was switched on. No other specimens appeared at the light during several collecting nights, also in the subsequent years, although the species was repeatedly observed during the daytime. To draw the attention of other entomologists to this apparently unique species, it is described here as new:

*Eupterote* (*Eupterote*) ***kalliesi* n. sp.**

Figs. 1 (ups.), 2 (us.), 3 (♂ genitalia)

Holotype: ♂, [Indonesia], "Sumatra Barat, Padang Panjang, Mt. Singgalang, 2100 m, LF, 10.–11. ii. 1996, leg. A. KALLIES"; GP (dissection no.) 1122/97 W. Nässig/Senckenberg, SMFL-no. 4160. In the Lepidoptera collection of Forschungsinstitut Senckenberg, Frankfurt am Main<sup>3</sup>.

The new species is named after the collector of the singleton, Axel KALLIES, Greifswald.

Description, ♂ (Figs. 1, 2): The holotype ♂ has a forewing length of 35 mm; this is slightly more than in the small Sumatran species *E. kageri* Nässig 1989 (ca. 29–33 mm), but less than in Sumatran specimens of the medium-sized *E. multiarcuata* Holloway 1976 (ca. 37–48 mm) and in all other species of the genus presently known from Sumatra. Body length (dried specimen before dissection, head to tip of abdomen) ca. 40 mm.

Antennae 12 mm long, blackish, bipectinate, shape as usual in the genus (rami in the centre of each antennal segment); longest rami (about at  $\frac{2}{3}$  of the antennal length from the base to the tip) ca. 2 mm long. Head black, with yellow hairs on frons and at the ventral side of the palpi.

The eyes of the holotype are clearly smaller than in ♂♂ of the other species of the group (height [i. e., the maximal diameter measured in dorso-ventral direction] of the compound eye in *E. kalliesi*: 1.17 mm, in *E. kageri*: 2.02 mm, in *E. multiarcuata*: 2.08 mm,

<sup>3</sup> As soon as further specimens of the new species become available, it is planned to transfer some part of the material to Museum Zoologicum Bogoriense, Bogor, Java, Indonesia.



always  $n = 1$ ). However, the single ommatidia of the eyes appear to be slightly smaller in *E. kalliesi* than in the two other species used for comparison. The total number of ommatidia per compound eye was not counted due to technical problems, but it appears that this total number may be similar to slightly smaller in *E. kalliesi* as compared to the other two species. There is an interesting observation: in *E. kageri* and, especially, *E. multiarcuata* the ommatidia are polymorphic in size; approximately in the centre of the eye, with a slight ventral orientation, there is a distinct area of much larger ommatidia (in *kageri* ca. 1.5, in *multiarcuata* ca. 2 times the diameter of the peripheral ommatidia), while in *E. kalliesi* such a polymorphism is not apparent. Such an ommatidia polymorphism is not rare in insects and often related to different visual specializations in different directions of sight (for more details, see Land, 1997).—These differences in the size of the compound eyes resemble those observed in *Endromis versicolora versicolora* (Linnaeus 1758) [= diurnal ♂♂, smaller eyes] and *E. versicolora eichleri* Alberti 1975 [= nocturnal ♂♂, larger eyes] (Endromididae respectively Endromidae) (see Nässig & Czipka, 1994:190).

Thorax dorsally with long greyish hairs with a slight yellowish tinge; ventrally yellow or blackish yellow. Legs externally (i. e., dorsally) black, internally (towards the thorax; i. e., ventrally) yellow; their short dorsal hairs and scales black, the long ventral and lateral hairs yellowish. Abdomen long and slender as usual in the genus; dorsally covered with a mixture of black, white and yellow scales, appearing slightly ringed at the segmental borders (i. e., with a weak concentration of white scales towards the distal end and black scales towards the proximal end of each segment); ventrally yellowish.

The wings are nearly hyaline, sparsely covered with black and white (the latter nearly invisible) scales, the venation is clearly visible. No yellow scales were found on the wings. Underside similar to upperside. The typical pattern of the genus *Eupterote* (*sensu stricto*) is still indicated: arched fasciae, the outer one dissolved into triangular patches with a black filling. The discoidal vein is closer to the wing base than in most other species. The discoidal cell therefore is clearly shorter than usual, with only 10 mm in length in *E. kalliesi* from the wing base to the discoidal vein, i. e., at 28% of the full fw. length; in *E. kageri* it is ca. 12–13 mm or ca. 38% ( $n = 2$ ), in *E. multiarcuata* it is ca. 14 mm or ca. 34–37% ( $n = 3$ ). Margin more densely covered with scales, black; marginal fringes, especially so on the hindwings, with a distinct white touch caused by some long white scales.

♂ Genitalia (Fig. 3): The genitalia show the typical morphology of the genus *Eupterote* Hübner, [1820] (*sensu lato*) as described first by Forbes (1955: 100 ff.)<sup>4</sup>, then by Holloway (1982: 190, 1987: 63 ff.): valves and dorsal appendages largely reduced, forming only some “hooks”, nearly immobile, tightly fused (ankylosed) to the tegumen-complex. Aedeagus tube firmly fused to the juxta, so that a separation is possible only when the juxta (or vinculum or annellus, see footnote 2 in Nässig, 1995) is disrupted.

4 Forbes (1955) illustrated the genitalia of most eupterotid genera, but his system of the family was mainly based on wing venation characters, and his tribe Eupterotini contains some genera which I am inclined to place outside this unit; his Eupterotini appear to me to possibly be a paraphyletic (or even polyphyletic?) conglomerate. Further studies are necessary (and in preparation).



The form of the valves resembles quite closely that of Sumatran *E. (E.) multiarcuata* (Fig. 4; see also Holloway, 1976: fig. 354), but the shape and orientation of the distal part of the valve's "hook" is slightly different. In contrast, the vesica bears no scobination or cornuti, while that of *E. multiarcuata* is densely scobinated. For further comparison with other species see the illustrations in Holloway (1982, 1987) or Nässig (1989, 1995). Within these publications a series of genera was synonymized with the oldest taxon, *Eupterote*, due to their uniform construction of male genitalia<sup>5</sup>. Genitalia morphology is consistent in all species dissected thus far, and the species-specific differences within the large conglomerate are usually only minor. It is thus not surprising that also the new species *Eupterote kalliesi* is similar to the other species, and a new taxon on the generic level (only typologically based on the distinct wing pattern and flight habits) would be totally inadequate for it.

♀, preimaginal instars and life history unknown.

## Discussion

Although it is always somewhat risky to describe a new species when only a singleton is known, because even apparently outstanding new characters may sometimes be the result of extensive individual variation, or even teratology, it appears to be a safe conclusion that the holotype of *Eupterote kalliesi* is not just a "freak", but represents a true new species. The enormous differences in external morphology and behaviour as well as in the genitalia clearly demonstrate the species rank.

The female of the new species is still unknown. Therefore it is not known whether the other sex shares the hyaline wing pattern and colouration as well as the diurnal behaviour of males.

Why did (at least) the ♂♂ of the new *Eupterote kalliesi* become diurnal? Species like the members of the genus *Eupterote* with strict limitations in their imaginal lifespan (because they do not take up any food) may reach these limits in mountainous areas: above 2000 m, even tropical areas close to the equator become quite cold at night (temperatures below 10 °C are not rare, see, e. g., Whitten et al., 1987). The heating up to flight temperature and the flight itself at low nocturnal ambient temperatures would cost a significantly larger amount of body energy (fat) than for other *Eupterote* species in the lowlands. To avoid this limitation ("cost factor 1", reaching the normal flight temperature in the thorax under low temperatures at night), species could shift their activity into the diurnal phase of the day, where ambient temperatures are much higher and moths can use the direct sunlight for heating up without loss of body energy. Diurnal behaviour in the mountains allows faster flight, better and faster localization of the ♀♀ and faster mating

5 It appears advisable to retain some of these synonymized genera on subgeneric level to have more possibilities for keeping the many species separated into distinct groups within the large genus *Eupterote*. This policy will be adopted in the forthcoming treatment of the Sumatran Eupterotidae fauna. However, the new species *E. kalliesi* does not at all require a new subgeneric taxon; it evidently is a fairly recent offspring of some of the yellowish species of *Eupterote* (*sensu stricto*), perhaps closely related to *E. (E.) multiarcuata*. It also appears that at least some of these subgenera will turn out to be monophyletic subunits within the large genus *Eupterote s. l.*



and sperma transmission. However, during the day other "cost factors" may become critical: fast and active optical predators, like lizards and, especially, birds are the dominant mortality factors during daytime<sup>6</sup>, in contrast to predators guided by sonar systems at night, like insectivorous bats. To minimize this second mortality factor, a very fast and erratic flight becomes necessary which would no longer be an energy problem during the day. However, additional other methods like enhancing the pattern and colouration to better escape optically guided predators would be quite advantageous. And the strange pattern and colouration of *E. kalliesi* is surely as well an adaptation to the diurnal behaviour. Such hyaline moths flying rapidly and erratically through the vegetation are nearly invisible from longer distances and very difficult to catch for predators, especially in foggy cloud forests. Whether there is another factor besides camouflage (e. g., mimicry?) related to the hyaline pattern is still unclear; many other diurnal moths are not hyaline at all.

The diurnal flight of *E. kalliesi* may also be the reason for the small eyes: nocturnal moths need to optimize their eyes for low light intensities, which is done best with big ommatidia and large eyes; but light is no longer at a minimum during the day, so eyes and ommatidia may become smaller. The ♂♂ of the new species will very likely locate the conspecific ♀♀ by means of sexual pheromones, because this is the usual method in the bombycoid moths in general, and thus far no primarily optical courtship behaviour was reported from any of the bombycoid families. A pheromone-guided mate locating behaviour is also indicated by the comparatively large ♂ antenna. Therefore, an optical apparatus specialized for a complicated optical courtship behaviour (known, e. g., from some butterflies) or prey locating and catching (e. g., in Odonata) does not appear to be necessary in *E. kalliesi*; and this could explain the possibly slightly lower number of ommatidia per compound eye when compared with closely related nocturnal species.

The case of *Endromis* cited above appears to be a similar development (in probably all aspects); the taxon from the colder climate is diurnal, the taxon from warmer areas nocturnal, although the morphological differences between *versicolora* and *eichleri* are only minor in that case (which explains the treatment of the two taxa as subspecies only, see Nässig & Czipka, 1994).

That the new species belongs to *Eupterote sensu stricto*, i. e. to the largest unit within the genus (sensu Holloway, 1982, 1987 and Nässig, 1995), is clearly and beyond doubt indicated by the genitalia morphology, by the remnants of the wing pattern, and by the yellow colour, especially conserved on the ventral side. Within the S.E. Asian Eupterotidae fauna, this is the second case known (after *Melanothrix*) where at least one sex is diurnal.

Genitalia morphology and general habitus may perhaps indicate a close relationship of the new species to *E. multiarcuata*, but a detailed analysis of the phylogenetic relationships of the new species must await further studies on the many other species of *Eupterote s. str.*

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6 While some other important predators, like spiders, are equally relevant mortality factors probably both at night and during the day.

The new species also exhibits an altitudinal distribution (thus far observed only above 2000 m) which is uncommon at least in the genus in SE Asia; most species of *Eupterote* are known only from below ca. 1500 m, where they prefer the understory vegetation of primary and secondary lowland to lower montane forests and shrublands, and sometimes gardens and orchards (Holloway, 1987); their larvae are usually polyphagous and often gregarious, at least in early instars.

It may be expected that the new species also shares the apparent synapomorphy of the older larvae (starting with ca. L2 to L4, depending on the species) of those species of *Eupterote* (*sensu lato*) where larval morphology is known, i. e., the presence of long, stiff bristles with barbed hooks hidden between the soft, longer normal hairs on the body, which transform most *Eupterote* larvae into well-protected "porcupines". These stiff bristles get loose from the larva when touched and then stick to and automatically move deeper into the skin of the disturber, where they may cause allergic reactions and other skin injuries. These larvae are, therefore, very unpleasant "pets" during rearing attempts in the laboratory. Removal of the bristles from the skin must be done very carefully, because the tip of the bristles may break off and stay in the skin. The lifespan of the larvae is usually very long in *Eupterote* s. l.; larval phases of 4–8 months without diapauses (with up to 7 or even more larval moults) are standard in the genus, as far as this is known.

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## Colour plate

Fig. 1: ♂ holotype (SMFL-no. 4160) of *Eupterote kalliesi* n. sp., upperside.

Fig. 2: underside. – Scale in cm with subdivisions in mm, both pictures to the same scale.

Photographs W. A. Nässig.



Sumatra Barat  
Padang Panjang  
Mt. Singgalang  
2100m LF  
10-11 II 1996  
leg. A. Kallies



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Padang Panjang  
Mt. Singgalang  
2100m LF  
10-11 II 1996  
leg. A. Kallies



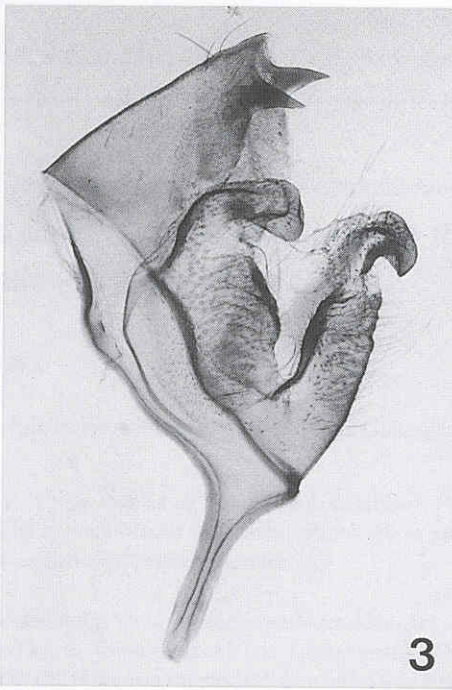
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**B&W plate:**

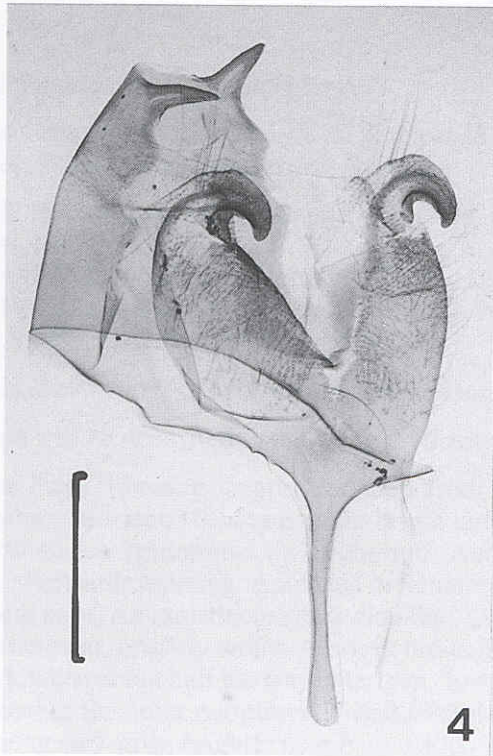
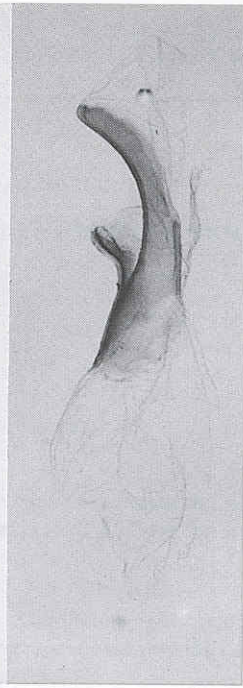
Fig. 3: ♂ genitalia (GP/dissection no. 1122/97 W. Nässig/Senckenberg, SMFL-no. 4160) of *Eupterote kalliesi*, holotype.

Fig. 4: ♂ genitalia of *Eupterote multiarcuata* Holloway, 1976 (GP 235/84 W. Nässig/Senckenberg) from N. Sumatra (1200 m) for comparison. – Aedeagus separate. Scale 1 mm, all pictures to the same scale. Photographs W. A. Nässig.





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