

Two species in *Saturnia (Rinaca) zuleika* HOPE, 1843 (Lepidoptera: Saturniidae)

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Abstract: The type locality for *Saturnia zuleika* HOPE, 1843 as reported in the original description (“Silhet”) is evidently erroneous; the same probably being the case for *Salassa lola* (WESTWOOD, 1847). Based on the illustration in the original description and possible syntype material, the taxon was apparently described from Himalayan material (probably from the Darjiling area) bearing wrong locality data. The populations from all extra-Himalayan localities belong to a different species, *Saturnia (Rinaca) lesoudieri* LE MOULT, 1933. The differences between the two species are particularly found in the hindwing eyespots, which are incurved on the distal side in the Himalayan *S. zuleika* and round in the extra-Himalayan *S. lesoudieri*. Further, there are slight differences in male genitalia and approximately 2% difference in the mtDNA COI barcode. Several synonyms are proposed. The subdivision of the genus *Saturnia* is briefly discussed. Specimens of both species, their male genitalia, larvae of *S. lesoudieri*, the barcode similarity tree and a distribution map are illustrated.

Key words: misidentified type locality, *Salassa lola*, *Saturnia (Rinaca) zuleika*, *Saturnia (Rinaca) lesoudieri*.

Saturnia (Rinaca) zuleika HOPE, 1843 besteht aus zwei verschiedenen Arten (Lepidoptera: Saturniidae)

Zusammenfassung: Der Typenfundort von *Saturnia zuleika* HOPE, 1843, so wie er in der Originalbeschreibung genannt wird („Silhet“), ist offensichtlich falsch; dasselbe gilt wohl genauso für *Salassa lola* (WESTWOOD, 1847). Gemäß der Abbildung in der Urbeschreibung und möglichem Syntypenmaterial wurde das Taxon auf der Basis von fehlerkettiertem himalayenischem Material beschrieben (wahrscheinlich aus der Gegend von Darjiling). Alle extrahimalayanischen Populationen gehören zu einer separaten Art, *Saturnia (Rinaca) lesoudieri* LE MOULT, 1933. Die Unterschiede zwischen den beiden Arten finden sich insbesondere in den Hinterflügel-Augenflecken, die bei der himalayenischen *S. zuleika* auf der Außenseite konvex eingebuchtet sind, hingegen bei *S. lesoudieri* stets rund ohne Einbuchtung; weiterhin finden sich geringe Unterschiede im männlichen Genitalapparat und ca. 2% Unterschied in Barcode. Die neuen Synonyme werden dargestellt. Die Untergliederung der Gattung *Saturnia* wird kurz diskutiert. Exemplare beider Arten, die männlichen Genitalien, Raupen von *S. lesoudieri*, der Barcode-Ähnlichkeitsbaum und eine Verbreitungskarte werden abgebildet.

Introduction

When analysing the mtDNA COI barcode of Asian *Saturnia* species (see NAUMANN & NÄSSIG 2010), we also studied the species-group of *Saturnia zuleika*. The results were not a total surprise; earlier authors already identified two

different populations in the group, but only hesitated to describe them at the species level. We also uncovered a misidentified type locality, which might also have been responsible for the hesitation of earlier authors.

Saturnia zuleika was described by HOPE (1843: 132, pl. XI, fig. 5) stating that it came from “Silhet”. HOPE’s new species was illustrated; this drawing is reproduced here (Fig. 1). (There is a primary junior homonym of *Saturnia zuleika* HOPE 1843: *Saturnia zuleika* WESTWOOD, 1847. The latter is a species of the genus *Cricula* WALKER, 1855 and will therefore not be considered further here.) Twelve years later, *Saturnia zuleika* was placed by WALKER (1855a: 1199 [key], b: 1274; see FLETCHER & NYE 1982: 143) into a separate genus, *Rinaca*.

The history of the case: two species involved?

HAMPSON (1893) had already noticed differences in the shape of the wing ocelli between Himalayan and Naga Hill specimens of *Saturnia zuleika* HOPE, 1843. 18 years later, JORDAN (1911a: 131) described these differences in more detail, writing:

- “*Rinaca zuleika orites* subsp. nov. [from Sikkim] ... differs from *R. z. zuleika* ..., which occurs in Silhet and the Khasia and Naga Hills, especially in the shape of the eye-spots. ... The discocellular reniform spot of forewing [of *orites*] longer and narrower; the corresponding spot on hindwing likewise incurved on distal side, being longer transversely to the veins than in basi-distal direction, while this eye-spot is rounded in *z. zuleika* and longest basi-distally.”

However, JORDAN evidently did not check HOPE’s publication (no author is cited by JORDAN), because if he had compared even just the illustration of HOPE (1843: pl. XI, fig. 5), and then perhaps also searched for the original specimen[s] (see the possible syntypes in OUM still existent today), he might have avoided the present problems with his description. HOPE’s illustration (reprinted here in Fig. 1) clearly shows a ♀ with exactly the shape of the hw. eyespots, “longer transversely to the veins than in basi-distal direction”, which JORDAN attributed to his Himalayan “subsp. *orites*”, and the same can also be seen in the two ♀ (possible ST) specimens that today are deposited in the collection of OUM (see Figs. 2 & 3). A pair with locality data “Silhet”, but with the narrower Himalayan hw. eyespots is also found in ZMHU ex

¹ 19th contribution to the Saturniidae fauna of China. (18th contribution: NAUMANN, S., & NÄSSIG, W. A. (2010): Revisional notes on the species-group of *Saturnia grotei* MOORE, 1859 of the genus *Saturnia* SCHRANK, 1802 (Lepidoptera: Saturniidae). — Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, 31 (1/2): 31–62.)

² 75th contribution to the knowledge of the Saturniidae. (74th contribution: NÄSSIG, W. A., & HOLLOWAY, J. D. (2010): Nomenclatural note on the correct name for *Antheraea roylei* MOORE, 1859 (Lepidoptera: Saturniidae). — Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. 31 (1/2): 92.)

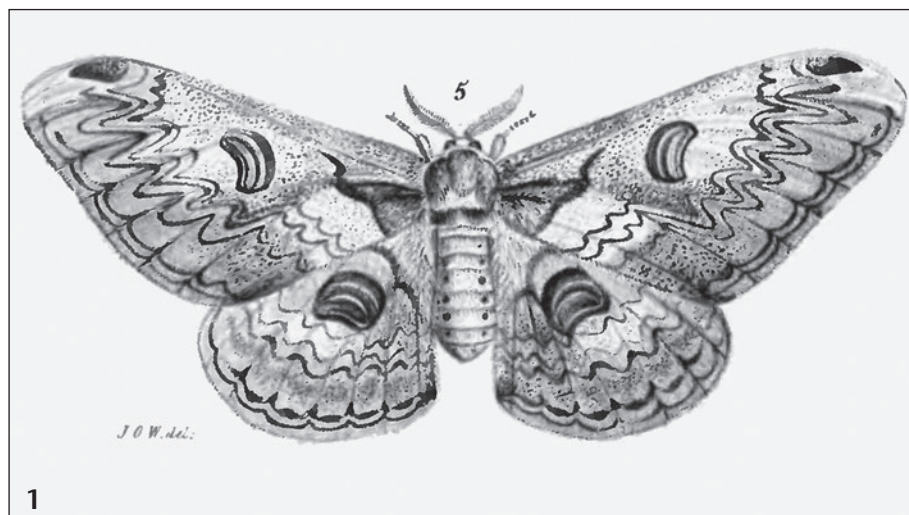


Fig. 1: Black and white reproduction of the illustration by HOPE (1843: pl. XI, fig. 5), showing the original drawing for the description of the taxon *zuleika* HOPE, 1843 (plate drawing by "J.O.W." = John Obadiah Westwood). See the hindwing eyespots being incurved on their distal side. — Reproduction copied from en.wikisource.org/w/index.php?title=Page:Transactions_of_the_Linnean_Society_of_London,_Volume_19.djvu/177&action=edit&redlink=1, available under Creative Commons Attribution-Share-Alike License 3.0, single picture extracted from plate and slightly modified. There exists also a hand coloured version of this figure. It can be found, digitised by Google Books from a copy in the University of Michigan Libraries, under the URL books.google.com, searching for the journal. This coloured figure also supports our ideas.

coll. MAASSEN (ZMHU accession numbers 75139 & 75140 ex coll. MAASSEN; the ♂ is shown here in Fig. 4).

Exactly the same problem of JORDAN's description was already noted by BOUVIER (1936: 225–226). BOUVIER obviously knew of LE MOULT's (1933) publication (he cites it for the taxon "*Antheraea*" *bonhourei* LE MOULT = *Caligula thibeta extensa* BUTLER, 1881 *sensu* BOUVIER), but overlooked LE MOULT's description of *Rinaca zuleika lesoudieri* in the same paper. With this provision, he then accepted only one species, *Rinaca zuleika*, with two subspecies, one from "Silhet et des monts Khasia et Naga" = *z. zuleika sensu* BOUVIER and one from Sikkim and Darjiling = *z. orites sensu* BOUVIER. He obviously he could not arrive at a more fitting conclusion because he did not reflect on the obviously erroneous label data on some specimens.

Saturnia zuleika sensu lato inhabits elevations between ca. 600 and 3200 m. It may not reach to the highest forested zones of the Himalaya (as do, e.g., some species of the *Saturnia grotei* species-group, see NAUMANN & NÄSSIG 2010), but it is certainly not a lowland dweller. In our opinion, and on basis of present knowledge of distribution and ecology, neither the specimen illustrated by HOPE, nor the two specimens in OUM, nor the "Silhet" specimens in ZMHU can have been collected in the surroundings of Sylhet or in the Khasi Hills. The two specimens in ZMHU from "Silhet" with their narrowed hw. eyespots are indistinguishable from other old specimens from Darjiling or Sikkim from a slightly later time (e.g., 1 ♂ ex coll. ATKINSON via coll. STAUDINGER in ZMHU from Darjiling, others without documented collection history).

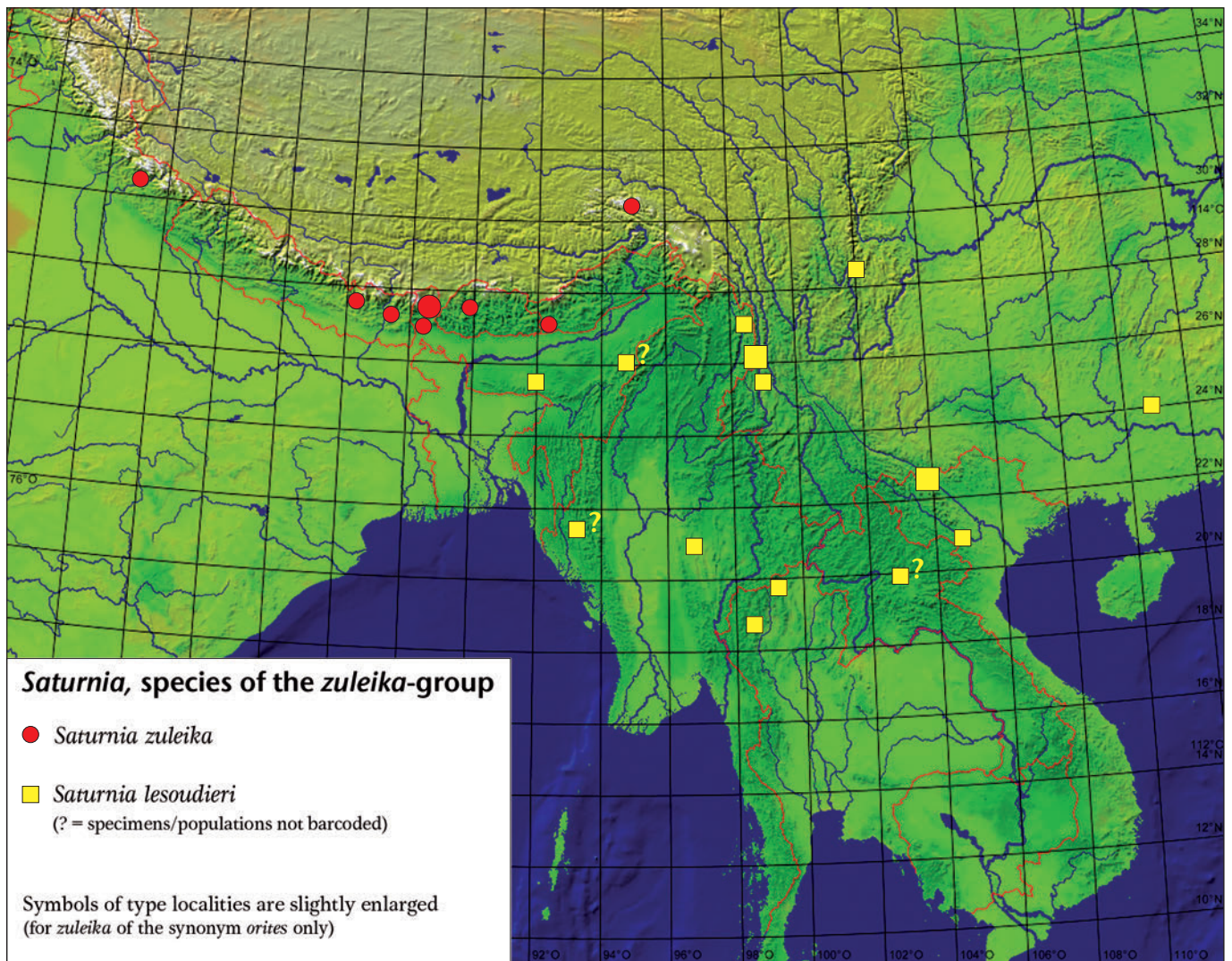
JORDAN was correct insofar as the specimens of the Himalayan populations of *Saturnia zuleika* indeed all show narrowed hw. eyespots (i.e., the spots on the hw. are incurved on their distal side), while specimens collected in the Khasi[a] and Naga Hills (situated in the former Indian "Greater Assam" province of colonial times, and now divided between India and Bangla Desh and subdivided into several federal states and districts) show much more rounded shape, just as all specimens from other localities to the south and east. The fw. eyespots are generally,

in contrast to JORDAN's interpretation, more variably narrowed in probably all populations and perhaps do not provide safe characters for distinction (see our col. pls.).

It might be argued that this Himalayan population with narrowed hw. eyespots could, instead of crossing low floodplains of the Brahmaputra, reach around in a more or less crescent-shaped arc through the eastern Indian mountain chains (approximately parallel to the Indian border to China and Myanmar) from Arunachal Pradesh across the border hill chains to the Naga Hills and then, across the narrow mountain bridge of the Cachar hills, to the Khasi Hills (and possibly also further down in the mountain chain west of the Irrawaddy river to Mt. Victoria in Chin State, Myanmar). However, as we have never seen a recently collected specimen of the narrowed hw. eyespots population with reliable data from these regions (all recently collected and all reliable material from there is round-eyed on the hw.), we believe that the "mislabelling hypothesis" is much more plausible. Further, the material from Nagaland in museum collections is always old, and we do not yet have any barcode results from there (and as well from Chin State).

There is no doubt that JORDAN largely observed the correct differences between two populations, and it appears that he was misled only by erroneous locality information from HOPE (and maybe also other collectors and authors), which he did not verify with original type material or at least with HOPE's illustration. His error was perhaps also compounded by the fact that material from former Greater Assam (i.e., Khasi[a] and Naga Hills) is much rarer in collections — still today! — than material from the Himalaya, and of "*zuleika*" from other areas of SE Asia, which has only become available for scientific study much more recently (beginning with LE MOULT 1933, ignored by BOUVIER 1936).

- So our interpretation, based on original illustration, possible ST material and interpretation of locality data, is: the names *zuleika* and *orites* were evidently coined *for the same population* and so indeed *for the same species* from the Himalaya.



Map: Distribution map of the group of *Saturnia (Rinaca) zuleika*. — Map created with Map Creator 2.0 Personal Edition, © 2003–2007 primap software, modified and localities added.

The differences in the hw. eyespots are obviously, regardless of the locality problems, real: the narrow spots with the incurved distal side are only found in Himalayan specimens (from Uttarakhand, Nepal, Sikkim, West Bengal, southern Central Tibet, Bhutan, Arunachal Pradesh), while the more rounded spots (with at most a straight distal edge, never concave, see, e.g., Figs. 15 [N. Vietnam] or 22 [E. Tibet]) only in the populations from further to the south and east (see Map).

As these differences do not correlate with prominent differences in larval and ♂ genitalia morphology (there are minor, evidently constant differences, but only in inconspicuous details), and also due to the discrepancies and inconsistencies between JORDAN's description and differential diagnosis of *orites* and the HOPE illustration (and the possible STs) of *zuleika*, we hesitated to work on this problem (e.g., NÄSSIG 1994c: 411, BROSCHE et al. 1999: 48). The differences were so confusing and inconspicuous that NÄSSIG (1994c), while describing the preimaginal instars from Darjiling (West Bengal, North India = *S. zuleika*) and northern Thailand (= *S. l. lesoudieri*, see below), united the populations into one species in spite of small, but clearly visible differences in the larvae.

Rather strange is the interpretation by SEITZ (1928: 515). First, he states that "Naga Hills specimens have rounded eyespots, while Sikkim specimens (= *orites*) have longer, narrower and more straight ones" [which is correct]. Then he states that "typical *zuleika* are from Silhet and the Khasi Hills, Assam" [which evidently is incorrect, see above], but does not describe their eyespots. We cannot verify the presence of *three* different forms in terms of the eyespots; specimens from Khasi and Naga Hills look quite alike, large and with round hw. eyespots (with these few exceptions of probably mislabelled specimens with narrowed hw. eyespots in old collections), although we have had no chance to obtain barcode results from Nagaland specimens thus far. Increasing the chaos further, SEITZ (1928) listed all the Asian *Saturnia* species in *Caligula* MOORE, 1862, but specifically excluded the type species of *Caligula* (= *simla* WESTWOOD, [1847], designated by KIRBY 1892: 934) from that genus, placing it instead into *Dictyoploca* JORDAN, 1911 (described by JORDAN 1911b: 218), which subsequently was designated to have the identical type species (JORDAN 1957), i.e., *Dictyoploca* became an objective synonym of *Caligula* (see FLETCHER & NYE 1982: 27).

Similar problematic illustrations and locality information are also found, for example, in SONTTHONNAX (1904: 89, pl. viii figs. 2, 3; he illustrated a pair without locality data; according to the hw. eyespots, both are from the Himalaya, the ♀ is very schematic, while the drawing of the ♂ is rather naturalistic; locality data provided is “Silhet, Sikhim, Assam”).

The results of the barcode analyses

Recently, in the course of preparing the systematic data of the Palaearctic Saturniidae for publication within the book series “Palaearctic Macrolepidoptera”, we began sending legs of most populations of *Saturnia zuleika* s.l. to the “Canadian Centre for DNA Barcoding” (CCDB) in Guelph, Ontario, for sequencing and analysing using the 658 base pairs (bp) of the barcode fragment of the mitochondrial cytochrome-*c* oxidase gene, subunit I (= mtDNA COI gene) (see RATNASINGHAM & HEBERT 2007; in the web: BARCODE OF LIFE 2010). DNA was extracted from the legs of dried specimens in the collections of the authors and others. Technical details of extraction and amplification and sequencing protocols can be found on the CCDB website (CCDB 2010) and are also described in, e.g., VAGLIA et al. (2008).

With the results of barcode data (a few barcodes have yet to be analysed and thus are not included in Fig. 31), we can now, in the present publication, analyse the relationships within the *zuleika*-group on basis of external (habitus), preimaginal and genitalia morphology, DNA barcode sequences (see Fig. 31), biogeography (see Map), and other available information. We have to admit, however, that some questions still remain open with regard to the true origin of the type material, and not all populations from geographically different areas (e.g., Nagaland, Chin State, Laos) have yet been barcoded.

- The differences in barcode sequences between the Himalayan populations with narrowed hw. eyespots and those from further south and east with round hw. eyespots are in the order of 2 %, which is often accepted as indicating separate species status in Lepidoptera.
- Smaller differences (around 1 %) are found between populations from Meghalaya and those from further south and east and may allow a further subspecific splitting. However, as we were not able to detect “hard” (i.e., visible and reliably constant) morphological differences between these two populations thus far, we refrained to erect a subspecies here. A description based on a small sample only, just stating differences in DNA base pairs as diagnostic characters, might possibly just fulfil the formal criteria of Art. 13.1.1. of the Code (ICZN 1999), but we do not consider such differences sufficient for the general purposes of taxonomy just yet.

So we eventually decided to split HOPE’s *Saturnia zuleika* into two species and, thereby, also correct some errors of other authors.

Type locality problems

Today, Silhet = Sylhet, the formal type locality of *Saturnia zuleika*, is a city (and district) in Bangla Desh at approx. 24°54' N, 91°52' E, on the banks of the Surma river (elevation ca. 15–30 m) in the lowland floodplains of the Brahmaputra river system, south of the Khasi Hills of the Indian Federal State of Meghalaya. Formerly, the area of the present-day district of Sylhet was at least in part ruled by the Maharajah of Tripura; the main parts of the formerly independent Tripura State today form the Indian Federal State Manipur (WIKIPEDIA 2010). Sylhet (the city) was in these early times an important place for tea trading, which might also explain why Lepidoptera might have come from there to England (thus likely giving rise to “Silhet” locality labels!), although they had been collected elsewhere – just like the Assam tea itself, which is planted predominantly at higher elevations of the Khasi Hills or even the Himalaya, not in the plains.

HOPE did not state how many specimens he had before him, so we do not know how many were in existence originally. SWINHOE (1892: 248) in his catalogue lists a [single?] “type in coll. PARRY” for his species no. 1161, *Rinaca zuleika*, from “Sylhet” plus 4 additional specimens from “India”. However, according to SMITH (1986: 140), there is no separate “coll. PARRY” in the Oxford University Museum (OUM); some material from the collection of Major F. J. S. PARRY was received in OUM (by exchange or buying) between 1858 and 1885 (i.e. after HOPE’s description; Reverend HOPE lived from 1797–1862 and donated his collection and library together with the J. O. WESTWOOD collection and library to the Oxford University: HAGEN 1862, HORN et al. 1990), and there is no separate entry on Indian Lepidoptera specimens from PARRY in SMITH. The two specimens figured in Figs. 2–3 are contained in a separate type collection of the Hope Entomological Collections of OUM today; there is no “coll. PARRY” today, and apparently this “type” listed by SWINHOE might be lost. F. J. S. PARRY was mainly a coleopterist; according to HORN et al. (1990), his beetles were in part auctioned, other parts reached the BMNH.

We interpret the two specimens found in OUM to be possible syntypes, because they agree so well (especially in the shape of the hw. eyespot – this indeed is the most obvious difference between the two species, see below) with HOPE’s illustration, but refrain from designating a lectotype, because we are not certain that they really are STs; they might belong to the additional “Indian” specimens of unclear origin and collection history listed by SWINHOE.

HOPE’s type material came “chiefly” [sic] from the collection of F. J. [S.] PARRY, so potentially either the collectors of PARRY, PARRY himself or HOPE might have produced this locality error. (Locality data were generally not dealt with so accurately in the 19th century anyway!) Also, HOPE did not, in contrast to several other descriptions within the same publication, explicitly write that the specimens he described as *Saturnia zuleika* indeed

came from coll. PARRY; so the origin of possible STs is further obscured. HOPE himself wrote “*Habitat in Silhet*”; however, there is no hint for the correctness of this “Silhet” locality on the preserved material in OUM: one of the specimens is, in fact, only labelled with the (badly legible!) locality “Ind[ia]”, the other one does not have any locality data on the pin.

- In any case, the HOPE specimens (his illustration as well as the possible STs in OUM) are specimens with the eyespot on the hw. incurved on distal side; they do not show a round hw. eyespot. As shown above, such specimens with narrowed hw. eyespots do not live in the Meghalaya/Sylhet area, and the locality “Silhet” from the HOPE description must be wrong.

There are two possibilities: either the locality data “Silhet” is – for one reason or another – just simply incorrect. Or the Himalayan population indeed had crossed the (nowadays densely populated) lowlands and the large river in an earlier time and managed to live in the foothills of the Khasis – while the SE Asian population already lived on that side of the Brahmaputra floodplain. The latter hypothesis appears much less likely and does not make much sense zoogeographically either. (All actual specimens from Meghalaya or Nagaland with *reliable* data that we have seen do not possess such narrowed hw. eyespots.) Mountain species like *S. zuleika* just do not inhabit such broad lowland river valleys, and these are (at least for saturniids) next to impassable. The present-day district of Sylhet in the Brahmaputra floodplains of Bangla Desh is no potential habitat for *S. zuleika sensu lato* whatsoever.

A similar case of an implausible type locality is that of *Salassa lola* (WESTWOOD, 1847). WESTWOOD (1847–48: 25) also indicates “Sylhet”, which was then repeated by HAMPSON (1893: 27) and, possibly as a result of this secondary source (because this looked like some kind of a “verification” of the locality data), was then translated into the present-day locality “Bangla Desh” in a modern publication (WITT & PUGAEV 2007: 3–4, in their lectotype designation for *S. lola*). *S. lola* is another typically Himalayan mountain species (and not even known to occur in the Khasi and Naga Hills at all!), living on average at even higher elevations than *Saturnia zuleika s.l.*, and thus surely also does not inhabit lowlands, as has already been noted by NAUMANN et al. (2010: 116–117) – this is most likely another drastic case of an erroneous type locality in Saturniidae.

In any case, all specimens in museum collections with narrowed hw. eyespots, but locality data “Sylhet”, “Khasi[a]” or “Naga Hills” are old, and there are only a relatively few such specimens; most specimens from these places, and especially the more recent ones, are always specimens with round hw. eyespots.

- Therefore, we believe that it is just an error of locating the origin of HOPE’s *zuleika*; most likely the specimens were collected somewhere in the southern foothills or slopes of the Himalaya range (i.e., north of the Brah-

maputra valley!), perhaps in what is West Bengal or Sikkim in India today, and only in error were stated as originating from “Silhet” – perhaps because HOPE or PARRY just received them from someone there.

The same can be expected for the specimens in ZMHU or other collections. At that time the small Darjiling–Shiliguri railway was not yet in existence (it was built 1879–1881), and the Assam tea trade from Darjiling and Sylhet – including all “accompanying stuff” like moths – might possibly have been lumped together somewhere before leaving India.

Abbreviations and conventions

Abbreviations of collections:

BMNH	The Natural History Museum, London (formerly British Museum (Natural History)), U.K.
CSLL	Collection Swen LÖFFLER, Lichtenstein/Sachsen, Germany.
CSNB	Collection Stefan NAUMANN, Berlin, Germany.
CWAN	Collection Wolfgang A. NÄSSIG, now in SMFL.
OUM	Oxford University Museum, Hope Entomological Collection, Oxford, U.K.
NHMW	Naturhistorisches Museum Wien, Vienna, Austria.
NRSS	Naturhistoriska Riksmuseet, Stockholm, Sweden.
RMNH	formerly Rijksmuseum van Natuurlijke Historie, now changed to Netherlands Centre for Biodiversity Naturalis, Leiden, Netherlands.
SMFL	Senckenberg-Museum, Frankfurt am Main, Lepidoptera collection, Germany.
SMTD	Senckenberg, Museum für Tierkunde, Dresden, Germany.
ZMHU	Zoologisches Museum der Humboldt-Universität, Berlin, Germany.

Other abbreviations and conventions:

‡	Invalid and unavailable name.
BC [no.]	Barcode [with number].
Fw.	Forewing.
GP [no.]	Genitalia dissection [with number] (Genitalpräparate-nummer).
HT	Holotype.
Hw.	Hindwing.
Lfw.	Length of the forewing, measured in a straight line from the base of the wing to the most distant point of the apex, without the width of the thorax.
Lhwa.	Length of the hindwing, measured in a straight line from the base of the wing along the anal margin to the begin of the greyish-olive marginal fascia at the outer margin.
L.t./l.t.	Locus typicus.
LT	Lectotype.
PT	Paratype(s).
ST	Syntype(s).
uns.	underside.
ups.	upperside.

Annotated catalogue of the taxa involved

Subsequent to BRYK (1944), the complex has been interpreted as one species, *Saturnia (Rinaca) zuleika*, comprising the following 5 formal taxa (4 valid, 1 invalid, in chronological order):

1. *zuleika* HOPE, 1843

Saturnia Zuleika: HOPE (1843: 132, pl. XI, fig. 5; reprinted here in Fig. 1), family Bombycidae. — L.t.: [India/Bangla Desh?], “Silhet” [= error in locality, correct: India, Himalaya, probably in West Bengal?]. — 2 possible ST ♀♀ in OUM [examined; see Figs. 2–3]. We refrain from designating a LT from them because of the uncertainty of their status (see above). There is also no specimen in the BMNH that could be interpreted as the type from “Silhet” (I. J. KITCHING, pers. comm.).

Note: BRECHLIN (2009: 49) modified the l.t. of *zuleika* to “Naga Hills, Assam”, without further explanation; this is in contrast to the locality data provided by HOPE (1843) in the original description itself, nor does it fit the illustration of HOPE. Therefore we believe this “secondary type locality definition” by BRECHLIN is erroneous.

2. *orites* JORDAN, 1911

Rinaca zuleika orites subsp. nov.: JORDAN (1911a: 131 [not illustrated]), family Saturniidae. — L.t.: [India,] Sikkim. — ST series (number not indicated: “a long series of both sexes”) via coll. ROTHSCHILD (Tring) in BMNH [examined years ago]. Today, there are 7 ♂♂ and 4 ♀♀ in BMNH labelled „Darjiling, F. MÖLLER”, one ♂ of which bears a small round red-bordered “type” label and a hand-written label stating it is the type of *orites* (to our information this was never validly published). There is also a single ♀ labelled “Sikkim” from the H. J. ELWES collection. All were part of the ROTHSCHILD Bequest, 1939-1 (pers. comm. I. J. KITCHING). — We do not designate a LT, because there are so many specimens from Sikkim (and West Bengal) in so many collections that the identity of *orites* is not all in doubt; see Fig. 6 here.

Note: In contrast to the statement by NÄSSIG (1994a: 257, 1994c: 411), which was based on the listing of the names *orites* (and *hampsoni*) as “forma” by SCHÜSSLER (1933: 237), and not on the original paper of JORDAN (1911a), the taxon *orites* was not described by JORDAN as an infrasubspecific (i.e., unavailable) form, but explicitly at the (valid and available) rank of subspecies.

3. *hampsoni* SCHÜSSLER, 1933 [5. VIII.]

Rinaca zuleika f. *hampsoni* SCHÜSSLER form. nov.: SCHÜSSLER (1933: 237 [not illustrated]), family Saturniidae. — Infrasubspecific unavailable name (see below). — Locality of origin (ex HAMPSON 1893, by indication, Art. 13.1.2 of the Code, ICZN 1999; this is not a type locality, as infrasubspecific taxa do not have types and type localities): [India,] Naga Hills [no details]. No actual specimen was cited or illustrated (neither by HAMPSON nor by SCHÜSSLER; the illustration by HAMPSON 1993: 22 clearly shows a *S. zuleika* specimen with narrowed hw. eyespots, which is thus not available as basis for SCHÜSSLER’s form).

Nomenclatural note: SCHÜSSLER (1933) regularly differentiated between “forms” and “subspecies”. Although he interpreted the taxon *orites* also to be a “f[orma]” (in spite of it being described as subspecies), which was probably just SCHÜSSLER’s personal opinion about this JORDAN taxon, this is, in our opinion, a clear case of the original author giving the taxon *hampsoni* expressly infrasubspecific rank (Art. 45.6.4; see also Art. 45.6.1.). Therefore, the taxon *hampsoni*

is unavailable under zoological nomenclature (Art. 45.5.). — SCHÜSSLER’s (1933) catalogue (imprinted date on the wrapper: 5. VIII. 1933) was published before LE MOULT’s (1933) work (see below), but as *hampsoni* was described as an infrasubspecific taxon, they do not compete for priority.

4. *lesoudieri* LE MOULT, 1933 [{31.} XII.]

Rinaca zuleika [sic!] s/sp. *Lesoudieri* nova: LE MOULT (1933: 21 [not illustrated]), family Saturniidae [sic]. — L.t.: [northern Vietnam,] Chapa (Tonkin) [i.e., Fansipan mountain range]. — HT ♂ (by original designation): deposition not indicated, not examined; several PTs (number not stated) of both sexes, deposition not indicated. The deposition of these types of LE MOULT is presently unknown. — Synonymized with *S. zuleika* by NÄSSIG (1994b: 346); BRECHLIN (2009: 49) doubted this synonymy without providing any new information. — The wrapper of the volume containing LE MOULT’s description, as bound in the copy in the library Universitätsbibliothek Johann Christian Senckenberg in Frankfurt am Main, has a date imprinted: “December 1933”, i.e., [31.] XII. (Art. 21.3.1 of the Code). Therefore it is more recent than the publication by SCHÜSSLER (1933), but as *hampsoni* was described as an infrasubspecific taxon, they do not compete for priority.

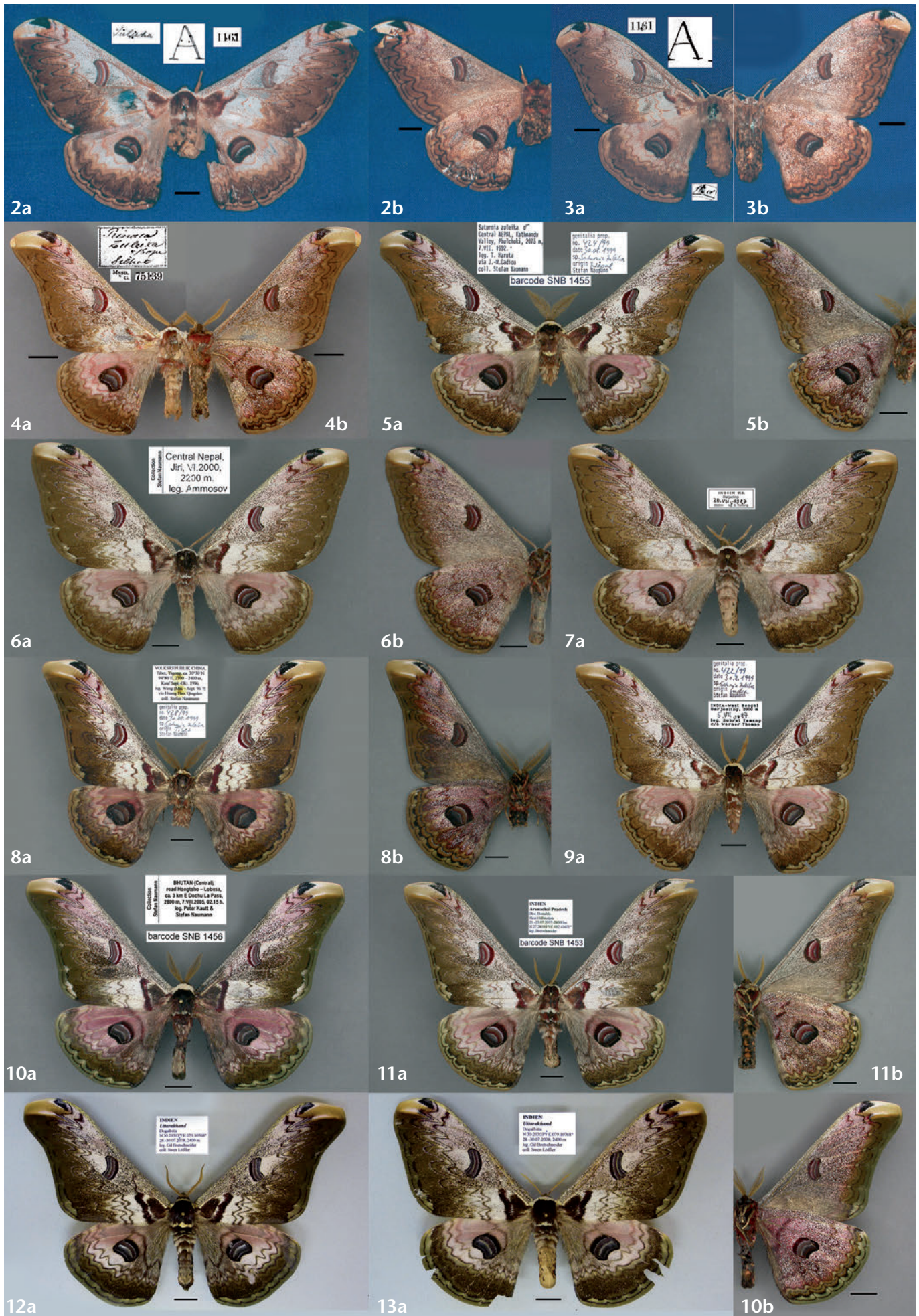
5. *malaisei* BRYK, 1944

Rinaca zuleika ssp. *malaisei* subsp. nova: BRYK (1944: 14, pl. 1, fig. 2), family Saturniidae. — L.t.: [Myanmar, border to China: Yunnan,] Kambaiti, 7000 ft. (= ca. 2350 m). — HT ♂ (by original designation): illustrated in NRSS (2010, in the WWW: low quality photos of specimen and ♂ genitalia); several PTs (number not indicated) of both sexes; deposition not indicated.

Systematic part: revision of the *zuleika*-group

Note: The altitudes given in the locality lists, especially for Chinese localities, refer mainly to the records of Chinese dealers, and we strongly suspect that altitudes given as e.g. 4000 or even 6000 m for localities in Yunnan or Tibet refer to the height of the mountain summit rather than to the real collecting locality somewhere on its slopes; serious data confirmed by European collectors range over lower altitudes (see also NAUMANN & NÄSSIG 2010: 56). Nevertheless, *S. zuleika* and *S. lesoudieri* are true mountain species not observed in lowlands below ca. 600 m; reliable altitude records range from ca. 600 to 3200 m, with most localities between 1800 and 2500 m.

Figs. 2–13: *Saturnia zuleika*, specimens. (Some old labels were transformed into greyscale and contrast enhanced to make them more clearly legible.) — **Figs. 2–3:** Possible ST specimens from OUM. The number “1161” is the species number from the SWINHOE catalogue (1892). **Fig. 2:** ♀ no. 1. **Fig. 3:** ♀ no. 2. **Fig. 4:** ♂, “Silhet” [locality most likely incorrect], ex coll. MAASSEN, ZMHU. **Fig. 5:** ♂, C. Nepal, Kathmandu valley, Phulchoki, 2075 m, 7. VII. 1992, leg. T. HARUTA, via J.-M. CADIOU in CSNB; BC SNB 1455. **Fig. 6:** ♀, C. Nepal, Jiri, 2200 m, VI. 2000, leg. AMMOSEV, CSNB. **Fig. 7:** ♀, India, W. Bengal, Darjiling, 2000 m, 30. VII. 1987, leg. S. TAMANG, via W. THOMAS via CWAN in CSNB. **Fig. 8:** ♂, China, C. Tibet, Yigong, 30.30° N, 94.80° E, 2300–2400 m, ca. v.–IX. 1996, leg. WANG, via Huang HAO in CSNB; GP SNB 428/99. **Fig. 9:** ♂, India, W. Bengal, Darjiling, 2000 m, 5. VII. 1987, leg. S. TAMANG, via W. THOMAS via CWAN in CSNB; GP SNB 422/99. **Fig. 10:** ♂, C. Bhutan, road Hongtsho–Lobesa, ca. 3 km E Dochu La, 2800 m, 7. VIII. 2005, leg. P. KAUTT & S. NAUMANN, CSNB; BC SNB 1456. **Fig. 11:** ♂, India, Arunachal Pradesh, Distr. Bomdila, near Hillstation, 27.28355° N, 92.41671° E, 2800 m, 21.–23. VII. 2007, leg. BRETSCHNEIDER, CSNB; BC SNB 1453. **Figs. 12, 13:** India, Uttarakhand, Dogalbitta, 30.29303° N, 79.10768° E, 2400 m, leg. G. BRETSCHNEIDER, CSLL; Fig. 12 ♂, Fig. 13 ♀. — Always: a = ups., b = uns. — Photos S.N., except Figs. 12, 13 (S. LÖFFLER). — Pictures not to the same scale. Scale bar (where present) = 1 cm.



According to our morphological and mtDNA barcode data (see Fig. 31), the systematics of the group should be interpreted as follows:

Saturnia (Rinaca) zuleika HOPE, 1843

= *Rinaca zuleika orites* JORDAN, 1911, syn. rev.

Here illustrated: Figs. 1 (illustration of the type, reproduced from HOPE 1843), 2–13 (specimens, col. pl. 1); genitalia plate: Figs. A–C; Fig. 31 (barcode similarity tree); Map (distribution data).

Distribution: The true *Saturnia zuleika* is an exclusively Himalayan species:

Nepal: HARUTA (1992 [as *Caligula zuleika*]: 93, pl. 25, fig. 6 plus frontpage of the Suppl.; 1994 [as *Caligula zuleika*]: 159); ALLEN (1993: 63, figs. 46.c & c, in error as „*Caligula thibet*“); [Bagmati District], Kathmandu valley, Phulchoki, 2075 m GP 424/99 SNB, BC 1455 SNB (CSNB); [Janakpur District], Central, Jiri, 2200 m (CSNB); [Sagarmatha District], Mt. Everest area, 2900 m, leg. GURKO (CSLL); Makwanpur District, Daman, 2308 m, leg. M. HOFFMANN, A. KUMAR (CSLL); [Gandaki District], Ganesh Himal, Phikuri Danda, 28.04198° N, 85.06345° E, 2900 m, leg. T. IHLE (CSLL).

India, Uttarakhand: Dogalbitta, 30.29303° N, 79.10768° E, 2400 m, leg. G. BRETSCHNEIDER (CSLL); Gaurikund, 30.37542° N 79.00349° E, 1700 m, leg. G. BRETSCHNEIDER (CSLL). — **West Bengal:** Darjeeling/Darjiling, 2000 m, leg. S. TAMANG and/or W. THOMAS, GP 422/99 SNB (CSNB, CWAN in SMFL); vic. Darjiling, Tiger Hill, 2400 m, leg. W. THOMAS (CSNB, CWAN in SMFL). — **Sikkim:** JORDAN (1911a); Pemayangtse, 2000 m, leg. W. THOMAS, GP 423/99 SNB (CSNB, CWAN in SMFL); “Sikkim, Darjeeling” [sic], vii. 1910, GP 1401/00 NÄSSIG (RMNH). — **Arunachal Pradesh:** distr. Bomdila, nr. hill station, 27.28355° N, 92.41671° E, 2800 m, leg. G. BRETSCHNEIDER, BC 1453 SNB (CSLL, CSNB); distr. Bomdila, road to Dirang, 27.28615° N, 92.42709° E, 2450 m, leg. G. BRETSCHNEIDER (CSLL).

Bhutan: Central, rd. Hongtsho–Lobesa, ca. 3 km E Dochu La, 2800 m, BC 1456 SNB (CSNB).

China, C. Tibet: ZHANG et al. (1986). WANG (1988, partim). Yigong, 30°30' N, 94°80' E, 2300–2400 m, GP 428/99 SNB (CSNB).

See Map.

Rearing report: ALLEN (1993: 69, in error as „*S. thibet*“); NÄSSIG (1994c, only the population from Darjiling, West Bengal, North India). See also in the discussion.

Cited in literature as:

Saturnia zuleika: HOPE (1843: 132, pl. XI, fig. 5); HAMPSON (1893: 21, fig. 11).

Saturnia Zuleica [sic]: SONTTHONNAX (1904: 89, pl. viii, figs. 2 & 3).

Saturnia zuleica [sic]: ANDRÉ (1908/09: 198).

Rinaca zuleika: WALKER (1855b: 1275); COTES & SWINHOE (1887: 230); COTES (1891: 84, pl. xiv, fig. 3); SILBERMANN (1897: 327); JORDAN (1911a: 131); BOUVIER & RIEL (1931: 49); SCHÜSSLER (1933: 236); BOUVIER (1936: 226, 226); SMITH (2001: 40).

Rinaca Zuleika: MOORE (1862: 320); WARDLE (1879: 501); KIRBY (1892: 761).

Rinaca Zuleica [sic]: MAASSEN (1872: p. [1], pl. 19, fig. 24).

Saturnia (Rinaca) zuleika: NÄSSIG (1994a: 256; 1994c: 411, pl. 1, figs. 6, 8, 9, 11, 12, 14, pl. 2, fig. 16 larvae); BRECHLIN (2009: 49).

Caligula zuleika: SEITZ (1928: 515, pl. 55 Ab, pl. 56 Ab); ZHU & WANG (1983: 413, pl. 134, fig. 2976, listing both species mixed together; 1993: 283, listing both species mixed together;

1996: 138, pl. viii, fig. 5, listing both species mixed together). WANG (1988: 461, listing both species mixed together). HARUTA (1992: 93, pl. 25, fig. 6; 1994: 159).

Caligula zuleoka [sic]: ZHANG et al. (1986: 25, pl. 8, fig. 63, listing both species mixed together).

Rinaca zuleika orites: JORDAN (1911a: 131).

Rinaca zuleica [sic] *orites*: BOUVIER (1936: 225).

Saturnia (Rinaca) zuleika f. *orites*: SCHÜSSLER (1933: 237). NÄSSIG (1994a: 257; 1994c: 411).

Caligula zuleika orites: SEITZ (1928: 515).

Caligula thibet: ALLEN (1993: 63, figs. 46a, b, fig. 52 larva [as “*C. thibet*”]).

Diagnosis. The two species can most easily and reliably be distinguished by the character already reported by JORDAN 1911: “... the [discocellular reniform spot] on hindwing ... incurved on distal side, being longer transversely to the veins than in basi-distal direction, while this eye-spot is rounded in *z. zuleika* [= *S. lesoudieri*!] and longest basi-distally.” This narrowing of the hw. eyespot is always present; the extent can sometimes be reduced, but the distal margin is always at least slightly indented. Further, *S. zuleika* has, on average, a higher proportion of white scales in the fw., while the colours of *S. lesoudieri* appear to be slightly more intense, and *lesoudieri*-♂♂ on average have a slightly broader fw. apex.

There are also a few small differences in ♂ genitalia morphology: The apical thorn of the phallus tube narrow and elongate in *S. zuleika*; sometimes quite acute (Nepal), sometimes more rounded (West Bengal, Sikkim); additional sclerite at the basal part of the vesica usually small; phallus tube diameter on average narrower than in *S. lesoudieri*. Saccus usually slightly narrower, but longer than in *S. lesoudieri*; juxta protuberances more laterally, shorter, with a broader base; harpe usually shorter, more rounded than in *S. lesoudieri*.

For larval differences, see Tab. 1.

Measurements. Lfw. ♂♂ 63–72 mm, average 66.1 mm ($n = 12$), ♀♀ 62–63 mm ($n = 2$); lhwa. ♂♂ 29–35 mm, average 32.5 mm ($n = 12$), ♀♀ 28/30 mm ($n = 2$); fw. eyespot, maximum diameter in basi-distal direction, ♂♂ 8–11 mm, average 8.7 mm ($n = 12$), ♀♀ 9/11 mm ($n = 2$); hw. eyespot, maximum diameter in basi-distal direction, ♂♂ 7–10.5 mm, average 9.1 mm ($n = 12$), ♀♀ 9.5/10 mm ($n = 2$); antennal length ♂♂ 13–16 mm, average 14.8 mm ($n = 12$), ♀♀ 12/12.5 mm ($n = 2$).

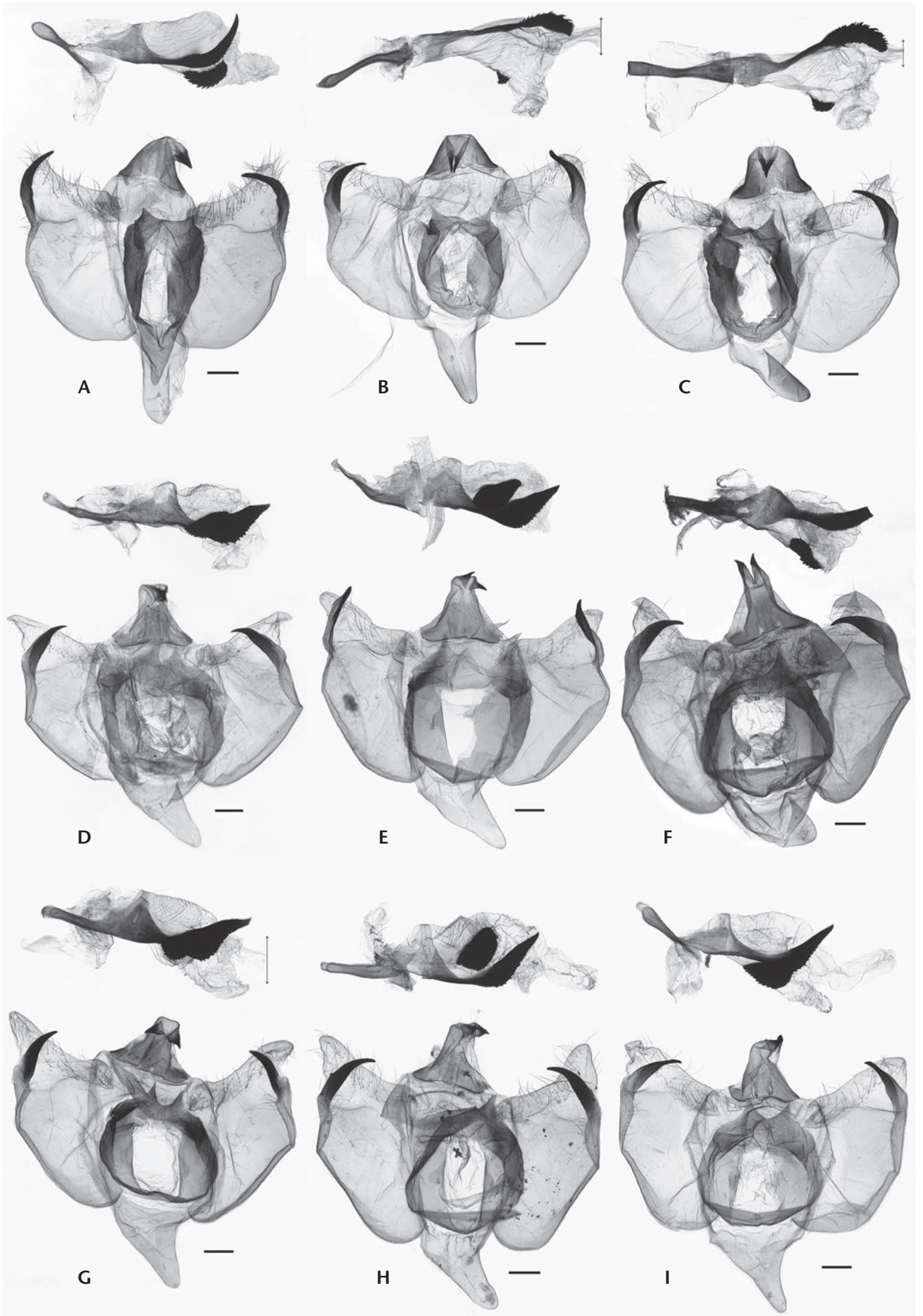
Saturnia (Rinaca) lesoudieri LE MOULT, 1933

= *Rinaca zuleika* [f.] *hampsoni* SCHÜSSLER, 1933 (infrasub-specific, unavailable).

= *Rinaca zuleika malaisei* BRYK, 1944, syn. n.

Here illustrated: Figs. 14–24 (specimens, col. pl. 2); 25–30 (larval instars); genitalia plate: Figs. D–I; Fig. 31 (barcode similarity tree); Map (distribution data).

Figs. A–I: ♂ genitalia. — **Figs. A–C:** *Saturnia zuleika*. — **Fig. A:** Nepal, GP SNB 424/99. **Fig. B:** India, Sikkim, GP SNB 423/99. **Fig. C:** India, West Bengal, GP SNB 422/99. — **Figs. D–H:** *S. lesoudieri*, Indochinese population. — **Fig. D:** N. Vietnam, GP SNB 427/99. **Fig. E:** N. Thailand, GP SNB 426/99. **Fig. F:** China, Yunnan, GP SNB 430/99. **Fig. G:** China, Yunnan, GP SNB 431/99. **Fig. H:** China, E. Tibet, GP SNB 429/99. — **Fig. I:** *S. lesoudieri*, Meghalaya population, GP SNB 425/99. — Pictures not to the same scale. Scale bar = 1 mm. Photos: S.N.



Distribution:

India, Meghalaya: Khasi[a] Hills, Shillong–Mawphlang, 600–1000 m (CSNB [GP 425 & 432/99 SNB, BC 2011 & 2012 SNB], CSLL, CWAN in SMFL [BC B3219–wn-B03]). Khasi Hills, vic. Shillong, ca. 1250–1500 m (BC B3219–wn-B01/02, CWAN in SMFL). Assam, Khasia Hills, 1926, coll. R. GSCHWANDNER, e.l. C.[?] ZACHER[?] (NHMW). “Assam 1920, Khasia Hills”, GP ♂ 1402/00 (RMNH, GP ♂ 1402/00 NÄSSIG). — **Nagaland:** Naga Hills (BMNH, SMTD, NHMW).

Myanmar, Kachin State: Kambaiti (BRYK 1944); Chudu Razi Hills, ca. 50 km E Kawnlangphu, leg. local coll., via A. M. COTTON, GP 2150/10 SNB, BC 1457 SNB (CSNB, via CSNB in CSLL); Kanphant, 26°8.512' N, 98°34.582' E, 1642 m, leg. M. LANGER, S. LÖFFLER & S.N. (CSLL). — **Shan State:** Shoe Pin (Shopping) vill., Utut Ni pass, 1773 m, 20°57.142' N, 96°37.635' E, leg. P. SPONA, T. IHLE & S. LÖFFLER (CSLL, via CSLL in CSNB); Sekya Inn village, Utut Ni pass, 10 km W Pindaya, 20°56.635' N, 96°37.523' E, 1712 m, leg. P. SPONA, T. IHLE & S. LÖFFLER (CSLL); Yee Htut village, Utut Ni pass, 18 km W Pindaya, 20°56.935' N, 96°36.390' E, 1804 m, leg. P. SPONA, T. IHLE & S. LÖFFLER, BC 2014 SNB (CSLL). — **Chin State:** Chin Hills, Mt. Victoria (Natma Taung) NP, 31 miles camp road Mindat–Matupi, 21°29.796' N, 93°47.365' E, 2455 m, leg. P. SPONA, T. IHLE & S. LÖFFLER, BC 2013 SNB (CSLL, via CSLL in CSNB); 20 miles camp road Mindat–Matupi, 21°25.152' N, 93°47.215' E, 2350 m, leg. M. LANGER, S. LÖFFLER & S.N. (CSLL); 9 miles W Mindat, Baw Kwe village agricultural station, 21°22' N, 93°55' E, 1844 m, ex wild collected pupa, leg. T. IHLE, S. LÖFFLER & S.N. (CSLL).

China, Tibet (Xizang Zizhiqu): E, Meilixueshan, vic. Yangging, ca. 6000 m[?], leg. WANG & LI, GP 429/99 SNB (CSNB); Jiulong County, Shangri La, 3200 m, leg. G. BRETSCHEIDER (CSLL). — **Yunnan:** NW, Dali Bai auton. pref., Yunlong co., 25.46° N, 99.06° E, Fengshuining Mts., 2600 m (CWAN in SMFL); NW, Deying, Baimaxueshan, 4000 m[?], leg. YING, GP 430 & 431/99 SNB, BC 2015 SNB (CSNB, via CSNB in CWAN in SMFL); NW, Daxueshan, Deying, 2500 m, leg. YING (CSLL); N, Sanfengshan, Yao-An, 2897 m, leg. YIN (CSLL); SW, Yongde, 3504 m, leg. YIN (CSLL); SE, Maguan, Suiyuan Qing, 2500 m, leg. LI & TU (via CSNB in CWAN in SMFL). — **Sichuan:** Huili (ZHU & WANG 1983. Daxue Shan, 40 km W Mianning, 28°34' N, 102° E, 2750 m, leg. SINIAEV & PLUTENKO (CWAN in SMFL); S, Daheishan, Panzihua, 1800 & 2100 m, leg. YING, JIN (CSLL). — **Guangxi:** Yinxiu, Dayaoshan, 1600 m, leg. LI, BC 1458 SNB (CSNB).

Thailand: PINRATANA & LAMPE (1990); N, Chiangmai prov., Doi Inthanon (several localities), GP 426/99 SNB (CSLL, CSNB, CWAN in SMFL); N, Chiangmai prov., Doi Phahompok nr. Fang, 2100 m, BC 2016 SNB (CSNB, CWAN in SMFL). **Laos:** Central, 100 km E Louang Phrabang (Prabang), ca. 1400–1600 m (BROSCH et al. 1999: 48).

Vietnam: LE MOULT (1933); N, Mt. Fansipan, Chapa vic., several localities, GP 427/99 SNB, BC 1459 SNB (CSNB, CWAN, CSLL); Mai-chau, 20°50' N, 104°50' E, 40 km SE Moc-chau, 1400 m, leg. SINIAEV, c/o A. SCHINTLMIESTER (CWAN in SMFL).

See Map.

Rearing report: NÄSSIG (1994c, only the population from northern Thailand); LAMPE (2010: 318, 361, from China, Yunnan). See also Figs. 25–30 from rearings by Steve KOHL (Fig. 25, Yunnan, Xishuangbanna, Jinghong, 1000 m) and S.N. (Figs. 26–30) in 2003.

Cited in literature as:

Saturnia zuleika: LAMPE (2010: 361, pl. 313 [erroneous authorship: HOPE 1933]).

Saturnia (Rinaca) zuleika: NÄSSIG (1994b: 346 [with *lesou-*

dieri cited as syn. n.]; 1994c: pl. 1, figs. 7, 10, 13 larvae); BRECHLIN (2009: 49).

Caligula zuleika: ZHU & WANG (1983: 413, pl. 134, fig. 2976, listing both species mixed together; 1993: 283, listing both species mixed together; 1996: 138, pl. viii, fig. 5, listing both species mixed together); WANG (1988: 461, listing both species mixed together); PEIGLER & WANG (1996: 168, figs. pp. 165 & 166 [erroneous authorship: HOPE 1842]); D'ABRERA (1998: 32, figs. p. 33, from Nagaland, Naga Hills; he stated the following nonsensical sentence: “This magnificent species has hitherto been erroneously treated in the genus *Rinaca*” [sic]).

Caligula zuleoka [sic]: ZHANG et al. (1986: 25, pl. 8, fig. 63, listing both species mixed together).

Rinaca zuleika f. *Hampsoni*: SCHÜSSLER (1933: 237). NÄSSIG (1994a: 257; 1994c: 411).

Rinaca zuleika [sic] *Lesoudieri*: LE MOULT (1933: 21).

Rinaca zuleika: PINRATANA & LAMPE (1990: 34, pl. 40).

Saturnia (Rinaca) zuleika lesoudieri: NÄSSIG (1994a: 257; 1994c: 411); BROSCH et al. (1999: 48).

Rinaca zuleika malaisei: BRYK (1944: 14, pl. I, fig. 2); NAUMANN et al. (2008: 151 [original combination retained]).

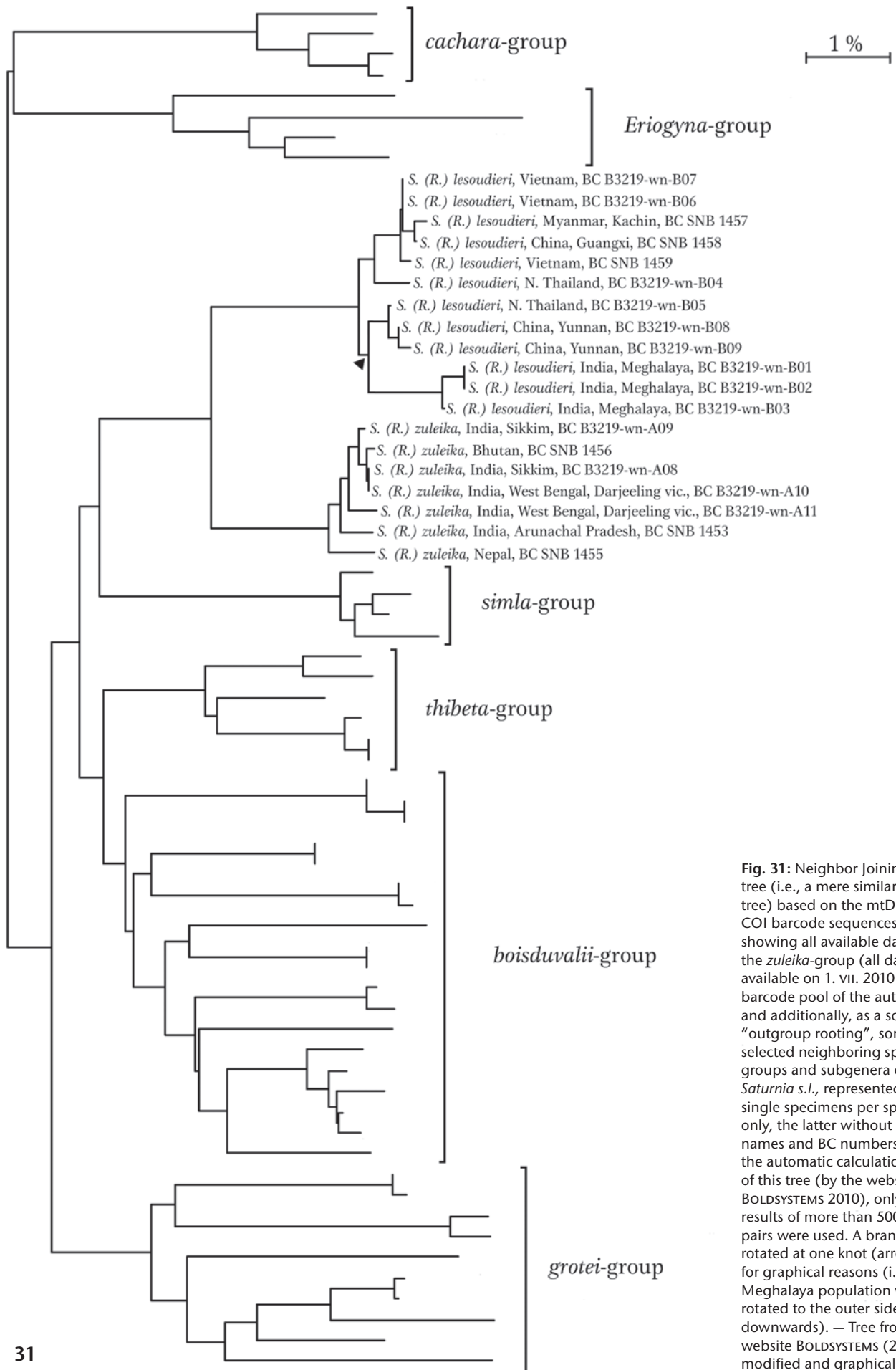
Saturnia (Rinaca) zuleika malaisei: NÄSSIG (1994a: 257; 1994c: 412).

Most old citations regarding Khasi (and Naga) Hills referred to the misidentified type locality “Silhet” and to specimens with narrowed hw. eyespots, not to actual specimens with round hw. eyespots. Thus, most references from that area are misleading and, therefore, not listed here.

Diagnosis. See diagnosis above for *S. zuleika*. The hw. eyespot of *S. lesoudieri* is always round or at maximum sometimes with a straight, never indented, distal margin. The apical thorn of the phallus tube of *S. lesoudieri* always large, broad, nearly triangular (except GP SNB 430/99 from Yunnan, see GP plate Fig. F; the tip appears to be broken); the additional sclerite at the basal part of

Figs. 14–24: *Saturnia lesoudieri*, specimens. — **Figs. 14–15:** Meghalaya population. **Fig. 14:** ♂, India, Meghalaya, Khasi Hills, rd. Shillong–Mawphlang, 600–1000 m, ix. 1995, leg. local coll., BC B3219–wn-B03, via L. DEL CORONA via CSNB via CWAN in SMFL. **Fig. 15:** ♂, India, Meghalaya, Khasi Hills, rd. Shillong–Mawphlang, 600–1000 m, vii.–viii. 1997, leg. local coll., via L. DEL CORONA in CSNB. — **Figs. 16–24:** Indochinese population. **Fig. 16:** ♂, N. Vietnam, Mt. Fan-si-pan Westseite, Cha-pa, 1600–1800 m, 20°22' N, 103°40' E, Sekundärwald, ix. 1994, leg. MONG, via A. SCHINTLMIESTER in CSNB; BC SNB 1459. **Fig. 17:** ♀, N. Vietnam, Mt. Fansipan, Chapa, 2400 m, 8.–28. v. 1993, leg. V. SINIAEV & K. SIMONOV, CSNB. **Fig. 18:** ♂, Myanmar, Shan State, Shoe Pin vill., Utut Ni pass, 1773 m, 20°57.142' N, 96°37.635' E, 4.–5. viii. 2007, leg. P. SPONA, T. IHLE & S. LÖFFLER, via CSLL in CSNB. **Fig. 19:** ♂, N. Thailand, vic. Chiangmai, Mae Ai, Doi Pha Hom Pok, 2000 m, 13.–18. vii. 2004, leg. T. IHLE, via CSLL in CSNB. **Fig. 20:** ♂, Myanmar, Kachin State, Chudu Razi Hills, ca. 50 km E Kawnlangphu, 15. viii. 2007, leg. local coll., via A. M. COTTON in CSNB; BC SNB 1457, GP SNB 2150/10. **Fig. 21:** ♂, Myanmar, Chin State, Chin Hills, Mt. Victoria Natl. Park, 31 Miles Camp road Mindat–Matupi, 21°29.796' N, 93°47.365' E, 2455 m, 10. viii. 2007, leg. P. SPONA, T. IHLE & S. LÖFFLER, via CSLL in CSNB. **Fig. 22:** ♂, China, NW Yunnan, Baimaxue Mt., vic. Dexin, ca. 4500 m[?], vi. 1999, leg. WANG & LI, CSNB; GP SNB 431/99. **Fig. 23:** ♂, China, Guangxi, Yinxiu, Dayaoshan, 1600 m, ix. 2003, leg. LI, CSNB; BC SNB 1458. **Fig. 24:** ♀, China, E Tibet, Meilixueshan, vic. Yangging, ca. 6000 m[?], vii. 1999, leg. WANG & LI, CSNB. — Always: a = ups., b = uns. — **Figs. 25–30:** Caterpillars of *S. lesoudieri*, L₁–L₄ (ultimate instar lacking). **Fig. 25:** L₁, Yunnan, Xishuangbanna, Jinghong, 1000 m. **Fig. 26:** L₂. **Fig. 27:** L_{2/3} in moult. **Fig. 28:** L₃. **Fig. 29:** L₄, penultimate instar (last instar looks nearly identical). **Fig. 30:** L₄, details of anal area. — Photos S.N., except Figs.: 14 (W.A.N.); 25 (S. KOHL). — Pictures not to the same scale. Scale bar (where present) = 1 cm.





Tab. 1: Differences between the preimaginal stages of the two species of the group of *Saturnia (Rinaca) zuleika*.

Instar	<i>Saturnia zuleika</i> (Himalaya) (see NÄSSIG 1994c: figs. 6, 8, 9, 11, 12, 14, 16)	<i>Saturnia lesoudieri</i> (Indochinese population) (see Figs. 25–30 here; also NÄSSIG 1994c: figs. 7, 10, 13; also LAMPE 2010: p. 318 pl. 313, p. 361)
L ₁ larva	Black, sublaterally sometimes brighter, head dark reddish (NÄSSIG 1994c: fig. 6)	Black incl. head, only ventral side brighter (Fig. 25 here; NÄSSIG 1994c: fig. 7).
L ₂ larva	Head and last segments reddish, dorsally yellowish-white with a greyish dorsal line with black dots in it; laterally blackish (NÄSSIG 1994c: fig. 6)	Head and last segments reddish, dorsally white without a mid-dorsal pattern; laterally blackish; legs yellowish (LAMPE 2010: pl. 313)
L _{3/4/5} larva (last three instars are very similar)	Body ground colour laterally and ventrally whitish-blue, dorsally bluish-white, with a white lateral stripe below the spiracles indicated; head and abdominal legs like body, thoracic legs reddish. Back and (lesser so) lateral sides covered with dense, long white hairs; in natural resting position an effective counter-shading, with the long white hairs giving the larvae a strange appearance. Between the white hairs bluish mechanical defensive bristles on the white scoli. A large, conspicuous pinkish dot laterally on the anal legs, partially framed with black.	Very similar to <i>S. zuleika</i> . The only possible difference appears to be the size and shape of the pinkish lateral anal dot, in <i>S. lesoudieri</i> usually slightly more rounded and perhaps a bit larger, in <i>S. zuleika</i> slightly drop-shaped.
Foodplants	See text.	See text.
Cocoon/ pupa	Similar to <i>S. thibeta</i> and the <i>simla</i> -group: large, pear-shaped, open-meshed, rather soft, with preformed valve-like exit ("Reuse").	As in <i>S. zuleika</i> . Cocoon and pupa illustrated by LAMPE (2010: pl. 313).

the vesica is larger, more massive; uncus slightly deeper incised in the middle. For larval differences, see Tab. 1.

Measurements (for *S. lesoudieri* from east and south of India, i.e. except Meghalaya and Nagaland). Lfw. ♂♂ 65–76 mm, average 72.7 mm ($n = 39$), ♀♀ 60–80 mm, average 72 mm ($n = 4$); lhwa. ♂♂ 33–36 mm, average 35.0 mm ($n = 10$), ♀♀ 32–35 mm, average 33.6 mm ($n = 3$); fw. eyespot, maximum diameter in basi-distal direction, ♂♂ 9–10 mm, average 9.5 mm ($n = 10$), ♀♀ 10–10.5 mm, average 10.4 mm ($n = 3$); hw. eyespot, maximum diameter in basi-distal direction, ♂♂ 10–10.5 mm, average 10.4 mm ($n = 10$), ♀♀ 9.5–10.5 mm, average 10 mm ($n = 3$); antennal length ♂♂ 15–17 mm, average 16.1 mm ($n = 15$).

Measurements (*S. lesoudieri* from Meghalaya, ♂♂ only). Lfw. ♂♂ 68–73 mm, average 70.6 mm ($n = 5$); lhwa. ♂♂ 35–36 mm, average 35.4 mm ($n = 5$); fw. eyespot, maximum diameter in basi-distal direction, ♂♂ 9–10 mm, average 9.5 mm ($n = 5$); hw. eyespot, maximum diameter in basi-distal direction, ♂♂ 10–10.5 mm, average 10.3 mm ($n = 5$); antennal length ♂♂ uniformly 17 mm ($n = 5$).

Within the species *Saturnia lesoudieri* only the population from the former Assam (Khasi Hills; the population from the Naga Hills has not yet been barcoded) stands out, with barcode differences of nearly 1% (Fig. 31) from the SE Asian populations (the Chin State population has not been barcoded so far as well). This might potentially allow a differentiation into two subspecies; however, we refrain from describing a separate subspecific taxon here to avoid formal problems with Art. 13.1.1. of the Code: The difference between the two populations is primarily based on the barcode only. The apical thorn of the phallus tube appears to be on average slightly more elongate in the Meghalayan *S. lesoudieri* than in the other populations.

Discussion

Subgenera in *Saturnia*: general notes

As was shown only recently (NAUMANN & NÄSSIG 2010), the systematic and phylogenetic subdivision of the genus *Saturnia* VON PAULA SCHRANK, 1802 into subgenera appears to require re-assessment on the basis of new

results, compared to the 16 year old summary by NÄSSIG (1994a). However, *Saturnia zuleika* HOPE, 1843 is the type species of the genus *Rinaca* WALKER, 1855; therefore, this subgeneric name remains available for the species-group dealt with here and consequently is used here.

In earlier publications, the second author (NÄSSIG 1994a, b, c) hypothesized that *Saturnia zuleika* and *S. thibeta* WESTWOOD, 1853 may be sister-species based on supposed synapomorphies in preimaginal (especially larval) morphology (compare also NÄSSIG [in NARDELLI] 1986 and NÄSSIG 1994c; the larva of Indian *S. thibeta* appears already to have been known to MOORE 1862: 322, although not illustrated). [A similar hypothesis regarding imaginal morphology was probably the reason for KIRBY 1892, in addition to *S. zuleika*, also including *S. thibeta* and *R. extensa* BUTLER, 1881 within *Rinaca*, while, e.g., HAMPSON 1893 placed all these within *Saturnia*.] This earlier hypothesis is not supported by DNA sequencing results from the recent barcode studies, according to which, the sister-group of the *zuleika*-group [= *S. zuleika* + *S. lesoudieri*] appears to be the *simla*-group, while the sister-group of the *thibeta*-group appears to be the *boisduvalii*-group of the genus *Saturnia* (see Fig. 31).

However, this is not yet a definitive result. Any changes to the species and specimen composition (i.e., adding new genera, species or specimens, as well as leaving out some genera, species or specimens) used for the automatic calculation of the Neighbor Joining tree by the BOLDSYSTEMS website may lead to (sometimes drastic!) changes in the structure of the similarity tree above the species-groups (which, in fact, is not a phylogenetic tree anyway). Based on the tree shown in Fig. 31, which is based on all *S. zuleika*/*S. lesoudieri* specimens available at the date of calculation (1. VII. 2010), but uses only a small part of the data of the large genus *Saturnia* s.l. and leaves out some subgenera, the subgenus *Rinaca* could well be used for the apparently monophyletic composit of species-groups of ([*zuleika*, *simla*], [*thibeta*, *boisduvalii*]), *grotei*, while the *cachara*-group remains clearly outside this frame and, in

the given structure of the tree, would even require the description of a new subgenus name. Other trees downloaded by us, with other genera and specimens included, resulted in quite different inter- and intrageneric structures; only species-groups (or small to very small [sub-] genera) appear to remain rather stable among the different trees. Further studies are necessary to stabilize these preliminary results.

The subgenera of the genus *Saturnia*: *Rinaca* and/or *Caligula*?

MIRANDA & PEIGLER (2007: 436) argued that the [sub-] generic name *Rinaca* should be used only for the species *zuleika* (i.e., now *S. zuleika* and *S. lesoudieri*). They denied the general applicability of *Rinaca* to those species earlier subsumed under a separate genus *Caligula* and then included in the subgenus *Rinaca* within *Saturnia* by NÄSSIG (1994a) and other authors. (The starting point for this systematic concept of *Caligula* was mainly JORDAN 1911b and SEITZ 1928, see above; but also keep in mind the story of *Dictyoploca*.)

MIRANDA & PEIGLER (2007) correctly noted that *Caligula* in the classic sense is not monophyletic, a conclusion that is now supported not only by imaginal and larval morphology, but also in the DNA-COI barcodes. They also found some supposedly monophyletic species-groups of the former genus *Caligula* that are at least to some degree similar or even identical to those shown above in the barcode tree (Fig. 31), but due to a different species and [sub-]genus coverage in comparison to our study, these are not easily compared. In the introduction, MIRANDA & PEIGLER (2007: 436) had already indicated very similar phylogenetic lineages (the *zuleika*-group excluded, because they had no material for their study) to those indicated in our own results (see above), i.e. they believed to have the following monophyletic species-groups: *simla*, *grotei* (with *thibeta* possibly included here), and *cachara*. However, in contrast to MIRANDA & PEIGLER (2007), we do not see any justification for retaining a separate genus *Rinaca* for the *zuleika*-group alone. The arguments of MIRANDA & PEIGLER for retaining both *Rinaca* and *Caligula* (as genera or subgenera) do not appear to be helpful because:

- The species-groups of *simla* and *zuleika* appear to be possible sister-groups; the type species of *Rinaca* is *zuleika*, that of *Caligula* is *simla* (see above). If both *Caligula* and *Rinaca* are retained as [sub-]generic names, several new [sub-]generic names would become necessary to avoid paraphyly of all other groups (e.g., when adopting the structure provisionally applied here: 1. for the *thibeta*-group, 2. for the *boisduvalii*-group, 3. for the *grotei*-group, 4. for the *cachara*-group, just to name those illustrated in Fig. 31).
- Further, both species-groups (*simla* and *zuleika*) are rather terminal branches in the barcode similarity tree. Provided that there is at least *some* phylogenetic information in the barcode tree at that rather low

level, if all terminal branches are to be given different names in the genus-group, we would need too many names in total – and we already have too many in most families of Lepidoptera anyway. It is much better to name the basal branches only and unite the terminal ones (provided they are apparently closely related) together. Propagating the creation of too many new names in the genus-group is nonsensical, because it degrades the overall conceptual and phylogenetic value of the genus category.

In general, it is always dangerous to use only a single character or character set to hypothesize phylogenies (see WIEMERS & FIEDLER 2007). Only a combination of

- as many different characters as possible from different methodological approaches (best independent characters and approaches), and
- additional ideas or hypotheses about the evolutionary direction of character shifts (as far as such ideas are available and likely)

may lead to a reliable cladogram. We are not yet in the state of knowledge for such a reliable phylogeny, but our aim is to learn more about and eventually reach the level of “integrative taxonomy”, as propagated by, e.g., DAYRAT (2005), WILL et al. (2005), or SCHLICK-STEINER et al. (2010).

The two species of the *zuleika*-group

The differences between the Himalayan *Saturnia* (*R.*) *zuleika* and the more widely distributed species *S. (R.) lesoudieri* are rather minor, but evidently constant. They comprise differences in larval morphology (see Tab. 1), hw. eyespot shape, ♂ genitalia and COI mtDNA base sequences (barcode). Earlier publications often noticed at least some of these differences (e.g., HAMPSON 1893, JORDAN 1911a, SCHÜSSLER 1933, LE MOULT 1933, BOUVIER 1936, BRYK 1944, NÄSSIG 1994b, c, BRECHLIN 2009), but did not consider them for species separation. We believe that the two taxa *Saturnia* (*R.*) *zuleika* and *S. (R.) lesoudieri* are two clearly distinct species, and the differences found in many characters support our idea.

Due to the fact that we do not have a dense sampling of localities, especially in the eastern Himalaya and the mountains between the Brahmaputra and Irrawaddy rivers and from the Cachar hills, and also that we do not yet have barcode results from Nagaland and Chin State, there is still a possibility that the species *S. zuleika* and *S. lesoudieri* are not fully separated, in spite of the rather large differences in the barcode. There is an especially large sampling “gap” in the NE corner of Arunachal Pradesh and in the neighboring area of NW Yunnan/SE Tibet across the border to China. The separation of the Himalayan *S. zuleika* from the other populations was probably rather recent.

We do not yet know about the status of the Khasi Hills, Naga Hills and West Chin State (Mt. Victoria area) populations of *S. lesoudieri*. According to barcode results, spe-

cimens from the Kachin State (near Yunnan border) in Myanmar doubtlessly belong to the true Indochinese *S. lesoudieri*, while the populations from Meghalaya show a clear difference in barcodes. However, as there are no evident “hard” morphological differences between the two populations, a status change (i.e., the description of a subspecies) could at present only be supported by mtDNA COI barcode studies (i.e., DNA base sequences), which appears to be slightly insufficient at present (Art. 13.1.1. of the Code). Also, the status of especially the Naga Hills and West Chin State populations appears to be crucial here for understanding the genetics and evolution.

Notes on the preimaginal instars of both species

Interesting, perhaps, is the rather slow development of the larvae of *S. zuleika* (and probably also *S. lesoudieri*) (see NÄSSIG 1994c: 413). Both species need (in Europe) about 7–9 weeks from egg to cocoon spinning (and the usual 5 instars); other *Saturnia* species usually only need between 4 and 6 weeks. The species of the *Eriogyna* species-group of *Saturnia* (*S. pinratanai* and *S. pyretorum*: 7 instars and about 4 months, see LAMPE & NÄSSIG 1994) need even longer for their development.

Reported larval foodplants: COTES (1891: 84) lists food-plant data for *S. zuleika* from Sikkim (based on observations by Mr. MÖLLER): *Acer caudatum* = *campbellii* (Aceraceae) and *Actinodaphne sikkimensis* (Lauraceae). SILBERMANN'S (1897: 327) information about “wild pear” is too vague and useless (Rosaceae hostplant?). ANDRÉ (1908/09: 199) merely cites from COTES (1891) without referring to this publication. (COTES is probably also the source for some other subsequent authors not listing this reference.) NÄSSIG (1994c: 413) reared *S. lesoudieri* from N. Thailand in Germany (to L₃ only) on *Acer pseudoplatanus* (Aceraceae) and *S. zuleika* (successful from egg to moth) from Darjiling on different *Salix* species (Salicaceae). T. HARMAN (pers. comm.) also reared successfully the species in England on *Salix* spp. The pictures in ALLEN (1993) came from him and were not based on *thibeta* larvae reared on avodado as indicated in the erroneous legends (a mix-up by the printer, not by the author, M. G. ALLEN, pers. comm.). In 2003, one of the present authors (S.N.) reared *S. lesoudieri* from Yunnan to adults on *Liquidambar* sp. (Hamamelidaceae). In the same year, LAMPE (2010: p. 318 pl. 313, p. 361) successfully reared Yunnanese larvae of *S. lesoudieri* on *Salix caprea*. The larvae appear to be rather polyphagous, but not easy to rear (there are generally many losses).

The larval habitus is quite similar to that of larvae of the *thibeta*-group: older larvae (last 3 instars) are covered on the dorsal side especially (= the underside when normally sitting under twigs), less so laterally, with a dense cover of very long soft whitish-green to whitish-blue hairs, which give the larva a strange appearance, as if it were sitting in a sort of silken cocoon. However, under this very dense layer of soft hairs there are also bluish spiny bristles on

the scoli which can pierce the skin of someone touching the larva; these bristles appear to serve only a mechanical defensive function, no secretion was observed. These hairs are probably also part of a countershading in the normal resting position, but may also (in humid rainy mountain cloud forest, the natural environment) suggest a cocoon or a mat of fungi growing on something rotten. However, the anal prolegs are covered laterally with a large pinkish dot with black frame that is surely either an eye mimic or a type of aposematic pattern. The older larva can produce a loud clicking and chirping sound with its mandibles, as do many other large Saturniidae caterpillars.

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Die Zahl der Arbeiten über Saturniidae mit C. LEMAIRE als (Ko-) Autor steigt damit auf 103.

Patronyme

Hispaniodirphia lemaireiana ROUGERIE & HERBIN, 2006

ROUGERIE, R., & HERBIN, D. (2006): *Hispaniodirphia lemaireiana* n. sp., a new saturniid from the Greater Antilles (Lepidoptera: Saturniidae, Hemileucinae). — *Zootaxa* **1204**: 53–59.

(Siehe auch unter www.mapress.com/zootaxa/2006f/z01204p059f.pdf; Abstract frei erhältlich, Text nur gegen Bezahlung.)

NOVA SPECIES. — Ausdrückliche Widmung.

[VIVES MORENO (2004) hat offenbar unsere Patronymliste übernommen, aber dabei einige Schreibfehler eingefügt: „*Palaemolis*“, „*Xanthisa*“, „*Lemairegia* THIAUCORT“, „*Eucles*“.]

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ROUGERIE, R., & HERBIN, D. (2006): *Hispaniodirphia lemaireiana* n. sp., a new saturniid from the Greater Antilles (Lepidoptera: Saturniidae, Hemileucinae). — *Zootaxa*, Auckland, **1204**: 53–59.

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(Siehe auch unter: redalyc.uaemex.mx/redalyc/src/inicio/ArtPdf-Red.jsp?iCve=45512701.) [Letzter Besuch der Seite: Juni 2010.]

Stefan NAUMANN, Ulrich BROSCHE & Wolfgang A. NÄSSIG

Corrigenda

To: NAUMANN, S., & NÄSSIG, W. A. (2010): **Two species in *Saturnia* (*Rinaca*) *zuleika* HOPE, 1843 (Lepidoptera: Saturniidae).** — *Nachrichten des Entomologischen Vereins Apollo*, Frankfurt am Main, N.F. **31** (3): 127–143.

Regrettably, a few errors have found their way into some of the recent publications.

On p. 132, under “*2. orites* JORDAN, 1911”, in the last line of the first paragraph, there are two misprints:

(1) In “the identity of *orites* is not all in doubt”, the little word “at” should be added; the correct text is: “the identity of *orites* is not at all in doubt”.

(2) We changed the composition of the plates several times. In an earlier version, Fig. 6 really depicted a specimen from Sikkim. However, we intended to preferably show specimens from other

localities rarely published before, so we changed the pictures, but overlooked to delete this cross-reference to the former Fig. 6 for Sikkim. We did not illustrate any longer a specimen from Sikkim in the printed version.

To make this clear beyond any doubt: for the taxon *orites* JORDAN, 1911, there is just a syntype series in BMNH, and we did not designate a lectotype in our paper, although this specimen with the “type” label might be well available for such a purpose. However, a designation of a LT does not appear to be necessary here.

wng.

To: NÄSSIG, W. A., KITCHING, I. J., PEIGLER, R. S., & TREADAWAY, C. G. (2010): **The group of *Cricula elaezia*: Comments on synonyms and priority questions, with illustrations of barcode similarity trees, distribution maps, a revised checklist and a formerly unknown female (Lepidoptera: Saturniidae).** — *Nachrichten des Entomologischen Vereins Apollo*, Frankfurt am Main, N.F. **31** (3): 145–165.

(1) On p. 146, right column, last paragraph at the bottom, last lines, we wrote that the journal ESS is printed in the house of F. MEISTER. However, Ron BRECHLIN informed me that they, in fact, use a commercial printer in Pasewalk. My apologies for this misunderstanding.

According to the invoice which RB showed me, 50 copies of the cover of ESS 3 (1) were printed on 8. I. 2010, together with 20 copies of the text. As these samples were just as well never validly published in the sense of the Code, this correction does not at all influence the results of our paper and the invalidity of U. PAUKSTADT's interpretations as demonstrated in our paper. Unpublished journal issues remain unpublished, regardless of the technical printing method used.

Additional note: This incorrect interpretation (not supported by the Code) of “two published versions” of ESS 3 (1) is regrettably

also shown in the internet (see, e.g., www.insectaweb.org/MWM/html/museum_entomo_satsphingia_en.html); this should preferably be changed to avoid further misinterpretations by subsequent authors; the footnote is (in my opinion) not sufficient.

(2) The species name [*Cricula*] *quinquefenestrata* is printed 13 times in the paper; in 11 cases it is spelled correctly. However, in two cases there is a misspelling “*quinquefenestrata*”; regrettably at prominent places: one of these misspellings is found on p. 156 in the headline of the catalogue entry for the species, the other one in the checklist on p. 162. Nobody of the authors noticed this, only Jeremy D. HOLLOWAY, London, found it, but his note came too late to change the then already printed paper (thanks for informing me, Jeremy!).

wng.

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Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Nachrichten des Entomologischen Vereins Apollo](#)

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Autor(en)/Author(s): Naumann Stefan, Nässig Wolfgang A.

Artikel/Article: [Two species in Saturnia \(Rinaca\) zuleika Hope, 1843 \(Lepidoptera: Saturniidae\) 127-143](#)