

Revisional notes on the species-group of *Saturnia cachara*, with description of a new subgenus and a new species (Lepidoptera: Saturniidae)¹

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Abstract: The new subgenus *Cachosaturnia* subgen. n. is introduced for the species-group comprising *Saturnia cachara* (MOORE, 1872) and relatives. Type species is *S. (C.) cachara*, subgen. comb. n. The new subgenus contains three species: *S. (C.) cachara*, for which a male lectotype is designated (in BMNH, London), *S. (C.) heinrichi* (LEMAIRE, 1976) subgen. comb. n., and *S. (C.) victoria* sp. n. (holotype male in ZMHU Berlin) which occurs syntopical with the latter. Type material, further specimens and the preimaginal instars of all three species are figured, an overview of the subgenus and its distribution is presented.

Key words: *Saturnia*, *Cachosaturnia*, new subgenus, new species, lectotype designation, Myanmar, Chin State

Beitrag zu einer Revision der Artengruppe von *Saturnia cachara*, mit Beschreibung einer neuen Untergattung und einer neuen Art (Lepidoptera: Saturniidae)

Zusammenfassung: Das neue Subgenus *Cachosaturnia* subgen. n. wird für die Artengruppe von *Saturnia cachara* (MOORE, 1872) eingeführt. Typus generis ist *S. (C.) cachara*, subgen. comb. n. Das neue Subgenus beinhaltet drei Arten, neben der schon erwähnten *S. (C.) cachara*, für die ein männlicher Lectotypus designiert wird (in BMNH, London), auch *S. (C.) heinrichi* (LEMAIRE, 1976) comb. n. sowie eine dritte Art *S. (C.) victoria* sp. n. (Holotypus Männchen in ZMHU, Berlin), die syntop mit der vorherigen vorkommt. Typenmaterial und weitere Falter sowie die Präimaginalstadien der drei Arten werden abgebildet, es wird ein Überblick über das neue Subgenus und dessen Verbreitung gegeben.

Introduction

As already discussed by MIRANDA & PEIGLER (2007) and NAUMANN & NÄSSIG (2010a: 59, 2010b: 140), the concept of subgenera of the genus *Saturnia* VON PAULA SCHRANK, 1802 as defined by NÄSSIG (1994a) requires now, after nearly two decades, some revision and adjustment.

The species-group of *Saturnia cachara* (MOORE, 1872) was so far seen as consisting of two species, *S. cachara* and *S. heinrichi*. Already WATSON (1920: 836) noted that “*Caligula*” *cachara* apparently did not belong to *Caligula* or *Dictyoploca*. After many decades of generic association with *Caligula* or *Dictyoploca* (*Caligula* MOORE, 1862; type species *simla* WESTWOOD, [1847], designated by KIRBY 1892: 934; and *Dictyoploca* JORDAN, 1911, identical type

species *simla* WESTWOOD, [1847], designated by JORDAN 1957, resulting in an *objective synonymy* of the two names, see FLETCHER & NYE 1982), the group was usually integrated into the subgenus *Rinaca* WALKER, 1855 (WALKER 1855a: 1199 [key], b: 1274; see FLETCHER & NYE 1982: 143; type species of *Rinaca*: *Saturnia zuleika* WESTWOOD, 1847) of the genus *Saturnia* (see NÄSSIG 1994a, followed by, e.g., BRECHLIN 2000, LAMPE 2010 and many other authors). Within that subgenus, it was usually either included into the *boisduvalii* species-group (e.g., NÄSSIG 1994a) or kept separate as *cachara* species-group. In contrast, MIRANDA & PEIGLER (2007) placed the *cachara*-group, based on morphology, as a separate 4th species-group into their genus *Caligula*, which, as defined by them in contrast to *Rinaca*, was expected by them to be a non-monophyletic unit. They did not have sufficient material of the *cachara*-group to include it in detail into their mainly morphology-based [especially larval scoli] phylogenetic analysis. These authors suggested to follow this generic concept of two separate taxa on genus-group level: *Caligula* and *Rinaca* (in spite of the apparent polyphyly of the first), to be kept separate “until more comprehensive hypothetical phylogenies can be supported with additional molecular and morphological data”, which we basically have done for our manuscript here.

The *cachara*-group always keys out as a very separate and isolated unit within the genus *Saturnia sensu lato* based on the data of mitochondrial DNA of the COI barcode in all NJ-trees delivered by the BOLD website (BARCODE OF LIFE 2012; see also NAUMANN & NÄSSIG 2010b: 138, fig. 31), in hypotheses based on morphological characters, and in results achieved from other statistical methods offered by the software package MEGA5 (TAMURA et al. 2011) based on the mtDNA barcode sequences.

When checking different trees, based on the selection of different ingroup- and outgroup-species (i.e., the rooting of the tree) and different specimens, as well as on different statistical methods applied for the analysis of the sequence data, the *cachara*-group “jumps” a bit through the system of the genus *Saturnia* s. l., but it remains always a separate unit, never integrated into another one of the well-defined subgenera or species-

¹ The expressions “[species]-group” and, subordinate to this, “[species]-subgroup” (sometimes also “species-complex”) are used in this publication as tentative informal groupings of species which are deemed to be closely related to each other and supposedly form a monophyletic unit. However, these groupings are here not intended to be published for the purpose of zoological nomenclature (ICZN 1999: Art. 8.2.; disclaimer), and these collective group names, therefore, do not enter into the genus-group of names in zoology (ICZN 1999: Art. 10.3., 10.4.).

² 24th contribution to the Saturniidae fauna of China (23rd contribution: S. NAUMANN, S. LÖFFLER & W. A. NÄSSIG [2012]: Taxonomic notes on the group of *Loepa miranda*, 2: The subgroup of *Loepa damartisi* (Lepidoptera: Saturniidae). – Nachrichten des Entomologischen Vereins Apollo, N.F. 33 (2/3): 87–108).

³ 82nd contribution to the knowledge of the Saturniidae.

groups of *Saturnia* (compare, e.g., NAUMANN & NÄSSIG 2010b: 138 [NJ tree from the BOLD website], 139–140); especially, it is never integrated within the largest (i.e., richest in species) subgenus *Rinaca*, although it may rarely come out as its sister-group. Genitalia morphology is here not very helpful, as the basic construction is absolutely identical within *Saturnia s. l.*, and morphology overlaps to some degree between the species-groups and subgenera involved.

In contrast to the expectation of MIRANDA & PEIGLER (2007), the type species of *Rinaca* (= *zuleika*) and its sister-species *lesoudieri* (compare NAUMANN & NÄSSIG 2010b) are always integrated as one of the *terminal* branches of the subgenus *Rinaca*, and this subgenus, after the exclusion of the *cachara*-group, always includes all other species-groups listed by MIRANDA & PEIGLER and thus, in contrast to their opinion, appears to be a well-defined monophyletic unit. (Further potential complications for the monophyly of *Rinaca* possibly caused by *Saturnia* (*Perisomena*) *caecigena* KUPIDO, 1825 and related taxa

will soon be discussed in another paper [in prep.] specifically devoted to that latter subgenus.)

In our opinion, based on the inclusive concept of the genus *Saturnia* VON PAULA SCHRANK, 1802 s. l. as successively defined by MICHENER (1952: 477), FERGUSON (1972: 176), LEMAIRE (1978: 129 ff.) and NÄSSIG (1994a), this context shows the isolated position of the *cachara*-group sufficiently to rule out its inclusion into one of the existing subgenera. The *cachara*-group does as well not fit with one of the synonymised generic names (*Caligula* and *Dictyoploca*): the *cachara* species-group never keys out within or as sister-group to the *simla* species-group. Compare also the discussion of the theses by MIRANDA & PEIGLER (2007) in NAUMANN & NÄSSIG (2010b: 140). *Caligula* (i.e., by type designation the *simla* species-group of *Saturnia* (*Rinaca*)) always, without exception, keys out rather peripherally *inmidst* the subgenus *Rinaca*, never outside of it or basally in it, in all COI-barcode trees we have seen so far (irrespective of the statistical analysis method used for tree construction). Therefore,

Table 1: Data of the specimens of *Saturnia* (*Cachosaturnia*) used for the mtDNA sequence analyses. — Additional abbreviations: GBAC = GenBank Access Code; HT = holotype; PT = paratype; SL = Sequence Length (data from BOLD); — = GBAC not yet available.

Species	Sample-ID	Process-ID	GBAC	SL	Sex	Deposition	Locality of Origin
<i>S. (C.) cachara</i>	SK 0152	SASKA152-07	—	528[0n]bp	♂	CSKK	India, Meghalaya
<i>S. (C.) cachara</i>	SK 0153	SASKA153-07	—	658[1n]bp	♀	CSKK	India, Meghalaya
<i>S. (C.) cachara</i>	SNB 0365	SASNA365-08	—	595[0n]bp	♂	CSNB	Myanmar, Kachin State
<i>S. (C.) cachara</i>	SNB 2113	SASNC029-11	JN278656	658[0n]bp	♂	CSNB	Myanmar, Sagaing State
<i>S. (C.) cachara</i>	SNB 2114	SASNC030-11	JN278657	658[0n]bp	♂	CSNB	Myanmar, Kachin State
<i>S. (C.) cachara</i>	SNB 0364	SASNA364-08	—	609[0n]bp	♂	CSNB	Myanmar, Chin State
<i>S. (C.) cachara</i>	SNB 2112	SASNC028-11	JN278655	658[0n]bp	♀	CSNB	Myanmar, Chin State
<i>S. (C.) cachara</i>	SNB 3553	SASNC899-11	—	658[0n]bp	♀	CSNB	Myanmar, Chin State
<i>S. (C.) cachara</i>	SNB 3554	SASNC900-11	—	658[0n]bp	♂	CSNB	Myanmar, Chin State
<i>S. (C.) cachara</i>	SNB 3555	SASNC901-11	—	658[0n]bp	♂	CSNB	Myanmar, Chin State
<i>S. (C.) cachara</i>	SNB 4649	SASNC2280-12	—	452[0n]bp	♂	CSLL	China, Hainan
<i>S. (C.) cachara</i>	SNB 3545	SASNC891-11	—	658[0n]bp	♀	CSNB	China, Yunnan
<i>S. (C.) cachara</i>	MNHN 0022	SPMNP015-07	—	658[0n]bp	♀	MNHN	China, Yunnan
<i>S. (C.) cachara</i>	MNHN 0023	SPMNPO16-07	—	658[0n]bp	♂	MNHN	China, Yunnan
<i>S. (C.) cachara</i>	MNHN 0024	SPMNPO17-07	—	658[0n]bp	♂	MNHN	China, Yunnan
<i>S. (C.) cachara</i>	Roug 1084	SATWA990-07	—	609[0n]bp	♂	CRRR	China, Yunnan
<i>S. (C.) cachara</i>	Roug 1085	SATWA991-07	—	609[0n]bp	♂	CRRR	China, Yunnan
<i>S. (C.) cachara</i>	Roug 1086	SATWA992-07	—	658[0n]bp	♂	CRRR	China, Yunnan
<i>S. (C.) cachara</i>	Roug 1087	SATWA993-07	—	609[0n]bp	♀	CRRR	China, Yunnan
<i>S. (C.) cachara</i>	SK 0361	SASKA361-09	GU664234	658[0n]bp	♂	CSKK	Thailand, Chiangmai
<i>S. (C.) cachara</i>	SK 0362	SASKA362-09	GU664233	658[0n]bp	♀	CSKK	Thailand, Chiangmai
<i>S. (C.) cachara</i>	SNB 3542	SASNC888-11	—	658[1n]bp	♂	CSNB	Thailand, Chiangmai
<i>S. (C.) cachara</i>	SNB 1475	SASNB475-09	GU702994	658[0n]bp	♂	CSNB	Vietnam, Lao Cai Prov.
<i>S. (C.) cachara</i>	SNB 3550	SASNC896-11	—	658[1n]bp	♀	CSNB	Vietnam, Lao Cai Prov.
<i>S. (C.) cachara</i>	SNB 3543	SASNC889-11	—	658[0n]bp	♀	CSNB	Laos, Houa Phan Prov.
<i>S. (C.) cachara</i>	SNB 3540	SASNC886-11	—	658[0n]bp	♂	CSNB	Thailand, Chiangmai
<i>S. (C.) cachara</i>	SNB 3541	SASNC887-11	—	658[0n]bp	♂	CSNB	Thailand, Chiangmai
<i>S. (C.) cachara</i>	SNB 4648	SASNC2279-12	—	565[0n]bp	♂	CSLL	Thailand, Tak
<i>S. (C.) cachara</i>	SNB 3544	SASNC890-11	—	658[0n]bp	♂	CSNB	China, Yunnan
<i>S. (C.) cachara</i>	SNB 3546	SASNC2247-12	—	658[0n]bp	♂	CSNB	China, Yunnan
<i>S. (C.) cachara</i>	SNB 3547	SASNC893-11	—	658[0n]bp	♀	CSNB	China, Yunnan
<i>S. (C.) cachara</i>	SNB 1474	SASNB474-09	GU702987	658[0n]bp	♂	CSNB	China, Guangxi
<i>S. (C.) cachara</i>	SNB 3548	SASNC894-11	—	658[0n]bp	♂	CSNB	China, Guangxi
<i>S. (C.) cachara</i>	SNB 2115	SASNC031-11	—	430[2n]bp	♂	CSNB	Myanmar, Kachin State
<i>S. (C.) cachara</i>	SNB 3556	SASNC902-11	—	658[0n]bp	♂	CSNB	Myanmar, Kachin State
<i>S. (C.) cachara</i>	SNB 3558	SASNC904-11	—	658[0n]bp	♀	CSNB	Myanmar, Kachin State
<i>S. (C.) victoria</i>	SNB 0367	SASNA367-08	—	658[0n]bp	♂	CSNB	Myanmar, Chin State
<i>S. (C.) victoria</i>	SNB 3552	SASNC898-11	—	658[0n]bp	♀	CSNB	Myanmar, Chin State
<i>S. (C.) heinrichi</i>	SNB 0366	SASNA366-08	—	658[0n]bp	♂	CSNB	Myanmar, Chin State
<i>S. (C.) heinrichi</i>	SNB 3535	SASNC881-11	—	658[0n]bp	♂	CSNB	Myanmar, Chin State
<i>S. (C.) heinrichi</i>	SNB 3536	SASNC882-11	—	658[0n]bp	♂	CSNB	Myanmar, Chin State

if anybody intends to use *Caligula* as a separate name of the genus-group (as genus or subgenus), practically all other species-groups of *Rinaca* must get a separate genus-group name as well – this would split up the subgenus *Rinaca* enormously without providing any further information at all.

Some authors have also argued against the use of subgeneric names in general. However, we still do believe that the category of subgenera, clearly allowed and supported by the Code (ICZN 1999), has its significant merits, because it allows one more level for classification in well-structured groups relatively rich in species. Therefore, we decided to create a new subgeneric name for the *cachara*-group now (below).

We also publish here a revision of the species of this small, well-defined new subgenus as part of the preparatory work for the Palaearctic Saturniidae fauna for publication within the book series “Palaearctic Macrolepidoptera”. The *cachara*-group (i.e., the new subgenus *Saturnia* (*Cachosaturnia*), described below) comprises, after this revision, 3 different species, one of them described below as new.

Material and methods

Morphological studies on imagos and genitalia followed standard procedures. Mainly material in the authors' collections was used for study, but we also studied all relevant types and other material in London (BMNH) and further material in other museum collections.

Data of the specimens which were used for the mtDNA analysis are listed in Table 1. DNA was extracted from the legs of dried specimens mainly in the collections of the authors, and further sequence data publically accessible were used. Technical details and references relative to the laboratory protocols see in RATNASINGHAM & HEBERT (2007) or on the CCDB website (CCDB 2012) and also in, e.g., DECAËNS & ROUGERIE (2008) or VAGLIA et al. (2008). Sequences of the specimens analysed have also been (and will be) deposited in GenBank (see Table 1) and are (or will soon be) publically available on the BOLD website (BARCODE OF LIFE 2012).

The type specimens of two of the three taxa in the catalogue are more than 35, respectively 140 years old and, therefore, not easily accessible for DNA analyses. Although it takes some effort to get useful results from old types (and not every case is successful), it should be tried at some time to analyse the DNA of the original types to coordinate and “root” the DNA barcode systematics with the existing (morphology-based) taxonomy. Instead, we have tried to get more recent material from as close to the type localities as possible for our barcode study, but regrettably did not succeed for all populations, in part also caused by the partial closing of the Canadian national funding for the barcode analyses in Guelph in early summer 2012 and following requirement of funding from side of the submitters.

Abbreviations used

BC	Barcode [no.].
BMNH	The Natural History Museum, London, UK (formerly British Museum (Natural History)).
CAPB	Collection Brother Amnuay PINRATANA, St. Gabriel's College, Bangkok, Thailand.
CMWM	Collection Museum Thomas J. WITT, München, Germany, to become part of ZSM, Germany.
CRRR	Collection Rodolphe ROUGERIE, Rouen, France.
CSLL	Collection Swen LÖFFLER, Lichtenstein/Sachsen, Germany.
CSNB	Collection Stefan NAUMANN, Berlin, Germany.
CUWA	Collection Ulrich WERTZ, Adenbüttel, Germany.
CWAN	Collection Wolfgang A. NÄSSIG, now in SMFL.
GP	Genitalia dissection/preparation [no.].
SMFL	Senckenberg-Museum, Lepidoptera collection, Frankfurt am Main, Germany.
ZMHU	Museum für Naturkunde der Humboldt-Universität Berlin, Germany.
ZSM	Zoologische Sammlung des Bayerischen Staates (formerly Zoologische Staatssammlung München), München (Munich), Germany.

Systematic part

The new subgenus

Saturnia (*Cachosaturnia*) subgen. n.

Type species: *Caligula cachara* MOORE, 1872. – Generic gender: female.

Etymology: The subgeneric name is, self-explanatory, a combination of the name of the oldest taxon and type species of the new subgenus, *Saturnia cachara*, and the genus group name *Saturnia*.

The new subgenus currently comprises three species:

- *Saturnia* (*Cachosaturnia*) *cachara* (MOORE, 1872), described from Cachar, Assam, India, and widespread from NE India via the western, northern and north-eastern parts of Myanmar, N Thailand, N Laos to SW China and N Vietnam; with its synonym *S. (C.) microcaligula* (NÄSSIG, 1994);
- *Saturnia* (*Cachosaturnia*) *heinrichi* (LEMAIRE, 1976), known only from the central parts of Chin State, W Myanmar, from the type series and further specimens collected near the type locality; and
- *Saturnia* (*Cachosaturnia*) *victoria* NAUMANN, LÖFFLER & NÄSSIG sp. n., described below, also from Chin State, W Myanmar.

Description and differential diagnosis

♂: Antennae of the ♂ quadripectinate (terms following SCOBLE 1995) with long rami; antennae of the ♀ very shortly bipectinate, and in both sexes as typical for the genus *Saturnia*. Clypeus and labium broad, covered with hair.

♂ forewing medium-sized for the genus *Saturnia*, almost rectangular or a little elongated in the apical part. Hindwing almost round. Colouration reddish to dark greyish brown with marginal parts often olive, with relativ straight antemedian band and a doubly curved

postmedian band. Both fore- and hindwings have a central round eye-spot with a very thin hyaline crescent-like bent line in the centre and, especially on the forewing underside and the hindwing upperside, always with a large black portion in individually differing extent especially distally to the hyaline line. The submarginal area has a white line which is partly interrupted. Forewing apical area with typical black patch with black and red scales bordering. On the ventral side wings generally with a little more intensive and darker colouration, forewing antemedian band lacking, hindwing ocellus without the black parts of dorsal side, and thereby a little smaller, but otherwise similar to dorsal side.

♂ forewing with veins M2 and M3 (cf. MICHENER 1952: 351) widely separated, R5 arising already almost at half the length of the costal margin, the discoidal cell relatively wide, in accordance with the large ocellus. Otherwise veins at the marginal end almost to the same distance. In the hindwing marginal distance of the veins similar, almost with same distance over the entire wing. Venation of the ♀ almost the same. Compared to the venation of members of other subgenera in *Saturnia* (e.g., the American *Calosaturnia* SMITH, 1886 or *Agapema* NEUMOEGEN & DYAR, 1894, figured by FERGUSON 1972: fig. 22) the venation is more evenly, without major differences in the distances between the veins.

♀ forewings rounded, of similar colours and ornamentation as in ♂♂, the median area of the forewing in most specimens also greyish scales and hairs, especially on the ventral side.

♂ **genitalia**: 8th abdominal segment without any prominently sclerotised structures. Uncus bifid, with two dorsal processes. Valves triangular or little elongated, with rounded dorsal apex and lateral sclerotised process. Saccus very short, juxta with two dorsolateral processes. Phallus short, with one lateral sclerotisation in individually variable expression and shape and a round bulb-like vesica. Generally, genitalia fit very well with structures of all other *Saturnia* s. l. species, but can be grouped together by their small lateral valve process, and the form and size of the phallus.

♀ **genitalia** were not specifically examined for diagnosis, as those of other *Saturnia* species did not show clearly distinct characters between species-groups.

Larvae: All species of the subgenus have very similar larvae which are characterised by their greenish to whitish-turquoise or bluish colour in combination with yellow pattern elements and medium-sized yellowish lateral and dorsal setae and black ornamentation. Two of the three members apparently always have crimson to purplish red dorsal tubercles (scoli) on thoracal segments 2 and 3, the third one (*cachara*) mainly in its most western populations only, but obviously not further to the east of its distribution. The green colour appears to result from the combination of the blue and the yellow ground colours, and the colour relations and shades of a larva may vary considerably both individually and between populations.

Generally, all those many details (colouration and ornamentation, wing venation, medium size, details of ♂ genitalia, typical larval habitus; also the barcode results showed a wider separation of the new subgenus from other members of the genus *Saturnia*) forced us to erect the new subgenus for this species-group. It has a somewhat surprising distribution pattern: While two species are confined to a small area in Chin State of Myanmar in the narrow mountain range between the Irrawaddy river valley and the Indian Ocean, where they occur partly syntopically and even synchronous, the third species has a distribution over wide parts of the Indochinese Peninsula at medium elevations.

Catalogue of the taxa already described

(In chronological order.)

1. *cachara* (MOORE, 1872)

Caligula cachara MOORE (1872: 578, not illustrated).

Type material: Number of ♂ syntypes not stated by MOORE [possibly only 1 specimen?]; "in coll. F. MOORE", BMNH (syntype examined, Figs. 1a–c). – To stabilise nomenclature and fix the identity of the here described subgeneric name, this syntype specimen mentioned and illustrated here (Figs. 1a–c) is herewith **designated** as lectotype of the taxon *Caligula cachara* MOORE, 1872.

Type locality: "N. Cachar (Major GOODWIN-AUSTEN)", [= India, Assam State, Cachar District; one of the most south-eastern districts of Assam, just NW of the Indian states of Mizoram and Manipur, which lie along the borderline of Chin State, Myanmar, south of the Brahmaputra valley].

Etymology: Named after the type locality in Cachar district.

2. *heinrichi* (LEMAIRE, 1976)

Dictyoploca heinrichi n. sp. LEMAIRE (1976: 299, figs. 1–2).

Type material: ♂ holotype by original designation, BMNH (GP LEMAIRE 3048 [originally published as A-398] = BMNH Sat. 273) (examined, Figs. 27a–c, 86); 40 ♂♂, 2 ♀♀ paratypes, BMNH (examined).

Type locality: Burma [= Myanmar], [Chin State], Mt. Victoria, Pakokku Chin Hills, 2600 m.

Etymology: Named after the collector G. HEINRICH.

3. *microcaligula* NÄSSIG, 1994

Saturnia (Rinaca) microcaligula sp. n., NÄSSIG (1994b: 347, figs. 2–4).

Type material: Holotype ♂ (by original designation) (GP 736/94 NÄSSIG), ex coll. SCHNTLMEISTER; via CWAN in BMNH (examined). 1 paratype ♂ in SMFL [and many para- and topotypes in different collections used for further comparison] (examined, Figs. 2a–c).

Type locality: N-Vietnam, [Lao Cai Prov.], vic. Cha-Pa, Mt. Fan-Si-Pan, ca. 2400 m, 22°15' N, 103°46' E, 8.–29. v. 1993, leg. SINJAEV & SIMONOV.

Etymology: Named for the small size in combination with the old generic name *Caligula*, which was found to be no longer in use.

Note: This taxon was described as a separate species by NÄSSIG (1994b). This was mainly based on the significantly smaller size of the Vietnamese specimens which were forming the type series, in combination with minor differences in external morphology and genitalia. However, with more material available, it appeared later to be probably no more

than a small-sized, rather common individual variant of *cachara* MOORE, 1872. Evidently the Vietnamese material of this taxon received by WAN from Russian collectors between 1993 and ca. 2000 was selected; the big specimens were taken out in advance. These remaining small specimens obviously also show some slight genitalia differences caused by the smaller body size (probably caused by allometric growth). — A synonymy of *microcaligula* with *cachara* was published by BROSCHE et al. (1999: 47).

Revisional notes, with the description of a new species

The following species are now, after revision, included in the new subgenus erected above:

Saturnia (Cachosaturnia) cachara (MOORE, 1872), new subgeneric combination

Caligula cachara MOORE (1872: 578), not illustrated. — Type material: ♂ LT, designated above, “in coll. F. MOORE”, now in BMNH. Type locality: “N. Cachar (Major GOODWIN-AUSTEN)”, [= India, Assam, Cachar District].

= *Saturnia (Rinaca) microcaligula* NÄSSIG, 1994; younger subjective synonym. — T.l.: northern Vietnam, vic. Cha-Pa, Mt. Fan-Si-Pan, 22.15° N, 103.46° E. (Synonymy first suggested by BROSCHE et al. 1999: 47.)

Note: See paragraph “Geographical population structure” (below) for a discussion of this synonymy.

Here illustrated: Figs. 1–24, 36–46, 74–82.

Cited in literature as:

Caligula cachara: MOORE (1872: 578, sp. n.); COTES & SWINHOE (1887: 230); COTES (1891: 84); ROTHSCCHILD (1895: 44); SONTONNAX (1904: 152, pl. VIII, fig. 1 ♂); PACKARD (1914: 171); WATSON (1920: 836, pl. 130, figs. a & b thoracic shield of larva, fig. c L₄ larva [line drawings]); PINRATANA & LAMPE (1990: 31, pl. 37 ♂, ♀); BAXTER (1992: 41, fig. 9 ♀); ALLEN (1993: 63); D'ABRERA (1998: 34, 35, figs. ♂, ♀); MIRANDA & PEIGLER (2007: 436).

Caligula Cachara: WARDLE (1881: 6); KIRBY (1892: 760); SILBERMANN (1897: 325); ANDRÉ (1907: 206, fig. 100: cocoon).

Saturnia cachara: HAMPSON (1893: 24); ROBINSON et al. (2001: 359); NAUMANN et al. (2008: 151); LAMPE (2010: 361, pl. 312).

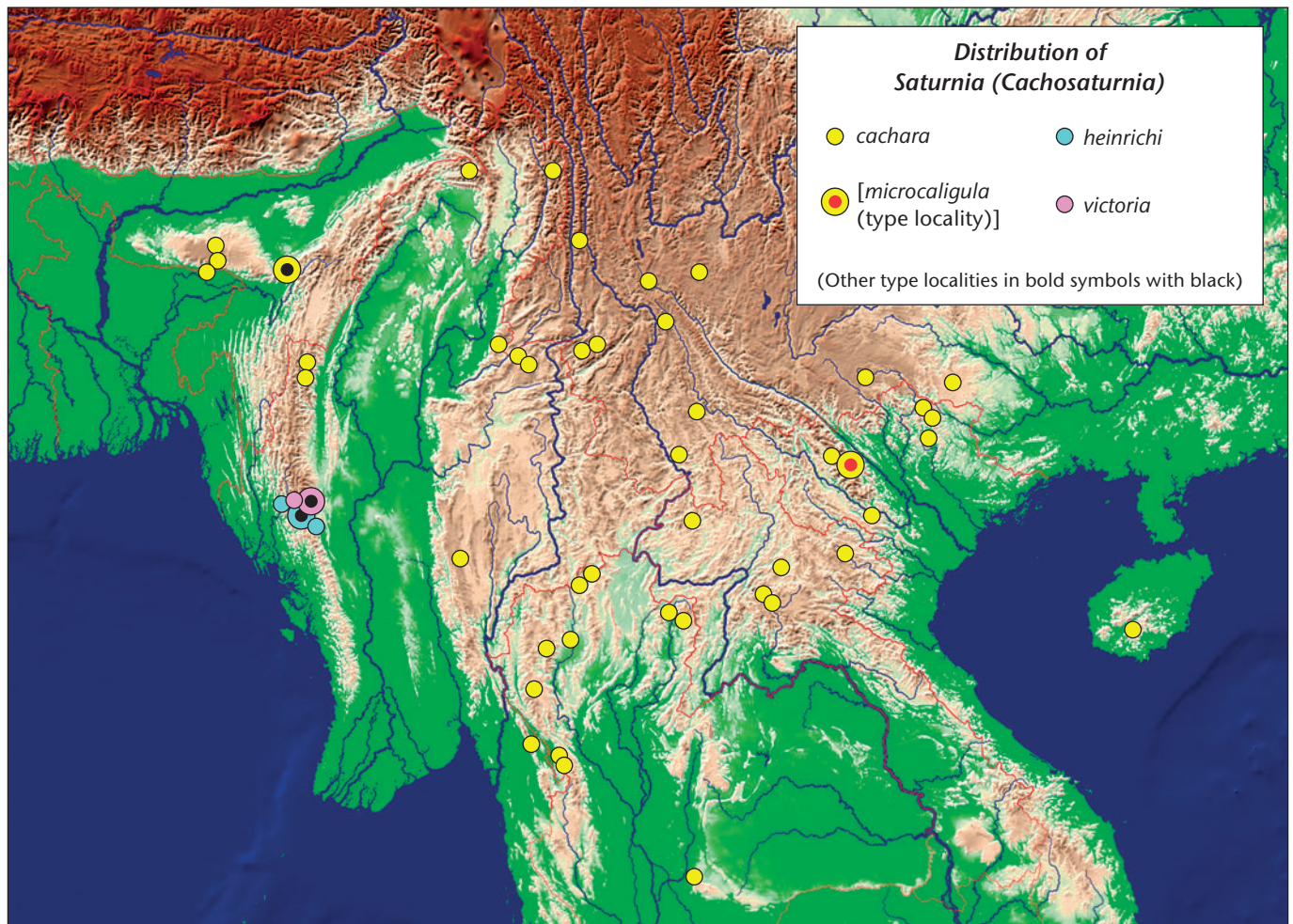
Dictyoploca cachara: WATSON in PACKARD (1914: 472, plate legend); SEITZ (1928: 516, pl. 55 B b ♂); BOUVIER & RIEL (1931: 38); SCHÜSSLER (1933: 243; 1935: 689); BOUVIER (1936: 205, 206, pl. VIII: fig. 5 ♀); CROTCH (1956: 87); LEMAIRE (1976: 299, 301); NARANG & GUPTA (1979: 201); GARDINER (1982: 129, fig. 21 cocoon); ZHU & WANG (1983: 412, pl. 134, fig. 2969 ♂; 1996: 130, pl. VII, fig. 4 ♂); WANG (2004: 411, fig. 34 ♂, misidentification, the specimen figured in fact is *S. (Rinaca) japonica* (MOORE, 1872)).

Dictyoploca chachara [sic]: MELL (1958: 210 [misspelling]).

Saturnia (Rinaca) cachara: NÄSSIG (1994a: 257, comb. n.; 1994b: 339, 347, fig. 1 ♂, figs. 5 & 6 ♂ GP); BROSCHE et al. (1999: 47); NAUMANN & NÄSSIG (2010a: 59; 2010b: 140); MEISTER (2011: 159).

Saturnia (Rinaca) microcaligula: NÄSSIG (1994b: 339, 347, fig. 2 ♂ HT, fig. 3 ♂ PT, fig. 4 ♂ GP, sp. n.; 1994a: 257); BROSCHE et al. (1999: 47, syn. n.).

Distribution and examined material (see Map):



Map: Distribution of the species of *Saturnia (Cachosaturnia)* in S Asia. One dot may represent more than one locality in close proximity; we have not located every label data on the map. — Map created with Map Creator 2.0 Personal Edition, © 2003–2007 primap software, modified and localities added.

India: “Indien”, GP 407/99 SNB, BC SNB 2109 (CSNB). — **Meghalaya:** Khasi Hills, e.p. III. & IV. 1995, BC SNB 3551 (CSNB). Khasi Hills, Shillong, e.p. 30. XII. 1976 (CSNB). “Assam”, Khasi Hills, Shillong vic., 1250–1500 m, specimens and cocoons collected 1994/95, received via H. SCHNITZLER (CWAN in SMFL). — Material in BMNH comprises (besides further specimens from Khasi Hills/Shillong etc.) the following localities, all in the South of the Brahmaputra valley: 2 ♂♂, Cherrapunji, Assam [= Meghalaya, SW of Shillong], VI. 1893, ROTHSCHILD Bequest B.M.1939-I; 1 ♂, 2 ♀♀, Jaintia Hills, Assam [= Meghalaya, E of Shillong], ex coll. SWINHOE, ROTHSCHILD Bequest 1939-I. 1 ♀, Cachar, ROTHSCHILD Bequest B.M. 1939-I.

- Regarding comments on a few most likely erroneous records from the Himalayan parts of India, Bhutan and Nepal, see the discussion under “Distribution” below.

Bangladesh: 1 ♂, 1 ♀, Chhatak [today Bangladesh, Silhet], ROTHSCHILD Bequest B.M. 1939-I (BMNH).

Myanmar: **Chin State:** Kennedy Peak, summit near pagoda, 2690 m, 18. V. 2001, during day at generator station, open grassland, *Rhododendron* & *Quercus* forest area, leg. S. NAUMANN, BC SNB 3554, 3555 (CSNB). Same locality, 18. V. 2001, ♂ 20.50 h, ♀ 1.50 h, leg. S. NAUMANN, ♂ GP 541/01 NAUMANN, BC SNB 2111, 2112 (CSNB). Thaing-gnin village, 2100 m, 20.30 h, agricultural area, BC SNB 0364 (CSNB). Ca. 1 km NW Thaing-gnin, way to Tiddim, 2160 m, 17. V. 2001, 23.40 h, primary forest with single cuts, leg. S. NAUMANN, BC SNB 3553 (CSNB). — **Sagaing State:** E Ngalong Ga, SEE Kumki (India), Tarung Hka river fork, 1 km Hkasi village, 1000 m, 27°7.875' N, 96°53.105' E, VI. 2008, ♂ GP 2262/12 SNB, BC SNB 2113, 3557 (CSNB). — **Kachin State:** Chudu Razi Hills, 30 miles E Kwanglangphu, v./VI. 2007, VI. 2008, ♂ GP 2261/12 SNB, BC SNB 0365, 2114 (CSNB). Same locality, VI. 2007 (CSLL). E Bhamo, Nashu Bum area, ca. 2000 m, VI. 2010, leg. LI & PENG, BC SNB 3556 (CSNB). Nankan Shan, Gukai, ca. 2000 m, near Yunnan borderline, IX. 2010, leg. Yi et al., BC SNB 3558 (CSNB). Xingwei, Tangpengshan, 2800 m, near SW Yunnan border, ca. 50 km S Ruili, early III. 2003, BC SNB 2115 (CSNB, CSL). — **Shan State:** 1 ♂, Kalaw, 16. IX. 1935, W. C. CARROTT, M. J. MANSFIELD, B.M. 1950-244 (BMNH). — **Kayin State:** Dawna, NE Moulmein, 1300 m, S. STEINKE (CWAN in SMFL).

PR China: **Yunnan:** (NW), Deying, Baimaxueshan, ca. 4000 m [sic], VII. 2002, leg. YING et al., BC SNB 3545 (CSNB). Same data (CWAN in SMFL). (NW), Wubaoshan, Yanlong, 4000 m [sic], end II. 2001, leg. LI, BC SNB 3544 (CSNB). (NW), near East Tibet border, Daxueshan, Deying, 2500 m, VII. 2002, leg. YING (CSLL). (N), Sanfengshan, Yaoan, 2897 m, VII. 2000, leg. YIN (CSLL). (SW), Daxueshan, Yongde, 3504 m, V. 2000, leg. YIN (CSLL). (SW), Juangjiang, Daxueshan, 3500 m, V. 1999, leg. WANG & LI (CSNB). Same data (CWAN in SMFL). (S), N Changyuan, near border of Dima County, Guokandashan, 2000–2300 m, IX. 1999, leg. WANG & LI (CSNB). Same area, 2800 m, XI. 2000, leg. LI & YIN, BC SNB 3546 (CSNB, CSL). CW, Yingdong, Wuliang Mts., ca. 3000–3800 m, 25.–28 V. 1999, leg. WANG & LI (via CSNB in CWAN in SMFL). CE, Lanchang County, E Simao, Heishan, 2200–2400 m, IX. 1999, leg. WANG & LI, BC SNB 3547 (CSNB). (S), Hei Mt., Lanchang, 2500 m, IX. 1999, leg. LI & WANG (CSLL). (S), Xishuangbanna, 27 km NW Jinghong vic., Beng Gang Ha Ni, 1800–2000 m, 25. V. 2008, leg. A. WEIGEL (CSLL). Weibaoshan, Weishan, 2500 m, III. 2003, leg. YING (CSLL). — **Guangxi:** (W), E. Yunnan borderline, Laogongshan, Xiling, 1800 m, VI. 2002, ♂ GP 2187/10 SNB, BC SNB 1474, 3548 (CSNB). — WANG (2004) reports “*S. cachara*” for Guangxi, but he figures (p. 411, fig. 34) a specimen of *S. japonica* under this name, thereby qualifying his record as very questionable. — **Hainan Island:** Ledong County, Jiangfengling National Forest Garden, 982 m, III. 2009, leg. Weiwei ZHANG, BC SNB 4649 (CSLL).

Vietnam: **Lao Cai Prov.:** Sapa, 1600 m, V. 1990, leg. Z. SKUTA, BC SNB 3549 (CSNB). Fan Si Pan Mt. (N), Sapa, 22°17' N, 103°44' E, 1600 m, prim. forest, IV. 1995, leg. SINIAEV & local collector, ♂ GP

404/99 SNB, BC SNB 1475 (CSNB). Same area, Fan Si Pan Mt. (W), 22°20' N, 103°40' E, 1600–1800 m, second. forest & cultured area, IX. 1994 & IV. 1995, leg. SINIAEV & local collector, ♂ GP 403/99 SNB, BC SNB 3550. Fan Si Pan Mt., Nui Se, 1930 m, 16./17. X. 2001, leg. S. LÖFFLER (CSLL). Several localities in the Fan Si Pan area, ca. 1600–1800 m, IV. + VI.–VIII. 1995 (CWAN in SMFL). — **Son La Prov.:** Mai-chau, 40 km SE Moc-chau, 20°50' N, 104°50' E, 1400 m, 7.–15. IV. 1995 (CWAN in SMFL). — **Bac Can Prov.:** Banh Trach, Ba Be Lake N.P., 300 m, 12./13. XI. 2002, leg. M. HOFFMANN (CSLL). Banh Trach, Ba Be Lake N.P., 5 km rd. Ba Be–Cao Bang, 300 m, XI. 2001, XII. 2002, XI. 2003, XI. 2005, XII. 2006, XII. 2007, XI. 2008, leg. H. B. NGUYEN (CSLL). Boc Bo, ca. 30 km N Ba Be Lake N.P., 600 m, 10./11. XI. 2000, leg. S. LÖFFLER (CSLL). — **Thai Nguyen Prov.:** Dong Hy, Mo Ba, 21°46'0" N, 105°52'2" E, 375 m, XII. 2010, leg. H. B. NGUYEN (CSLL).

Thailand: **Chiangmai Prov.:** Doi Angkang, 19°54' N, 99°3' E, 1600 m, VI. 2002, leg. T. IHLE, BC SNB 3540 (CSNB). Same locality, I. & VI. 2002, leg. T. IHLE (CSLL). Doi Angkang, Fang, 1400 m, IV. 2006, leg. T. IHLE (CSLL). Doi Inthanon, road km 37.4, ranger station, 18°31'33.3" N, 98°29'58.3" E, 1681 m, VI. 2007, BC SNB 3542 (CSNB). Doi Inthanon, II. 1987, X. & XII. 1988, I., VI. & X. 1989, XII. 1996, IX. & X. 1998 (CAPB). Doi Pha Hom Pok, Mae Ai, 2000 m, I. 2004, BC SNB 3541 (CSNB). Same locality, I. & VI. 2004, VI. 2005, II. & VII. 2006, leg. T. IHLE (CSLL). Chiangmai, 1986 [no further data], ♂ GP 406/99 NAUMANN (CSNB). 25 km N Bo Luang, 1150 m, XI. 1996, leg. T. CSOVARI & L. MIKUS (CMWM). Same locality, XII. 1998, leg. M. HREBLAY, Y. SHERPA & J. SOOS (CMWM). Same locality, VII. 1998, leg. J. SOOS & A. SZABO (CMWM). 22 km N Bo Luang, 1100 m, VI. 1998, leg. J. SOOS & A. SZABO (CMWM). — **Nan Prov.:** 30 km E Pua, 1700 m, XI. 1999, leg. M. HREBLAY (CSNB). Same locality, III. 1996, leg. T. CSOVARI & P. STEGER (CMWM). Same locality, VII. 1996, leg. J. SOOS & A. SZABO (CMWM). Same locality, XI. 1998, leg. T. CSOVARI & L. MIKUS (CMWM). Same area, XI. 1999, 1000–1150 m, leg. M. HREBLAY &/ex coll. A. SCHINTLMEISTER (CWAN in SMFL). 25 km N Bo Luang, 1150 m, XI. 1996, leg. T. CSOVARI & L. MIKUS (CMWM). Same locality, XII. 1998, leg. M. HREBLAY, Y. SHERPA & J. SOOS (CMWM). Same locality, VII. 1998, leg. J. SOOS & A. SZABO (CMWM). 6 km W Pha Lak, 800 m, VI. 1998, leg. J. SOOS & A. SZABO (CMWM). — **Tak Prov.:** Doi Mussoe, rd. Tak–Mae Sot, 800 m, IV. 2002, leg. T. IHLE, BC SNB 4648 (CSLL). — **Saraburi:** “Saraburi”, v. + 14. VII. 1989, leg. S. STEINKE (ex coll. PAUKSTADT in SMFL [this is a questionable locality because this is just the former trading house of S. STEINKE/LEHMANN at the entrance of the Khao Yai National Park, and there material was usually stored and stamped with data, but not collected; the dot is, however, plotted on the map]).

Laos: **Louang Prabang Prov.:** ca. 100 km E Louang Prabang, military camp, 1400–1600 m, VII.–VIII. 1997, leg. M. STEINKE, ♂ GP 405/99 (CSNB). Same data (CWAN in SMFL). Ban Pakgaeng, Phou Khun, 1100 m, XII. 2010 & I. 2011, leg. T. IHLE (CSLL). Pak Gaeng Noi, 1200 m, VII. 2011, leg. T. IHLE (CSLL). Phou Khoun, 1500 m, XII. 2005, leg. T. IHLE (CSLL). — **Vientiane Prov.:** Ban Viang Kham, 15 km S Phou Khoun, 950 m, X. 2003, IX. 2010, leg. T. IHLE (CSLL). — **Xam Neua Prov.:** Phun Pan, 1800 m, IV. 2003, leg. K. NARUYAMA, BC SNB 3543 (CSNB). — **Louang Namtha Prov.:** Houay La Kan, Muang Sing District, Louang Namtha, 1688 m, 1.–25. VII. 2007, leg. M. VONGKHAMPHA (CSLL). — **Huaphane Prov.:** Mt. Phu Pane, 1200–1800 m, 10. V.–11. VI. 2011, leg. S. JAKL (CSNB).

Diagnosis and description

♂ (Figs. 1–15): Ground colour ochreous, reddish or light olive brown. Antennae ochreous, length 10.5–11.5 mm, quadripectinate. Frons and collum with long greyish hair. Forewings with little elongated and rounded apex, length 37–46 mm, hindwings round. On dorsal side the

antemedian and postmedian areas of both fore- and hindwings in ground colour, the median area suffused with more or less large amount of grey scales, and separated by a single dark grey antemedian line and two dark grey undulated postmedian lines. The forewing median area has a central round ocellus of 5.0–7.0 mm maximum diameter, mainly coloured in ground colour, with proximal red, white and pink crescent-like pattern. That of the hindwing also round, with 5.5–7.5 mm maximum diameter, with same proximal colouration but broader red portion and wide black outer margin. The submarginal area of the forewing with a row of tiny white patches, that of the hindwing a little more intense, sometimes forming a white undulated line. Forewing apical area with typical black and white patch. On the ventral side wings of little more intensive and dark colouration, forewing antemedian band missing, the postmedian lines further marginally. The forewing ocellus with huge black lens and black margin in the marginal half, the hindwing ocellus without the black parts shown on dorsal side, and thereby a little smaller.

♂ **genitalia** (Figs. 74–82): Uncus bifid, with two relatively slender and acute processes, bent a little to ventral side. Valves relatively compact, with rounded harpe, a rounded dorsal processus and a ventral one which is strongly sclerotised, even near its base, more or less rounded at its tip. Saccus broad, short and rounded, juxta with two acute lateral processes. Phallus very small, with a left lateral thorn-like process turned dorsally, ventral ridge slightly dentate, vesica round without any significant structures. 8th abdominal segment also without any significant structures. Generally, genitalia of Myanmar specimens are somewhat smaller and have less pronounced processes, which is in accordance with the generally smaller size of specimens.

♀ (Figs. 16–23): Aside from sexually dimorphic characters such as different antennae, more rounded wings of larger size and larger abdomen, similar to the ♂♂. ♀♀ have bipectinate antennae of 11.0–11.5 mm maximum length, the forewing length is 44–51 mm. The median area of both fore- and hindwings bears more greyish scales than in the ♂♂, so that often an indicated median line can be seen.

Preimaginal instars (Figs. 36–46): Larvae of *S. (C.) cachara* have not often been reared, described and published. SEITZ (1918: 66, 136) already wrote about problems to rear the species in Europe; his data are very vague and do not help much. WATSON (1920) delivers some line drawings from a rearing up to L_4 . SCHÜSSLER (1935: 689) mentioned a [line-?]drawing of the larva by CALLIESS on the title page of *Internationale Entomologische Zeitschrift*, Guben, vol. 28 (2) (1934), but in all German libraries consulted this title page was cut away during the binding process, and thus the illustration was not seen by us. It appears, therefore, that it is LAMPE (2010: 317) who as the first author provided a series of colour photographs depicting the preimaginal instars in printed media.

In all instars larvae are coloured in a combination of yellow, black and bluish/greenish colour. The yellow tubercles are connected by black ornamentation and a dorsal black band, on the lateral side the colour tends from yellow to a more greenish turquoise. The head is black in all instars for the eastern populations; the western ones have about 50% yellow pattern elements mixed in. There tends to be an interesting geographical population structure in *S. (C.) cachara* which is discussed below in more detail: While in the western populations larvae more or less regularly show red dorsal tubercles on thoracal segments 2 and 3, these are yellow in all populations of the East.

Ecological observations: There exist a few published larval foodplant records: WATSON (1920: 837) reared the species on *Crataegus* with poor success, and SEITZ (1928: 516) recommends *Juglans regia*. Also CROTCH (1956: 87) and GARDINER (1982: 129) cite this as best foodplant, RAGUS (1987: 173) reared it successfully on *Prunus laurocerasus*, and ROBINSON et al. (2001: 359) cite further potential foodplants from literature; LAMPE (2010: 361) noted *Tilia platyphyllos* as foodplant for his rearing figured, and SN used *Prunus serotina*. A compilation of some literature records for the evidently polyphagous species is published by MEISTER (2011: 159), although the literature sources are not cited. The repeated rearing attempts by one author (WAN) in the early 1980s took place with the usual *Saturnia* foodplants (*Ligustrum*, *Prunus*, *Salix* etc.). The rearing success was low (only a very few specimens were ever achieved, most larvae died), but this was caused by larval infections, not primarily by foodplant problems; the larvae appear to be quite prone to infections. So far no records of foodplants of *S. (C.) cachara* in the wild exist.

Arrival times of specimens of *Saturnia (Cachosaturnia) cachara* at light have only been reported for a few specimens in Myanmar, Chin State:

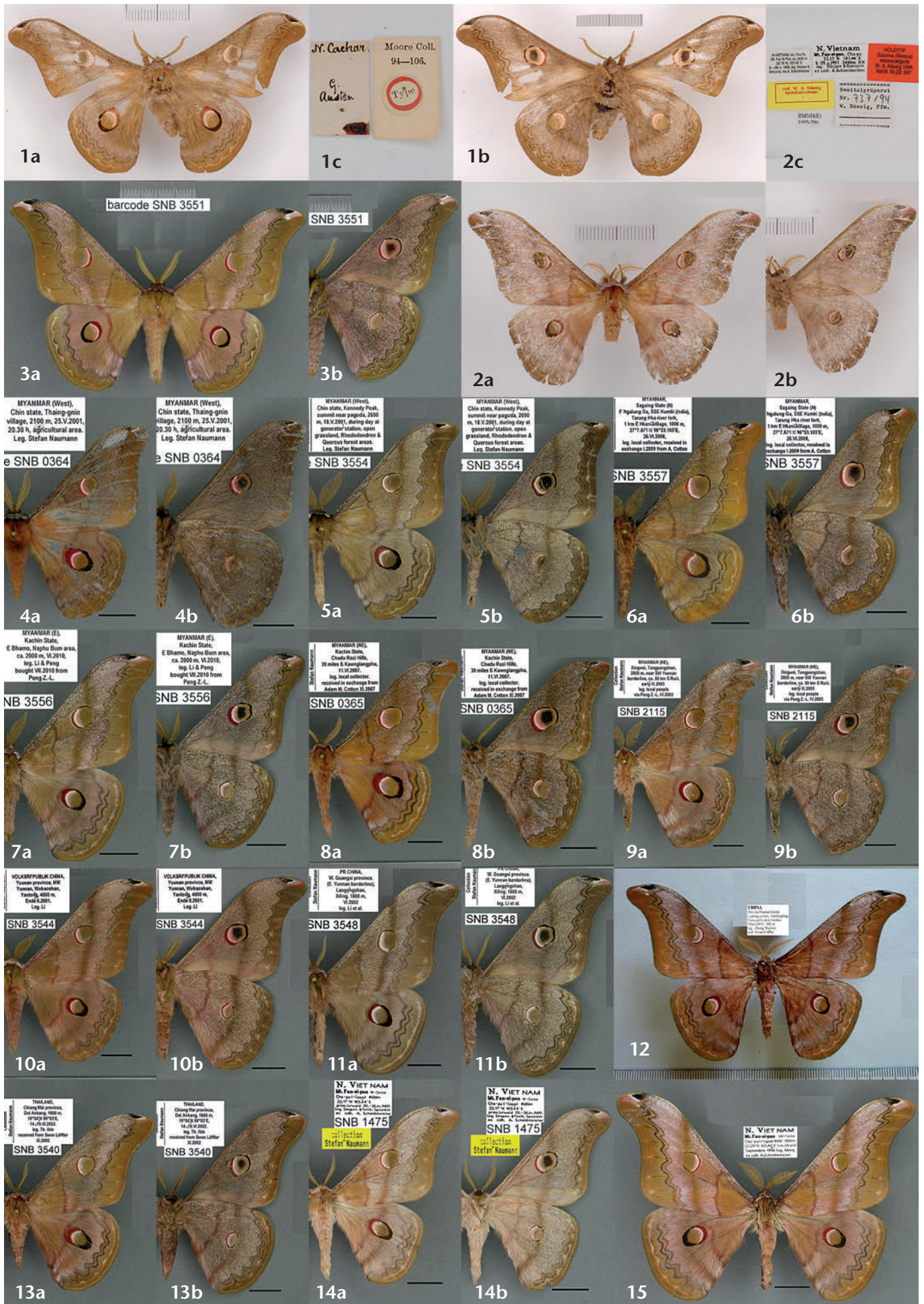
♂♂: 20:30 h, 20:50 h.

♀♀: 23:40 h, 1:50 h.

Distribution

(See Map.)

S. (C.) cachara is a widespread southeast Asian species occurring from northeast India south of the Brahmaputra valley via mountainous areas of Myanmar to northern Thailand, northern part of Laos, southwest China (including Hainan island) and northern provinces of Vietnam. It is missing (or has never been reliably recorded) in the Himalaya and further north- and eastward at higher altitudes of China (see separate discussion below). Specimens were collected at lower to medium altitudes from ca. 300 (in N Vietnam) to 2690 m (in W Myanmar); we believe that elevation data on labels of Chinese dealers' material for higher altitudes (up to 4000 m in Yunnan) are highly unreliable: these elevations are just the highest summits of the mountain chains involved, surely not the collecting localities somewhere on their





Figs. 1–33: *Saturnia* (*Cachosaturnia*) specimens (a [or no letter] = dorsal, b = ventral side, c ff. = other associated objects), males. Figs. 1–24: *S. (C.) cachara*. Figs. 1a–c: ♂ HT *S. cachara*, India, Assam, Cachar, BMNH; c = labels. Figs. 2: ♂ HT *S. (R.) microcaligula*, Vietnam (N), Fan Si Pan Mt., BMNH; c = labels. Fig. 3: ♂, India, Meghalaya, CSNB. Fig. 4: ♂, Myanmar (W), Chin State, CSNB. Fig. 5: ♂, Myanmar (W), Chin State, CSNB. Fig. 6: ♂, Myanmar (NW), Sagaing State, CSNB. Fig. 7: ♂, Myanmar (NE), Kachin State, CSNB. Fig. 8: ♂, Myanmar (NE), Kachin State, CSNB. Fig. 9: ♂, Myanmar (E), Shan State, CSNB. Fig. 10: ♂, China, Yunnan, CSNB. Fig. 11: ♂, China, Guangxi, CSNB. Fig. 12: ♂, China, Hainan, CSLL. Fig. 13: ♂, Thailand (N), Chiangmai, CSNB. Fig. 14: ♂, Vietnam (N), Fan Si Pan Mt., CSNB. Fig. 15: ♂, Vietnam (N), Fan Si Pan Mt., CSNB.

Figs. 16–23: *S. (C.) cachara*. — Fig. 16: ♀, India, Meghalaya, CSNB. Fig. 17: ♀, Myanmar (W), Chin State, CSNB. Fig. 18: ♀, Myanmar (NE), Kachin State, CSNB. Fig. 19: ♀, Myanmar (NE), Kachin State, CSNB. Fig. 20: ♀, China, Yunnan, CSNB. Fig. 21: ♀, Laos (N), Houaphan, CSNB. Fig. 22: ♀, Thailand (N), Chiangmai, CSNB. Fig. 23: ♀, Thailand (N), Nan, CSNB. — Figs. 24–26: *S. (C.) victoria* sp. n. Fig. 24: ♂ HT, Myanmar (W), Chin State, ex CSNB in ZMHU. Fig. 25: ♂ PT, Myanmar (W), Chin State, CSNB. Fig. 26: ♀ PT, Myanmar (W), Chin State, CSNB.

slopes (compare also NAUMANN & NÄSSIG 2010a: 56). Nevertheless, in the “material examined” sections we cite the altitudes from the original labels. For western Myanmar populations only a few flight activity records are noted: ♂♂ were attracted to light between 20.30 and 20.50 h, while ♀♀ arrived between 23.40 and 1.50 h.

A “de-Himalayan” distribution range

Besides a few quite doubtful records, no populations of *S. (C.) cachara* have been reliably recorded for the Himalaya so far. We have not plotted these localities on the map, as we do not believe them to be correct:

Bhutan: Only on repeated and insistent request at their British rearer he very reluctantly provided some locality data (“Bhutan, Chirong”) combined with somewhat partly nonsensical rearing protocols when selling cocoons to one of the authors (WAN; the resulting specimens as well as freeze-dried larvae from the offspring are preserved in CWAN in SMFL) in the early 1980s. This locality data did not appear to be a convincingly reliable report, neither then nor especially now on a much broader knowledge; however, the specimens do have that label data in SMFL now. No specimens were recorded during recent expeditions.

Nepal: D’ABRERA (1998: 34) is the only source for “Nepal” (and “Sikkim”) data, without providing any detailed record to prove this. HARUTA (1992, 1994) and ALLEN (1993) did not find the species in Nepal.

India (regarding Himalayan areas north of the Brahmaputra: Uttarakhand, Sikkim, Arunachal Pradesh etc.): SWINHOE (1894) and ARORA & GUPTA (1979) surprisingly did not mention *S. (C.) cachara* for India at all (in spite of its later proven presence in the Khasi Hills, and in spite of the type locality in Cachar, all south of the Brahmaputra). For Sikkim see D’ABRERA (1998: 34) above. 2 ♂♂ specimens in an old amateur collection in ZSM with label “*Saturnia grotei* [sic!] von WERNICKE 1920, Mussorie” [= India, Uttarakhand] are most unreliable, and we believe that this (including the wrong determination) is an entirely erroneous labelling.

There are no specimens of *S. (C.) cachara* from any Himalayan locality in the drawers of the BMNH (checked by SN in ix. 2012 in London), and this collection is the most comprehensive one with regard to the former British Empire of the 19th/early 20th century. There are many Indian specimens from different places in the former “larger” Assam and from areas which belong to Bangladesh or Myanmar today, but always from south of the Brahmaputra valley. And the species was, to our information, never collected in the Himalaya after 1980, starting with the expeditions by the late Werner †THOMAS in Darjiling (i.e., in Sikkim and West Bengal), nor later by M. PETERSEN in Nepal, nor during recent expeditions by S. NAUMANN, P. KAUTT, A. HAUENSTEIN and R. TRUSCH in Bhutan, nor by G. BRETSCHNEIDER in Arunachal Pradesh. ALLEN (1993: 63) expects *S. (C.) cachara* to occur in East

Nepal, and BRECHLIN (2009: 53) in Bhutan, but this all is only speculative, and we have severe doubt about it. The distribution “Himalayas and Tibet” given by BAXTER (1992: 41) is plainly nonsense. Obviously people always identified “northeastern India” to necessarily and automatically include the NE Indian Himalaya – which apparently may be true for the distribution of one or the other species, but obviously not for Saturniidae in general. A closer look on most groups studied so far has demonstrated this: the Himalayan species-group of *Saturnia (Rinaca) grotei* has a separate species south of the Brahmaputra (NAUMANN & NÄSSIG 2012a), just as well as *Saturnia (Rinaca) zuleika* (NAUMANN & NÄSSIG 2010b), and also *Archaeoattacus* has two different species in the North and South of the Brahmaputra valley (NÄSSIG et al. 2010); in all cases this southern species may then be widespread in S China and the Indochinese Peninsula, while the northern species is usually restricted to the Himalaya and perhaps Tibet, sometimes only to small areas. However, in case of the *cachara*-group, the corresponding species in the Himalaya is obviously inexistent, and only three species south of the Brahmaputra are known. By contrast, the species-group comprising *Salassa royi* ELWES, 1887 and relatives (Saturniidae: Salassinae) is perhaps an example for a complementary distribution: these taxa only occur north of the Brahmaputra in the Himalaya, not to the South of the river (NAUMANN et al. 2010: 117).

Of course, this case of a “de-Himalayan” species-group forming the *cachara*-group has potential consequences for the analysis of the evolutionary scenario of this subgenus. It may perhaps be expected that the ancestor species of this subgenus originated somewhere on the Indochinese Peninsula (its sister-taxon has so far not been reliably identified) or, as a somewhat opposite idea, in what is today the mountain range in western Chin State, around the present Mt. Victoria. Caused by a different coastline during times of higher sea levels (ca. 60 to over 100 m, depending on authors) in Tertiary times, before the water was trapped in the polar ice-shields, the lower Brahmaputra and Irrawaddy valleys were to a large extent submersed, and the diverse Assamese hill chains S of the Brahmaputra river as well as the mountains between the Irrawaddy and Brahmaputra river systems were islands and peninsulas, in part well-isolated from the continental mountains. This isolation evidently prevented the colonisation of the Himalaya range.

Probably these narrow mountain chains between Brahmaputra and Irrawaddy valleys were also in other ecological dimensions (local climate, vegetation, ...?) and/or just in the narrow width of the area less suitable for the ancestor of *S. (C.) cachara*, because the only clearly separate species are both found in the Chin Hills in the area of the high peak of Mt. Victoria nowadays: *S. (C.) heinrichi* as the most separate species, most likely being the first colonisator of the Chin Hill area (either as an early invasion or as the oldest remnant of the ancestor, depending on the direction of evolution) and, therefore,

with more time for genetic separation, and *S. (C.) victoria*, which is still much closer to *S. (C.) cachara* and surely a later split-off of the *cachara*-complex with less time for genetic differentiation.

Geographical population structure

Saturnia (Cachosaturnia) cachara exhibits some quite well-expressed population structure across its distribution range, both indicated in larval and imaginal morphology and in mtDNA COI-barcode sequences.

Larval morphology

As shown in Figs. 36–46 there are different larval forms known.

- Larvae from “Bhutan” (*recte*: most likely India, Meghalaya, vicinity of Shillong, rather close to the type locality Cachar), reared by WAN in the early 1980s in Frankfurt, had in most cases red dorsal tubercles (sometimes looking very broad, as if a second subdorsal scolus would have been included in the construction) on thoracal segments 2 and 3, of which sometimes the bases of the scoli appeared to be fused mid-dorsally, and red thoracic legs. (The larvae were not photographed in detail in those days, but as many of them died caused by infections, several were stored in the deep-freeze and later freeze-dried. Some of these freeze-dried, bleached larvae are illustrated here. They lost all of the bluish and greenish colour and most of the red; only the yellow and black “survived” the freezing process. But these dry larvae illustrated here in Figs. 36–38 still show the differing pattern and remnants of the red colour quite well.) Such red tubercles are also mentioned, e.g., by WATSON (1920: 837), CROTCH (1956: 87) or GARDINER (1982: 129), but not by BAXTER (1992: 41), although this colour in life is very impressive. We suppose that all material they had in their hands during these times originated from India (former Assam, probably mainly Meghalaya: Khasi Hills, vicinity of Shillong, and perhaps Cachar). Besides the red thoracal scoli and legs, these western larvae differed as well in the dorsal hair cover of the body (yellowish to whitish setae on the scoli and a relatively dense cover of the rest of the dorsal surface with secondary yellowish hairs between the scoli, much more conspicuous than in eastern populations), in details of the black pattern (less black on the anal prolegs, on the dorsal side of the body and generally fewer black pattern elements) and in the colour and pattern of the head capsule in mature larvae, which always had not more than ca. 50% black on it (higher percentage in eastern populations).
- Populations east of Chin State in Myanmar known to us (only known from China: Yunnan and [in part] Thailand; we do not know, e.g., the larvae of Chin State *cachara*, and of all other areas) do not possess these red dorsal tubercles, but have completely yellow ones (compare, e.g., LAMPE 2010: 317). Also the thoracic legs are usually not red. There is clearly less hair cover

on the body dorsally. The black pattern is generally much increased, the larvae appear much darker on average (especially dorsally) and further tend to show a more intensively bluish ground colour. In some rearing of Yunnan populations we even observed single larvae with a huge black portion in their colouration and reduced turquoise parts; one such larva is figured here by courtesy of U. WERITZ (Fig. 46).

As there is not much known about the larvae of most populations, we do not know presently whether these clearly differing larval forms are connected by intermediate forms or strictly separated. The lack of further morphological data of larvae also prevents a clear comparison with the four different “barcode populations” for the time being, see below.

Genitalia morphology

The ♂ genitalia of *S. (C.) cachara* across its range are also quite variable; for example, smaller specimens from western Myanmar (Chin) also show smaller and more delicate genitalia (while the genitalia of *S. (C.) victoria*, which is a larger species, also are small and delicate – another hint for the specific distinctness of *victoria* and *cachara*). Further, the structure of the sclerotised prolongation of the sacculus on the ventral side of the valves [“harpe”] and the shape of the valves as well as (to a lower degree) shape and size of uncus and juxta are different between populations. However, also in this case there is so far no clear relationship visible in comparison to the other variables in larval morphology and barcode, again perhaps mainly due to our present gaps of knowledge.

COI-barcode mtDNA sequences

The mtDNA COI-barcode sequences available to us show a clear separation into four populations (Text-Fig. 1; but see also discussion and Text-Fig. 2). For the western population there are only two specimens barcoded (only one with full sequence length, see Tab. 1), with incomplete data (“Meghalaya”), kindly provided by S. KOHL; the topotypical population from Cachar has not been barcoded due to lack of fresh material. No recently collected specimens with reliable collecting data from the Himalaya have ever been recorded.

Conclusion for *S. (C.) cachara*

The populations of *S. (C.) cachara* show a rather clear substructure in larval and imaginal [male genitalia] morphology as well as in barcode sequences. However, these data sets are not really comparable, because the larval morphology is only more or less known from 3 populations (Meghalaya, Yunnan and N Thailand), while the barcode data is better in the eastern part, but quite weak in the West; only ♂ genitalia have a better coverage, but are not overall coincident with the other data. Further, the geographical distribution of the barcode data is somehow enigmatic (compare locality data and position of the samples within the ME tree) and does as well not show a clear correlation. Based on this incompleteness of



Figs. 27–33: *S. (C.) heinrichi*. Fig. 27: ♂ HT *D. heinrichi*, Myanmar (W), Chin State, BMNH; c = labels. Figs. 28–31: ♂♂, Myanmar (W), Chin State. Figs. 32–33: ♀♀, Myanmar (W), Chin State. — Specimen photos S. NAUMANN, except Figs. 1, 2 + 28 (© The Natural History Museum [BMNH], London; photos provided by A. GIUSTI, BMNH) and Fig. 12 (S. LÖFFLER). — Pictures of specimens approximately to the same scale, scale in cm with 0.5 mm subdivisions (dark grey scale), respectively 1.0 mm subdivisions, or scale bar = 1 cm. — Figs. 34–35: Habitat of *S. (C.) heinrichi* and *S. (C.) victoria* in West Myanmar, Chin State, W of Mindat, ca. 2400 m. — Photos S. NAUMANN.

data and uncertainty, we do not dare to subdivide *S. (C.) cachara* any further today. However, it is clear that this complex is comprising quite a lot of genetic differentiation and requires further research. In concordance with the above facts, we interpret *S. microcaligula* to remain in synonymy of *S. (C.) cachara* for the time being – alternatively it might turn out to be the adequate name for some of the eastern populations.

Saturnia (Cachosaturnia) victoria sp. n.

Holotype: ♂, Myanmar (West), Chin State, ca. 9 miles W Mindat, Baw Kwe village, agricultural station, 21°22' N, 93°55' E, 1960 m, cocoon leg. x. 2002 on *Persea americana*, e.p. 18. v. 2003 in Berlin, leg. S. NAUMANN & W. MEY. – The holotype (ex CSNB) will be deposited in ZMHU. A red HT label will be added. – We have selected as holotype a perfect specimen from a rearing from a pupa found in the wild, because wing shape, size, pattern and colour are absolutely identical to specimens collected at light, but the latter are on average much more worn.

Paratypes: all Myanmar, Chin State (in total 85 ♂♂, 86 ♀♀): 7 ♂♂, 11 ♀♀, same data as holotype, ex pupa 15. ii., 11. iii., 25. iv., 17. v., 18. v., 29. v., 16. xi. 2003 (♂♂), 2× 15. ii., 25. iii., 22. iv., 10. v., 17. v., 18. v., 21. v., 22. v., 8. xi., 16. xi. 2003 (♀♀), ♂ GPs 1849/08, 2259 & 2260/12 SNB, BC SNB 2110, 3552 (CSNB). 19 ♂♂, 18 ♀♀, same locality, cocoons leg. 3. ii. 2005, e.p. 2. iv., 7. iv., 3× 9. iv., 3× 10. iv., 11. iv., 2× 13. iv., 2× 15. iv., 16. iv., 17. iv., 18. iv., 23. iv., 26. iv., iv. 2005 (♂♂), 7. iv., 9. iv., 3× 11. iv., 12. iv., 6× 15. iv., 3× 16. iv., 17. iv., 23. iv., 27. iv. 2005 (♀♀) in Berlin, leg. S. NAUMANN, S. LÖFFLER & T. IHLE (CSNB). 1 ♂, 1 ♀, same data, e.p. iv. 2005, ex CSNB (CUWA). 12 ♂♂, 23 ♀♀, same data, e.p. 3.–31. v., 4.–18. vi. 2005 (CSLL). 1 ♂, 8 km W. Mindat, avocado plantation, 21°23'34.7" N, 93°52' 29.4" E, 1914 m, 30. vi. 2008, 20.15 h, leg. LANGER, LÖFFLER & NAUMANN, BC SNB 0367 (CSNB). 1 ♂, same data (CSLL). 1 ♂, Mt. Victoria N.P., Chin Hills, rd. Mindat Matupi, 20-miles-camp, 2350 m, 27.–29. vi. 2008, leg. S. NAUMANN, M. LANGER & S. LÖFFLER (CSLL). 1 ♂, Burma, Mt. Victoria, Pak-koku Chin Hills, 2200 m, 15.–30. vi. 1938, G. HEINRICH, Brit. Mus. 1938-689 (BMNH). 1 ♂, Mt. Victoria (Nat Ma Toung) N.P., rd. Mindat-Matupi, ca. 500 m W 22-miles-camp, 21° 26.427' N, 93°47.121' E, 2286 m, 14. v. 2012, leg. S. LÖFFLER & S. NAUMANN (CSLL); 1 ♂, same locality, but 20. v. 2012 (CSLL); 3 ♂♂, same data (CSNB). 1 ♂, Mt. Victoria (Nat Ma Toung) N.P., rd. Mindat-Matupi, 55 miles, Twedain village monastery garden, 21°34.752' N, 93°43.279' E, 2432 m, 16. v. 2012, leg. S. LÖFFLER & S. NAUMANN (CSLL); 6 ♂♂, same locality, but 18. v. 2012 (CSLL); 4 ♂♂, same data, collected between 19.50 and 20.30 h (CSNB). 1 ♀, Mt. Victoria (Nat Ma Toung) N.P., rd. Mindat-Matupi, ca. 600 m N 30-miles-camp, 21°29.807' N, 93°47.576' E, 2580 m, 19. v. 2012, 20.10 h, leg. S. LÖFFLER & S. NAUMANN (CSNB). 1 ♂, Mt. Victoria (Nat Ma Toung) N.P., rd. Mindat-Matupi, 8 miles, Agricultural Research Station Mindat, 21°23.440' N, 93°52.478' E, 1916 m, 22. v. 2012, 19.20 h, leg. S. LÖFFLER & S. NAUMANN (CSNB). 15 ♂♂, 21 ♀♀, Mt. Victoria (Nat Ma Toung) N.P., rd. Mindat-Matupi, 8 miles, Agricultural Research Station Mindat, 21°23.440' N, 93°52.478' E, 1916 m, cocoons collected 22. v. 2012, reared ex pupa 23. v.–20. vi. 2012 (CSLL); 10 ♂♂, 11 ♀♀, same data, reared ex pupa 23. v.–10. vi. 2012 (CSNB). – Blue paratype labels will be added accordingly. Some of the specimens of CSNB will be deposited in the collections of SMFL and BMNH.

Etymology: *S. (C.) victoria* sp. n. is named after the type locality of the new taxon, the slopes of Mt. Victoria in Chin State, West Myanmar.

Here illustrated: Figs. 24–26, 47–61, 83–85.

Diagnosis and description

♂ (Figs. 24–25): Ground colour olive with a carmine or greyish note. Antennae ochreous, quadripectinate, length 10.8–12.0 mm. Frons and collum covered with long hair-like scales in ground colour. Forewings with little elongated and rather rounded apex, length 42–49 mm (HT: 47 mm), hindwings rounded. On dorsal side the antemedian and postmedian areas of both fore- and hindwings in ground colour, suffused with olive scales, the median area suffused with more or less lots of grey and carmine or violet scales, and separated by a single dark greyish carmin antemedian line and two undulating postmedian lines, of which the proximal one always is of dark carmine colour and the more marginally one dark grey. The forewing median area has a central round ocellus of 7.0–7.5 mm (HT 7.5 mm) maximum diameter, mainly coloured in ground colour, with proximally broad red, white and pink crescent-like pattern. That of the hindwing also round, 7.0–8.0 mm (HT 8.0 mm) maximum diameter, with same proximal colouration but broader carmine red portion, and wide black outer margin. The submarginal area of the forewing with a row of partly connected white patches, that of the hindwing with a white undulated line. Forewing apical area with typical black and white patch. On the ventral side wings of more intensive and dark olive to carmine brown colouration, forewing antemedian band missing, the postmedian lines further marginally. The forewing ocellus with huge black lens and black margin in the marginal half, the hindwing ocellus also with black outer ring in the marginal half.

♂ **genitalia** (Figs. 83–85): Uncus bifid, with two very slender processes which are longer and more acute than in *S. (C.) cachara*, bent also to the ventral side. Valves, compared to *S. (C.) cachara*, more slender, the dorsal process without sclerotisation, more triangular, the ventral one more slender and more acute than in *S. (C.) cachara*, bent to dorsal side at its tip. Saccus very short and slender, juxta with two longer acute lateral processes. Phallus even smaller, the thorn-like sclerotised process with a small indentation to distal side, vesica again without sclerotisation. 8th abdominal segment again without any significant characters. Generally, the genitalia of *S. (C.) victoria* are smaller and sclerotised parts are less developed than in *S. (C.) cachara*, although specimens are generally bigger and have a more compact form.

♀ (Figs. 26, 59): Aside from sexually dimorphic characters such as different antennae, more rounded wings of larger size, and larger abdomen similar to the ♂♂, but so far only reddish to carmine brown specimens are known. ♀♀ have bipectinate antennae of 12.5 mm maximum length, the forewing length is 49–52 mm. The median area of both fore- and hindwings bear sometimes more greyish scales than in the ♂♂, so that often a weakly indicated median line can be seen.

By the larger size, different carmine colouration, the inner carmine postmedian line, the white hindwing submarginal line, the outer black portion of the ventral

hindwing ocellus and details in ♂ genitalia *S. (C.) victoria* can easily be separated from *S. (C.) cachara*. Interestingly, specimens of both taxa look most distinctive in populations originating from Chin State in West Myanmar where *S. (C.) cachara* gets especially small and often lacks parts of its ornamentation.

Preimaginal instars (Figs. 47–58): Ova are of creamy white colour and are fixed side-by-side in flat patches on surfaces (in contrast to the eggs of *S. (C.) heinrichi* which are deposited in lines of many single eggs) with a brown secrete, often directly on the cocoon of the hatched ♀ on a tree. As in *S. (C.) cachara*, larvae are in all instars coloured in a combination of yellow, black and turquoise, but colours more intensive than in *S. (C.) cachara*, with bigger lateral turquoise portion, and with yellow dorsally. The black markings are much reduced, compared to eastern populations of the latter species. In the first 3 instars the head is black, in 4th and 5th instar it is getting chestnut brown. Larvae bear in all instars orange to crimson red dorsal tubercles on thoracic segments 2 + 3, and all tubercles bear long yellow setae and on the rest of the dorsal surface several creamy white secondary hairs. In the last instar the broad dorsal yellow portion is tending to a creamy white. The general view resembles somehow the larvae of the Meghalaya population *S. (C.) cachara*, but is more colourful. Pupation takes place in cocoons on the bark of the foodplant trees, usually with some cover of moss or lichens, so larvae are almost never leaving their trees. The cocoons were found in several years in the same area on different cultivated trees, mainly on *Persea americana* (Lauraceae), but also on *Prunus armeniaca* and *P. avium* (Rosaceae) in Myanmar, always on the most rain-exposed side of the trees or the underside of larger branches where lots of rain could wet the cocoons (Figs. 56–57). The cocoon is of a net-like (with only incompletely open meshes), hard, dark brown silk, with a preformed double, valve-like exit.

Ecological observations: Two parasitoid flies (Diptera: Tachinidae, probably Tachininae) hatched from cocoons collected in the wild in xi. 2002 and vi. 2003 (Fig. 60, in CSNB), and in vi. 2012 a parasitoid wasp of the genus *Pimpla* (Hymenoptera: Ichneumonidae, Pimplinae) was found in the pupa cage (Fig. 61, in CSNB). These wasps attack cocoons, paralyze the pupa and insert one egg each (pers. comm. R. S. PEIGLER). *Pimpla* sp. wasps were not mentioned so far to attack cocoons of *S. (C.) cachara* (PEIGLER 1994).

S. (C.) victoria is known so far to occur in an area of about 100 km around Mt. Victoria in Chin State, West Myanmar, only, and there always syntopical and in most occasions also synchronous with *S. (C.) heinrichi*. Only for a few specimens the arrival times at light were recorded:

♂♂: 19:20 h, 19:50 h, 20:15 h, 2× 20:30 h;

a single ♀: 20:10 h.

Most of these observations were made in the monastery garden, and the collecting of ♂♂ was obviously improved

by the presence of a freshly hatched ♀ close to the light. At other collecting localities this ♀ was already dead and did no longer attract ♂♂. Most other specimens come from cocoons, which are more easy to find. The attractiveness of artificial light is obviously quite weak for *S. (C.) victoria*, in contrast to both *S. cachara* and *S. heinrichi*.

Saturnia (Cachosaturnia) heinrichi (LEMAIRE, 1976), new subgeneric combination

Dictyoploca heinrichi n. sp.: LEMAIRE (1976: 299, figs. 1–2).

Type material: ♂ holotype by original designation, BMNH (GP LEMAIRE 3048 [originally published as A-398] = BMNH Sat. 273) (examined, Figs. 27a–c, 86). 40 ♂♂, 2 ♀♀ paratypes, BMNH (examined). Of these, 2 deposited in coll. LEMAIRE in MNHN, 1 in SMFL.

Type locality: Burma [= Myanmar], [Chin State], Mt. Victoria, Pakokku Chin Hills, 2600 m.

Etymology: Named after the collector Gerd HEINRICH. He was a specialist for Ichneumonidae of the Oriental fauna and an ornithologist, and he undertook a famous expedition to “Upper Burma” in 1938 from which also the type material of *S. (C.) heinrichi* resulted.

Here illustrated: Figs. 27–33, 62–73, 86–88.

Cited in literature as:

Dictyoploca heinrichi: LEMAIRE (1976: 299, fig. 1 ♂ holotype, fig. 2 ♂ GP).

Caligula heinrichi: D'ABRERA (1998: 34, 35, fig. ♂ holotype, ♀ paratype); MIRANDA & PEIGLER (2007: 436).

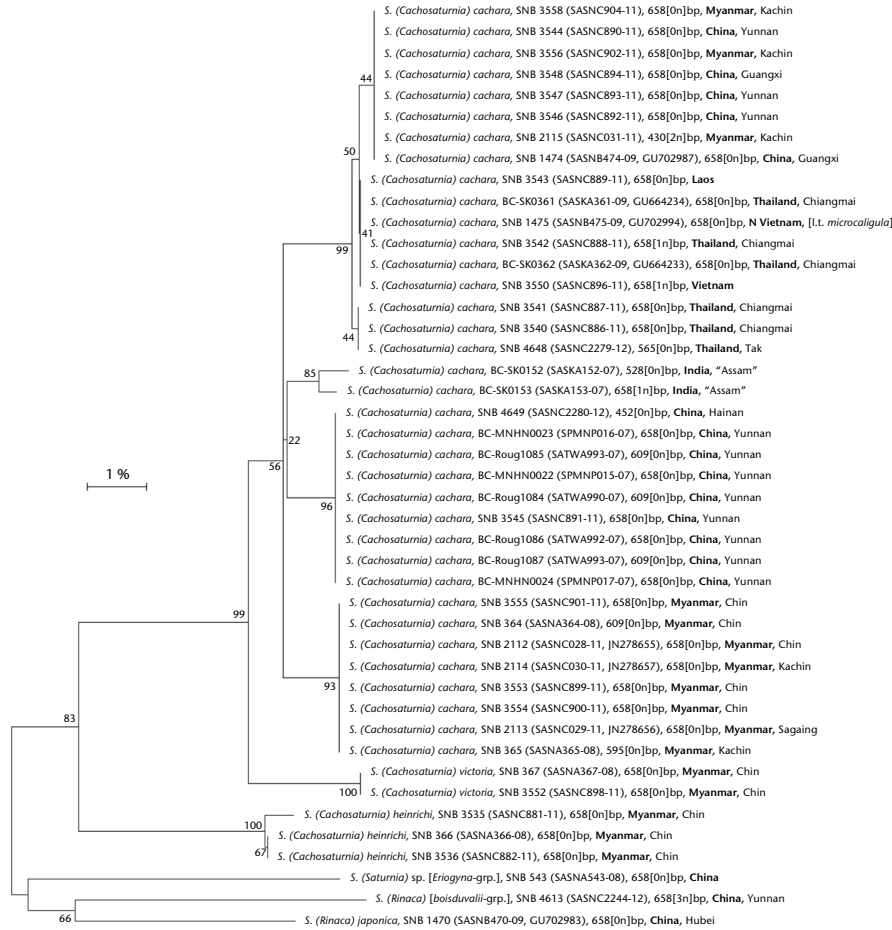
Saturnia (Rinaca) heinrichi: NÄSSIG (1994a: 257, comb. n.; 1994b: 339, 347, fig. 7 ♂ GP).

Distribution and examined material (see Map):

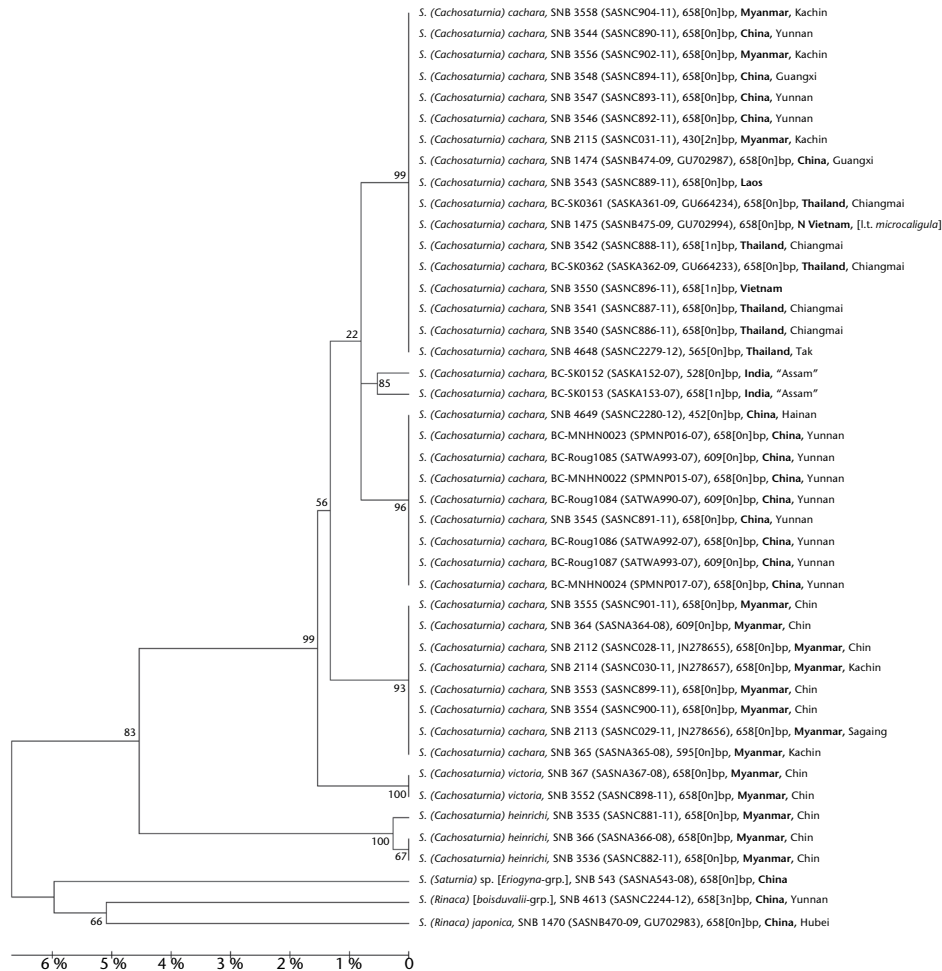
Myanmar, all Chin State: Mt. Victoria, Pakokku Chin Hills, 2600 m, 2. v.–30. vi. 1938, leg. G. HEINRICH, (BMNH, MNHN, SMFL). Mt. Victoria N.P., 16 miles camp, *Quercus-Rhododendron* forest, 2548 m, 10.–12. vii. 2005, leg. M. HOFFMANN (CSLL). Natma Taung N.P., rd. Mindat–Matupi, 20 miles camp, 21°25' 15.2" N,

Text-Figs. 1a–b: Molecular phylogenetic analysis of the mtDNA COI barcode nucleotide sequences of *Saturnia (Cachosaturnia)*. The analysis involved 44 nucleotide sequences (= specimens, including outgroup samples). There were a total of only 384 positions in the final dataset, because so many sequences were incomplete (see Table 1; compare Text-Fig. 2). — **Text-Fig. 1a:** The evolutionary history was inferred using the **Minimum Evolution** method (RZHETSKY & NEI 1992). The bootstrap consensus tree inferred from 1000 replicates is taken to represent the evolutionary history of the taxa analyzed (FELSENSTEIN 1985). Branches corresponding to partitions reproduced in less than 50% bootstrap replicates are collapsed. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) are shown next to the branches (FELSENSTEIN 1985). The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The evolutionary distances were computed using the Maximum Composite Likelihood method (TAMURA et al. 2004) and are in the units of the number of base substitutions per site. The rate variation among sites was modelled with a gamma distribution (shape parameter = 3). The differences in the composition bias among sequences were considered in evolutionary comparisons (TAMURA & KUMAR 2002). The ME tree was searched using the Close-Neighbor-Interchange (CNI) algorithm (NEI & KUMAR 2000) at a search level of 0. The Neighbor-joining algorithm (SAITOU & NEI 1987) was used to generate the initial tree. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. Evolutionary analyses were conducted in MEGA5 (TAMURA et al. 2011). —

Text-Fig. 1b: The same **ME-consensus tree** as before, but linearized, so that the percentages of difference in the sequences become clearer visible.

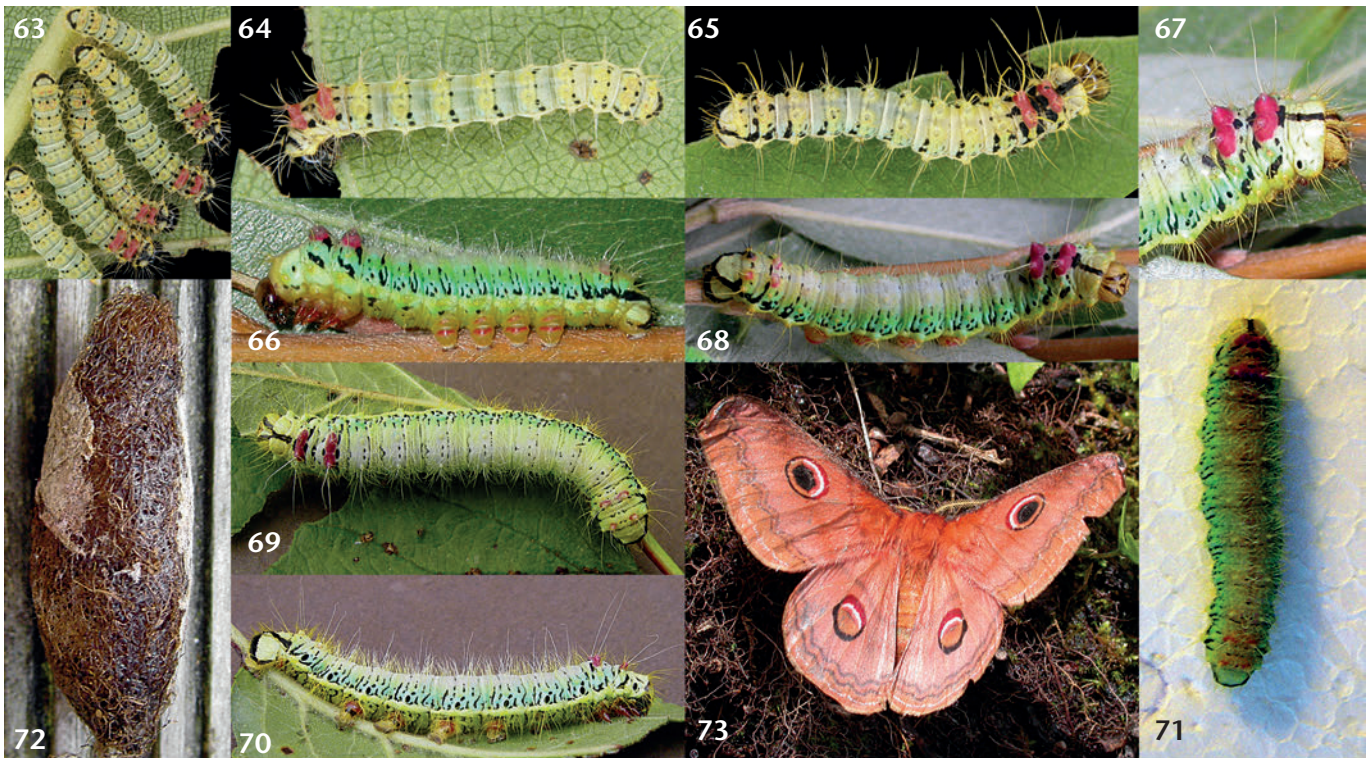


Text-Fig. 1a



Text-Fig. 1b





Figs. 36–73: *Saturnia (Cachosaturnia)* preimaginals, parasitoids and living specimen. — Figs. 36–46: *S. (C.) cachara*. Figs. 36–38: Freeze-dried larvae from the rearing in the early 1980s, cult. WAN, “Bhutan” [recte: most likely Meghalaya], L₅ (mature caterpillars). Fig. 39: dried eggs, BMNH. Fig. 40: empty cocoon, BMNH. Figs. 41–44: N Thailand, cult. SN. Fig. 41: L₁. Fig. 42: L₂. Figs. 43–44: L₄. Figs. 45–46: China, Yunnan, cult. U. WERITZ. Fig. 45: L₃. Fig. 46: L₅, dark form. — Figs. 47–61: *S. (C.) victoria*, all from Myanmar, Chin State. Fig. 47: ova. Fig. 48: ova and L₁. Fig. 49: L₁. Fig. 50: L₂. Fig. 51: L₃. Fig. 52: L₄. Fig. 53–55: L₅ (Fig. 54: in nature). Fig. 56–57: cocoon in nature. Fig. 58: cocoon from rearing in Europe. Fig. 59: living reared ♀. Fig. 60: 2 Tachinidae sp., hatched xi. 2002 from wild collected cocoons, CSNB. Fig. 61: *Pimpla* sp., Ichneumonidae, hatched vi. 2012 from wild collected cocoon, CSNB. — Figs. 62–73: *S. (C.) heinrichi*, all from Myanmar, Chin State. Fig. 62: ova. Fig. 63–64: L₁. Fig. 65: L₂. Fig. 66: L₃. Figs. 67–68: L₄. Fig. 69–71: L₅ (Fig. 71: prepupal stage). Fig. 72: cocoon. Fig. 73: living ♀ in its habitat. — Photos SN, except: Figs. 36–38 WAN; Fig. 54 SL; Figs. 45–46, 55, 69–72 U. WERITZ; Figs. 63–65 S. KOHL; Figs. 49–54, 59 K. WOLFE. Photos of BMNH material: © The Natural History Museum, London.

Figs. 74–88: ♂ genitalia of *Saturnia (Cachosaturnia)*. Figs. 74–82: *S. (C.) cachara*. Fig. 74: GP 407/99 SNB, India, Meghalaya. Fig. 75: GP 541/01 SNB, Myanmar, Chin State. Fig. 76: GP 2262/12 SNB, Myanmar, Sagaing State. Fig. 77: GP 2261/12 SNB, Myanmar, Kachin State. Fig. 78: GP 401/99 SNB, China, Yunnan. Fig. 79: GP 2187/10 SNB, China, Guangxi. Fig. 80: GP 406/99 SNB, Thailand, Chiang Mai. Fig. 81: GP 405/99 SNB, Laos, Louang Prabang Prov. Fig. 82: GP 403/99 SNB, Vietnam, Hoang Lien Son Prov. — Figs. 83–85: *S. (C.) victoria*, Myanmar, Chin State. Fig. 83: GP 1849/08 SNB, PT. Fig. 84: GP 2259/12 SNB, PT. Fig. 85: GP 2260/12 SNB, PT. — Figs. 86–88: *S. (C.) heinrichi*, Myanmar, Chin State. Fig. 86: GP A-398 C. LEMAIRE (= 3048 LEMAIRE, = BMNH Sat. 273), HT, in BMNH (© The Natural History Museum, London). Fig. 87: GP 1848/08 SNB. Fig. 88: GP 2263/12 SNB. — Genitalia not exactly to the same scale. Scale bar (where present) = 1 mm.

93°47'21.5" E, 2350 m, vi. 2008, leg. LANGER, LÖFFLER & NAUMANN, ♂ GPs 2063 & 2064/12 SNB, BC SNB 0366 & 3536 (CSNB, CSLL). Same area, 30 miles camp, 21°29'47.0" N, 93°47'21.9 E, 2495 m, vi. 2008, leg. LANGER, LÖFFLER & NAUMANN, ♂ GP 1848/08 SNB, BC SNB 3535 (CSNB, CSLL). Same locality, e.o. iv. 2009 reared on *Salix babylonica* (CSNB). Same area, 8 km W Mindat, avocado plantation, 21°23'34.7" N, 93°52'29.4" E, 1914 m, vi. 2008, leg. LANGER, LÖFFLER & NAUMANN (CSNB, CSLL). Natma Taung N.P., ca. 5 km W Kanpetlet, "blockhouse", ca. 1750 m, vi. 2008, leg. LANGER, LÖFFLER & NAUMANN (CSNB). Mt. Victoria env., 1800 m, v.–vi. 2002, leg. Y. KUSAKABE, via Y. KISHIDA (CSNB). Rd. Mindat–Matupi, ca. 500 m W 22-miles-camp, 21°26.427' N, 93°47.121' E, 2286 m, 14.+20. v. 2012, leg. S. NAUMANN & S. LÖFFLER (CSLL, CSNB). Rd. Mindat–Matupi, 22-miles-camp, 21°26.259' N, 93°47.228' E, 2310 m, 14. v. 2012, leg. S. NAUMANN & S. LÖFFLER (CSLL, CSNB). Rd. Mindat–Matupi, ca. 100 m SW 30-miles-camp, 21°29.782' N, 93°47.364' E, 2498 m, 15. v. 2012, leg. S. NAUMANN & S. LÖFFLER (CSLL, CSNB). Rd. Mindat–Matupi, 55 miles, Twedain village monastery garden, 21°34.752' N, 93°43.279' E, 2432 m, 16.+18. v. 2012, leg. S. NAUMANN & S. LÖFFLER (CSLL, CSNB). Rd. Mindat–Matupi, ca. 600 m N 30-miles-camp, 21°29.807' N, 93°47.576' E, 2580 m, 19. v. 2012, leg. S. NAUMANN & S. LÖFFLER (CSLL, CSNB). Rd. Mindat–Matupi, 8 miles, Agricultural Research Station Mindat, 21°23.440' N, 93°52.478' E, 1916 m, 22. v. 2012, leg. S. NAUMANN & S. LÖFFLER (CSNB).

Diagnosis and description

♂ (Figs. 27–31): Ground colour in most times ochreous orange, but some specimens also of pinkish olive or dark reddish brown. Antennae ochreous, quadripectinate, length 9.5–11.5 mm. Frons with long hair in ground colour, collum similar to forewing costa, dark greyish black. Forewings with round apex, length 36–44 mm, hindwings rounded. On dorsal side antemedian, median and postmedian areas of both fore- and hindwings in ground colour. There are a single indicated, slightly more intense antemedian line and two dark grey undulated postmedian lines. The forewing median area has a typical central ovoid ocellus of 8.0–9.2 mm maximum diameter, with a huge proximal carmine, white and pink portion and an inner black lens with a lenticular hyaline line, and a marginal outer black line. The ocellus of the hindwing also ovoid or round, with 7.0–9.0 mm maximum diameter, with same proximal colouration, centre of olive to brown colour, and wide black outer margin. The submarginal area of the forewing with a row of tiny white patches, that of the hindwing a little more intense, forming a white undulated line. Forewing apical area with small black patch. On the ventral side wings of more intensive and dark colouration, sometimes even dark chocolate brown or blackish, forewing antemedian band missing, the postmedian lines further marginal. The forewing ocellus with huge black lens and black margin in the marginal half, similar to the structure on dorsal side, the hindwing ocellus without any black parts shown on dorsal side which are only visible as through-shining shadow, and thereby much smaller. The marginal parts of the median area and the marginal area are often suffused with white scales.

♂ genitalia (Figs. 86–88): Uncus bifid, the most slender and least sclerotised structure in the subgenus. Valves

more slender than in two previous species, with triangular to rectangular dorsal process without sclerotisation, and a "finger-like" little sclerotised ventral process. Saccus very small, almost invisible, juxta with two lateral acute processes, Phallus very small, with a less sclerotised lateral plate-like process which is slightly dentate on dorsal and ventral side, and a knob-like dorsal end. Vesica and structures of 8th abdominal segment again without significance. Generally the smallest and least sclerotised ♂ genitalia structures for the entire subgenus.

♀ (Figs. 32–33, 73): Aside from sexually dimorphic characters such as different antennae, more rounded wings of little larger size, and larger abdomen very similar to the ♂♂. ♀♀ have bipectinate antennae of 9.5–10.0 mm maximum length, the forewing length is 42–44 mm. The dorsal and the ventral postmedian area of both fore- and hindwings is a little darker than the rest of the wing, the ventral median area is widely suffused with greyish scales.

Preimaginal instars (Figs. 62–73): Ova are of creamy white colour and are fixed in single lines (or rows) of up to 30 on the surface. Larvae are very similar to those of *S. (C.) cachara* and *S. (C.) victoria*, but miss the turquoise portion in the first instars and are mainly coloured in a combination of whitish yellow to green colours, with only a few black markings. In the first instar the head is black, then becoming more greyish brown, and in 4th and 5th instar it is turning to light yellowish brown. Larvae bear in all instars orange to crimson red dorsal tubercles on thoracic segments 2 and 3, and all tubercles are crowned with long creamy white setae. From end of 3rd instar onward also the dorsal tubercles on abdominal segments 8 and 9 are becoming pink, later light crimson red but of much smaller size than the thoracic scoli. From 4th instar the dorsal yellow portion is tending to a creamy white. Pupation takes place in a hard cocoon consisting again of a net-like (with only incompletely open meshes), dark brown silk, with a preformed double, valve-like exit.

No larvae were found in the habitat of *S. (C.) heinrichi* yet, but the species was reared with mixed success and big losses in Germany from ova deposited in Myanmar. *Salix babylonica* (Salicaceae), *Prunus serotina* and *Prunus domestica* (both Rosaceae) were used as foodplants; only very few cocoons could be achieved from rearings in different hands.

Ecological observations: Nocturnal flight pattern of males and females see Diagram. ♂♂ of *S. (C.) heinrichi* were found to be attracted to lights between 19:40 (not plotted) and 21:50 h, with a few singletons collected around 23.00 h, ♀♀ arrived at light between 23:20 and 0:15 h. Attractivity of artificial lights is much higher than for *S. (C.) victoria*.

S. (C.) heinrichi is known only from the southern central parts of Chin State, West Myanmar, from the type series and further specimens collected in an area of about 100 km around the type locality.

Discussion

DNA sequencing

The Minimum Evolution analysis of the mtDNA COI barcode sequences delivered a very clear separation for *Saturnia (Cachosaturnia) heinrichi* and a less clear separation for *S. (C.) victoria* (see Text-Figs. 1a, b). When the specimens with incomplete sequence data are eliminated for the analysis (see Text-Fig. 2, based on 35 instead of 44 specimens, each tree including outgroup samples), the internal structure of *S. (C.) cachara* becomes slightly more complicated and less clearly structured than in the version containing all data, but the topology for the three species does not really change. A very similar topology is also achieved when the same data are analysed with the Neighbor Joining method of MEGA5.

However, when analysing the same data sets with the Maximum Likelihood method of MEGA5, the topology changes, and *S. (C.) victoria* disappears from its separated position and changes to a terminal place within the complex species *S. (C.) cachara*. We decided nevertheless to describe the population as a separate species, because there are additional and rather clear morphological differences, and, therefore, took the ME analysis for illustration here. As the morphological differences between species and populations are often small or subtle and, especially, hard to be interpreted in terms of evolutionary directions (and thus also hard to be pressed into a plausible scheme for statistical analysis), we have not constructed an integrative tree using both morphological and mtDNA characters for the phylogeny analysis. It appears unlikely that *S. (C.) victoria* is no more than a subspecies of *S. (C.) cachara*. However, it also cannot decisively be ruled out today that this might be a similar case like in *Archaeoattacus* (see NÄSSIG et al. 2010), where overlapping populations (*Archaeoattacus*: in West Malaysia; *Cachosaturnia*: in the Chin Hills/Mt. Victoria area of Myanmar) of separate species show an increased barcode difference within the area of overlapping. Further studies are necessary.

Saturnia (Cachosaturnia) cachara exhibits a clear population structure in larval morphology, ♂ genitalia and mtDNA barcode, but the different data sets are incomplete and largely incongruent and do not allow any reliable subdivision of this complex species presently; also, the barcode differences are only quite small. In case that further studies improve the picture, the resurrection of the synonymic taxon *microcaligula* for some of the eastern populations might be necessary, as well as possibly further new names for subspecifically (or even specifically?) distinct populations.

All three species are found in Myanmar: Chin State, and *S. (C.) heinrichi* and *S. (C.) victoria* both are also found syntopically and in part synchronous in the South of that state in the area around Mt. Victoria.

Larval morphology

Similar conspicuous red dorsal scoli of the larvae can be observed outside the subgenus *Cachosaturnia* in some species of the *boisduvalii* species-group of the subgenus *Rinaca*. For example, LAMPE (2010: 295) illustrates *S. (R.) naumannii* BRECHLIN, 2001 from Vietnam [as “*boisduvalii*”, misidentification] and *S. (R.) boisduvalii* EVERS-MANN, 1847 from Russia (LAMPE 2010: 319), which both show similar red dorsal scoli along most abdominal segments and in 2nd and 3rd thoracic segments, but only in early instars, not as mature caterpillar. The larva of *S. (R.) jonasi* BUTLER, 1877 from Japan (LAMPE 2010: 321) shows these red scoli in early instars only on the meso- and metathorax. The partly blue colouration of the larvae in general more resembles that of *Saturnia s. str.* larvae in the *Eriogyna* group.

Checklist of the subgenus *Saturnia (Cachosaturnia)* subgen. n.

Saturnia (Cachosaturnia) cachara (MOORE, 1872)
(subgen. comb. n.)

= *Saturnia (Rinaca) microcaligula* NÄSSIG, 1994

Saturnia (Cachosaturnia) victoria NAUMANN, LÖFFLER & NÄSSIG, 2012 (sp. n.)

Saturnia (Cachosaturnia) heinrichi (LEMAIRE, 1976)
(subgen. comb. n.)

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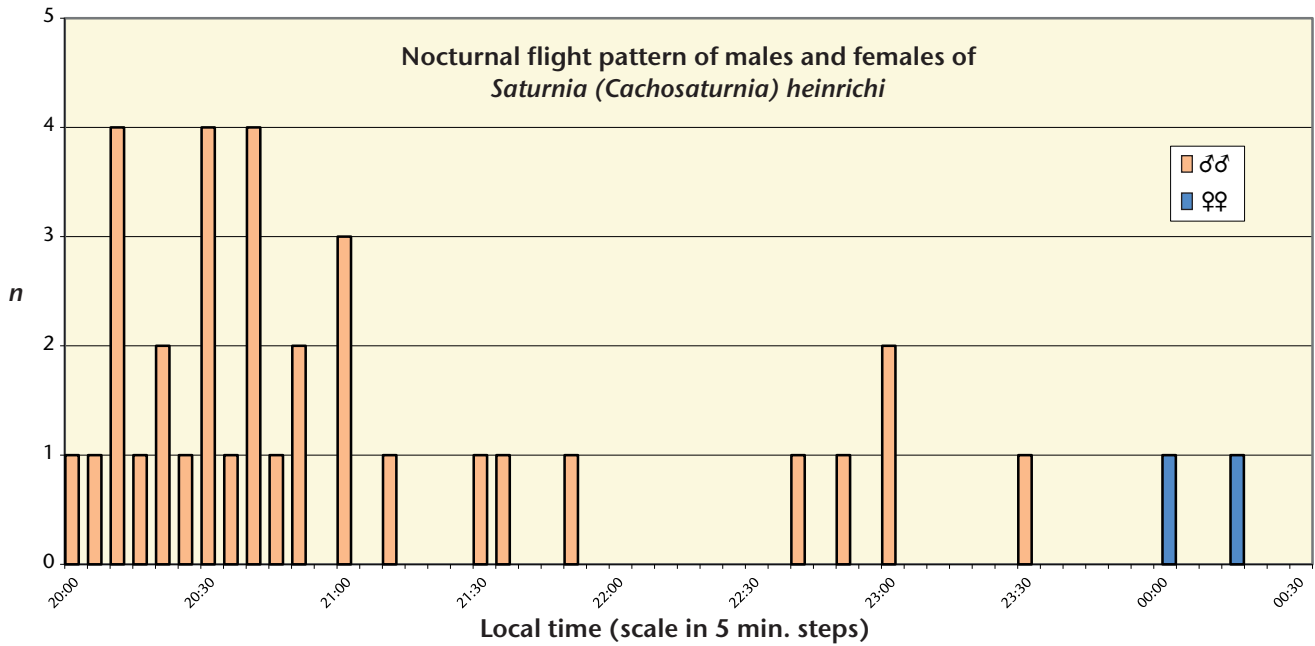
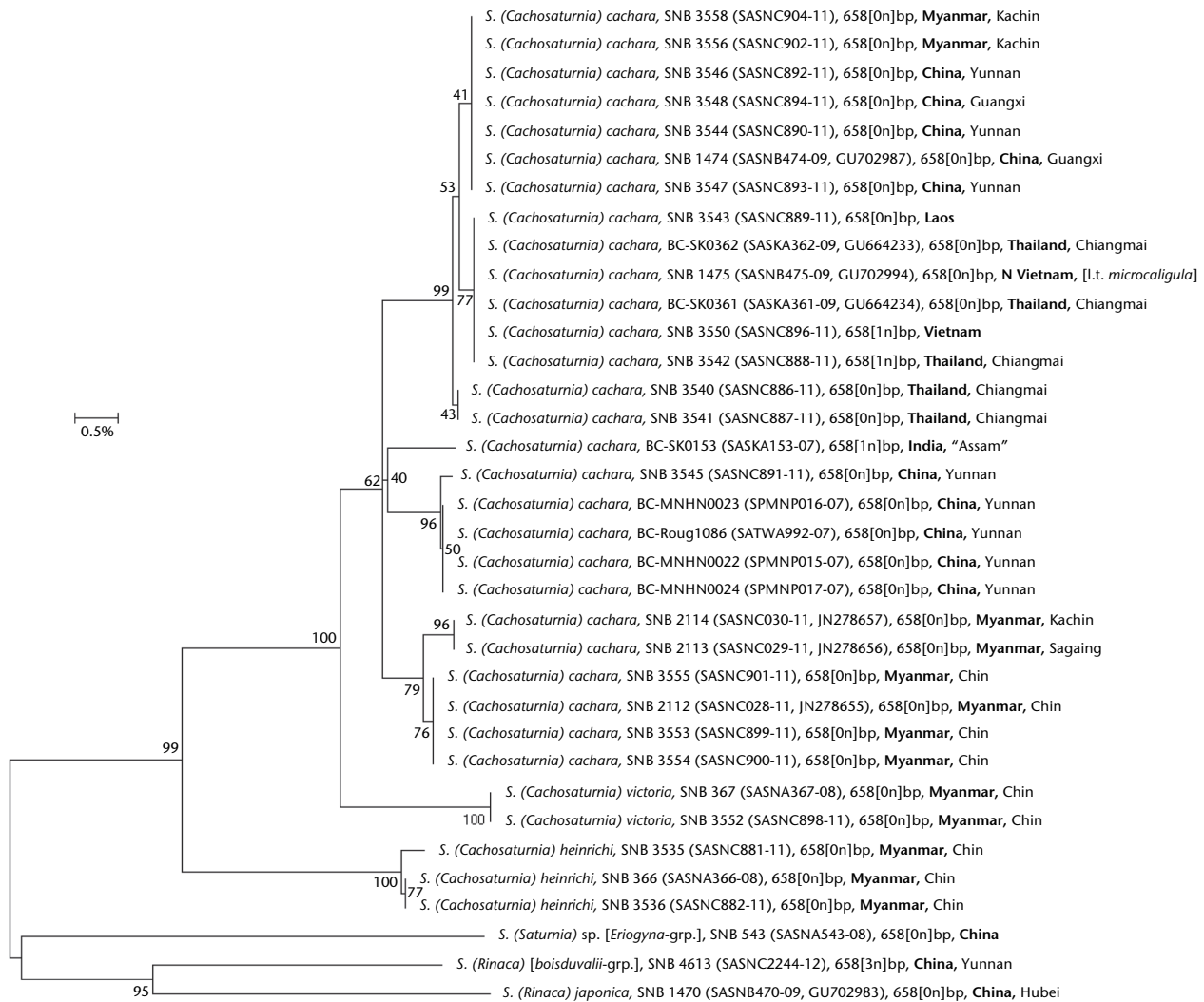


Diagram: Nocturnal flight pattern (arrival times at artificial lights) of males and females of *Saturnia (Cachosaturnia) heinrichi*.



Text-Fig. 2: Molecular phylogenetic analysis of the mtDNA COI barcode nucleotide sequences of *Saturnia (Cachosaturnia)*. The analysis involved 35 nucleotide sequences (= specimens, including outgroup samples). There were a total of 652 positions in the final dataset, because all incomplete sequences under 650 bp were excluded (see Table 1; compare Text-Fig. 1a, b). — The evolutionary history was inferred using the Minimum Evolution method (RZHETSKY & NEI 1992). Evolutionary analyses were conducted in MEGA5 (TAMURA et al. 2011). For further details, compare Text-Fig. 1.

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