

A new species of the species-group of *Actias maenas* from South India: *Actias keralana* sp. n. (Lepidoptera: Saturniidae)

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Abstract: A new species of the genus *Actias*, species-group of *A. maenas*, is described from S. India: *Actias keralana* sp. n. (holotype male in coll. Senckenberg-Museum, Frankfurt am Main, Germany). Male and female moths are illustrated in colour, as well as the male genitalia. It is known so far from the Indian Western Ghats in the States of Kerala and Karnataka. It differs from its relatives in habitus, male genitalia morphology and mtDNA COI barcode (BOLD's BIN: ACC1562).

Eine neue Art aus der Artengruppe von *Actias maenas* aus Südindien: *Actias keralana* sp. n. (Lepidoptera: Saturniidae)

Zusammenfassung: Eine neue Art der Gattung *Actias*, Artengruppe von *Actias maenas*, wird beschrieben aus Südindien: *Actias keralana* sp. n. (Holotypus Männchen in coll. Senckenberg-Museum, Frankfurt am Main, Deutschland). Männchen und Weibchen der neuen Art werden farbig abgebildet, gleichfalls die männlichen Genitalien. Bisher ist die Art bekannt aus den indischen Westlichen Ghats in den Bundesstaaten Kerala und Karnataka. Sie unterscheidet sich im Habitus, in der männlichen Genitalmorphologie sowie im „Barcode“ der mtDNA (COI) (BOLDS BIN-Code: ACC1562).

Introduction

The long-“tailed” greenish or yellowish “moon moths” of the family Saturniidae have always gained much interest from lepidopterologists, and the group of large species comprising *Actias maenas* DOUBLEDAY, 1847 and related taxa especially so. Before U. & L. H. PAUKSTADT (1992), the taxa involved in the group were usually (with few exceptions like, e.g., MOORE 1877) most or all interpreted as subspecies of *A. maenas* (see WESTWOOD 1849, ROTH-SCHILD & JORDAN 1901, SEITZ 1926, TOXOPEUS 1948, ROEPKE 1954, NÄSSIG & PEIGLER 1984, HOLLOWAY 1987, and many others). A preliminary (and in the meanwhile repeatedly amended) modern review of the *maenas* species-group was then provided by NÄSSIG (1994); further taxa were described, respectively upranked by NÄSSIG & TREADAWAY (1997), KISHIDA (2000), U. & L. H. PAUKSTADT (2010a, 2020), U. PAUKSTADT et al. (2010b) and others.

Already in 2000 one of the authors (W.A.N.) received a single, very worn specimen of the *maenas*-group from Kerala in S. India and soon suspected that it might be a distinct species, which was later supported by morphological and COI mtDNA barcode studies. The

present paper was therefore written to make a new name available for this South Indian member of the *maenas*-group, because this taxon, in spite of morphological differences and a well-separated barcode, was so far neither recognised by Indian nor by non-Indian specialists – even despite several photographs of live specimens from different localities in South India have appeared on the internet since 2000.

Material and methods

Material lists used for this study see below under the taxa and localities dealt with. Morphological studies followed standard procedures. The mtDNA COI barcodes were analysed in Guelph, Ontario, Canada (see RATNASINGHAM & HEBERT 2007).

Abbreviations and conventions

Abbreviations of collections

BRCB	Butterfly Research Centre, Jones Estate, Bhimtal, Uttarakhand, India.
CSKK	Collection Steve KOHL, Kayl, Luxembourg.
CSNB	Collection Stefan NAUMANN, Berlin, Germany.
CUPW	Collection U. & L. H. PAUKSTADT, Wilhelmshaven, Germany.
CWAN	Collection Wolfgang A. NÄSSIG, in SMFL.
MZB	Museum Zoologicum Bogoriensis, Bogor, Java, Indonesia.
NHMUK	The Natural History Museum (formerly British Museum (Natural History), BMNH), London, U.K.
SMFL	Senckenberg-Museum, Lepidoptera collection, Frankfurt am Main, Germany.

Other abbreviations and conventions

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.
PT	Paratype(s).
TS	Type species [of a genus].
uns.	underside.
ups.	upperside.

¹ 92nd contribution to the knowledge of the Saturniidae (91st contribution: NAUMANN, S., & NÄSSIG, W. A. (2020): The status of *Antheraea* (*Antheraea*) *knyveti* HAMPSON, 1893, a “forgotten” species, with an overlooked synonymy (Lepidoptera: Saturniidae). – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. 40 (3/4): 136–146. – Corresponding author.

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Systematic part

NÄSSIG (1994: 327) established the informal name “*maenas*-group” for a small, but evidently monophyletic species-group of “moon moths” closely related and similar to *Actias maenas* DOUBLEDAY, 1847, distributed in south and southeast Asia from the Indian subcontinent to south China, across Indochina including Vietnam, Sundaland, the Philippines, to eastern Indonesia and East Timor. In 1994 this was based solely on morphology, but later it became supported by mtDNA barcode results (see Text-Fig. A).

Based on the results of our general studies on the entire genus in recent decades, we do not believe that the *maenas* species-group deserves a higher taxonomic rank than that of a species-group within the genus *Actias*. Specifically, we do not agree with a separate subgenus- or genus-equivalent level name *Sonthonnaxia* WATSON, 1913 for that group, as used by some writers, e.g., ARORA & GUPTA (1979) and other Indian authors.

Genus *Actias* LEACH, 1815

Actias: LEACH, 1815(: 25). — A more complicated extended [and perhaps at this length entirely unnecessary] authorship citation would be: LEACH in LEACH [text author] & NODDER [illustrator, drawings]. SCHÜSSLER (1936) wrote: MACLEAY in LEACH, because LEACH quoted on p. 25 that “the characters of which were communicated by my worthy friend A. MACLEAY”.

TS: *Phalaena luna* LINNAEUS, 1758, by subsequent designation by GROTE (1874: 257).

= *Sonthonnaxia* WATSON, 1913(: 42; TS *Actias maenas* DOUBLEDAY, 1847, by original designation); junior subjective synonym of *Actias*.

Further generic synonymy see also FLETCHER & NYE (1982), LERAUT (1997) or NÄSSIG & TREADAWAY (1998: 258–259). Synonymies are here only provided as far as relevant for the new member of the *maenas* species-group.

The new species

Amongst the few Saturniidae specimens received in 2000 by one author (W.A.N.) from Alexander SCHINTLMEISTER, Dresden, Germany, from his travel in southern India in 1997 together with Viktor SINIAEV, there was one specimen of the *maenas* species-group from Kerala which soon was suspected to be thus far undescribed. We dissected the specimen back in 2000, and a COI barcode analysis was done in Canada in 2012; both results supported the theory of a new species. In subsequent years we tried to get further information on (and material of) South Indian *Actias* of the *maenas*-group, but there was not much to be found.

ARORA & GUPTA (1979; genus citation as *Sonthonnaxia*), SATHE (2007) and SHUBALAXMI (2018) do not list any southern Indian localities within their distribution data for “*Actias*” or “*Sonthonnaxia maenas*”. SHUBALAXMI et al. (2011) found no records for Maharashtra. A specimen of what was identified as “*Sonthonnaxia maenas*” and most likely is identical with the new species was reported by CHATURVEDI (2001) to have been photographed in

the Kudremukh National Park of Karnataka, South India, but unfortunately this specimen seems not to be deposited in the collections of the Bombay Natural History Society (N. CHATURVEDI in litt. 16. XI. 2004). (By the way: It appears quite likely that the so-called “*Loepa katinka*” of CHATURVEDI 2001: 132 from S. India is in fact *L. schintlmeisteri* BRECHLIN, 2000.) SONDHI et al. (2018: 75, fig. 238) mention and figure a living ♂ specimen as “*Actias maenas*”, recorded on 28. VIII. 2014 in Ponmudi, Agastyamalai Biosphere Reserve, Kerala, at 865 m altitude. It is unclear whether the specimen was collected or just photographed. All these specimens have not been examined by us, except published photos, where existing.

Another specimen from South India (a ♀) was reported by Ian J. KITCHING (email of 13. x. 2010) from NHMUK on our request, from the Supplementary Collection, labelled “India, Kadur dist., Umbidi”, collected in VIII. 1905. Ian KITCHING checked out the locality, and Umbidi (which is probably the current spelling) seems to be in Kerala, 4 km from Karukachal and 2.5 km from Thottakkad Kavala. Later, A.G. took photographs of this ♀ for all authors. Finally, there is one recently collected ♂ from Karnataka, Coorg (Madikeri), in the collection of the Butterfly Research Centre, Bhimtal, Uttarakhand, which we could examine by photographs with help from Peter SMETACEK. So, the new species appears to inhabit at least the two states of Kerala and Karnataka in southwestern India.

Actias keralana n. sp.

Holotype ♂: “S-India, Kerala, (7), 7 km N Munnar, Eravikulam Natl. Park, 1740 m, 10°9' N, 77°4' E, Reste von prim. Regenwald, LF 12.–13. IV. 1997 (16° um 1.00 h), leg. SCHINTLMEISTER & SINIAEV, XI. 2000 in coll. W. A. NÄSSIG”. — Deposited via CWAN in SMFL, catalogue no. SMFL 4791. Figs. 1a, 1b. — Dissection no. 1405/00 NÄSSIG (Figs. 2a–2d), BOLD barcode no. SNB 4895.

Paratypes (1 ♂, 1 ♀): 1 ♂, “India, Karnataka, Coorg (Madikeri), 930 m, 29. VII. [20]19 (light)”, coll. P. SMETACEK, Bhimtal, Uttarakhand, India, in BRCB (Fig. 4a, 4b). 1 ♀, “India, [Kerala], Kadur dist., Umbidi, VIII. 1905”, NHMUK (Fig. 3a, 3b).

BOLD's BIN (of the HT; sensu RATNASINGHAM & HEBERT 2013): ACC1562 (see Table 1).

Etymology: The name refers to the state of Kerala in south India, from where the species was found and identified as being undescribed first.

Range: Southwestern India, [Western Ghats and hills further south]: **Kerala** (see HT + PT; further SONDHI et al. 2018: Ponmudi in the Agastyamalai Biosphere Reserve); **Karnataka** (see PT; further CHATURVEDI 2001: Kudremukh National Park).

Description and diagnosis

Male (Figs. 1a, 1b HT; Figs. 4a, 4b PT): Generally, there are not many morphological differences compared to specimens of *A. maenas*, therefore we keep the description short and focus on the main differences.

There were two males being studied by two authors (W.A.N. & S.N.), the HT and the ♂ PT (photographs only). The PT shows a more yellowish ground colour

compared to the HT. We do not know whether this is due to some sort of individual or geographical variability or seasonality (see collecting dates of type material) or to other reasons.

Forewing length, from base to apex, 71 mm (HT, left side still nearly complete) and 75 mm (PT), the apex acute, but in both known specimens this part of the wing is more or less damaged, so the original shape can only be estimated.

Antennae quadripectinate, ca. 12 mm in length (HT; PT with broken antennae), with longest rami of nearly 2 mm, apical rami steeply reducing, last 7 antennal joints reducing from 4 over 2 rami to 1 to none; of ochreous colour.

Ground colour on dorsal side creamy yellow, faded parts of wings with less scales become more shining green.

Thorax and abdomen yellow with brown markings. Legs of violet brown colour.

Both fw and hw show a slightly modified typical purplish brown pattern: Fw costa grey, antemedian area completely brown with a small basal yellow patch. The yellow median field contains a large halfmoon-like ocellus with 10 mm maximum diameter; the narrow inner halfmoon is entirely black with a basal tiny row of blue scales, the marginal part broader, of creamy orange colour, bordered marginally with a black line. The upper part of this halfmoon structure begins at the costal vein and shows its greatest extend along the discoidal vein; the lower end of it is bent backward towards the wing base along the vein for about half a centimeter in both known specimens, while it is ending just behind the lower furcation of the discoidal vein in continental *A. maenas* s. str. specimens. The brown zigzag postmedian line seems to be reduced in the apical half of the wing while it is entirely present in all examined specimens of *A. maenas*; in specimens of *A. diana* MAASSEN, 1872 it is even more reduced and narrower. Postmedian area broad, dark brown, in the marginal and apical half suffused with yellow scales. Outer margin dark greyish brown.

Hw pattern very similar to fw, hw length from base to tip of the tail 128 mm (HT) and 126 mm (PT). Antemedian field again brown with basal yellow patch. The yellow median field with almost round ocellus of 6.5 mm (HT) and 7.0 mm (PT) maximum diameter, with a proximal broader outer black ring. Inner part of violet and light orange colour and central small whitish speckle. The hw ocellus of *A. maenas* is less bordered with black and of lighter colour, and those of *A. diana* are always of ovoid shape. The postmedian zigzag line not very prominent, but of intense dark colour, and the outer postmedian field broad dark brown, broader and more intense than in any examined specimen of *A. maenas* and *A. diana*. The tail dark greyish brown, with purple parts in the basal part, distal folded part yellow, similar to specimens of *A. maenas* and *A. diana*.

Ventral side of thorax and abdomen entirely yellow. Ventral side of wings with less pattern, antemedian and median field of both fw and hw without brown portion, just separated by a small area of brown scales. Both fw and hw ocelli round, the one on the fw with a thick black outer margin and a central lighter area, that of the hw with a proximal black inner lid-like area and orange distal portion. Postmedian zigzag line dark brown, marginal area again broad dark. The tail of same colour as on upperside.

♂ **Genitalia:** Dissected 1 ♂, HT, dissection no. 1405/00 NÄSSIG (Figs. 2a–d).

The basic groundplan of the ♂ genitalia of the entire *maenas* species-group is quite constant, and differences between species are usually mainly based on different proportions of saccus and phallus length in comparison to the size of the rest of the genitalia. This is especially true for the more apomorphic species such as *A. maenas* or *A. diana* compared to the most plesiomorphic ones, such as *A. groenendaeli* ROEPKE, 1954 *sensu lato*. Consistently, the genitalia of *Actias keralana* sp. n. ($n = 1$) are overall smaller, less sclerotized and generally look distinctly more fragile than those of *A. maenas* s.l. (i.e., *A. maenas* + *A. diana*), otherwise they do not differ much.

The phallus of *A. keralana* is approximately 10 mm long, the tubular part of the saccus (from the tip to the beginning of the ventral tegumen broadening) approx. 3.5 mm. The comparison to North Indian *A. maenas* shows: a specimen from Nepal (NHMUK loan no. GP 2007B, from photograph) has a phallus of ca. 15 mm and a sacculus of ca. 7 mm length; a specimen from Meghalaya (GP WAN 1235/00) a phallus of ca. 12 mm and a sacculus of ca. 5.3 mm length. In both cases the entire apparatus is generally clearly larger and stronger sclerotized.

Female (Figs. 3a, 3b PT): Only a single female is known so far, therefore it is impossible to say anything about variability. In addition, it is an old specimen, collected more than a hundred years ago, so the colour is probably a little faded.

Forewing length, from base to apex, 88 mm, the apex almost rectangular.

Antennae yellowish-ochreous, quadripectinate, of 13 mm length, with longest rami of ca. 1 mm, basal and apical rami shorter, but not fully reduced.

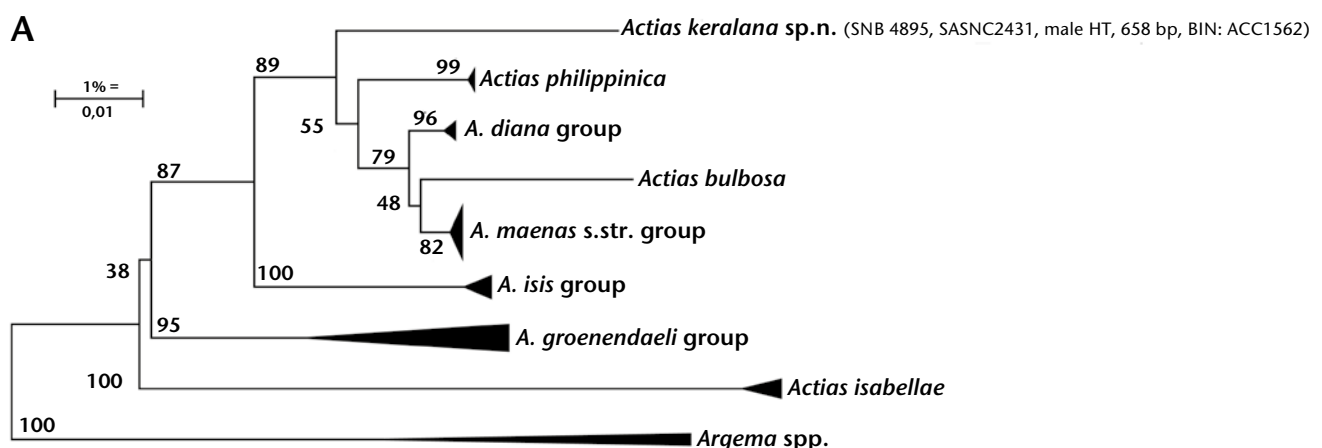
Ground colour on dorsal side creamy greenish yellow, the few markings on the fw are represented by the dark greyish costa, the straight dark grey antemedian line, the ocellus which is similar to the males, a faint zigzag postmedian line, and a dark purple outer margin.

Hw length from base to tip of the tail 144 mm, only with a shade of greyish zigzag ante- and postmedian line. The central ocellus is round (while it is little ovoid in *A. maenas* and even more in *A. diana* females), of 8 mm diameter, with a basal black line, an inner purple and a marginal larger yellow portion. The outer margin as on

Table 1: Data of the 48 specimens (46 of which showing 658 bp, the 2 other have 637 resp. 645 bp) of *Actias* of the *maenas*-group *sensu lato* and outgroups used for the mtDNA barcode analyses with MEGA5. Specimens arranged from top to bottom in the order of the NJ-tree graph (Text-Fig. A), based on data extracted from the BOLD website on 27. xi. 2019. — Additional abbreviations: HT = holotype; SL = Sequence Length (bp-data from BOLD); BOLD's BIN-Code = Barcode Index Number; an automatically assigned identifier for genetic clusters within BOLD, see RATNASINGHAM & HEBERT (2013). — **Notes:** The BIN Code for the *diana*-group and the *maenas*-s.str.-group is in both cases identical: AAB9593; however the barcode of *A. bulbosa*, which keys out in between these two clusters during the MEGA5 calculation (and *A. bulbosa* is, according to morphology, well-defined on species-level), is AAM2928. Accordingly, the species names with "group" are only provisional here. — The *groenendaeli*-group contains 4 described populations (separated on different islands) which differ remarkably in their BIN-Codes, but have been interpreted as different subspecies (U. PAUKSTADT et al. 2010b); but see also U. & L. H. PAUKSTADT (2020). — For the *Argema* specimens, there are still some studies necessary on the specific identity, but they were only used as outgroups here (just like *A. isabellae*).

Sample ID	Process ID	Species — BOLD's BIN-Code	Deposition	SL	Sex	Origin
BC SNB 4895	SASNC2431-12	<i>Actias keralana</i> sp.n. — ACC1562	CWAN/SMFL	658 bp	♂	India, Kerala, 7 km N Munnar, Eravikulam NP, 1740 m, LF 12.–13. iv. 1997 [HT <i>A. keralana</i>]
BC SNB 745	SASNA745-09	<i>Actias philippinica</i> — ABZ5462	CSNB	658 bp	♂	Philippines, E. Luzon, Sierra Madre Mangan, 15°38' N, 121°15' E, 950 m
BC SK0275	SASKA275-07	<i>Actias philippinica</i> — ABZ5462	CSKK	658 bp	♂	Philippines, Eastern Visayas, Leyte, Mt. Balocaue, 700 m
BC SK0276	SASKA276-07	<i>Actias philippinica</i> — ABZ5462	CSKK	658 bp	♂	Philippines, Eastern Visayas, Leyte, Mt. Balocaue, 700 m
BC SK0277	SASKA277-07	<i>Actias philippinica</i> — ABZ5462	CSKK	658 bp	♀	Philippines, Eastern Visayas, Leyte, Mt. Balocaue, 700 m
BC SK0278	SASKA278-07	<i>Actias philippinica</i> — ABZ5462	CSKK	658 bp	♂	Philippines, Eastern Visayas, Leyte, Mt. Kitanglad
BC SNB 746	SASNA746-09	<i>Actias philippinica</i> — ABZ5462	CSNB	658 bp	♂	Philippines, Leyte, Mt. Bulokawi
BC SNB 741	SASNA741-09	<i>Actias diana</i> group — AAB9593	CSNB	658 bp	♂	Indonesia, West Sumatra, Mt. Kerinci, 1200 m
BC SNB 737	SASNA737-09	<i>Actias diana</i> group — AAB9593	CSNB	658 bp	♂	Thailand, Isthmus of Kra, Ranong, 500 m
BC SNB 738	SASNA738-09	<i>Actias diana</i> group — AAB9593	CSNB	658 bp	♂	Thailand, Isthmus of Kra, Ranong, 500 m
BC SNB 740	SASNA740-09	<i>Actias diana</i> group — AAB9593	CSNB	658 bp	♂	West Malaysia, Cameron Highlands
BC SNB 1934	SASNB839-10	<i>Actias diana</i> group — AAB9593	CSNB	658 bp	♂	Indonesia, Bali Island, Tabanan Distr., Bedugul env., 1200 m
BC SNB 1935	SASNB840-10	<i>Actias bulbosa</i> — AAM2928	CSNB	658 bp	♀	Philippines, Palawan Isl., Mantalingahan Mt., Brookes Pt., 1500 m
BC SNB 731	SASNA731-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	India, Meghalaya, rd. Shillong-Mawphlang, 600–1000 m
BC SNB 4884	SASNC2420-12	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	Myanmar, Chin State, Mindat
BC SNB 6128	SASNC3907-18	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	India, [no data]
BC SNB 733	SASNA733-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	China, Yunnan, Mengla, 900 m, 21°27' N, 101°34' E
BC SNB 732	SASNA732-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	Laos, Vientiane, Ban Viang Kham, 15 km S Phoukhoun, 950 m
BC SNB 734	SASNA734-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	N Thailand, Chiang Mai, Mae Rim Distr.
BC SNB 4885	SASNC2421-12	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	Myanmar, Kayin State, Dawna Range
BC SNB 735	SASNA735-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	N Thailand, Chaingmai, Doi Suthep, 1400 m
BC SNB 4886	SASNC2422-12	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	Nepal, Pokhara, rd. Pokhara-Syangja
BC SNB 750	SASNA750-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	India, Andaman Isl., Mt. Harriet NP, near Pt. Blair, 200 m, 11°43'21" N, 92°44'3" E
BC SNB 4894	SASNC2430-12	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	India, Andaman Isl., Mt. Harriet NP, 200 m
BC SNB 736	SASNA736-09	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	N. Vietnam, Tam Dao
BC SNB 5694	SASNC3325-15	<i>Actias maenas</i> s.str. group — AAB9593	CSNB	658 bp	♂	Vietnam, Quang Ngai Prov.
BC SK0335	SASKA335-09	<i>Actias maenas</i> s.str. group — AAB9593	CSKK	658 bp	♂	Thailand, "M. J." [= Mae Jaen, N. Thailand?]

Sample ID	Process ID	Species — BOLD's BIN-Code	Deposition	SL	Sex	Origin
BC SNB 749	SASNA749-09	<i>Actias isis</i> group — AAC7326	CSNB	658 bp	♂	Indonesia, Sulawesi Tengah, Banggai Archip., Peleng Isl.
BC SK0338	SASKA338-09	<i>Actias isis</i> group — AAC7326	CSKK	658 bp	♀	Indonesia, Sulawesi Selatan, Panggala Toraja
BC SK0336	SASKA336-09	<i>Actias isis</i> group — AAC7326	CSKK	658 bp	♂	Indonesia, Sulawesi Selatan, Panggala Toraja
BC SNB 747	SASNA747-09	<i>Actias isis</i> group — AAC7326	CSNB	658 bp	♂	Indonesia, S. Sulawesi, Tanah Toraja, Puncak Palopo
BC SK0339	SASKA339-09	<i>Actias isis</i> group — AAC7326	CSKK	645 bp	♀	Indonesia, Sulawesi Selatan, Panggala Toraja
BC ULP0223	SAUPA223-10	<i>A. groenendaeli timorensis</i> — AAD7074	CUPW>MZB	658 bp	♂	Indonesia, Prov. NTT, Timor Isl., Gunung Mutis, 1720 m [HT <i>A. groenendaeli timorensis</i>]
BC SNB 751	SASNA751-09	<i>A. groenendaeli timorensis</i> — AAD7074	CSNB	658 bp	♀	Indonesia, Nusa Tenggara Timur, West Timor, Buraen env., 60 km SE Kupang, 350 m
BC SNB 1550	SASNB550-09	<i>A. groenendaeli timorensis</i> — AAD7074	CSNB	658 bp	♂	Indonesia, Nusa Tenggara Timur, East Timor, Bobanaro
BC SNB 752	SASNA752-09	<i>A. groenendaeli acutapex</i> — AAD7075	CSNB	658 bp	♂	Indonesia, Nusa Tenggara Timur, Sumba Isl., Lewa, 400 m
BC SNB-RR 0098	SASNC3794-18	<i>A. groenendaeli acutapex</i> — AAD7075	CSNB	658 bp	♂	Indonesia, Nusa Tenggara Timur, Sumba Isl., Luku-Melolo N.R., 250 m
BC ULP0220	SAUPA220-10	<i>A. groenendaeli sumbawaensis</i> — AAF2481	CUPW>MZB	658 bp	♂	Indonesia, Nusa Tenggara Barat Prov., Sumbawa Isl., Marinteh env., 700 m [HT <i>A. groenendaeli sumbawaensis</i>]
BC SNB-RR 0100	SATWB092-07	<i>A. groenendaeli sumbawaensis</i> — AAF2481	CSNB	658 bp	♂	Indonesia, Nusa Tenggara, Barat Prov., Sumbawa Isl., 2 km SE Marinteh, 700 m
BC SNB 729	SASNA729-09	<i>Actias isabellae</i> — AAB7791	CSNB	658 bp	♀	España, Sierra de Guadarrama, vic. Madrid, reared
BC SNB 728	SASNA728-09	<i>Actias isabellae</i> — AAB7791	CSNB	658 bp	♂	Helvetia, Wallis, Simplonstrasse obh. Brig, 1200 m, lured with female
BC SNB 730	SASNA730-09	<i>Actias isabellae</i> — AAB7791	CSNB	658 bp	♂	España, Catalunya, vic. Casteltersol
BC SNB 2228	SASNC144-11	<i>Actias isabellae</i> — AAB7791	CSNB	658 bp	♂	France, N. Guillestre, Combre du Queyras, 1300 m
BC SNB 2230	SASNC146-11	<i>Actias isabellae</i> — AAB7791	CSNB	658 bp	♀	España, Teruel, Sierra de Albarracin, Noguera, 1400 m
BC SNB 753	SASNA753-09	<i>Argema besanti</i> — AAD2575	CSNB	637 bp	♂	Kenya, Eastern Prov., rd. Mwingi-Kangondi, betw. Ngumi and Mwingi, 700-1400 m
BC SNB 754	SASNA754-09	<i>Argema mimosae</i> — AAB5369	CSNB	658 bp	♂	Zambia, Kafue
BC SNB 5328	SASNC2959-14	<i>Argema occidentalis</i> — ACE6075	CSNB	658 bp	♂	Angola, Huila



Text-Fig. A: NJ COI barcode tree (cf. Saitou & Nei 1987) of the species-group of *Actias maenas sensu lato* and some outgroups. The figure is based on a total of 48 data sets (= individuals; extracted from the BOLD website on 27. XI. 2019) and calculated with MEGA5 software (Tamura et al. 2007, 2011). The optimal tree with the sum of branch length = 0.45148285 is shown. 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 percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1600 replicates) are shown next to the branches (Felsenstein 1985). 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 modeled with a gamma distribution (shape parameter = 3). The differences in the composition bias among sequences were considered in evolutionary comparisons (Tamura & Kumar 2002). Details and some notes for the specimens see in Table 1. It was not intended to solve all systematic and evolutionary questions of the entire genus here; further analyses of the species-group of *Actias maenas sensu lato* will be shown in a forthcoming revision of the entire group.

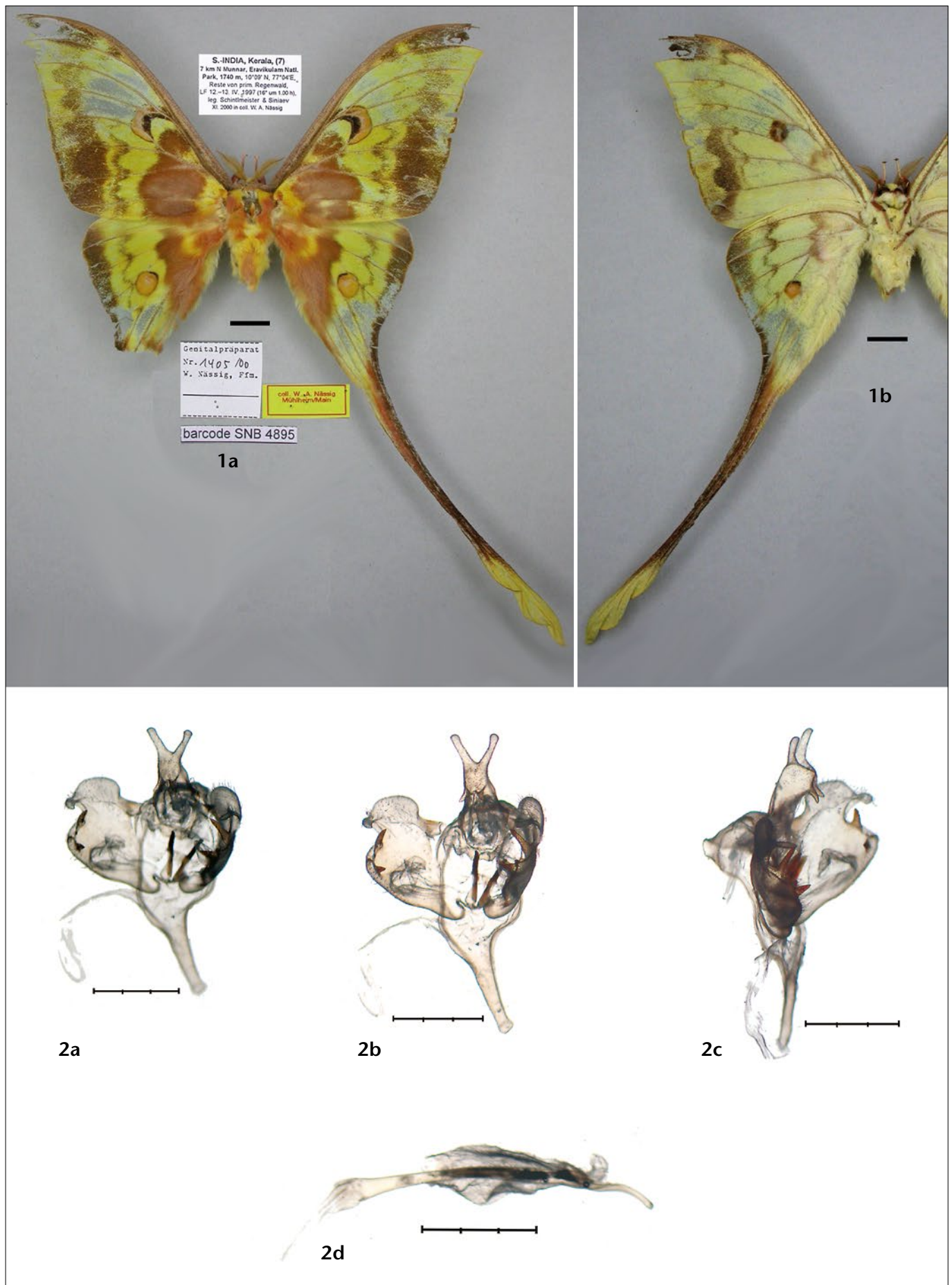


Fig. 1: *Actias keralana* sp. n., ♂ HT, "S.-India, Kerala, 7 km N Munnar, Eravikulam Natl. Park, 1740 m, 10°9' N, 77°4' E, 12.-13. iv. 1997", ca. at 90% original size; **1a** = ups., **1b** = uns. In SMFL. — Scale bar = 1 cm. — **Fig. 2:** *Actias keralana* sp. n., ♂ HT, genitalia, in alcohol (therefore right valve not flattened); **2a**, **2b**: caudoventral view, with slightly varying angle; **2c**: lateral view; **2d**: phallus. — Not to identical scale; scale bars = 3 mm with subdivisions in 1 mm each.

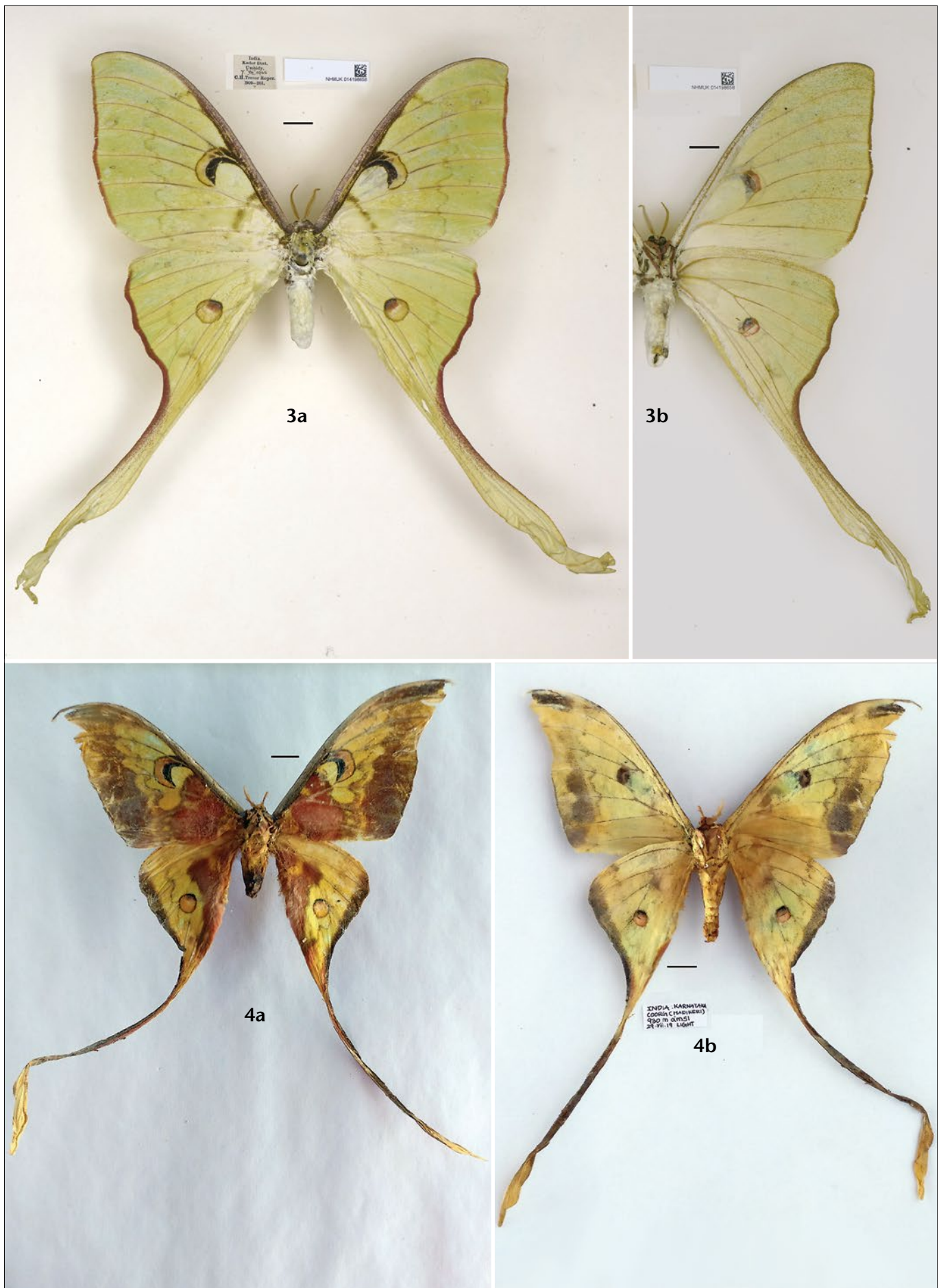


Fig. 3: *Actias keralana* sp. n., ♀ PT, "India, [Kerala], Kadur dist., Umbidy, viii. 1905", NHMUK; 3a = ups., 3b = uns. — **Fig. 4:** *A. keralana* sp. n., ♂ PT, "India, Karnataka, Coorg (Madikeri), 930 m, 29. vii. [20]19 (light)", coll. P. SMETACEK, Bhimtal, Uttarakhand, India; 4a = ups., 4b = uns. — Scale bars = 1 cm.

the fw, dark purple, and is continued on the proximal half of the tail.

Ventral side of lighter ground colour, more whitish, and with less markings. The antemedian line is absent, the postmedian line only very thin, like a shade, both fw and hw ocelli rounded, with huge proximal black portion (absent in *A. maenas* and *A. diana* females). Marginal line as on upperside.

Thorax and abdomen both on dorsal and ventral side entirely in yellow ground colour, without brown markings; legs purplish brown.

Discussion

Why was *A. keralana* identified so late?

In general, not many Saturniidae have been described from southern India, except in early colonial times, with many of these descriptions probably based on adults reared from early instars found on cultivated shrubs or hedgerows around agricultural areas or gardens.

Below is a list of some plausible reasons why so few specimens of the *A. maenas* species-group have been recorded from South India, and therefore the new species not identified much earlier:

- The British did not spend much time collecting moth at light in South India, during the colonial times in the 19th and early 20th century. Besides, at that time collecting of nocturnal moths was not yet technically optimized, i.e. no electric UV-lights could be used.
- Collecting at light has always been generally relatively scarce in southern India compared to northern India; in earlier times, furthermore, heavy collecting equipment made the climbing of the mountains arduous. SONDHY et al. (2018: 66) give a complete overlook and provide extensive bibliography on the work of early and recent moth diversity of the Western Ghats, and publish an illustrated catalogue for four different localities in Kerala.
- Also, collecting after midnight was much less done then in comparison to today, and *maenas* species-group moths are generally known to preferably arrive at light late, often after midnight.
- Larvae and also imagines of the *maenas* species-group, as species of primary forest, apparently live primarily in the canopies of trees, supposedly the larvae on smaller twigs up in the canopy, not usually on lower bushes; indeed the cocoons are spun between leaves and usually anchored at small twigs, and there are observations of these moths flying freely (and very straight, with elegant and safe landing maneuvers even on smooth bark or artificial substrates) above the canopies when approaching a light on a hilltop. VEENAKUMARI et al. (2005) confirmed this also for *Actias ignescens*, as they found two larvae on the higher twigs of *Crypteronia paniculata* (Crypteroniaceae, Myrtales), the only known foodplant of this species on

S. Andaman Island. Although the authors only found *Crypteronia paniculata* trees that were “12–18 m” tall on S. Andaman Island in the Mt. Harriet NP, this tree can actually reach heights of 30 m (FERN 2019).

- India is very densely populated by humans today; only a very few larger areas are left in at least tentatively primary forested conditions, and even some of the national parks are presently being partially cleared of trees and used for agriculture. So species depending on primary forest, like many Saturniidae moth species, have only very restricted refuges at present and might be on the edge of extinction or even already locally extinct.
- And finally, the new species externally resembles the northern Indian populations of *A. maenas* s. str. rather closely, and without at least a dissection (or without a DNA barcode study) it may quite easily be misidentified.

The relatives of *A. keralana* in the *maenas* species-group

The mtDNA COI barcode alone, consisting only of 658 bp, is only a small portion of the entire genome of these insects. Nevertheless, it is quite helpful, as a first step, for sorting out new and little known species. However, since the data produced are not always sufficient to defining species, with the support of “classical” morphological methods, or other characters, it is often rather easy to find additional clues to sort species apart (see, e.g., WILL et al. 2005; not further discussed here).

The other species of the *maenas* species-group known are:

- *A. groenendaeli* ROEPKE, 1954 *sensu lato* from Eastern Indonesia and Timor island, i.e., *A. groenendaeli* ROEPKE, 1954 [Flores], *A. acutapex* KISHIDA, 2000 [Sumba], *A. sumbawaensis* PAUKSTADT, PAUKSTADT & ROUGERIE, 2010 [Sumbawa] as well as *A. timorensis* PAUKSTADT, PAUKSTADT & ROUGERIE, 2010 [Timor]; these four island populations have just recently been upgraded to full species rank by PAUKSTADT & PAUKSTADT (2020: 134),
- *A. isis* (SONTHONNAX, 1899) from Sulawesi island,
- *A. philippinica* NÄSSIG & TREADAWAY, 1997 from the Philippines except Palawan,
- *A. bulbosa* NÄSSIG & TREADAWAY, 1997 from Palawan,
- *A. diana* MAASSEN, 1872 from Sundaland,
- *A. ignescens* MOORE, 1877 from the Andaman islands,
- *A. maenas* DOUBLEDAY, 1847 from the Indochinese Peninsula to South China and North India and
- *A. keralana* sp. n. from South India.

These species are in part less clearly defined and some of them superficially quite similar to each other.

However, there are indeed differences especially in male genitalia morphology (see NÄSSIG & TREADAWAY 1998: 260, Tab. 10; b&w pl. 4, figs. 11–15) and details of genitalia and external morphology (both in imagines

and preimaginal instars) as well as (although not always) in COI-barcode, and we are convinced that at least the well-isolated ones of these populations (*A. philippinica*, *A. bulbosa*, *A. ignescens*, *A. isis*, the insular populations of *A. groenendaeli* s.l., see above, and also *A. keralana*), are separate species. For differences in preimaginal instars see, e.g., NÄSSIG & PEIGLER (1984), VEENAKUMARI et al. (2005) and the many publications by U. & L. H., resp. L. H. & U., PAUKSTADT given in the references list. We do not agree with all conclusions by these authors, but they have done a good job in rearing and describing morphological differences of preimaginals; undoubtedly further studies are necessary.

For the remaining complex (here treated as two morphologically defined species, *A. maenas* and *A. diana*) from South China and North India to Sundaland, it is important to emphasize the fact that there are no significant natural barriers between the populations to prevent genetic interchange at present time; however, the Isthmus of Kra north of Sundaland has been submersed by sea-level changes at least twice for over 1 million years each during the Tertiary (DE BRUYN et al. 2005), and there is a lot of differentiation also in other Lepidoptera groups between Sundaland and the northern continental area today.

A revision of the entire *maenas* species-group s.l. is in preparation.

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