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The taxonomy of *Catocala nupta* (Linnaeus, 1767) and its allies, with description of a new species (Lepidoptera: Noctuidae)

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Abstract

The taxonomy of the *Catocala nupta* (L.), 1757 complex is analyzed using corresponding characters of the male genitalia, wing pattern, and COI 5' mitochondrial DNA, and is presently found to contain only two additional species: *Catocala concubia* Walker, [1858], and a new species *Catocala benedeki* described herein. Three new lectotypes are designated, and 12 status changes for existing names are introduced (10 new synonyms, 2 revised statuses).

Key words: Lepidoptera, Noctuidae, *Catocala*, new species, synonymy, Pakistan, China, India

Introduction

Catocala nupta is the type species of the diverse Holarctic moth genus *Catocala* Schrank, and is one of approximately 40 species with red/pink-banded hindwings whose larvae feed on Salicaceae (willows and poplars). The taxonomy and nomenclatural histories of the Salicaceae-feeding *Catocala* are problematic (see Gall & Hawks, 2002, 2010, 2015 for overview of the Nearctic taxa; comparable recent assessments of the Palearctic fauna are lacking). However, *C. nupta* is part of a morphologically well-defined species group, herein named the *C. nupta* species group. This group includes 7 currently recognized Palearctic species: *C. nupta*, *C. concubia*, *Catocala szechuena* Hampson, 1913, *Cactoala amnonfreidbergi* Kravchenko, Speidel, Witt, Mooser, Seplyarsky, Saldaitis, Junnila & Muller, 2008, *Catocala adultera* Menetries, 1856*, Catocala neglecta* Staudinger, 1888*,* and *Catocala laura* Saldaitis, Ivinskis & Speidel, 2008, as well as most Nearctic Salicaceae feeders (the four exceptions being *Catocala amatrix* (Hubner, [1813])*, Catocala cara* Guenée, 1852*, Catocala carissima* Hulst, 1880*,* and *Catocala concumbens* Walker, [1858]). These species are highly homogeneous in their genitalic structure. Exemplary synapomorphies include: left valve saccular extension along ventral margin of cucullus 2–3 times as long as wide (Figs. 41, 55–61); right valve saccular extension (same); dorsal side of right valve costa with a distinct notch just anterior of midpoint (Fig. 54); large patch of sclerotization surrounded by membrane in the anterior half of the right cucullus (Figs. 41, 55–61); ventral side of left clasper convex proximally and concave distally, dorsal side of left clasper convex proximally and concave distally (Figs. 41, 55–61) (except in *C. neglecta* and *C. laura*); and vesica with numerous small sclerotized plates adjacent to ventral aedeagus hood (sometimes fused together) (Fig. 62).

Among the seven Palearctic species noted above, *C. nupta*, *C. concubia*, *C. szechuena* and *C. amnonfreidbergi* are the most closely similar in wing pattern, and are referred to herein as the *C. nupta* complex. These four are all readily distinguishable from the differently patterned *C. neglecta*, *C. laura*, *C. adultera,* and all of the related Nearctic species. Below we summarize the results of our studies on the *Catocala nupta* complex, using a combination of genitalic, wing pattern, and COI 5' mitochondrial DNA character systems (see Table 1, Appendix 1).

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TABLE 1. Variable COI 5' characters among *C. benedeki, C. concubia,* & *C. nupta.* Bold font character states in larger font size are unique to one species among these three; underlined character states are infraspecific polymorphisms.

	49	85	88	274	325	335	343	433	460	520	547	548	574	607	GenBank
Catacala benedeki 6015 India	A	T	T	**C**	T	G	C	A	C	A	T	C	T	C	GU678880
Catacala benedeki 9004 Pakistan	A	T	T	**C**	T	G	C	A	C	A	T	C	T	C	HQ970472
Catacala benedeki 10249 Pakistan	A	T	C	**C**	T	G	C	A	C	A	T	C	T	C	KT960834
Catacala benedeki 20430 Pakistan	A	T	C	**C**	T	G	C	A	C	A	T	C	T	C	KT960832
Catacala benedeki 20431 Pakistan	A	T	C	**C**	T	G	C	A	C	A	T	C	T	C	KT960833
Catacala benedeki 20436 Pakistan	A	T	C	**C**	T	G	C	A	C	A	T	C	T	C	KTPL0835
Catocala concubia 20432 China	A	T	T	T	T	G	T	A	**T**	A	T	**T**	T	**T**	KT690828
Catocala concubia 2121 China	A	T	T	T	T	G	T	A	**T**	A	T	**T**	T	**T**	
Catocala concubia 2122 China	A	T	T	T	T	G	T	A	**T**	A	T	**T**	T	**T**	
Catocala concubia 8000 China	A	T	T	T	T	G	T	A	**T**	A	T	**T**	T	**T**	HM426442
Catocala nupta 9564 China	A	T	T	T	T	G	C	A	C	A	**C**	C	T	C	
Catocala nupta 10250 China	A	T	T	T	T	G	C	G	C	A	**C**	C	T	C	KT960831
Catocala nupta 20439 China	A	T	T	T	T	G	C	G	C	A	**C**	C	T	C	KT960829
Catocala nupta 8002 China	A	T	T	T	T	G	C	G	C	A	**C**	C	T	C	HM426444
Catocala nupta 8004 E Russia	A	T	T	T	T	G	C	G	C	A	**C**	C	T	C	HN426446
Catocala nupta 8071 China	A	T	T	T	T	G	C	G	C	A	**C**	C	T	C	HM426488
Catocala nupta 8003 China	A	T	T	T	T	A	C	G	C	A	**C**	C	T	C	HM426445
Catocala nupta 9218 Japan	C	T	T	T	T	G	C	G	C	A	**C**	C	C	C	JF860521
Catocala nupta 9219 E Japan	C	T	T	T	T	G	C	G	C	A	**C**	C	C	C	JF860522
Catocala nupta 5625 E Russia	C	C	T	T	T	G	C	G	C	A	**C**	C	C	C	
Catocala nupta 8005 E Russia	C	C	T	T	T	G	C	G	C	A	**C**	C	C	C	HN426447
Catocala nupta MM15851 Finland	A	T	T	T	C	G	T	A	C	G	**C**	C	T	C	HM876626
Catocala nupta 20019 Kyrgyzstan	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	KT960830
Catocala nupta 20394 Kyrgyzstan	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta 2332 Slovakia	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta MM04216 Finland	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	HM872333
Catocala nupta MM04750 Finland	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	HM872531
Catocala nupta 8001 W Russia	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	HM426443
Catocala nupta BC ZSM Lep 21863 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	JF415760
Catocala nupta BC ZSM Lep 29037 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	JF415759
Catocala nupta BC ZSM Lep 64831 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep 64832 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep 70164 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep 72632 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep 75217 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep 78585 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep 80284 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta BC ZSM Lep R 21673 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta P21863 Germany	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	
Catocala nupta TLMF Lep 09855 Austria	A	T	T	T	C	G	T	A	C	A	**C**	C	T	C	KM572102

Materials and methods

Methods for data analysis, genitalic dissection, and terminology follow Kons and Borth (2015) and as described at http://www.lepidopterabiodiversity.com. Paul Hebert's lab at the University of Guelph sequenced the 5' region of COI as described in Hebert *et al.* (2003). Statistical analyses were performed in v9.4 of SAS for Windows (SAS Institute, Cary, NC). Acronyms for institutional and private collections are as follows: AFM, Alessandro Floriani (Milan, Italy); ASV, Aidas Saldaitis (Vilnius, Lithuania); NHM, Natural History Museum (London, England); KIS, Katsumi Ishizuka (Saitama, Japan); MNHU, Museum fur Naturkunde (Berlin, Germany); RJB, Robert J. Borth (Milwaukee, USA); SEHU, Hokkaido University Museum (Hokkaido, Japan); ZSM, Zoologische

Staatssammlung, München (Munich, Germany); ZFMK, Zoologisches Forschungsmuseum, A. Konig (Bonn, Germany); WIGJ, World Insect Gallery (Joniškis, Lithuania).

Systematic part

We find that in the *Catocala nupta* complex, only *C. nupta* and *C. concubia* are diagnosable by any discrete morphological characters. Exemplary differences in upperside wing pattern that separate *C. nupta* from *C. concubia* include: the medial red band on the hindwing is nearly concolorous throughout its length in *C. nupta*, but is noticeably paler white with only sparse red scaling along the leading edge of the hindwing in *C. concubia*; the inner hindwing margin has red/dark hairs in *C. nupta*, but red orange hairs in *C. concubia*; and the forewing of *C. concubia* has scattered pale violet tinted scales, and *C. nupta* lacks these where a bluish tint is sometimes evident. Specimens we have measured of *C. concubia* average 38.0 mm (sd=0.7 mm, n=5) in forewing length (base to apex) compared to 33.2 mm in *C. nupta* (sd=1.9 mm, n=43), and this size difference is significant ($F=33.91$, $df=1/44$, $p < 0.001$, by ANOVA controlling for sex). There are also several character state differences in COI 5' mtDNA sequences between *C. concubia* and *C. nupta* (Table 1). Since *C. concubia* has been treated inconsistently in the Palearctic literature as a synonym of *C. nupta* (e.g., Hampson 1913, Poole 1989, Kononenko 2010), a subspecies (Goater *et al.* 2003: 84), or a full species (e.g., Warren 1913, Goater *et al.* 2003: 83) we here reaffirm specific rank for *C. concubia*, **stat. rev.** This species occurs from Sichuan and Yunnan Provinces in China west to Punjab in northern India.

We also find no justification for subdividing *C. nupta* into further infraspecific taxa. *Catocala nupta* is the most geographically widespread of the Palearctic *Catocala* species, ranging from Portugal and England in the west to Russia and Japan in the east. The wing pattern of *C. nupta* exhibits considerable inter- and infrapopulational variation, but our research shows this variation to be continuous, and the differences in COI 5‘ haplotypes seen within *C. nupta* do not correspond to known morphological differences (Table 1; see Diagnosis section below).

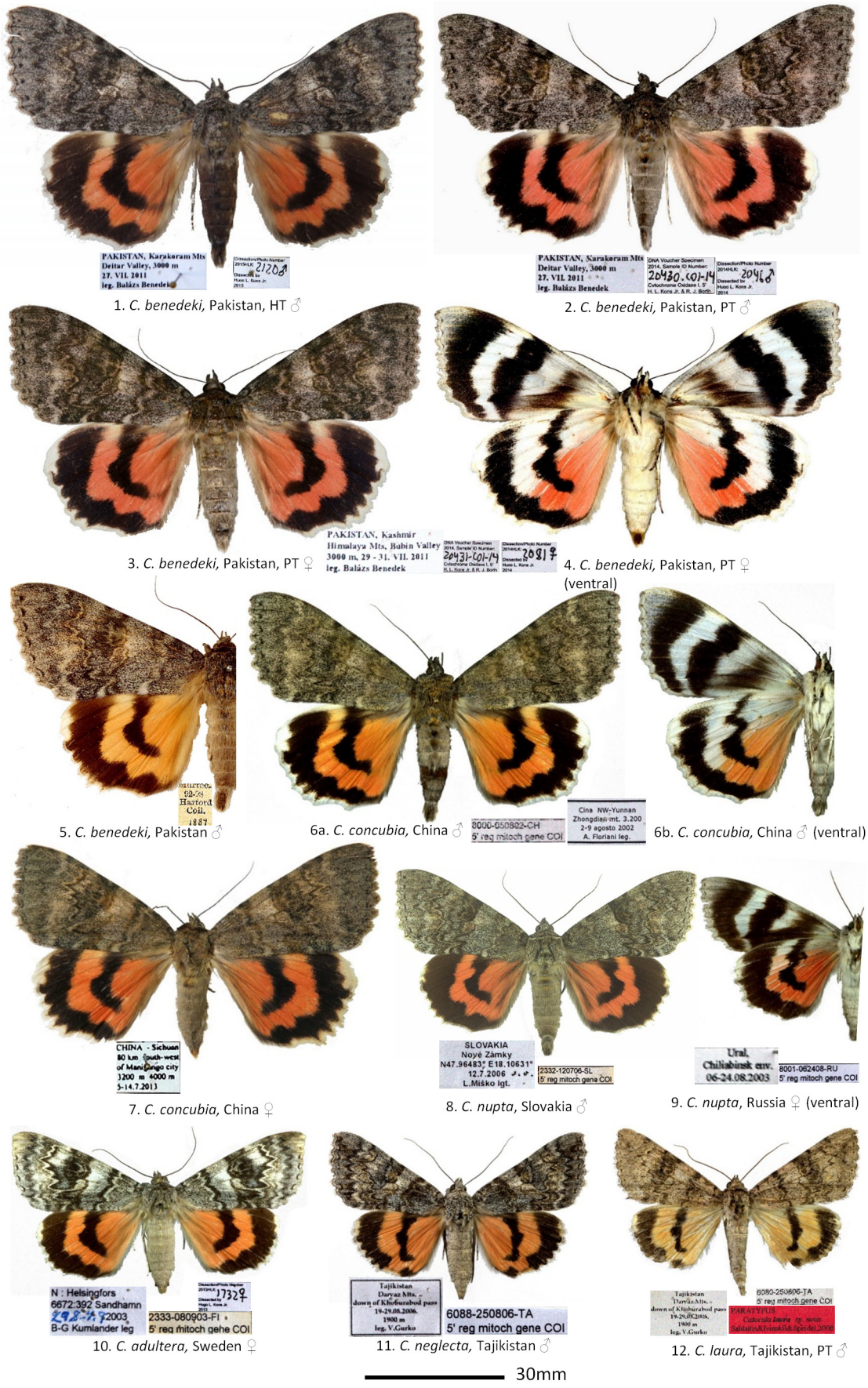
In addition, we have identified an additional diagnosable species from the northern region of the Indian subcontinent close to *C. concubia* that lacks an available name, which we describe as new.

Catocala benedeki Borth, Kons, Saldaitis & Gall sp. nov.

(Figs 1–5, 38–55, 62–69, 77, 78, 85–96)

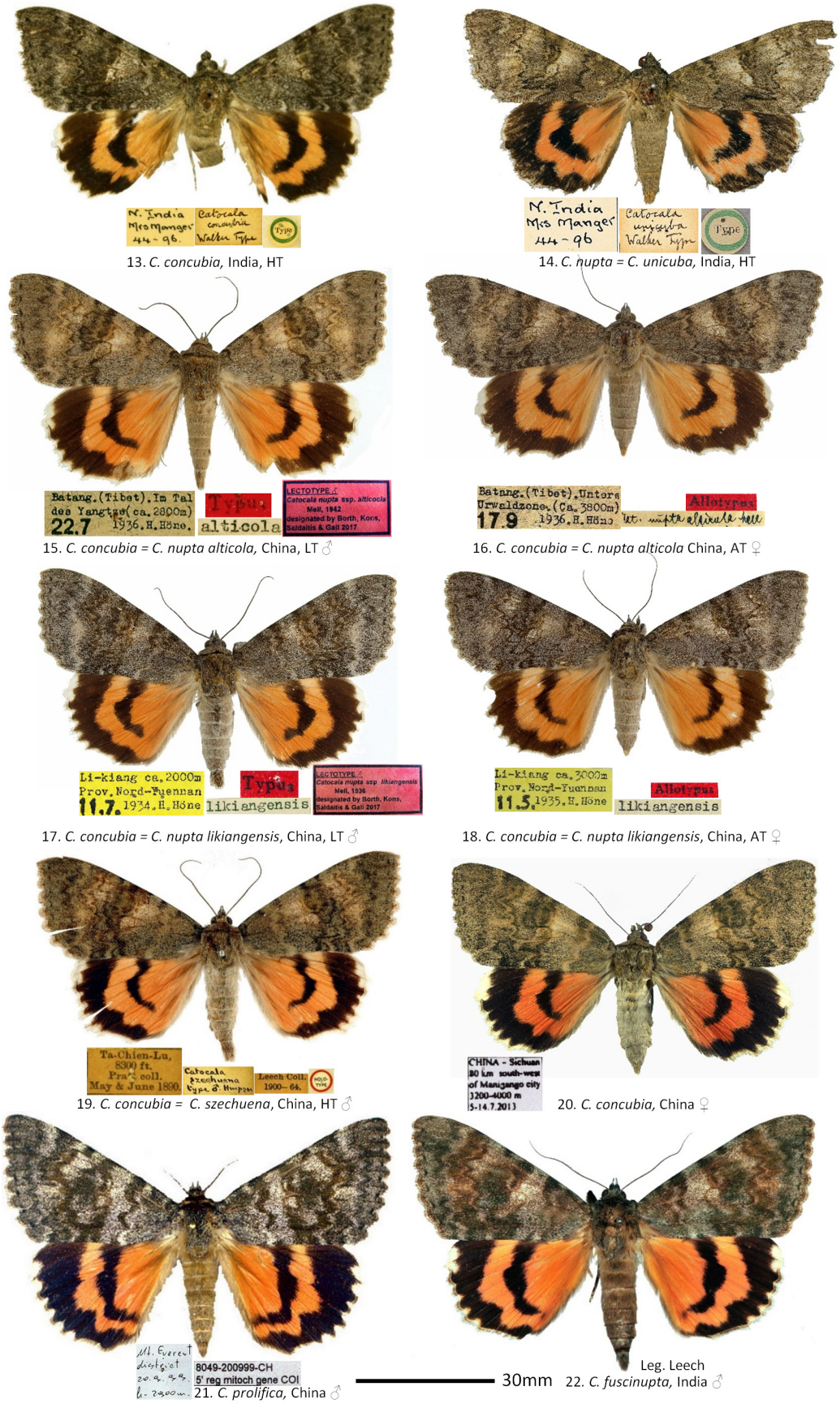
Type material. Holotype: Male (Fig. 1), Pakistan, Karakoram Mts., Deitar Valley, 3000 m, 27.VII.2011, leg. Balázs Benedek (Dissection No. 2015HLK:2120; DNA No. 10249-270711-PA) preserved in ASV collection, later to be deposited in the WIGJ.

Paratypes: (Figs 3–4), PAKISTAN: 1 male, Karakoram Mts., Deitar Valley, 3000 m, 27.VII.2011, leg. Balázs Benedek (Dissection No. 2014HLK:2046; DNA No. 20430-COI-14) (collection of (coll.) RJB); 1 male Karakoram Mts., Deitar Valley, 3000 m, 27.VII.2011, leg. Balázs Benedek (coll. AFM); 1 male Kashmir, Karakoram Mts., Deitar Valley, 3000 m, 29.VI.2014, leg. Balázs Benedek (coll. RJB); 1 female, Himalaya Mts., Bubin Valley, 3000 m, 29–31.VII.2011, leg. Balázs Benedek (Dissection No. 2014HLK:2081; DNA No. 20431-COI-14) (coll. RJB); INDIA: 1 male, Prov. Uttar Pradesh, Garwahl Himal, Gangotri, 3000 m, 4.1X.1997, L. Nadai (Dissection No. JB1071) (coll. AFM); 1 female, Kashmir, PirPanJar, Tatakutti, Astar, 4000m, 11.VIII. 2012, leg. T. Surumaki (coll. KIS); 4 males, S. Kashmir, Tatakutti Area, PirPanJal Mts., Mt. Ashitar, 3800m, 2–3.VIII.2013, leg. T. Surumaki (coll. KIS).

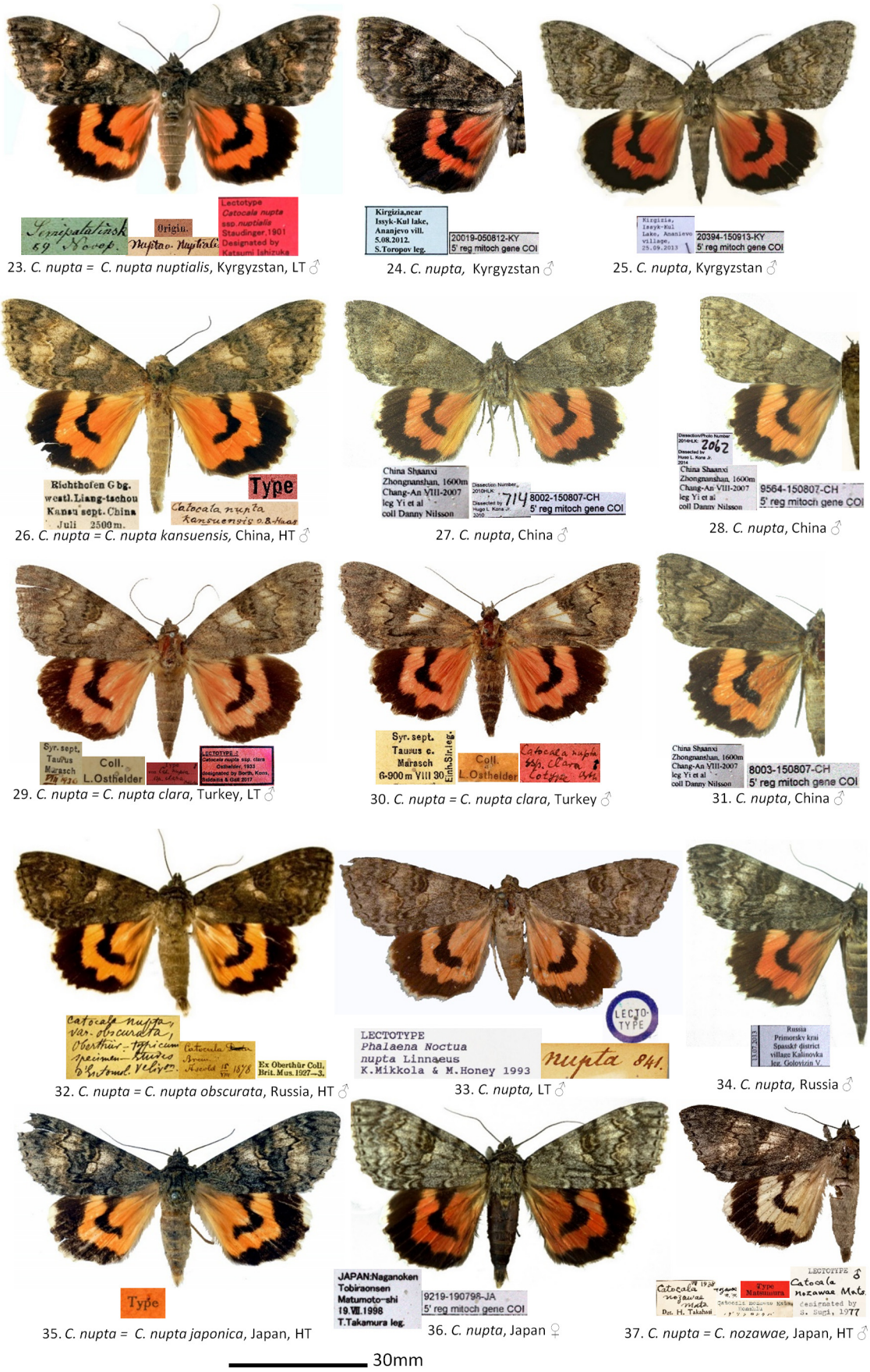


1. *C. benedeki*, Pakistan, HT ♂
2. *C. benedeki*, Pakistan, PT ♂
3. *C. benedeki*, Pakistan, PT ♀
4. *C. benedeki*, Pakistan, PT ♀ (ventral)
5. *C. benedeki*, Pakistan ♂
6a. *C. concubia*, China ♂
6b. *C. concubia*, China ♂ (ventral)
7. *C. concubia*, China ♀
8. *C. nupta*, Slovakia ♂
9. *C. nupta*, Russia ♀ (ventral)
10. *C. adultera*, Sweden ♀
11. *C. neglecta*, Tajikistan ♂
12. *C. laura*, Tajikistan, PT ♂

FIGURES 1–12. Imagos of Palearctic *nupta* group: *C. benedeki, C. concubia, C. nupta, C. adultera, C. neglecta & C. laura*.



FIGURES 13–22. Imagos of high altitude *Catocala* from India & China: *C. concubia, C. prolifica* & *C. fuscinupta*.



23. *C. nupta* = *C. nupta nuptialis*, Kyrgyzstan, LT ♂
24. *C. nupta*, Kyrgyzstan ♂
25. *C. nupta*, Kyrgyzstan ♂
26. *C. nupta* = *C. nupta kansuensis*, China, HT ♂
27. *C. nupta*, China ♂
28. *C. nupta*, China ♂
29. *C. nupta* = *C. nupta clara*, Turkey, LT ♂
30. *C. nupta* = *C. nupta clara*, Turkey ♂
31. *C. nupta*, China ♂
32. *C. nupta* = *C. nupta obscurata*, Russia, HT ♂
33. *C. nupta*, LT ♂
34. *C. nupta*, Russia ♂
35. *C. nupta* = *C. nupta japonica*, Japan, HT
36. *C. nupta*, Japan ♀
37. *C. nupta* = *C. nozawae*, Japan, HT ♂

FIGURES 23–37. Imagos of *C. nupta* types compared to similar sequence vouchers.

Diagnosis. The wing pattern of *C. benedeki* (Figs 1–4) resembles the closely related *C. concubia* (Figs 6a–7, 13–20) and *C. nupta* (Figs 8, 9, 23–37). Both *Catocala fuscinupta* Hampson, 1913 (Fig. 22) and *Catocala prolifica* Walker, [1858] (Fig. 21) are superficially similar in wing pattern (but are dissimilar in genitalia), and can be readily separated by the ventral hindwing median band, which is distinctly curved basally between veins Rs and M2 in *C. benedeki,* and not so in either *C. fuscinupta* or *C. prolifica.* The following characters enable the separation of *C. benedeki, C. concubia,* and *C. nupta.* Forewing upperside: *C. benedeki* has mottled grey and white forewings with strong contrasts in maculation, whereas *C. concubia* has a more diffused, less distinct pattern (especially in males) with an olive and brownish cast. The smaller *C. nupta* is highly variable: some specimens are grey with white, but they have lower densities of white mottling giving the wings a smoother, less powdery appearance. *Catocala benedeki* has pale violet tinted scales, which are present to a lesser extent in *C. concubia,* but are lacking in *C. nupta* where a bluish tint is sometimes evident. Hindwing upperside: In *C. benedeki* the inner hindwing margin has dense pale tan hairs contrasting against the red background color, *C. nupta* has red or red and dark hairs, and *C. concubia* has red orange hairs. The area posterior to vein Rs between the medial and marginal black bands is pale white with sparse red scaling in *C. benedeki*; this area is also pale in *C. concubia* with slightly denser red orange scaling, but in *C. nupta* there is dense red scaling with much less pale contrast. Wing size: The average forewing length (base to apex) in measured specimens of *C. benedeki* is 42.0 mm (sd=1.0 mm, n=3), versus 38.0 mm (sd=0.7 mm, n=5) in *C. concubia,* and 33.2 mm (sd=1.9 mm, n=43) in *C. nupta*. The differences among species are significant ($F=46.36$, $df=2/45$, $p < 0.001$, by ANOVA controlling for sex, pairwise species comparisons $p < 0.05$ using Tukey least squares means). Male genitalia: While we compared all of the male genitalic characters covered in the description (below) among *C. benedeki* (n=2) (Figs 38–55, 62–69, 77, 78), *C. concubia* (n=2) (Figs 56, 57, 71, 72, 79, 80), and *C. nupta* (n=4) (Figs 58–61, 73–76, 81–84), the only genitalic characters found to vary between these three species were minor but consistent differences in vesica diverticula 6 and 7. While purported differences in the length, shape, or sclerotization of valve costa have been suggested as a basis for subdividing *C. nupta* into additional species or subspecies (e.g., Kravchenko *et al.* 2008) we found no evidence these characters have diagnostic value at the species level within the *Catocala nupta* complex (Figs 41, 55–61). The following vesica characters are best viewed when the vesica is orientated in lateral aspect with the ventral aedeagus hood on top. In *C. benedeki* and *C. concubia* diverticulum 6 has two shallow but distinct subdiverticula (Figs 76–79), whereas *C. nupta* has three (Figs 80–83); the equivalent of subdiverticulum 6b in *C. benedeki* and *C. concubia* is subdivided in *C. nupta* (Figs 80–83). *Catocala benedeki* and *C. nupta* have two distinct subdiverticula on diverticulum 7 (Figs 67–69, 72–75) whereas in *C. concubia* diverticulum 7 is expanded on the anterior side in the equivalent position but there is no clear bifurcation (Figs 70–71). In *C. benedeki* the ventral base of subdiverticulum 7a is closer to the anterior base of diverticulum 7 than in *C. nupta* (Figs 68–69 versus Figs 72–75). In *C. benedeki* and *C. nupta* diverticula 6 and 7 diverge from near the posterior base of diverticulum 6 and the anterior base of diverticulum 7, creating a distinct separation near the base; the diverticula touch or nearly touch farther distally where diverticula 7 expands laterally on the anterior side (Figs 67–69, 72–75). However, in *C. concubia* diverticula 6 and 7 touch throughout the basal half of their length or more (Figs 70–71). When viewed laterally with a slight lateral tilt such that diverticulum 7 appears as wide as possible, subdiverticulum 7b is distinctly narrower in *C. benedeki* compared to *C. nupta* (Figs 68–69 versus 74–75; in Figs 72–73 diverticulum 7 is slightly tilted from where it appears widest, causing diverticulum 7b to appear narrower). Female Genitalia: No diagnostic characters are known between *C. benedeki, C. concubia,* and *C. nupta*. COI 5' Mitochondrial COI 5' DNA: *Catocala benedeki* can be diagnosed from all sequenced *Catocala* species by the following unique combination of six character states: 274(C), 343(C), 460(C), 547(T), 548(T) and 607(C). There are two consistent character state differences between *C. benedeki* and *C. nupta*, and five between *C. benedeki* and *C. concubia* (see Table 1).

Description. **Head.** Vertex with predominantly grey scales, peppered with darker grey, white, and tan scales. Frons predominately grey but peppered with white and tan scales. Labial palp basal segment almost exclusively white, with sparse grey scales on the lateral side; middle segment predominately grey with a peppering of white scales increasing in density distal to proximally; terminal segment predominately grey with a peppering of white scales. Antennae dorsally and laterally predominantly covered by grey scales with scattered white scales, except for scape and pedicel which are predominately white with sparse grey scales.

Thorax. Patagia predominantly grey with a dense scattering of white and tan scales. Tegulae with heavily mottled with grey and white scales, narrow irregular band along inner margin mottled with tan and darker grey scales. Elsewhere a mix of grey, tan, and white scales, sometimes with a diffuse grey and white inverted "U"

pattern. Paired tufts of hair on posterior mesothorax predominately tan with some grey. Ventrally with dense pale tannish-white hairs.

Wings (Figs 1–4). Wingspan: Forewing length (base to apex) of holotype male 41 mm; forewing length of paratypes: male (n=1) 42 mm, female (n=1) 43 mm. Forewing Shape: length of FW base to apex divided by length of FW apex to anal angle: holotype male 1.77, paratype male 1.68, paratype female 1.75. Forewing upperside: Background color predominantly grey, mottled with white scales creating a powdery appearance, many white scales with a distinct violet tint under natural light. Two small areas where white scales dominate: on the basal side of the reniform and orbicular spots, and between the postmedial and subterminal lines between veins M2 and M3. Reniform spot oblong, basal side smoothly curved, distal side irregular to slightly dentate, primarily with dark greyish-black scales, diffuse lighter grey scales in center. Reniform border with a mix of pale brown and light grey scales, rimmed with a smooth basally curved greyish black basal border, fused with the medial band on anterior and posterior sides of reniform. Basal dash absent. Basal line sharp greyish-black posterior of discal cell, comprised of an anterior distally curved loop and a posterior fairly straight line. Antemedial line distinctly double, dark grey to greyish black borders with pale whitish-grey between, borders variably sharp or diffuse. Antemedial line comprised of three distinct distally curved loops: posterior loop (below vein 2A) protruding basally on anterior side; second (medial) loop spanning between veins 2A and lower margin of discal cell; third loop irregular, from lower discal cell margin to costa, distal border doubly looped, basal border a single jagged loop. Median line distinct the full length of the wing except where broken by the open base of the subreniform spot, black, sharp anterior to reniform and posterior to vein Cu2, generally diffuse between. Median line irregularly undulated to dentate, double between costa and anterior base of subreniform, the two sections widely separated anterior of vein R4, fused together at distal anterior corner of reniform and intersection of veins R4 and R5, then narrowly separated and fusing back together at anterior base of subreniform. Postmedial line black, sharp, distinctly contrasting, bordered distally by a sharp to diffuse narrow band of pale whitish grey. Postmedial line undulations: below vein 2A convex loop, extended as far basal as edge of reniform at vein 2A; between Cu2 and 2A singly or doubly dentate; subreniform open, but pale band on distal side of postmedial line fused; tooth between veins Cu1 and Cu2 with apex close to vein Cu2; shallow tooth between veins M3 and Cu1; two dentate distally protruding teeth between veins M1 and M3 with a concave division between them across vein M2; concave and angling basally between veins R5 and M1, then sharply turned basally along vein R4 roughly perpendicular to costa and thickened as small black patch slightly distal to the outer border of the reniform. Subterminal line broad and diffuse pale whitish grey, a series of undulated to dentate, distally protruding chevrons with diffuse to indistinct black distal border. Wing margin with series of diffuse to sharp black, straight to slightly concave bars or patches between each pair of veins from R4 to CuA2. Farther distally at the extreme margin, a sinusoidal, broken, thin dark grey line between veins R4 and 2A, with the distal protruding convex loops transecting the veins and basally protruding concave loops between the veins. Fringe peppered pale whitish grey and darker grey, the darker grey progressively increasing in density posterior to anterior, without patches along veins. Hindwing upperside: Background color reddish (with a slight pink tinge) posterior to vein Rs, predominately pale white anterior to vein Rs, peppered with a variable amount of the reddish background scales. Black median band prominent, distal side with three distal undulations and smoothly angled along vein M2, basal side a fairly smooth simple distal curve; bulged basally between costa and vein M2, and bulged distally between veins M2 and Cu1, oblong patch with no distinct curvature in cell CuA2; thin, diffuse, and discontinuous between vein 2A and inner margin. Marginal black band thick and fairly smoothly curved anterior to vein Cu2, deep concave gouge in interspace between veins Cu2 and 2A, each side of gouge with triangular basally pointing projection with apices on veins 2A and CuA2, thin and narrow at anal angle. Band of dense pale tan hairs along inner margin, contrasting against background colour, some darker grey hairs mixed in, tan and grey hairs along the veins basal to the median band. Fringe thick and clean, bright white, some small patches of pale white intruding into the marginal black band between the veins such that the distal edge of the marginal band is undulated between M1 and CuA2. Apical patch prominent, a paler white than the fringe, basal edge with two basally protruding undulations divided by vein Rs. Anterior margin with a thin band of white. Forewing underside: Background color bright, clean white. Marginal band thick and black with sharp margins, except on distal side at apex, where it blends into a greyish white area at apex; outer side with two broad undulations divided by vein M2, a distally protruding triangular indentation at the veinlet posterior of vein CuA2, a smaller triangular indentation of white along vein 2A, small slivers of white intruding along some of the other veins. Termen with the thin undulating line present dorsally, but more diffuse and becoming progressively

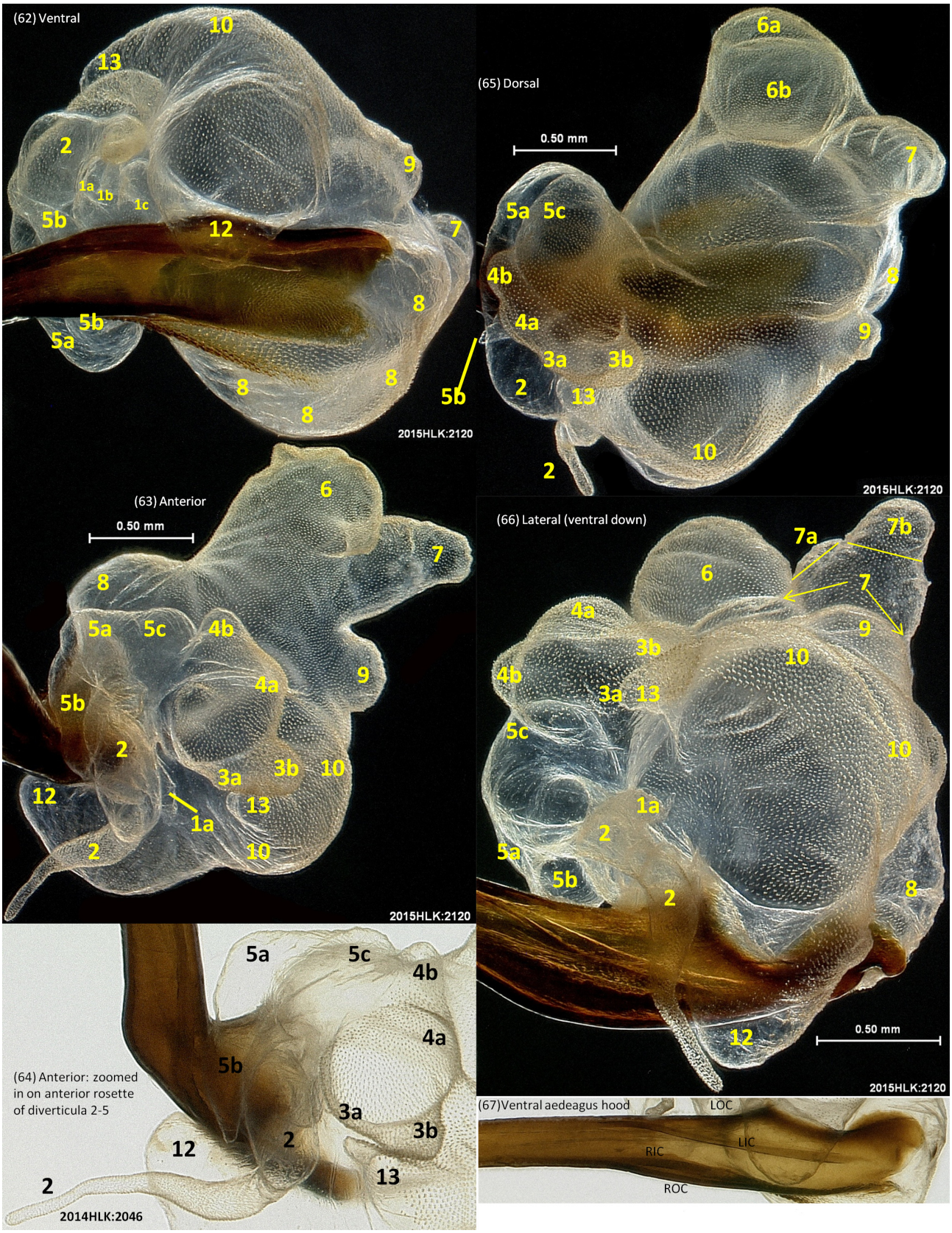
less distinct posteriorly. Median band wide and black; sharply contrasting but with some whitish diffusion along the edges; both sides angle distally along vein M2, progressively narrowing between vein M2 and inner margin, tapering to a blunt point at inner margin; a distally protruding triangular tooth at veinlet posterior of vein CuA2, with the tooth apex on the veinlet. Basal band diffuse and lighter black; both margins irregular; extends between anterior margin of discal cell and vein 2A, but costa anterior to discal cell and inner margin posterior to vein 2A white with sparse black diffusion. Incomplete diffuse marginal black band between basal and median bands between the veinlet posterior of vein CuA2 and 2A, becomes more diffuse distally and partially fuses with median band. White background color basal to basal band with a pale tan tint. Hindwing underside: Marginal black band similar to upperside but slightly narrower and with more diffused margins, and not extending anterior of vein Sc+R1 where this area is white with a peppering of black scales. Medial black band of dissimilar shape to upperside; relatively thin anterior to vein Rs, slightly narrowing anteriorly, fairly straight but with diffused and slightly irregular margins; distinctly curved basally between veins Rs and M2; widest at intersection with vein M2, strongly tapering between veins M2 and CuA2 with an undulated distal edge; similar to upperside in cell CuA2, but with a faint but distinct distal curve; absent between vein 2A and inner margin. Small, diffuse, black discal spot on the veinlet. Background color: basal to medial band: white anterior to posterior margin of discal cell, pale red with some white diffusion posteriorly; distal to medial band: white anterior to vein CuA1, pale red with some white diffusion posteriorly. Fringe, apical patch, and extreme outer margin similar to upperside.

Legs. Similar in male and female except male mesotibia has a hair pencil groove on the inner side and is slightly wider. Foreleg: Profemur without laterally flattened apical spine. Protibia unspined, but with small convex sulcus with radiating spines near basal extremity on the inner side. Protibial flange in shallow ovuloid pit, ventral margin of flange with dense row of short setae. Protarsomeres 1–4 with three ventral rows of large triangular spines, and two rows of minute hair-like curved spines between them; protarsomere 5 with four rows of large triangular spines, with two rows of minute hair-like spines in-between. Irregularly spaced hair-like spines present on lateral sides of tarsomeres. Pretarsus simple. Arolium convex on basal side, widening distally with lateral margins concave and then convex, distal margin slightly concave, sclerotization predominately dark brown to blackish, most intense along basal and basal-lateral sides, translucent greyish on distal and distal-lateral margins. Midleg: Mesofemur unspined, mesotibia with a single row of fourteen to fifteen large spines on outer side, hairpencil groove on inner side. Tarsal spination/pretarsus/arolium as in proleg. Hindleg: sclerotization pattern typical for *Catocala*, with femur sclerotized throughout, mesotibia translucent white except at base, metatarsomere 1 translucent white except at apex, remaining tarsomeres sclerotized throughout. Metafemur unspined, metatibia with three subapical spines on outer side near ventral margin, two thicker spines ventral to one much thinner spine. Tarsal spination/pretarsus/arolium like proleg except metatarsomere 1 with a few extra smaller spines scattered between the three rows of ventral spines.

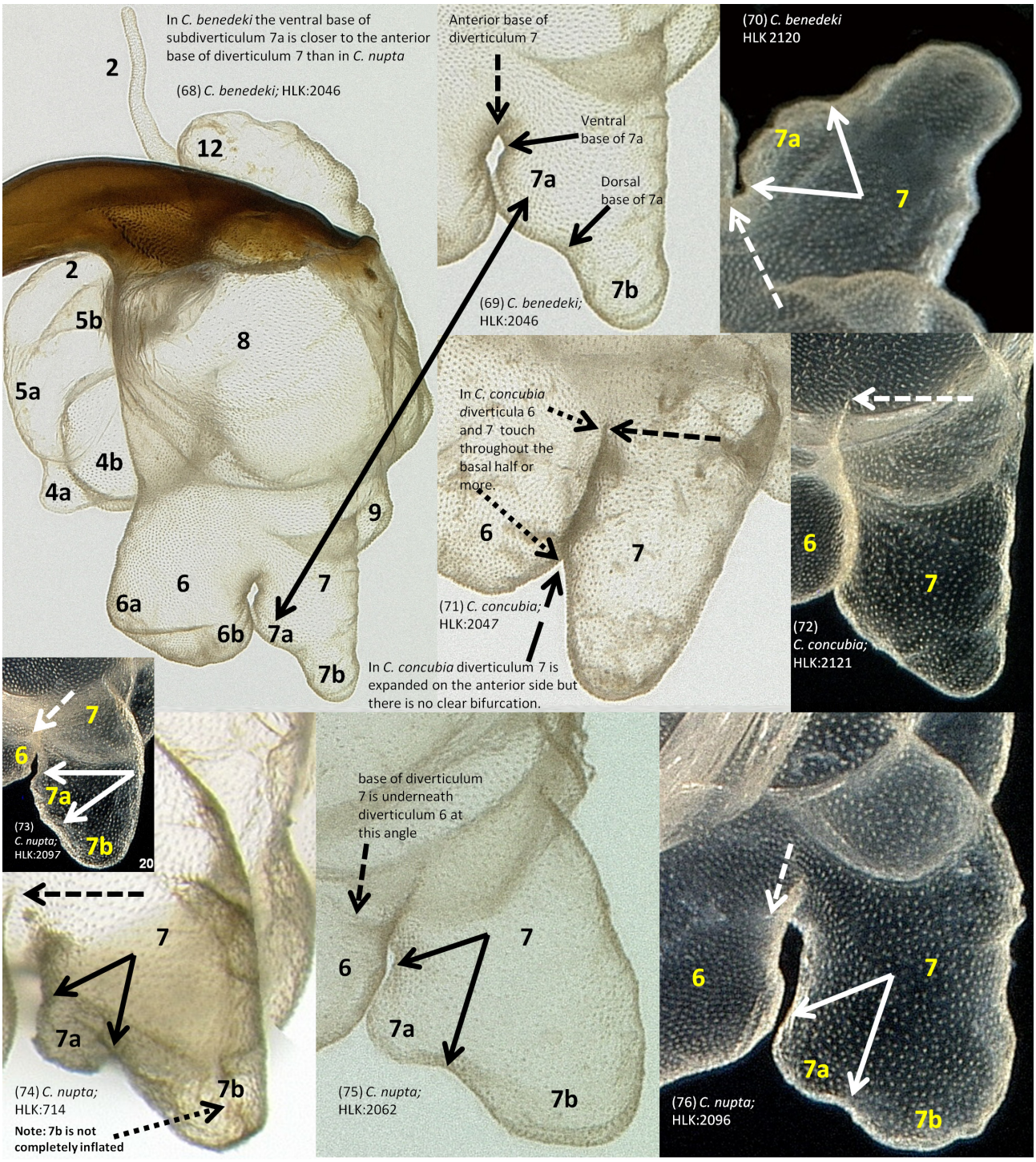
Abdomen. Scale pattern grey dorsally, white and pale tan ventrally. Cuticle (Figs 51–53, 92–94): male tergites 1–6 as shown in Fig. 51, sternites 2–7 as shown in Fig. 52, terminal tergite (left) and sternite (right) as shown in Fig. 53. Female tergites 1–6 as shown in Fig. 92, sternites 2–6 as shown in Fig. 93, tergite 7 (Fig. 94) with strongly convex sides, convex posterior side, anterior side with shallow concave depressions on each side and fairly straight in the middle.

Male genitalia (Figs 38–55, 62–69, 77, 78). Capsule (Figs 38–41, 48): Juxta and vinculum strongly fused with valvae, vinculum weakly fused with tegumen, vinculum arms laterally expanded and weakly fused midventrally, diaphragma membranous except for juxta/anellus. Valvae (Figs 41 & 55): asymmetrical. Outer surfaces densely covered with elongate tan colored hairs and scales except for anterior portion of sacculus (Fig. 39); inner surface of "cucullus" (or the membranous valvae structure in the equivalent position) with shorter scales and hairs along ventral margin. Sacculus with triangular posterior extension at fusion with cucullus, approximately twice as long as wide; inner side densely covered with elongate setae (Figs 41 & 55). Additional elongate setae scattered along posterior margin of sacculus on inner side. Ventral inner sides of sacculus with concave indentation along margin of clasper base (Fig. 38). Left cucullus clear and membranous. Right cucullus with an ovuloid patch of sclerotization between clasper and ventral margin of cucullus, additional sclerotization bordering the cucullus medially, otherwise clear and membranous (Figs 41 & 55). Cucullus with scattered elongate setae on inner surface along ventral margin, densest anteriorly. Left costa (Figs 41 & 55) heavily sclerotized, widest medially, narrowest posteriorly; ventral margin concave anteriorly, convex medially, and concave posteriorly; dorsal margin strongly convex anteriorly, more weakly concave medially, then weakly convex, concave, and convex posteriorly (anterior

FIGURES 38–54. Male genitalia and cuticle of *C. benedeki* Holotype; **55–61**: valvae (inner) of *C. benedeki*, *C. concubia* and *C. nupta.*

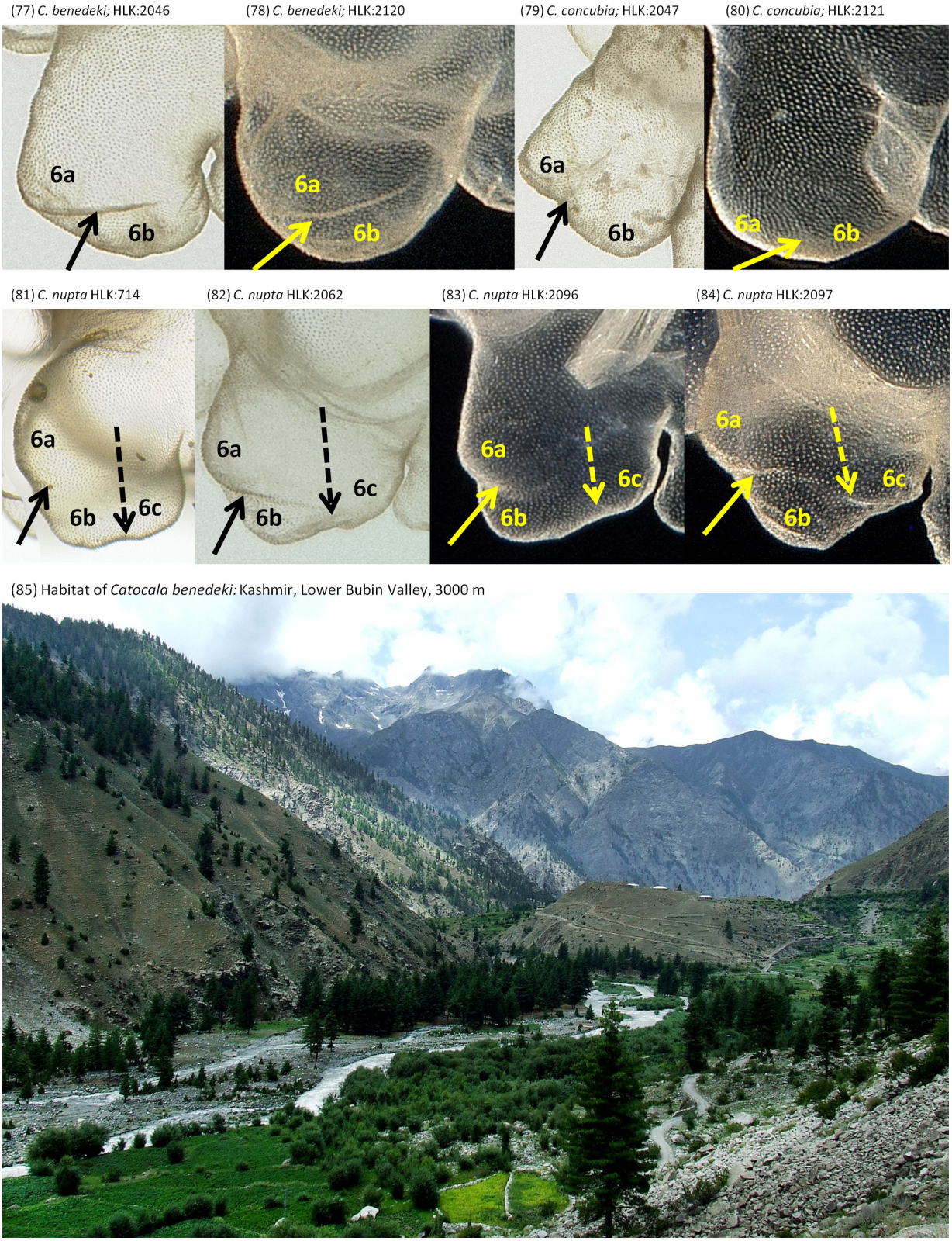


FIGURES 62–67. Everted vesica at different angles for *C. benedeki.*

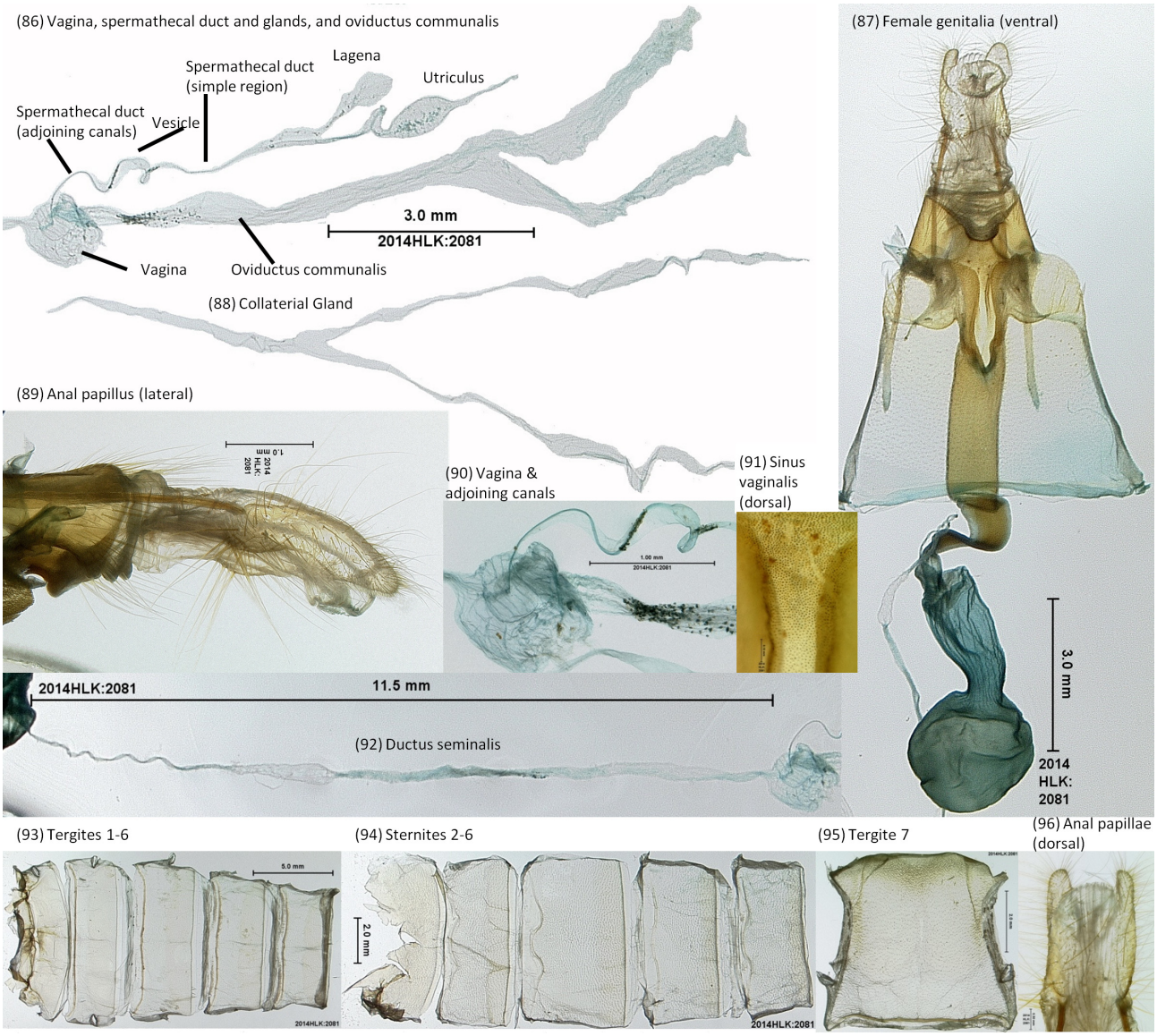


FIGURES 68. Everted vesica of *C. benedeki* (lateral aspect with ventral aedeagus hood orientated up); **69:** Diverticulum 7 of *C. benedeki* (lateral aspect with ventral aedeagus hood orientated up); **70:** Diverticulum 7 of *C. benedeki* (lateral aspect with ventral aedeagus hood orientated down); **71–72:** Diverticulum 7 of *C. concubia* (lateral aspect with ventral aedeagus hood orientated up); **73–76:** Diverticulum 7 of *C. nupta* (lateral aspect with ventral aedeagus hood orientated up) [Note: In Fig. 73 the apex of 7a is partially inverted inward making it appear shorter]. Solid arrows point to the boundaries of subdiverticulum 7a; dashed arrows point to the anterior base of diverticulum 7. Note: It is impossible to photograph diverticulum 7 in this aspect at exactly the same angle between specimens, and some apparent minor differences in shape within species are incidental to minor differences in the angle between the photographs.

to posterior); costa extends distinctly beyond cucullus where it projects ventro-posteriorly. Right costa (Figs 41 & 55) dissimilar to left; distinct thickened anterior section terminates anterior of clasper apex, posterior to this the "costa" may be modified sclerotized cucullus, sclerotization less intense than on left costa in this area; ventral margin concave anteriorly, weakly convex medially, weakly concave posteriorly; dorsal margin strongly convex anteriorly, beyond thickened area convex overall but exact shape somewhat variable; extends slightly posteriorly beyond membranous cucullus, but shorter than left costal extension. Dorsally left costa smooth and narrow, right costa with a distinct notch slightly anterior to the clasper apex (Fig. 54, arrow). Claspers asymmetrical (Figs 41 & 55). Left clasper ventral side convex basally, concave medially-distally, convex at apex; dorsal side convex basally, concave distally. Right clasper ventral margin concave, dorsal margin also concave but relatively less so. Left clasper base much wider than left (Figs 41 & 55), left clasper but not right curved ventrally at apex (Figs 41 & 55), both clasper apices curved inward but right apex more strongly so (Fig. 38). Clasper apices covered with scattered minute short setae, apices with knob-like expansions (Fig. 20). Ventral and dorsal margins of each clasper base with patches of elongate setae, with scattered shorter setae extending distally along ventral margin. Juxta (Fig. 49): Two elongate slightly asymmetrical lobes, right lobe slightly shorter, both narrowest posteriorly, progressively widening anteriorly, with a narrow band of darker sclerotization along inner margin. Lobes narrowly fused to anellus at posterior apex, barely touching each other near posterior end but not fused together. Pitted pattern of anellus not extending to juxta lobes. Anellus (Fig. 49): Lobes fused together throughout and appearing as a single sclerotized plate, strongly asymmetrical with right lobe larger and wider than left. Outer margin of left lobe strongly concave but with small convex protrusion medially, outer margin of right lobe concave, posterior apex narrowly rounded, anterior edges of both lobes convex. Band of sclerotized dense shallow depressions (pits) of variable lateral width throughout longitudinal midline. Uncus (Figs 45–46): Tubular, progressively gradually narrowing distally, posterior margin strongly convex, anterior margin strongly concave; terminating in heavily sclerotized curved spine, laterally appearing pointed apically but narrowly rounded in dorsoventral view. Extensive lateral setae throughout length, most not longer than width of uncus but longest setae 2–3 X width of uncus and located in medial and subapical areas. Tuba analis (Fig. 44–45): Membranous except for scaphium, scaphium an elongate rectangular plate terminating slightly dorsally to the uncus apex. Aedeagus (Figs 42–43, 47): Translucent throughout. Coecum of similar width to adjacent aedeagus, weakly bent. Aedeagus bent at posterior margin of coecum, and strongly bent before ventral extension over vesica, fairly straight in-between. Left flank of posterior ventral extension ("hood" over everted vesica) with a concave gouge and a convex posterior-lateral expansion (Fig. 67), right flank weakly convex (Figs 62 & 67), apex concave medially and convex on edges (Fig. 62). All of the four sclerotized chords sometimes present on the ventral hood in *Catocala* are clearly present (Fig. 67): left outer chord (LOC) extends almost to the apex of the hood (Figs 62 & 67); left inner chord (LIC) terminates well anterior of apex, roughly parallel with LOC at terminus (Figs 62 & 67); right inner chord (RIC) terminates about even or just anterior to anterior side of concave depression on left flank of hood, merges with right outer chord (ROC) on both ends (Fig. 67); ROC gradually weakens posteriorly along outer edge of hood with no clear terminus (Fig. 62). Ductus ejaculatorius (Fig. 50): Slender region with distinct bend just before scoop-shaped region, bent over at about 180 degrees. Scoop-shaped region strongly convex on outer side with prominent concave gouge basally, inner side convex at base, then strongly concave. Vesica (Figs 62–66, 68, in part Figs 69–84): Vesica diverticulum 1 trilobed, concealed underneath diverticula 2 at most angles but best seen in ventral view with the hood slightly tilted to the left (Fig. 62), or in anterior aspect with the focal plane underneath diverticulum 2; 1a the most elongate of the three lobes, fang-shaped with outer side convex, inner side concave, and apex narrowly rounded; 1b and 1c finger-like with convex apex, 1b about half as wide as 1c (Fig. 62). Diverticulum 2 (Figs 63–64 & 66) lacking subdiverticula, elongate and gradually tapering to a narrowly rounded apex, strongly bent in two places. Diverticulum 3 not clearly bifurcate but wide with convex bulges on each side, fairly straight in-between (Figs 63–64). Diverticulum 4 clearly bifurcate with two distinct convex bulges on each side and concave in-between (Figs 63–64). Diverticulum 5 with three lobes, the central (5a) a broadly rounded convex bulge; the left (5b) somewhat fang-shaped, narrowly rounded (almost pointed) apically, with the left side convex and the right side concave; the right (5c) a broadly rounded shallow convex bulge barely distinct from 5a and separated by a shallow convex to nearly straight separation (Figs 63–64). Diverticulum 6 large and broad, with two shallow but discernible convex lobes at apex (Figs 68, 77–78). Diverticulum 7 distinctly bilobed with posterior/distal lobe (7b) longer and narrower than anterior lobe (7a), 7b protruding from posterior corner, 7a protruding from anterior side, posterior side of 7 roughly parallel to anterior side of diverticulum 6, anterior base of 7 diverging from base of 6 with a distinct separation, but touching or nearly so farther distally where 7a bulges out (Figs 68–70). Diverticulum 8



FIGURES 77–84. Diverticulum 6 of *C. benedeki* (Figs 77-78), *C. concubia* (Figs 79-80), and *C. nupta* (Figs 81–84) in lateral aspect with the ventral aedeagus hood orientated up. In *C. nupta* diverticulum 6 has three shallow but distinct subdiverticula; in *C. benedeki* and *C. concubia* there are two. Solid arrows point to the dorsal margin of subdiverticulum 6a; dashed arrows point to the anterior edge of subdiverticulum 6c. Note: It is impossible to photograph diverticulum 6 at exactly the same angle between specimens, and some apparent differences in shape within species are due to minor differences in the angle between the photographs, especially between Figs 79 and 80. **FIGURE 85.** Habitat of *C. benedeki:* Kashmir, Lower Bubin Valley, 3000 m.



FIGURES 86–96: Female genitalic structures and abdominal cuticle of *C. benedeki* (HLK:2081).

broad but shallow convex bulge curving around right and apical sides of ventral aedeagus hood, several times as wide as high (Figs 62 & 68). Diverticulum 9 a simple convex bulge (Figs 63 & 65). Diverticulum 10 a broad simple convex bulge wider than high (Figs 62 & 65). Diverticulum 11 not discernible. Diverticulum 12 a prominent convex bulge (Figs 62–63, 66) overlapping most of the ventral aedeagus hood when viewed in the flattest ventral aspect (Fig. 67). Diverticulum 13 a prominent, fairly narrow convex bulge, longer higher than wide, paralleling the distal margin of diverticulum 3 (Fig. 64). Much of vesica covered with minute inward projecting triangular teeth, proximal teeth on diverticulum 8 bordering the right flank of the aedeagus hood larger, sclerotized, some with the sclerotization fused together into a narrow triangular plate (Fig. 62).

Female genitalia (n=1) (Figs 86–96): Papillae analis (Figs 87, 89, & 96): Transparent except for a broad band of light dorsal sclerotization on each papillus. Longest setae at base, projecting posterior/outward. Shorter setae throughout papillae project posterior/outward or perpendicular. Apices and medial area densely covered with short setae (shorter than width of papillus) in addition to less dense longer setae of variable lengths. Papillae curved such that dorsal side strongly convex, ventral side convex proximally and distally, strongly concave medially, apex broadly rounded. Papillae of similar width throughout most of length, widest proximally and subapically and weakly constricted medially, progressively tapering apically. Intersegmental membrane between papillae and segment 8 (Fig. 87): Narrowing anterior to posterior, anterior end approximately 1.4 times width of anterior end.

Length/width at anterior end = 1.5. Segment A8 (Fig. 87): Ventrally extending well posterior of lamella antevaginalis (only slightly overlapping on anterior side), shape as shown in Fig. 87; dense, elongate, posteriorly projecting setae encircling A8 posterior margin and much of dorsal and lateral sides, absent in area of ventral midline; thin heavily sclerotized U-shaped band connecting posterior margins of plates on ventral side. Intersegmental membrane between lamella and segment 8 on ventral side (Fig. 87): Slightly curved (concave), moderately sclerotized and with minute spiculations (Fig. 91), posterior end of sclerotization broader with convex sides, anterior end tubular and narrower with straighter sides. Lamella antevaginalis (LAV) (Fig. 87): Posterior margin broadly convex; anterior margin convex on inner side, slightly concave on outer side, roughly perpendicular to the midline. Slit in LAV along ventral midline with an ovuloid expansion throughout its length; sides sclerotized and thickened anteriorly. Antrum (Fig. 87): Sclerotized throughout except a small area around juncture with corpus bursae. Sides fairly straight to weakly convex, widest and most convex at anterior end of slit in LAV. Ductus bursae (Fig. 87): Rectangular and strongly dorso-ventrally flattened with a sclerotized plate on each side, posterior approximately 2/3 strongly curved ventrally, anterior approximately 1/3 twisted about 90 degrees to left of ventral. Corpus bursae (Fig. 87): Posterior section with longitudinal wrinkles, elongate, about 4 times as long as wide at anterior base (ventral aspect), sides convex, widening anterior to posterior. Anterior section densely covered with minute inverted teeth, globular and nearly spherical. Ductus seminalis (Fig. 92): Total length approximately 12 mm if straightened out. Coiled basal section about 3.5 mm straightened out,with about five coils. Distal section about 8.5 mm, oblong bulla seminalis about 1.7mm. Collaterial gland complex ((Figs 87, 89 & 96) 86, 88, & 90): Terminology follows Mitter (1987). Adjoining differentiated canals of receptacle duct with one coil basal to the vesicle; abrupt transition to undifferentiated section in basal third of vesicle; vesicle unsclerotized, expanded relative to preceding coil, singly curved (Fig. 90). Utriculus and lagena elongate (Fig. 86), utriculus with many narrow longitudinal grooves throughout. Collaterial gland elongate and tubular, gradually widening basal to distal and then slightly widening into a two pronged sack from which the paired glands arise (Fig. 88). Oviductus communalis as shown in Fig. 86, typical of *Catocala nupta* complex. Vagina globular, almost spherical (Fig. 86).

COI 5' Mitochondrial DNA: the *C. benedeki* holotype has the following sequence for COI 5' positions 1–658; a single position was polymorphic among six sequenced specimens: 88(C&T).

AACTTTATATTTTATTTTTGGAATTTGAGCAGGAATAGTAGGAACTTCATTAAGATTATTAATTCGAGCT
GAATTAGGTAATCCTGGCTCTTTAATTGGAGATGATCAAATTTATAATACTATTGTTACAGCTCATGCTTT
TATTATAATTTTTTTTTATAGTTATACCAATTATAATCGGAGGATTTGGTAATTGATTAGTACCTTTAATATT
AGGAGCTCCTGATATAGCTTTTCCTCGTATAAATAATATAAGTTTTTGACTTCTACCCCCCTCATTAACTT
TATTAATTTCAAGAAGAATTGTAGAAAATGGAGCAGGAACTGGATGAACAGTTTATCCCCCTCTTTCTT
CTAACATTGCTCATAGAGGTAGTTCAGTAGATTTAGCTATTTTTTCCCTACATTTAGCTGGAATTTCTTC
AATTTTAGGAGCTATTAATTTTATTACTACAATTATCAATATACGATTAAATAATTTAATATTTGATCAAAT
ACCTTTATTTATTTGAGCTGTTGGAATTACTGCATTTCTTCTTCTTTCTCTACCAGTATTAGCTGGAG
CTATTACTATACTTCTAACTGATCGAAATTTAAATACTTCCTTTTTTGATCCTGCTGGAGGAGGAGATCC
TATTTTATATCAACATTTATTT.

Biology and distribution. The larval host of *C. benedeki* is unknown, but related species whose host plant usages are documented all feed on various Salicaceae. The new species is found in the Karakoram Mountains, where willow and poplar thickets occur along watercourses up to 3000 m (Bessarabov & Allan 2017). Abbas *et al.* (2014) reported *Salix alba* L. and *Salix denticulata* Bayoow from the Haramosh Valley in Central Karakoram National Park, which is located approximately 25 km from where the holotype of *C. benedeki* was collected. We note that Hampson (1913: 87) tabulates *C. concubia* specimens at the NHM from "Murree (Harford), 2♂, 2♀" (now in Kashmir). We show one of these specimens (Fig. 5, collected 1887, Murree Hills, ex. Harford collection) which matches *C. benedeki* in wing pattern.

Etymology. *Catocala benedeki* is named for Balázs Benedek who collected most of the type series during four trips to Kashmir.

Nomenclature of the *Catocala nupta* complex

The identity of *C. nupta*, pivotal to the genus, had been considered settled since the early 1800s despite the fact that

typification occurred only recently. Mikkola and Honey (1993: 141) located two suitable syntypes in the Linnaean collection, and selected a female from Germany collected by Schreber as lectotype (Fig. 33; see http://linnean-online.org/insects.html). They also suggested the remaining unlabeled male paralectotype (collected by Brander) could be from North Africa i.e., "Barbaria" as stated in the original description. "Barbaria" is an unusual locality for *C. nupta* given that among red-hindwing Salicaceae feeders only *Catocala elocata* Esper, 1787 and *Catocala oberthuri* Austat, 1879 have otherwise been recorded from what is present day Morocco, Algeria, and Tunisia (see reviews by Oberthur 1918, Rothschild 1920, Rungs 1981; Arahou 2008). The number of original *C. nupta* types was not indicated, and Linnaeus' "Barbaria" might suggest a specimen or label attribution error, or even a mixed-taxon type series. Fortunately, Mikkola and Honey anchored *C. nupta* to prevailing usage and limited the type locality.

We are aware of 34 names that have been tabulated in the synonymy of *C. nupta*, only four of which were described originally as full species: *Catocala concubina* Borkhausen, 1792, *Catocala unicuba* Walker, [1858], *C. concubia*, and *Catocala nozawae* Matsumura, 1911. The location of Borkhausen's types and collection remain unknown (Stafleu & Cowan 1976), but we consider that *C. concubina* has been appropriately treated as a synonym of *C. nupta* (both were illustrated by Hubner [1803]: pl. 69, figs 329, 330; see also Godart 1837, Herrich-Schaffer 1845, Guenée 1852, Staudinger & Wocke 1861). Walker's holotype of *C. unicuba* (Fig. 14) falls within the normal range of variation of *C. nupta*, and *C. unicuba* has been appropriately treated as a synonym of *C. nupta* (see Hampson 1894, Poole 1989, Kononenko 2010). Walker's holotype of *C. concubia* (Fig. 13) represents a species separable from *C. nupta*, as discussed above. Matsumura's (1911: 89, Pl. XXXVII, Fig. 1) illustration and English description of *C. nozawae* are both consistent with *C. nupta*, although Matsumura noted the hindwing was not red but "yellowish white" and that "it resembles somewhat to *Catocala lara* Butl. [sic] but much smaller and the markings quite others." At the SEHU is a single male labeled by Matsumura as type of *C. nozawae* (Fig. 37). This specimen has whitish hindwings that appear to be albinic and/or faded from exposure to light, consistent with comparison having been made to the larger *C. lara* Bremer, 1861 (which does have a yellowish-white hindwing band). It also bears a lectotype label dated 1977 by Sugi. It is known that Sugi affixed lectotype labels to Matsumura lepidopteran types but did not publish designations (M. Owada, in litt. 2017), and we have been unable to locate a publication in which Sugi designated a lectotype for *C. nozawae*. The Japanese segment of the original description states "body length 1 sun [=30 mm], expanse 1 sun 4 bu [=42 mm]. This was collected by Mr. Shunjiro Nozawa in the Sapporo area in Meiji-23-year [=1890], seemed to be very rare." In addition, the entry for *C. nupta nozawae* in Sugi (1959: 142) states "the subspecific name *nozawae*, which was given to an abnormal individual with whitish underwings instead of red, is nomenclaturally available, and *japonica* Mell, named to a normal form, is a junior synonym of it." All the above evidence suggests that *C. nozawae* was described from only one specimen, and we therefore consider the SEHU male to be the holotype by monotypy. *Catocala nozawae* has recently been treated as a synonym (e.g., Poole 1989, Kononenko 2010) or subspecies (e.g., Goater *et al.* 2003) of *C. nupta*, and since the *C. nozawae* holotype is an otherwise typical specimen of *C. nupta*, we hereby reaffirm *Catocala nozawae* **syn. rev.** as a synonym of *C. nupta*.

The other 30 names in the synonymy of *C. nupta* were described in infraspecific contexts. Thirteen are explicitly infrasubspecific aberrations: "flava" Schultz, 1906, "mutilata" Schultz, 1906, "dilutior" Schultz, 1909, "fida" Schultz, 1909, "alterata" Warren, 1913, "brunnescens" Warren ,1913, "languescens" Warren, 1913, "rubridens" Warren, 1913, "xanthophaea" Schawerda, 1925, "salmonea" Cokayne, 1946, "quasiinterrupta" Schnaider, 1949, and "nigra" Cockayne, 1951 (the infrasubspecific "nigrata" Lempke, 1966 is an unnecessary replacement for the infrasubspecific "nigra" Cokayne, 1951, nec "nigra" Lempke, 1949). Another 8 form names (e.g., "f. n.") are clearly infrasubspecific based on analysis of the original descriptions: "guiartii" Lambillion ,1905, "confusa" Oberthur, 1912, "grisescens" Hanneman, 1917, "nigrescens" Hanneman, 1917, "victoria" Woskressensky, 1927, "nigra" Lempke, 1949, "sanguinea" Lempke, 1949, and "variegata" Lempke, 1949.

The two varietal names *Catocala nupta* var. *obscurata* Oberthur, 1880 and *Catocala nupta* v. *nuptialis* Staudinger, 1901 have been treated as available since geographical context appears in their original descriptions. The holotype of *C. nupta* var. *obscurata*, **syn. nov.** (Fig. 32) at the NHM is a melanized but otherwise typical specimen of *C. nupta* (melanics occasionally occur throughout the species' geographic range), and the lectotype of *C. nupta* var. *nuptialis*, **syn. nov.** (Fig. 23) designated by Ishizuka (2015: 100) at the MNHU is a typical specimen of *C. nupta*. The name *nuptialis* Staudinger 1901 is preoccupied by the Nearctic species *Catocala nuptialis* Walker, [1858], with the replacement name for *nuptialis* Staudinger, 1901 being *centrasiatica* Kusnezov, 1903 (the name

ottostaudingeri Ishizuka, 2015 is a subsequent and hence unnecessary replacement name for *nuptialis* Staudinger, 1901). The name *centrasiatica* Kusnezov **syn. nov.** is thus a synonym of *C. nupta.*

The remaining five names in the *Catocala nupta* synonymy were described as subspecies: *Catocala nupta* ssp. *kansuensis* Bang-Haas, 1927, *Catocala nupta* ssp. *clara* Osthelder, 1933, *Catocala nupta* ssp. *japonica* Mell, 1936, *Catocala nupta* ssp. *likiangensis* Mell, 1936, and *Catocala nupta* ssp. *alticola* Mell, 1942. The lectotype of *C. nupta* ssp. *kansuensis* **syn. nov.** (Fig. 26) designated by Ishizuka (2010: 105) at the MNHU is a typical specimen of *C. nupta*. The holotype of *C. nupta* ssp. *japonica* **syn. nov.** (Fig. 35) is also at the MNHU, and is a small but otherwise typical specimen of *C. nupta*. The original description for *C. nupta* ssp. *clara* states "M[arasch und Umgebung] VIII. [19]30 einige leidlich frische Stücke" [="Marasch and environment. August 1930 Some tolerably fresh specimens"], and to clarify application of the name, we hereby designate a male at the ZSM as LECTOTYPE for *C. nupta* ssp. *clara* (Fig. 29). The type locality is hereby restricted to the Taurus Mountains near Kahramanmaras (formerly Marash) in south central Turkey on the basis of the lectotype labels (="Syr. sept./Taurus/ Marasch"). The lectotype of *C. nupta* ssp. *clara* **syn. nov.** is a typical specimen of *C. nupta*. Examination of the types for *C. nupta* ssp. *likiangensis* and *C. nupta* ssp. *alticola* demonstrates these to be specimens of *C. concubia*, not *C. nupta* (Mell stated that his *likiangensis* and *alticola* were larger than *C. nupta*, which is consistent with the size difference between *C. nupta* and *C. concubia*). The original description for *C. nupta* ssp. *likiangensis* lists 27 specimens, and to clarify application of the name, we hereby designate a male at the ZFMK as LECTOTYPE for *C. nupta* ssp. *likiangensis* (Fig. 17). The type locality is hereby restricted to Lijiang (=Likiang), Yunnan Province, China, on the basis of the lectotype labels ("Li-kiang ca. 2000m/Prov. Nord-Yuennan"). The name *C. nupta* ssp. *likiangensis* **syn. nov.** is a synonym of *C. concubia*. The original description for *C. nupta* ssp. *alticola* lists several localities but does not enumerate specimens. Mell stated that *C. nupta* ssp. *alticola* had slightly more white on the hindwing than *C. nupta* ssp. *likangensis*, but this falls within the normal range of variation in *C. concubia*. To clarify application of the name, we hereby designate a male at the ZFMK as LECOTYPE for *C. nupta* ssp. *alticola* (Fig. 15). The type locality is hereby restricted to the Jinsha River valley, Batang, Sichuan Province, China on the basis of the lectotype labels ("Batang. (Tibet). Im Tal/des Yangtze (ca. 2800 m)" [=in valley of Yangtse]; Jinsha River is the name of the upper stretches of the Yangtze River). The name *C. nupta* ssp. *alticola* **syn. nov.** is a synonym of *C. concubia*.

Both *C. szechuena* and *C. amnonfreidbergi* were described as species, and have not previously been placed in synonymy. The name *C. szecheuna* appears not to have been analyzed: Mell (1936: 71) devotes one terse sentence to it in his otherwise detailed study of the Asian *Catocala* fauna, Goater *et al.* (2003: 83) simply include it in their checklist of Palearctic species, and the name is absent in Kononenko (2010) and Ishizuka (2011). Hampson's description of *C. szechuena* states it has "a narrow black medial band," in contrast to *C. concubia* which has "an obliquely curved medial black band from costa to vein 1, expanding towards costa and its outer edge excurved at vein 5." We have found the width of the black medial band to be quite variable within *C. nupta* and related taxa. The holotype of *C. szechuena* (Fig. 19) is at the NHM. The medial band of the *C. szechuena* holotype represents the narrowest end of continuous variation exhibited by *C. concubia,* and we place the name *C. szechuena* **syn. nov.** as a synonym of *C. concubia*.

Catocala amnonfreidbergi was described as a distinct species on the basis of a single male specimen from Israel, and was diagnosed as separable by having the "finger of left valva much longer than in *C. nupta*; black band of hindwing less angled, more curved." The genitalia of the holotype (illustrated in Kravchenko *et al.* 2008) are within the normal range of genitalic variation that we have found in our dissections of *C. nupta,* and the hindwing band is similarly typical of *C. nupta.* Hence we place the name *C. amnonfreidbergi* **syn. nov.** as a synonym of *C. nupta.* Kravchenko *et al*. (2008) also observed that the "Japanese taxon (*C. nozawae* = *C. japonica*) is very unusual as the left valva is without a sclerotised costa and finger, whereas the right valva has a sclerotised costa with a short finger," and suggested this might represent a character of species-level distinction. Our male *C. nupta* dissections from Japan have a sclerotized left costal extension that is longer than the right, and this holds for our *C. nupta* dissections from other geographic locations. In this regard, we note that sometimes the left costal extension can be broken off (for example, if specimens were placed in envelopes when the apex of the male genitalic capsule was protruding) and such specimens can misleadingly appear to lack an extension of the left costa.

Checklist of the *Catocala nupta* complex:

Catocala benedeki Borth, Kons, Saldaitis & Gall, 2017
Catocala concubia Walker, [1858] **stat. rev.**
=*szechuena* Hampson, 1913 **syn. n.**
=*nupta likiangensis* Mell, 1936 **syn. n.**
=*nupta alticola* Mell, 1942 **syn. n.**
Catocala nupta (Linnaeus, 1767)
=*concubina* Borkhausen, 1792
=*unicuba* Walker, [1858]
=*nupta obscurata* Oberthür, 1880 **syn. n.**
=*nupta nuptialis* Staudinger, 1901 **syn. n.** (preocc. by *nuptialis* Walker, [1858])
=*nupta centrasiatica* Kusnezov, 1903 **syn. n.** (nom. nov. for *nuptialis* Staudinger, 1901)
=*nozawae* Matsumura, 1911 **syn rev.**
=*nupta kansuensis* Bang-Haas, 1927 **syn. n.**
=*nupta clara* Osthelder, 1933 **syn. n.**
=*japonica* Mell, 1936 **syn. n.**
=*amnonfreidbergi* Kramvchenko *et al.*, 2008 **syn. n.**
=*ottostaudingeri* Ishizuka, 2015 (unnecessary nom. nov. for *nuptialis* Staudinger, 1901)

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APPENDIX 1: Data for *Catocala concubia* and *C. nupta* sequence and dissection vouchers

Species name	Sample ID	Dissection No. HLK:	Country	State/ Province	Collection Date	Lat	Lon	Elev (m)	Collector	Collection	COI-5P base pr.
C. concubia	2121-Yale	2121 (male)	China	Sichuan	10-Jul-2013	31	98	3600		NRCV	658[0n]
C. concubia	2122-Yale	2122 (female	China	Sichuan	10-Jul-2013	31	98	3600		NRCV	658[0n]
C. concubia	8000-050802-CH		China	Yunnan	5-Aug-2002	25.7	101.6	2000	A. Floriani	RJB	658[0n]
C. concubia	20432-COI-14	2047 (male)	China	Yunnan	19-Jun-2009	28	99.7	3356	B. Benedek	RJB	658[0n]
C. concubia	8067-280700-TI		China	Tibet	28-Jul-2000	29.02	89.258	3800	D. Bruna	NRCV	307[0n]
C. nupta	Non DNA Voucher	951 (female)	Russia		14-Aug-2003	55.1	61.4	256		RJB	N/A
C. nupta	2332-120706-SL		Slovakia		12-Jul-2006	47.97	18.106	109	L. Misko	RJB	658[0n]
C. nupta	Non DNA Voucher	1555 (female	Lithuania		2003				V. Pacevicius	RJB	N/A
C. nupta	20394-150913-KY		Kyrgyzstan		15-Sep-2013	42.1	77.6	1700	S. Toropov	NRCV	658[0n]
C. nupta	20019-050812-KY		Kyrgyzstan		05-Aug-2012	42.74	77.67	1632	S. Toropov	NRCV	658[0n]
C. nupta	8001-062408-RU	2097 (male)	Russia	Chelyabinsk	24-Jun-2008	55.2	61.4	2100		RJB	658[0n]
C. nupta	20439-280814-CH		China		28-Aug-2014	31.8	103.73	1600	Floriani & Saldaiti	AFM	658[0n]
C. nupta	9564-150807-CH	2062 (male)	China	Shaanxi	15-Aug-2007	33.9	109.1	1600	D. Nilsson	RJB	658[0n]
C. nupta	8003-150807-CH		China	Shaanxi	15-Aug-2007	33.9	109.1	1600	D. Nilsson	RJB	658[0n]
C. nupta	8002-150807-CH	714 (male)	China	Shaanxi	15-Aug-2007	33.9	109.1	1600	D. Nilsson	RJB	658[0n]
C. nupta	10250-240911-CH		China	Sichuan	24-Sep-2011	33.32	103.93	2100	A. Floriani	AFM	658[0n]
C. nupta	8071-210807-CH		China		21-Aug-2007	25	102	3400	S. Murzin	RJB	658[0n]
C. nupta	8005-150704-RU		Russia	Primorsky Krai	15-Jul-2004	43.2	131.5	170	Aniskovich	RJB	658[0n]
C. nupta	5625-250702-RU		Russia	Primorsky Krai	25-Jul-2002	45	134	170	Aniskovich	RJB	658[0n]
C. nupta	8004-160502-RU		Russia	Primorsky Krai	16-May-2002	44.82	131.9	180	K. Kolesnichenko	RJB	658[0n]
C. nupta	9218-190798-JA	2096 (male)	Japan		19-Jul-1998	36.2	137.97	594	Takamura	RJB	658[0n]
C. nupta	9219-190798-JA		Japan		19-Jul-1998	36.2	137.97	594	Takamura	RJB	658[0n]
C. nupta	TLMF Lep 09855		Austria	Vorarlberg	26-Sep-10	47.27	9.64	468			658[0n]
C. nupta	MM04216		Finland	Aland Islands	07-Oct-2006	59.96	20.012	0	M. Mutanen		658[0n]
C. nupta	MM04750		Finland	Finland Proper		60.44	22.202	15	M. Mutanen		658[0n]
C. nupta	MM15851		Finland			60.41	26.819	0	M. Mutanen et. al.		658[0n]
C. nupta	BC ZSM Lep 29037		Germany	Bavaria	14-Aug-2001	47.9	12.851	440	A. Haslberger	ZSM	613[0n]
C. nupta	BC ZSM Lep 78585		Germany	Bavaria	15-Sep-2013	48.26	11.545	481	A. Hausmann	ZSM	658[0n]
C. nupta	BC ZSM Lep R 21673		Germany	Bavaria	13-Aug-1983			450	F. Stamer	ZSM	658[0n]
C. nupta	BC ZSM Lep 80284		Germany	Schleswig-Holste	05-Sep-1995	54.3	10.433	34	Dr. D. Kolligs	ZSM	658[0n]
C. nupta	BC ZSM Lep 64832		Germany	Sachsen		51.16	13.2	250	M. Franzen	ZSM	658[0n]
C. nupta	BC ZSM Lep 72632		Germany	Saarland	07-Sep-2012	49.19	7.0581	321	H. Martin	ZSM	658[0n]
C. nupta	BC ZSM Lep 64831		Germany	Sachsen		51.16	13.2	250	M. Franzen	ZSM	658[0n]
C. nupta	BC ZSM Lep 75217		Germany	Sachsen	18-Sep-2012	50.83	12.983	371	S. Erlacher et al.	ZSM	658[0n]
C. nupta	BC ZSM Lep 70164		Germany	Bavaria	17-Jul-2012	48.15	11.334	480	A. Hausmann	ZSM	658[0n]
C. nupta	BC ZSM Lep 21863		Germany	Bavaria	05-Sep-1996	48.26	11.545	480	A. Hausmann	ZSM	658[0n]