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Revision of *Pazala* Moore, 1888: The *Graphium* (*Pazala*) *mandarinus* (Oberthür, 1879) Group, with Treatments of Known Taxa and Descriptions of New Species and New Subspecies (Lepidoptera: Papilionidae)

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Table of contents

Abstract

The previously recognised closely related species *Graphium* (*Pazala*) *mandarinus* (Oberthür, 1879) and *G.* (*P.*) *sichuanica* (Koiwaya, 1993) are shown to comprise seven species as a result of both molecular and morphological analysis. Molecular dating analysis is also performed on the *mandarinus* group in order to investigate the divergence time of the taxa. Two

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taxa, *G.* (*P.*) *garhwalica* (Katayama, 1988) stat. nov. and *G.* (*P.*) *paphus* (de Nicéville, 1886) stat. nov., are raised from subspecific to specific status; *G.* (*P.*) *hoeneanus* Cotton & Hu nom. nov., stat. rev. is separated from *sichuanica* at species level; and two previously unrecognised new species, *G.* (*P.*) *daiyuanae* Hu, Zhang & Cotton **sp. nov.** and *G.* (*P.*) *confucius* Hu, Duan & Cotton **sp. nov.** are described from Vietnam and China respectively, the latter being sympatric with nominate *G.* (*P.*) *mandarinus*. The identity of the lectotype of *G.* (*P.*) *mandarinus* is confirmed and a lectotype is designated for the taxon *Papilio Glycerion* Gray, 1831. A new subspecies of *G.* (*P.*) *mandarinus* is described from western Yunnan and northern Myanmar, *G.* (*P.*) *mandarinus stilwelli* Cotton & Hu ssp. nov.

Key words: Leptocircini, *Pazala*, new species, India, China, Vietnam

Introduction

The genus *Graphium* Scopoli, 1777 (Papilionidae: Leptocircini) includes a number of species groups found in Asia, Australasia and Africa, and has relatives in Europe (genus *Iphiclides* Hübner, [1819]), Australia (genus *Protographium* Munroe, 1961) and the Americas (genus *Eurytides* Hübner, [1821]). Very few studies have been published on the genus as a whole in recent times, with major works dating from the 1980s. For instance, Saigusa *et al.* (1982) only studied the Asian species in subgenus *Graphium*, Hancock (1983) treated the genus as comprising 89 species in 4 subgenera, and Miller (1987) also recognised 4 subgenera without lower classification. This study concentrates on a single subgenus within the genus, and will be split into at least two parts.

The swordtail subgenus *Pazala* Moore, 1888 is a small group of Asian butterflies considered to comprise seven species enumerated by Racheli & Cotton (2009) as *eurous* (Leech, 1893), *mandarinus* (Oberthür, 1879), *sichuanica* (Koiwaya, 1993), *mullah* (Alphéraky, 1897), *alebion* (Gray, [1853]), *tamerlanus* (Oberthür, 1876) and *parus* (de Nicéville, 1900). Among these species, *G.* (*P.*) *mandarinus* (Oberthür, 1879) has the widest distribution range from N.W. India to C. China as well as N. Indochina (Racheli & Cotton 2009). Five subspecies have been recognised in *G.* (*P.*) *mandarinus* over the last 137 years, three of which were described in the 1980s (de Nicéville 1886; Murayama 1982; Okano 1986; Katayama 1988). Koiwaya (1993) described an allied species, *G.* (*P.*) *sichuanica*, from W. China based on differences of wing pattern and genitalic structures. Apart from its distinguishing characters, *G.* (*P.*) *sichuanica* shares a unique character with *G.* (*P.*) *mandarinus* — the two discal black bands on the hindwing underside twisted into an "8"-shaped pattern with a short line between the two rings, resembling a pair of glasses in appearance. Based on this shared character and the similarity of other morphological characters as well as genitalic structures, the authors use the term '*mandarinus* group' to represent these taxa in the present study.

G. (*P.*) *mandarinus* is a variable species, with the identity of some populations previously uncertain (Cotton & Racheli 2007; Racheli & Cotton 2009). During DNA barcoding research on Chinese swallowtail butterflies in 2011, the authors of this study encountered a very strange anomaly, namely the samples of *G.* (*P.*) *mandarinus* from a single locality in W. Sichuan split into two clades in the phylogenetic tree, implying that a cryptic species might be present in the samples. However, all co-authors were unable to draw any conclusions due to morphological similarity and limited samples available at that time. Subsequently in 2015, two specimens which appeared to be *G.* (*P.*) *mandarinus* collected from Sapa, N. Vietnam were flagged as a distinct species by DNA barcoding analysis, different from both *G.* (*P.*) *mandarinus* and the previously unidentified taxon. As a result, we decided to re-examine specimens in collections while obtaining more samples from different localities, in an attempt to form a better understanding of the *mandarinus* group.

After examining a long series of specimens across the distribution range of the *mandarinus* group with associated molecular data, seven species are now recognised within this group, including two new species and three previously recognised taxa elevated to specific status, one of which requires a new name. The name *G.* (*P.*) *mandarinus* (Oberthür, 1879) is assigned to the correct species after examining the lectotype specimen in the BMNH (Natural History Museum, London) collection and a lectotype is designated for a historically problematic taxon. The westernmost population of the true *G.* (*P.*) *mandarinus* is described as a new subspecies. The findings, a revision of the *mandarinus* group with descriptions of new taxa and a replacement name, are presented in this study.

Materials and methods

Taxon sampling. A large number of specimens of all taxa in the *mandarinus* group were examined and sampled from the authors' private collections, other private collections and specimen depositories of academic institutions, with permission. All the extensive material of *mandarinus* group taxa examined, including type material, together with the names and abbreviations of depositories, is documented in Appendix 1 at the end of this work. Subspecific designations for *Pazala* species followed Racheli & Cotton (2009). Sixty-two specimens of *mandarinus* group taxa were used in molecular analysis and the GenBank accession numbers are listed in Table 1. Since this research focuses on the *mandarinus* group, only the nominotypical subspecies of the other previously recognised *Pazala* species were included in the present study, and specimens of these taxa are not listed in Appendix 1.

TABLE 1. Specimens used in molecular analysis with GenBank accession numbers, accession numbers shared between samples with the same *cox1* sequence.

Taxon (sample code)	Locality	Accession No.
G. (*P.*) *garhwalica* (UT1)	Joshimath, Uttaranchal, India	MG197758
G. (*P.*) *paphus* (MT1–5)	Metok, Tibet, China	MG197757
G. (*P.*) *sichuanica* (LHG1–3)	Laohegou, Sichuan, China	MG197767
G. (*P.*) *sichuanica* (TJH1)	Tangjiahe, Sichuan, China	MG197768
G. (*P.*) *sichuanica* (TJH2)	Tangjiahe, Sichuan, China	MG197767
G. (*P.*) *hoeneanus* (ZY1)	Ziyuan, Guangxi, China	MG197762
G. (*P.*) *hoeneanus* (ZY2)	Ziyuan, Guangxi, China	MG197763
G. (*P.*) *hoeneanus* (LG1)	Lingui, Guangxi, China	MG197764
G. (*P.*) *hoeneanus* (LG2)	Lingui, Guangxi, China	MG197765
G. (*P.*) *hoeneanus* (LG3)	Lingui, Guangxi, China	MG197766
G. (*P.*) *hoeneanus* (TMS1)	W. Tianmu Shan, Zhejiang, China	MG197759
G. (*P.*) *hoeneanus* (TMS2)	W. Tianmu Shan, Zhejiang, China	MG197760
G. (*P.*) *hoeneanus* (TMS3)	W. Tianmu Shan, Zhejiang, China	MG197761
G. (*P.*) *daiyuanae* (SP1–4)	Sapa, Lao Cai, Vietnam	MG197773
G. (*P.*) *daiyuanae* (SP5)	Sapa, Lao Cai, Vietnam	MG197774
G. (*P.*) *daiyuanae* (SP6)	Sapa, Lao Cai, Vietnam	MG197775
G. (*P.*) *confucius* (HY1)	Hanyuan, Sichuan, China	MG197770
G. (*P.*) *confucius* (EB1)	Ebian, Sichuan, China	MG197770
G. (*P.*) *confucius* (BX1–2)	Baoxing, Sichuan, China	MG197769
G. (*P.*) *confucius* (DC1, DC3)	Dongchuan, Yunnan, China	MG197771
G. (*P.*) *confucius* (DC2)	Dongchuan, Yunnan, China	MG197772
G. (*P.*) *confucius* (KM1–3)	Kunming, Yunnan, China	MG197771
G. (*P.*) *mandarinus kimurai* (CM1)	Doi Inthanon, Chiang Mai, Thailand	MG197752
G. (*P.*) *mandarinus kimurai* (CM2–4)	Doi Inthanon, Chiang Mai, Thailand	MG197753
G. (*P.*) *mandarinus kimurai* (CM5)	Doi Inthanon, Chiang Mai, Thailand	MG197754
G. (*P.*) *mandarinus fangana* (CM1–3)	Doi Pu Meun, Chiang Mai, Thailand	MG197751
G. (*P.*) *mandarinus stilwelli* (WX1)	Weixi, Yunnan, China	MG197755
G. (*P.*) *mandarinus stilwelli* (YX1)	Yunxian, Yunnan, China	MG197755
G. (*P.*) *mandarinus stilwelli* (TC1–2)	Tengchong, Yunnan, China	MG197755
G. (*P.*) *mandarinus stilwelli* (YB1–2)	Yangbi, Yunnan, China	MG197755
G. (*P.*) *mandarinus stilwelli* (SG1)	Tarung Hka River, Sagaing, Myanmar	MG197755
G. (*P.*) *mandarinus stilwelli* (KC1)	Chudu Razi Hills, Kachin, Maynmar	MG197755
G. (*P.*) *mandarinus mandarinus* (BX1–4)	Baoxing, Sichuan, China	MG197749
G. (*P.*) *mandarinus mandarinus* (BX5)	Baoxing, Sichuan, China	MG197750

Morphological comparison

Specimens were spread for examination, with the scent scales on their hindwings exposed.

Spread specimens were photographed using a Fujifilm S8600 digital camera (Fujifilm, Japan) with medium grey background. Photos were adjusted using Adobe Photoshop CS (Adobe, USA). Diagnostic characters of the new taxa were also denoted using Adobe Photoshop CS. For comparison between taxa, the lengths of forewing were measured to 0.5 mm precision. Average lengths of forewing were calculated, and the standard deviations were also calculated when $n \geq 3$.

To observe the male and female genitalia, the abdomen was taken from the specimen and placed into a 1.5 mL microcentrifuge tube, and 1 mL water was added to the abdomen to rehydrate the tissue at 50 °C for 30 min, then 1 mL 10% sodium hydroxide solution was used to digest soft tissue at 70 °C for 1 h. The treated abdomen was neutralised with 2% acetic acid and then dissected in a water-filled Petri dish under the stereoscope to remove residual tissues, scales, and hair. The genitalia were then transferred to 80% glycerol for 12 h to render them transparent. Photographs were taken with a Nikon DMX1200 digital camera (Nikon, Japan) mounted on a Nikon SMZ1500 stereoscope (Nikon, Japan) and automatically stacked using Helicon Focus 3.2 (Helicon Software, USA). The distance between socii of male genitalia is a useful morphometric character helpful to distinguish species (Koiwaya 1993); therefore this distance was measured to 0.2 mm precision for all dissected male genitalia. Similarly, average distances between socii were calculated, and standard deviation was also calculated when $n \geq 3$. After observation and photography, all parts of the genitalia were fixed on a glue card and pinned with the specimen.

Molecular phylogenetic analyses

For each specimen, one or two legs (except forelegs) on the same side were extracted, homogenised in protease buffer containing 100 μL STE (10 mmol/L Tris-HCl, 1 mmol/L EDTA, 100 mmol/L NaCl, pH = 8.0) and 2 μL Proteinase K (20 mg/mL) (O'Neill *et al.* 1992). Homogenised samples were treated at 37 °C incubation for 15 min to rehydrate the tissue and then at 95 °C incubation for 10 min to lyse the tissue. The supernatant was recovered through centrifugation at 6,000*g* and used directly as DNA template in polymerase chain reactions (PCR).

The PCR reaction was applied in a 25 μL system by using TaKaRa Ex *Taq* Kit (TaKaRa Biotechnology Co., Ltd., Dalian, China) which contained 2.5 μL of 10× PCR buffer, 2.0 μL of $MgCl_2$ (25 mmol/L), 2.0 μL of dNTP mixture (2.5 mmol/L each), 0.25 μL of *Taq* DNA polymerase (5 U/μL), and 0.5 μL of each of forward and reverse primers (20 μmol/L). Primers LCO1490 (5'- GGT CAA CAA ATC ATA AAG ATA TTG G-3') and HCO2198 (5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3') (*cox1*; Folmer *et al.* 1994) were used. The thermal profile of PCR consisted of an initial denaturation at 95 °C for 3 min; 30 cycles of denaturation at 94 °C for 1 min, annealing at 50 °C for 1 min, and elongation at 72 °C for 1 min; then a final elongation at 72 °C for 5 min. Sequences were obtained by using an ABI Prism 3730 sequencer (Applied Biosystems, California, USA).

Raw sequences were proofread and aligned using Clustal W (Thompson *et al.* 1994) in BioEdit 7.0.9 (Hall 1999), and any sequence containing double peaks in the chromatograms was strictly excluded. The product sequences were checked by MEGABLAST against the genomic references and nucleotide collection in NCBI. Amino acid translation was realised with the invertebrate mitochondrial criterion in MEGA 6.0 (Tamura *et al.* 2013) to detect possible *Numts* (nuclear copies of mtDNA fragments). A search for nonsynonymous mutations, in-frame stop codons, and indels was carried out to further minimise the existence of cryptic *Numts* (Song *et al.* 2008; Bertheau *et al.* 2011). The Kimura two-parameter (K2P) distances (Kimura 1980) between identified taxa were calculated by MEGA 6.0.

The phylogeny was reconstructed using Bayesian Inference (BI) method as implemented in MrBayes 3.2.6 (Ronquist *et al.* 2012), with the most appropriate nucleotide substitution model recovered by jModelTest 0.1 (Guindon & Gascuel 2003; Posada 2008). An individual of *Iphiclides podalirius* (Linnaeus, 1758) and of *Lamproptera meges* (Zinken, 1831) was used as outgroup, because we found that tree topology and node support were improved when using outgroup species which branched before *Pazala* split from the rest of *Graphium*. Initial trees using *Graphium chironides* (Honrath, 1884) as outgroup were poorly resolved. First, we reconstructed the phylogeny for a dataset containing the currently recognised species of *Pazala* (7 in total, subspecies not included) in an attempt to obtain an overall phylogenetic framework for the subgenus. Second, we reconstructed phylogeny for a dataset containing only the currently recognised species and subspecies of the *Graphium mandarinus* group to produce phylogenetic relationships among the focal taxa in the present study. BI analyses consisted of two independent runs, each with four Markov chain Monte Carlo (MCMC) running for 10 million generations (sampled every 1000th generation) to calculate the clade posterior probabilities (PP).

Phyletic properties of each taxon in the *mandarinus* group were assessed using an online tool, Monophylizer (Mutanen *et al*. 2016; http://monophylizer.naturalis.nl/). Taxa identified as monophyletic were treated as good species or subspecies, while those identified as paraphyletic were further analysed using morphological characters and geographical ranges.

To estimate divergence times and infer their credibility intervals, we performed Bayesian relaxed-clock analyses using MrBayes on both datasets (for the *mandarinus* group and for the subgenus *Pazala*). For these analyses, we relied on the partitioning scheme and the substitution models as determined above. MrBayes analyses were performed with the same settings as above but running for 20 million generations with sampling tree every 2,000 generations. We used the autocorrelated clock model for two reasons. First, the autocorrelated model is more appropriate for our dataset because the rate along a given branch is more similar to its parent branch than a branch chosen at random, though autocorrelation models differ in the degree to which they restrict rate variation between parent and daughter branches (Thorne *et al*. 1998; Thorne & Kishino 2002). Second, Lepage *et al*. (2007) and Rehm *et al*. (2011) showed that the autocorrelated clock model generally offers the best fit, as compared to the uncorrelated model and a strict molecular clock model.

Calibration priors are based on the time-calibrated tree of Papilionidae (Condamine *et al*. 2012). We set four secondary calibrations using a (conservative) uniform prior with bounded by the minimum and maximum ages of the 95% credibility interval (CI) of the divergence times (a normal prior is not recommended, Schenk 2016). We could not use fossils in this study because the three fossils do not belong to the subfamily Papilioninae (Condamine *et al*. 2012). We calibrated the following nodes: (i) the root of the tree (crown of Leptocircini) set between 27.6 and 43.4 Ma; (ii) the crown between *Iphiclides* and *Lamproptera* set between 20.8 and 35.5 Ma; (iii) the crown of the genus *Graphium* set between 21.2 and 35.7 Ma; and (iv) the crown of the subgenus *Graphium* set between 14.4 and 29.7 Ma.

For all Bayesian runs (phylogenies and dating), convergence was ensured by checking average deviation of split frequencies (ADSF), potential scale reduction factor (PSRF) values, effective sample size (ESS) of all parameters, and by plotting log-likelihood of samples against number of generations in Tracer 1.6. To reach good convergence, the runs must have values of ADSF approaching zero, PSRF close to 1.00 and ESS above 200. Bayesian consensus trees were obtained using the 25% burn-in criterion (Ronquist *et al*. 2012), and the remaining samples were used to generate a 50% majority rule consensus tree.

All phylogenetic and dating analyses were performed on the computer cluster CIPRES Science Gateway (Miller *et al*. 2015), using BEAGLE (Ayres *et al*. 2012) with default parameters.

Results

Pazala Moore, 1888

Pazala Moore, 1888; Descr. Indian Lep. Ins. Atkinson, Pt. III: 283; TS: *Papilio Glycerion* Gray, 1831.

Non-mimetic without sexual dimorphism. Forewing short, triangular, glossy, and semitransparent in the basal, costal, and apical interspaces, with slightly curved costa, broad and obtuse apex, and slightly concave termen. Forewing creamy white or greyish white, with ten black bands. Hindwing triangular, with long and oblique costa, very oblique and sinuous termen, deeply scalloped tornal area, and long sword-like tails. Tornal area black, marked with three grey-blue crescents, and two connecting yellow spots above the black patch. Male anal scent fold narrow, with sparse long scales at the base, but no scent wool. The ventral lobes of ostium in female genitalia strongly forked, as stated by Miller (1987).

Phylogenetics of subgenus *Pazala* and the *mandarinus* group

The BI phylogenetic tree divided subgenus *Pazala* into four major clades, supported with maximal posterior probability (Figure 1). The first clade to branch off contains *Graphium* (*Pazala*) *alebion*, which is thus sister to all other *Pazala* species. A second clade comprises *G.* (*P.*) *tamerlanus* and *G.* (*P.*) *parus* (as *tamerlanus* group hereafter). The third clade contains *G.* (*P.*) *eurous* and *G.* (*P.*) *mullah* (as *eurous* group hereafter). The fourth clade includes *G.* (*P.*) *mandarinus* and *G.* (*P.*) *sichuanica* (hereafter referred to as the *mandarinus* group).

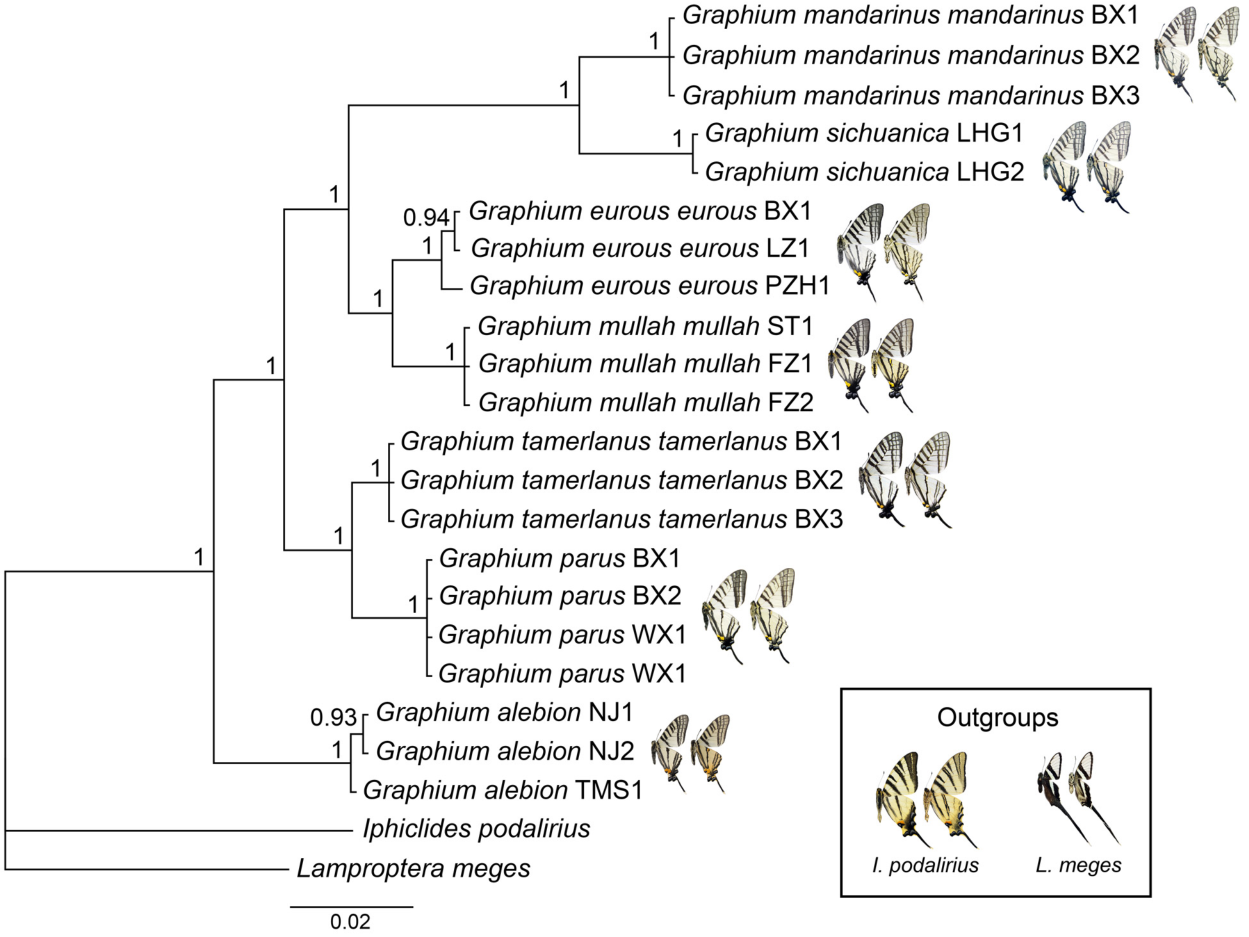

FIGURE 1. The Bayesian phylogenetic tree of subgenus *Pazala* Moore, 1888, with specimen photos (upperside on the left, underside on the right) near the end of each taxon clade. Values at nodes indicate the posterior probability. *Iphiclides podalirius* and *Lamproptera meges* as outgroup (specimen photos in the box at bottom right).

Phylogenetic analyses of the *mandarinus* group showed that species were well defined as monophyletic with high (if not maximal) posterior probabilities (Figure 2). It must be noted that within the *mandarinus* group, *G.* (*P.*) *garhwalica* stat. nov. is found to be sister to all taxa in the group, followed by *G.* (*P.*) *paphus* stat. nov., a further branch containing *G.* (*P.*) *sichuanica* and *G.* (*P.*) *hoeneanus* nom. nov., stat. rev., followed by the pairing of *G.* (*P.*) *daiyuanae* **sp. nov.** and *G.* (*P.*) *confucius* **sp. nov.**, and finally four subspecies of *G.* (*P.*) *mandarinus*. Recently other molecular analyses of Papilionidae have shown similar presence of cryptic species previously only recognised as subspecies, e.g. Shiraiwa *et al.* (2014) separated several *Heraclides* taxa at species level as a result of their studies.

The Monophylizer analysis identified most taxa in the *mandarinus* group as monophyletic except *G.* (*P.*) *mandarinus stilwelli* **ssp. nov.**, which tangled (but not mixed) with *G.* (*P.*) *mandarinus mandarinus* forming a paraphyletic clade in the tree (Table 2). The phylogenetic structure and Monophylizer assessment of the *mandarinus* group indicates four main taxonomic results: (i) *G.* (*P.*) *daiyuanae* **sp. nov.** and *G.* (*P.*) *confucius* **sp. nov.** are both distinct species, differing from each other as well as from other known species; (ii) *G.* (*P.*) *garhwalica* and *G.* (*P.*) *paphus* are both distinctive species, instead of being subspecies of *G.* (*P.*) *mandarinus* as previously recognised; (iii) *G.* (*P.*) *hoeneanus* nom. nov., stat. rev. is different from *G.* (*P.*) *sichuanica* and should be given full species status; and (iv) *G.* (*P.*) *mandarinus stilwelli* **ssp. nov.** is genetically rather close to the nominate subspecies of *G.* (*P.*) *mandarinus*, but is morphologically a good subspecies.

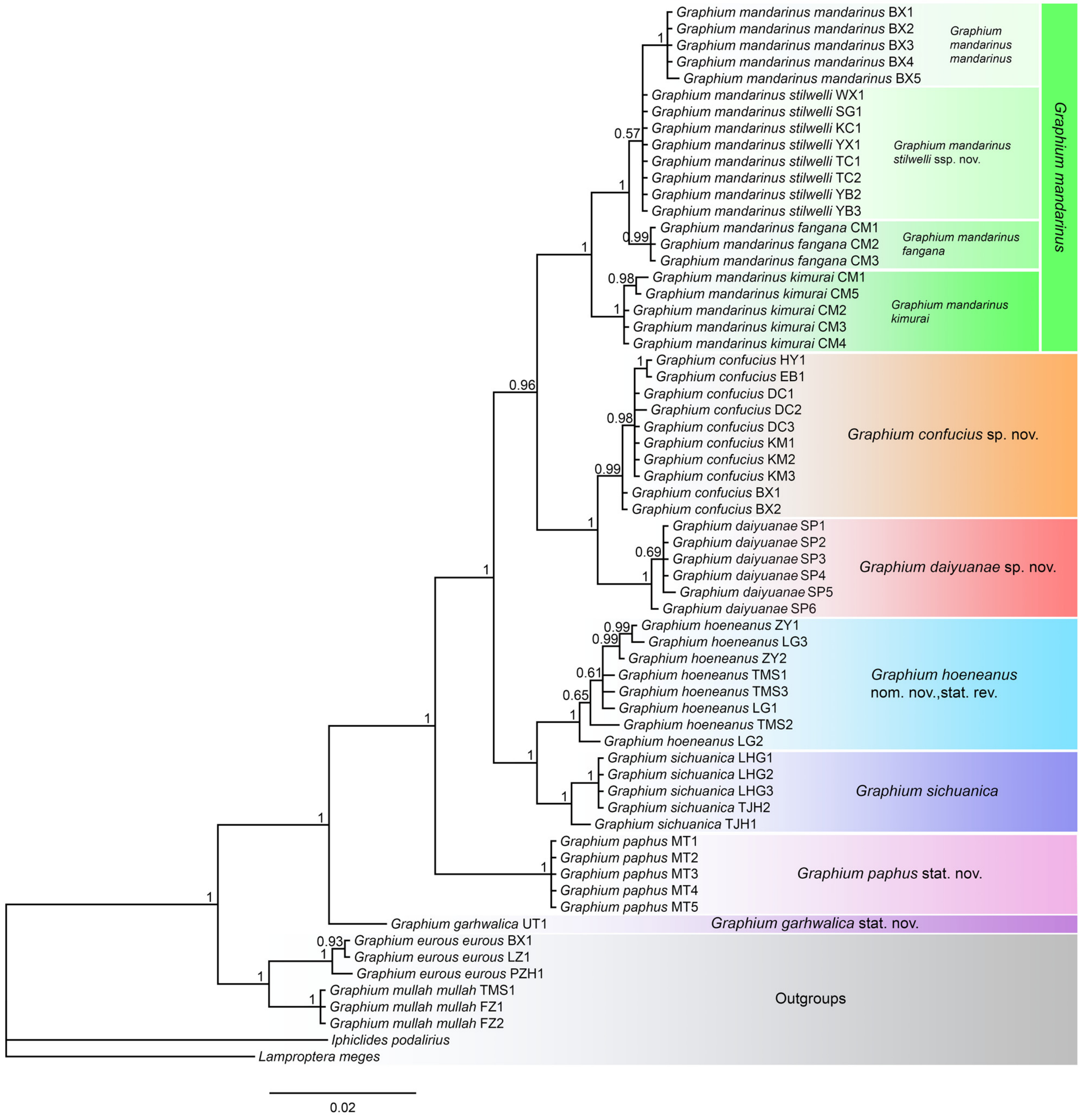

FIGURE 2. The Bayesian phylogenetic tree of *Graphium* (*Pazala*) *mandarinus* group, with *Iphiclides podalirius* and *Lamproptera meges* as outgroup. Coloured rectangles delineate the species and subspecies of the *mandarinus* group. Values at nodes indicate the posterior probability.

The Kimura 2-parameter (K2P) distances (in percentage) between taxa ranged from 0.46% to 6.48%, with that between *G.* (*P.*) *mandarinus fangana* and *G.* (*P.*) *mandarinus stilwelli* **ssp. nov.** being the smallest, while that between *G.* (*P.*) *garhwalica* stat. nov. and *G.* (*P.*) *mandarinus mandarinus* being the greatest. Most K2P distances between identified species were greater than 2%, except that between *G.* (*P.*) *daiyuanae* **sp. nov.** and *G.* (*P.*) *confucius* **sp. nov.**, being only 1.71% (Table 3).

Morphological examination, detailed in the revision section below, supported the species level phylogenetic analysis particularly in differences of both male and female genitalia.

TABLE 2. Monophylizer assessment of species and subspecies in *Graphium* (*Pazala*) *mandarinus* group.

Taxon	Assessment	Tanglees
G. (*P.*) *garhwalica* stat. nov.	monophyletic	—
G. (*P.*) *paphus* stat. nov.	monophyletic	—
G. (*P.*) *sichuanica*	monophyletic	—
G. (*P.*) *hoeneanus* nom. nov., stat. rev.	monophyletic	—
G. (*P.*) *daiyuanae* **sp. nov.**	monophyletic	—
G. (*P.*) *confucius* **sp. nov.**	monophyletic	—
G. (*P.*) *mandarinus*	monophyletic	—
ssp. *kimurai*	monophyletic	—
ssp. *fangana*	monophyletic	—
ssp. *stilwelli* **ssp. nov.**	paraphyletic	ssp. *mandarinus*
ssp. *mandarinus*	monophyletic	—

TABLE 3. The Kimura 2-parameter distances (shown in percentages) between species and subspecies in *Graphium* (*Pazala*) *mandarinus* group.

Taxon	1	2	3	4	5	6	7a	7b	7c	7d
1. *garhwalica* stat. nov.										
2. *paphus* stat. nov.	5.42									
3. *sichuanica*	4.75	5.10								
4. *hoeneanus* nom. nov., stat. rev.	5.10	4.82	2.03							
5. *daiyuanae* **sp. nov.**	4.54	5.32	3.94	3.46						
6. *confucius* **sp. nov.**	5.27	5.12	4.12	4.15	1.71					
7a. *mandarinus kimurai*	6.20	5.72	4.04	4.16	3.88	3.41				
7b. *mandarinus fangana*	5.76	5.96	3.29	4.09	3.46	2.67	1.64			
7c. *mandarinus stilwelli* **ssp. nov.**	5.93	6.13	3.46	4.26	3.62	3.12	1.48	0.46		
7d. *mandarinus mandarinus*	6.48	6.33	3.98	4.42	3.22	2.99	1.67	0.95	0.49	

Molecular dating analyses

For both the *mandarinus* group and the *Pazala* datasets, the Bayesian dating runs converged very well: almost all PSRF values were at 1.0 (average at 1.0 and maximum at 1.005) for both, and the ADSF was at 0.001 and 0.005 (maximum at 0.03), respectively. All the parameters have ESS well above 200, indicating good mixing of the MCMC.

The results of the molecular dating analyses are presented in Figures 3 and 4 for both the previously recognised seven *Pazala* species and the *mandarinus* group taxa designated in the present study, respectively. We estimated that the currently recognised subgenus *Pazala* originated in the early Miocene *ca.* 20.4 Ma (95% CI: 13.8–27.4 Ma). Most speciation events occurred before the Pliocene and we estimated no event in the Pleistocene (Figure 3), with the last speciation event taking place *ca.* 6.48 Ma (95% CI: 2.0–11.96 Ma). On the contrary in the *mandarinus* group, we estimated that most phylogenetic events happened in the Pliocene and Pleistocene (Figure 4). The crown age of the subspecies complex of *mandarinus* is estimated at 2.76 Ma (95% CI: 0.7–6.85 Ma). We note a good congruence between the age estimates obtained with the *Pazala* and the *mandarinus* datasets (e.g. crown age of Leptocircini is 35.8 Ma and 38.1 Ma, crown age of *Graphium* is 31.2 Ma and 31.5 Ma, crown age of *Pazala* is 20.4 Ma and 16.0 Ma, most recent common ancestor of *G.* (*P.*) *mandarinus* and *G.* (*P.*) *sichuanica* is 6.5 Ma and 5.8 Ma, respectively).

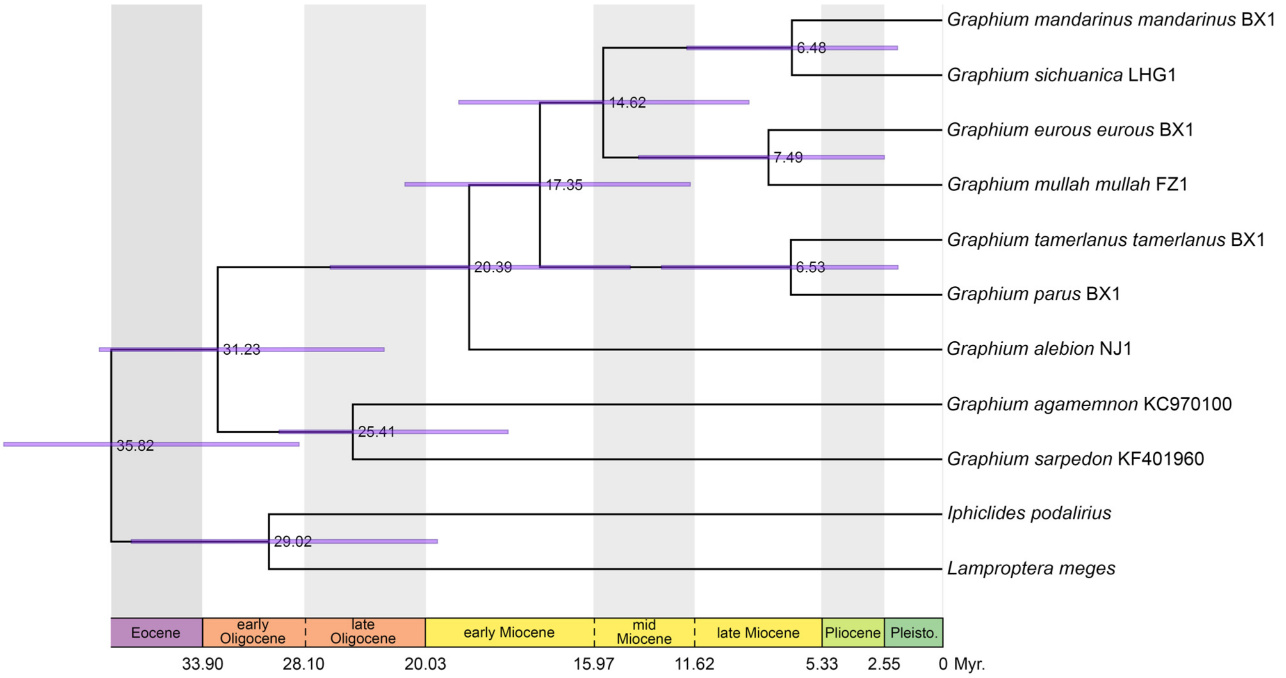

FIGURE 3. Bayesian molecular dating for the seven previously recognised species in the subgenus *Pazala* Moore, 1888. Values at nodes indicate the median divergence times, purple bars show 95% CI. Pleisto. = Pleistocene.

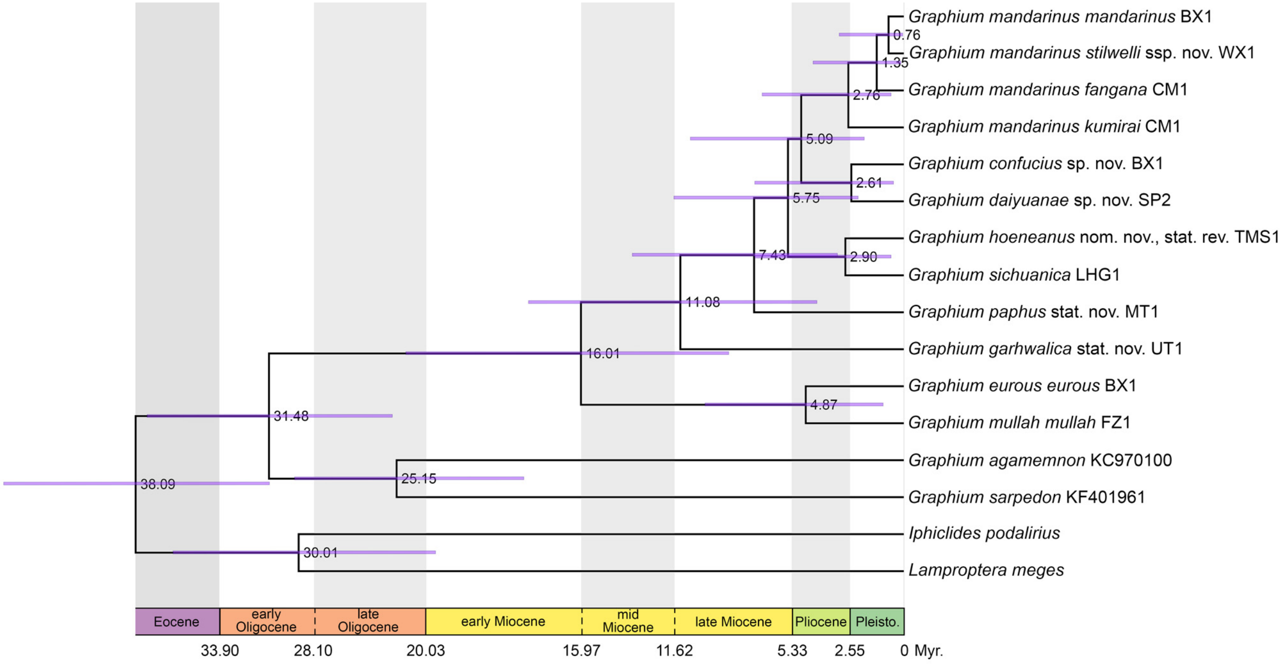

FIGURE 4. Bayesian molecular dating for species and subspecies in the *Graphium* (*Pazala*) *mandarinus* group found in this study. Values at nodes indicate the median divergence times, purple bars show 95% CI. Pleisto. = Pleistocene.

Revision of *Graphium* (*Pazala*) *mandarinus* group

Nomenclature of *Pazala* genitalia

Examination of *Pazala* male genitalia showed that extra names are needed (Figure 5) for the various structures of the valve, since they are probably not homologous with those used for the Afrotropical *Graphium* species of Smith & Vane-Wright (2001), whereas nomenclature of female genitalia follows that publication (Figure 6). General descriptions of male and female genitalia are given below while only distinguishing characters are listed under each species.

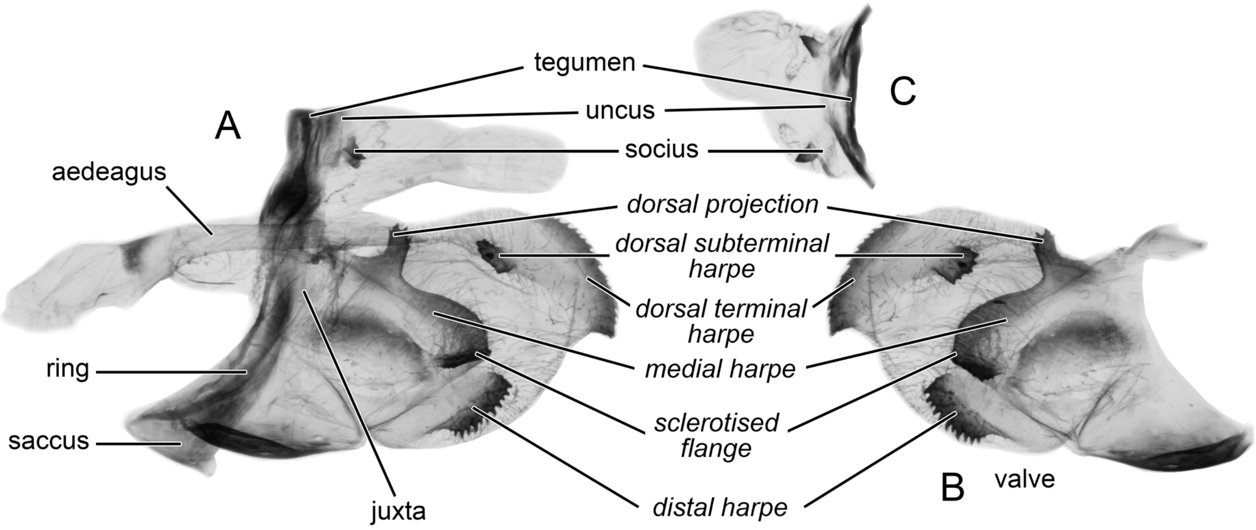

FIGURE 5. Nomenclature of male genitalia of the *Graphium* (*Pazala*) *mandarinus* group used in this study, illustrated by *G.* (*P.*) *sichuanica* (Koiwaya, 1993). A: male genitalia with left valve removed, B: right valve, C: dorsal view of tegumen, socius, and uncus (subsequently as TSU in the text). Names proposed for the harpes and projections of the valve in italics.

General description of male genitalia. Moderately to highly sclerotised. Ring moderate in width, straight in the lower half and wavy in the upper half; saccus small to nearly reduced; socii small, ventrally curved with acutely pointed end, distance between the base of socii varies among taxa. Valve short, oval in general with five highly sclerotised harpes: the dorsal terminal harpe extends from apical 1/3 of the dorsal margin to the end of the valve, with curved, serrate edge and a tip of varying shape; the dorsal subterminal harpe, with serrate edge, of variable size located in the upper and outer 1/4 to 1/3 of the valve, opposite to the dorsal terminal harpe; the distal harpe large, the ventral margin with strongly serrate edge; the medial harpe long and curved, with a dorsal projection variable among taxa and a serrate sclerotised flange. Aedeagus long, curved ventrally, with a funnel-shaped base and pointed end. Juxta weakly sclerotised with hairy membrane on both sides.

Our study showed that the shape, size, and relative position of the dorsal terminal harpe, the dorsal subterminal harpe, and the shape of the dorsal projection are important diagnostic characters. Also, the uncus does not project noticeably from the tegumen, but contains a pair of socii with useful morphometric characters helpful in distinguishing species (Koiwaya, 1993).

General description of female genitalia. Papillae anales short, margin smooth and round; posterior apophysis slender, reaching approximately half of the 9th abdominal section; ostium partially covered by lamella antevaginalis and ostial lobe; lamella postvaginalis paired, approximately petal-shaped; lamella antevaginalis broad horizontally, lined with moderately sclerotised longitudinal striae; ostial lobe heavily sclerotised, with the posterior margin concave in the middle, separating it into a pair of spurs variable between taxa; ductus bursae of medium length; signum well defined by sclerotised granules.

Our study showed that the ostial lobe (i.e., bifurcation of posterior margin, shape of spurs) varies among species, and probably can be used as a diagnostic character. The characters of the ostial lobe of each species and the differences from other species are listed in detail below.

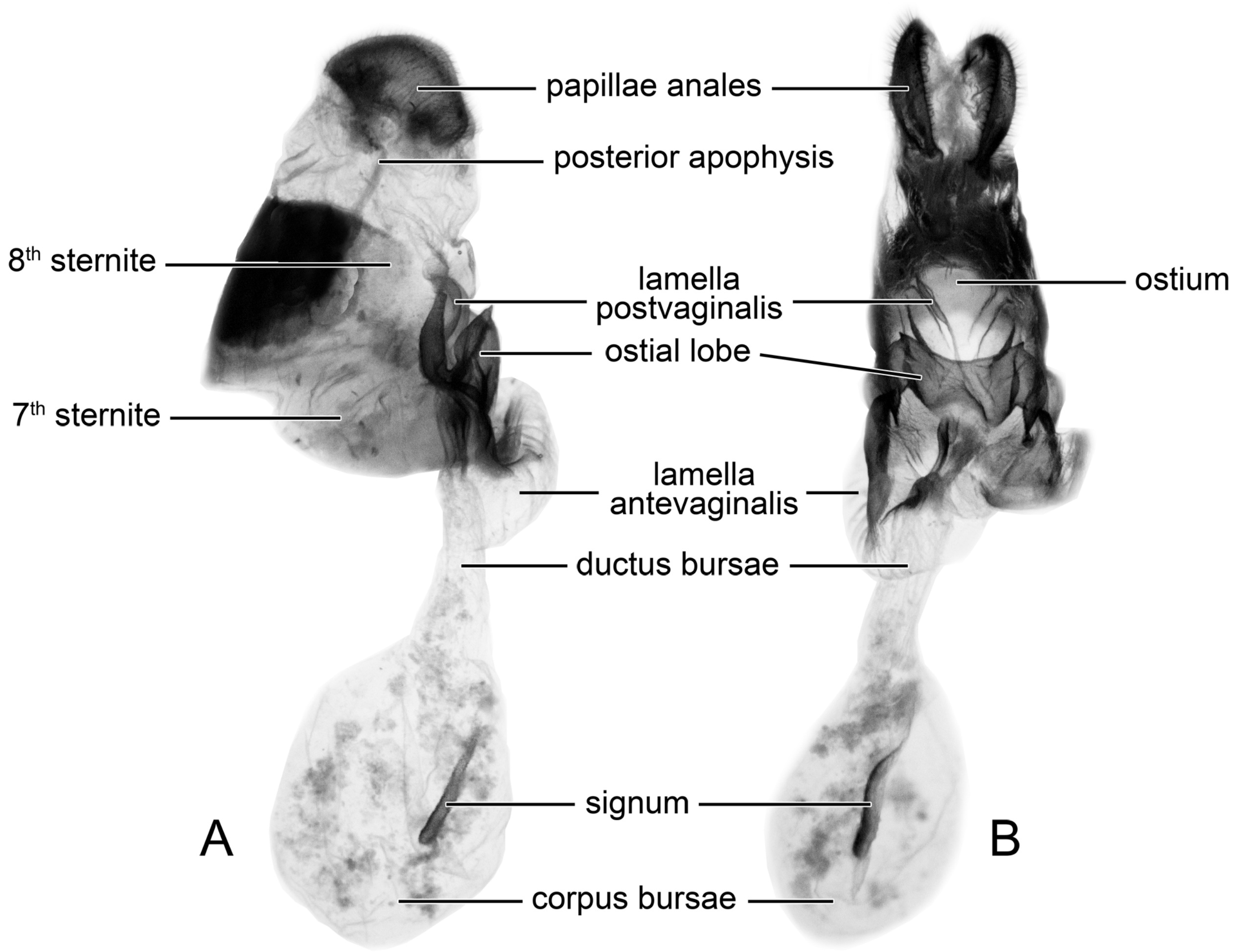

FIGURE 6. Nomenclature of female genitalia of the *Graphium* (*Pazala*) *mandarinus* group used in this study illustrated by *G.* (*P.*) *mandarinus mandarinus* (Oberthür, 1879). A: lateral view, B: ventral view.

Confirmation of the identity of *Papilio Glycerion* variété géographique *Mandarinus* Oberthür, 1879 and Lectotype Designation for *Papilio Glycerion* Gray, 1831 (section authors: Cotton & Hu)

Since this study has shown that the previously recognised nominate population of *Graphium* (*Pazala*) *mandarinus* (Oberthür, 1879) comprises two separate species, it is necessary to confirm which taxon the name *mandarinus* applies to.

On page 115 of Études d'Entomologie IV (1879) Oberthür described [*Papilio*] *Glycerion* variété géographique *Mandarinus* from an unspecified number of specimens 'de Moupin et de Kouy-Tchéou' without designating a holotype. On page 64 of the same publication he listed a single specimen of *Papilio glycerion* from Moupin (A. David [leg.]) and two males from 'Népaul'.

Hemming (1934: 195) designated the specimen from Moupin [= Baoxing, Sichuan, China] as lectotype of the taxon in accordance with article 74.5 of the ICZN Code (1999) by stating 'type from Moupin'. Since only a single Moupin specimen was listed by Oberthür in the syntypic series the specimen Hemming had designated was unambiguously identified despite the brevity of the statement. This action also fixed the type locality to Moupin under Code article 76.2 and rendered the status of the Kouy-Tchéou specimens as paralectotypes.

The lectotype (Figure 7) is clearly identifiable on morphological characters as conspecific with taxa previously treated as subspecies of *Graphium mandarinus* rather than the sympatric new species, *Graphium confucius* Hu, Duan & Cotton **sp. nov.**, recognised in this work; thus maintaining stability of names for the majority of relevant taxa. Two paralectotypes from Kouy-Tchéou are housed in BMNH, London. The Trustees kindly provided photos of these specimens which clearly belong to *Graphium* (*Pazala*) *confucius* Hu, Duan & Cotton **sp. nov.**, and are designated as paratypes of the new taxon below.

FIGURE 7. Lectotype of *Papilio Glycerion* variété géographique *Mandarinus* Oberthür, 1879; upperside left, underside right, all labels below. All images © Reproduced with permission and with thanks to the Trustees of the Natural History Museum, London.

FIGURE 8. Lectotype of *Papilio Glycerion* Gray, 1831 designated in the present study; upperside left, underside right, all labels below. All images © Reproduced with permission and with thanks to the Trustees of the Natural History Museum, London.

From 2003 Campbell Smith worked on *Pazala* at the Natural History Museum, London (BMNH), intending to publish a revision of the subgenus. The first author of this section was in personal communication with Smith from 2006 until his retirement in early 2009 but the proposed revision of the group was never submitted for publication, as confirmed by R. I. Vane-Wright (pers. comm.) in 2016. Smith shared part of his manuscript with the first author, in which he was planning to designate the only known extant syntype of *Papilio Glycerion* Gray, 1831, housed in

BMNH, as lectotype of that taxon. Even though only one specimen is known it must be treated as a syntype since there was no indication of the number of specimens in the original description. Lectotype designation is necessary in order to fix the identity of the name due to long standing historical confusion detailed by Racheli & Cotton (2009: 26), even though the name is a junior homonym.

Since Smith never published his revision we herein designate as the Lectotype of *Papilio Glycerion* Gray, 1831 the male syntype chosen by Campbell Smith. This specimen (Figure 8) has the following labels attached: 1702 a [hand written on round white label] / Nepaul. Hardwicke Bequest. 1702 a. [hand written] / B. M. TYPE No. RH11072. Papilio glycerion, ♂ Gray / Type [round red edged label] / LECTO-TYPE [round dark blue edged label] / LECTOTYPE [purple print] *Papilio glycerion* G.R. Gray C.R. Smith det. 2003 / BMNH(E) # 149384.

***Graphium* (*Pazala*) *garhwalica* (Katayama, 1988) stat. nov.**

(Figure 9, A–B)

Pazala glycerion garhwalica Katayama, 1988; Gekkan-Mushi, 203: 8; pl. 1, f. 1–2; TL: "Joshimath (2400 m), Uttar Pradesh [= Uttaranchal], NW. India".

Diagnostic characters: Small in size, forewing length: male 32.5–33.5 mm (n = 2), female 32.0 mm (only one female examined) [Katayama (1988) stated 36 mm for the female in the original description]. Both wings rather whitish. Forewing, glossy, apex blunt, termen straight (a); veins M_3 to Cu_2 discally completely free of black scales in both sexes (b). Hindwing, black discal band on the upperside completely reduced in both sexes (c), short submarginal black lines also reduced on the upperside in both sexes, only reaching space sc+r_1.

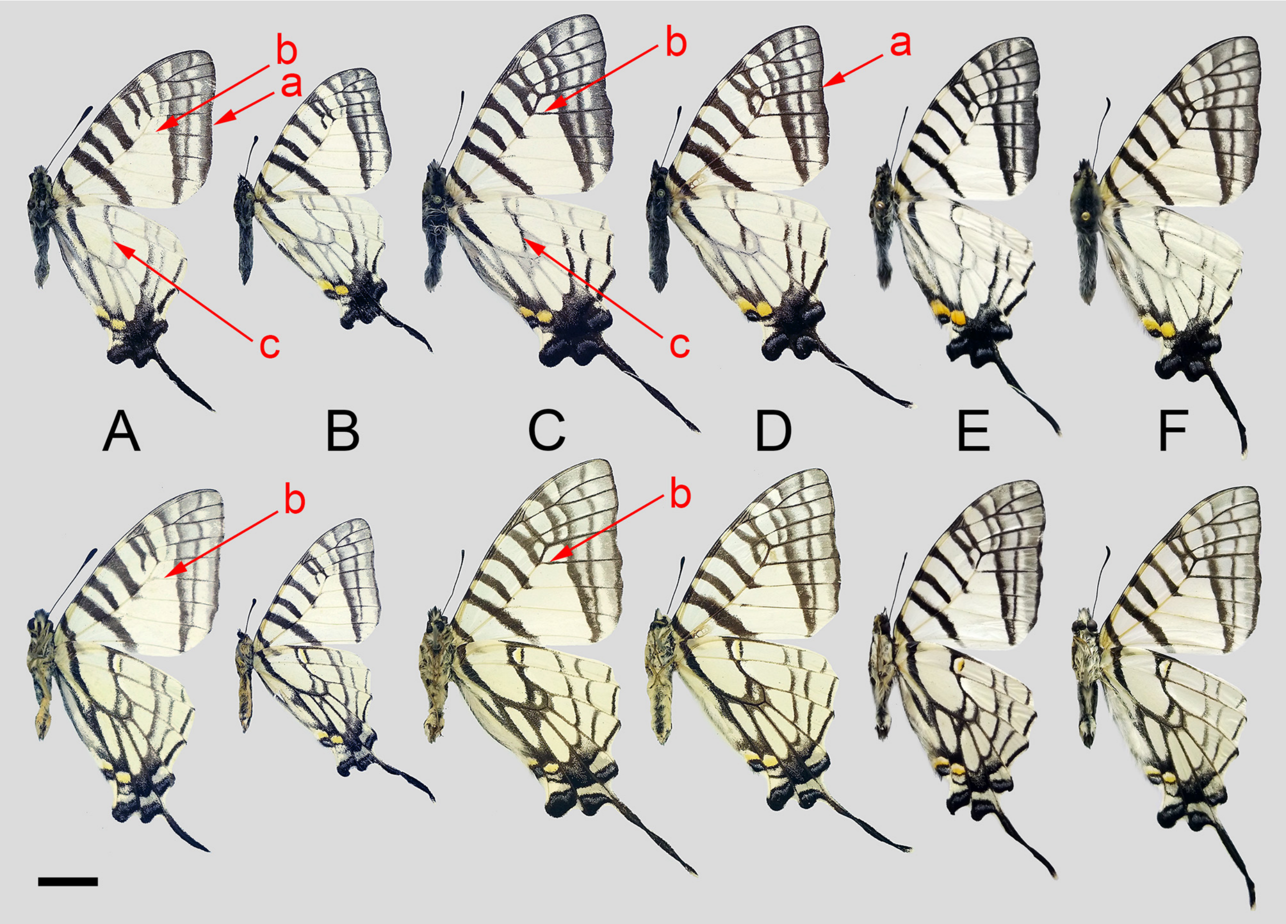

FIGURE 9. *G.* (*P.*) *garhwalica* (Katayama, 1988) stat. nov. (A–B) and *G.* (*P.*) *paphus* (de Nicéville, 1886) stat. nov. (C–F); upperside in the first row, underside in the second row; scale bar = 10 mm. A: ♂, Joshimath, N.W. India, **PARATYPE**; B: ♀, ditto; C: ♂, Tiger Hill, Darjeeling, N. India; D: ♀, ditto; E: ♂, Metok, S. Tibet, China; F: ♂, Tarung Hka River, N. Sagaing, Myanmar.

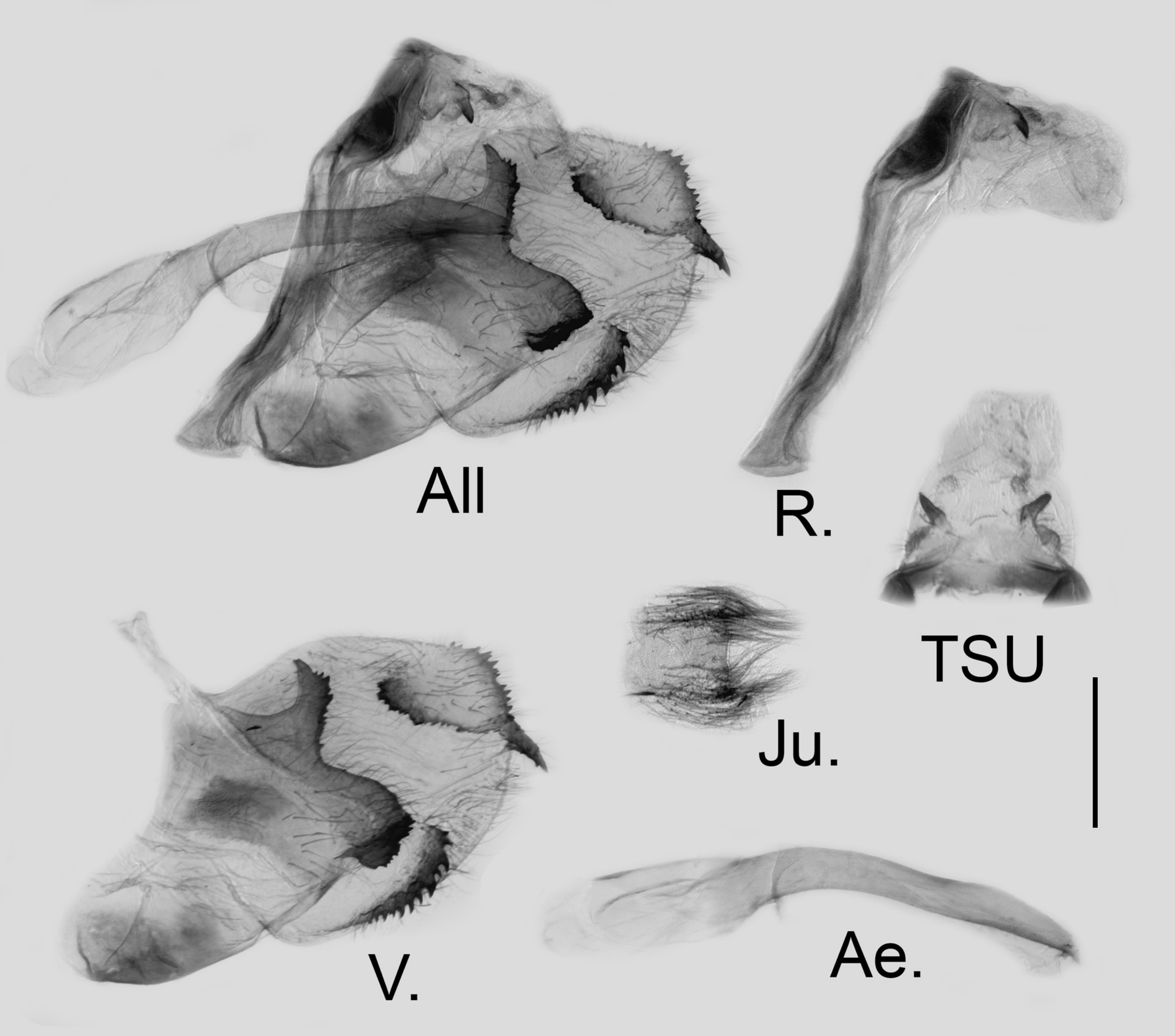

FIGURE 10. Male genitalia of *G.* (*P.*) *garhwalica* (Katayama, 1988) stat. nov. **PARATYPE** from Joshimath, N.W. India; scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

Distribution: N.W. India (Uttaranchal Pradesh) to C. Nepal (Annapurna).

Phenology: Univoltine in April-May.

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

Male genitalia (Figure 10)**:** In total two male genitalia were dissected, the general characters are consistent. Highly sclerotised. Ring slightly wavy in the upper half; saccus very small, nearly reduced; distance between the base of socii 0.64–0.68 mm ($n = 2$). Valve short, oval in general, the end of dorsal terminal harpe extends into distinctly elongate acute tip; the dorsal subterminal harpe reaching the base of the elongate tip; the medial harpe long and curved, the dorsal projection flat and serrate; no tooth in the middle of the medial harpe. Juxta weakly sclerotised with hairy membrane on both sides.

Female genitalia: The abdomen of the only available female specimen was unfortunately crushed prior to obtaining the specimen, the ostial lobe was still identifiable but split into three pieces. The first author photographed the three pieces and digitally rejoined them without alteration, obtaining a reconstructed image of the ostial lobe (Figure 11). Ostial lobe (Figure 11) heavily sclerotised, broad at the base with the posterior margin widely bifurcated into a pair of broad spurs in ventral view.

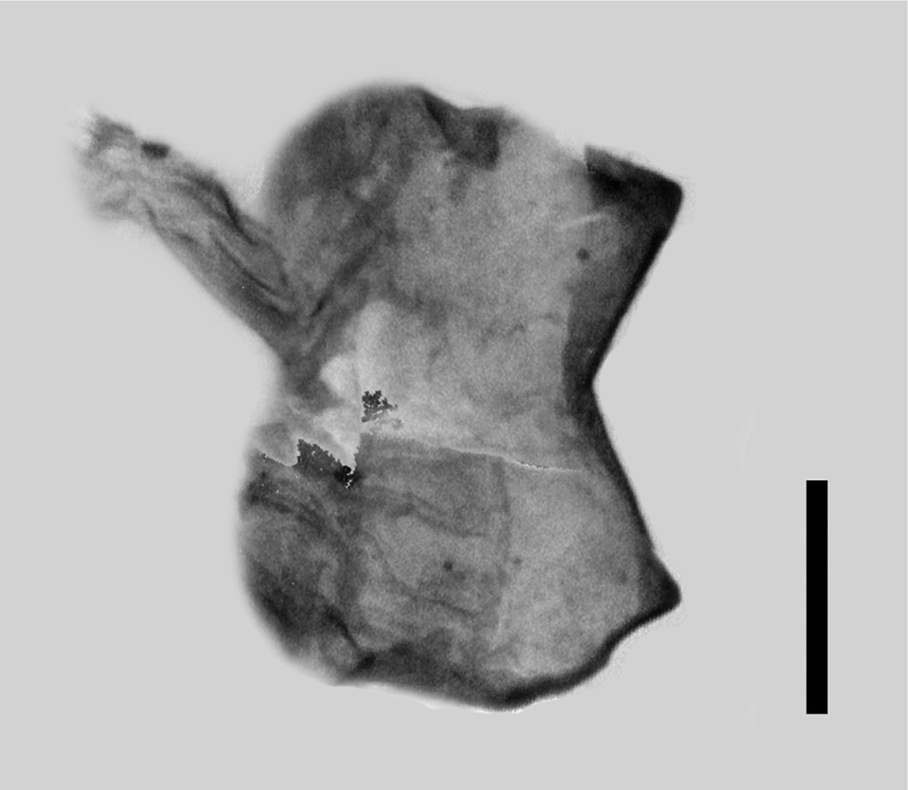

FIGURE 11. Ventral view of digitally reconstructed ostial lobe of female genitalia of *G.* (*P.*) *garhwalica* (Katayama, 1988) stat. nov. from Joshimath, Uttaranchal, N.W. India; scale bar = 0.5 mm.

***Graphium* (*Pazala*) *paphus* (de Nicéville, 1886) stat. nov.**

(Figure 9, C–F)

Papilio paphus de Nicéville, 1886; J. Asiat. Soc. Bengal, 55 Pt. II (3): 254, pl. 11, f. 6; TL: Sikkim.

Papilio Glycerion Gray, 1831 (junior homonym of *Papilio Glycerion* Borkhausen, 1788 [Nymphalidae: Satyrinae]); Zool. Miscell., 1: 32; TL: "Nepaul" [= Nepal].

Diagnostic characters: Larger than the preceding species, forewing length: male 35.0–41.0 mm (mean = 37.1 ± 1.3 mm, $n = 29$), female 39.5 mm (only one female examined). Both wings rather whitish. Forewing, apex more obvious than that of *garhwalica*, termen concave in the middle and slightly wavy at the end of each vein (a); veins Cu1 and Cu_2 mostly free of black scales except the base, while vein M_3 entirely black (b). Hindwing, black discal band on the upperside incomplete but usually present near and in the cell (c), short submarginal black lines reaching space $sc+r_1$.

Distribution: Nepal, Bhutan, N. India (Sikkim, Assam), N. Myanmar (Sagaing), and W. China (S. Tibet, i.e., Metok).

Phenology: Univoltine. Adults were collected from late April to mid May in Metok (Wa Da, pers. comm.).

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

Male genitalia (Figure 12)**:** In total eight male genitalia were dissected, the general characters are consistent, with slight variation in the harpes. Highly sclerotised. Ring wavy in the upper half; saccus small; distance between the base of socii 0.64–0.74 mm (mean = 0.70 ± 0.03, $n = 8$). Valve short, oval in general, the dorsal terminal harpe with an acute but not elongate tip (elongate in *garhwalica*); the dorsal subterminal harpe small and isolated (reaching the dorsal terminal harpe in *garhwalica*), with serrate edge; the medial harpe long and straight, dorsal projection bayonet-shaped (in sharp and acute triangular pyramid shape) (flat in *garhwalica*); a variable number of teeth (0–2) in the middle of the medial harpe.

Female genitalia (Figure 13)**:** Only one female was available for genitalia dissection. Lamella postvaginalis small, round-shaped; ostial lobe heavily sclerotised, broad at the base and abruptly narrowing into a sharp spur in lateral view, while the posterior margin deeply bifurcated into a pair of acute spurs in ventral view (only shallowly bifid in *garhwalica*).

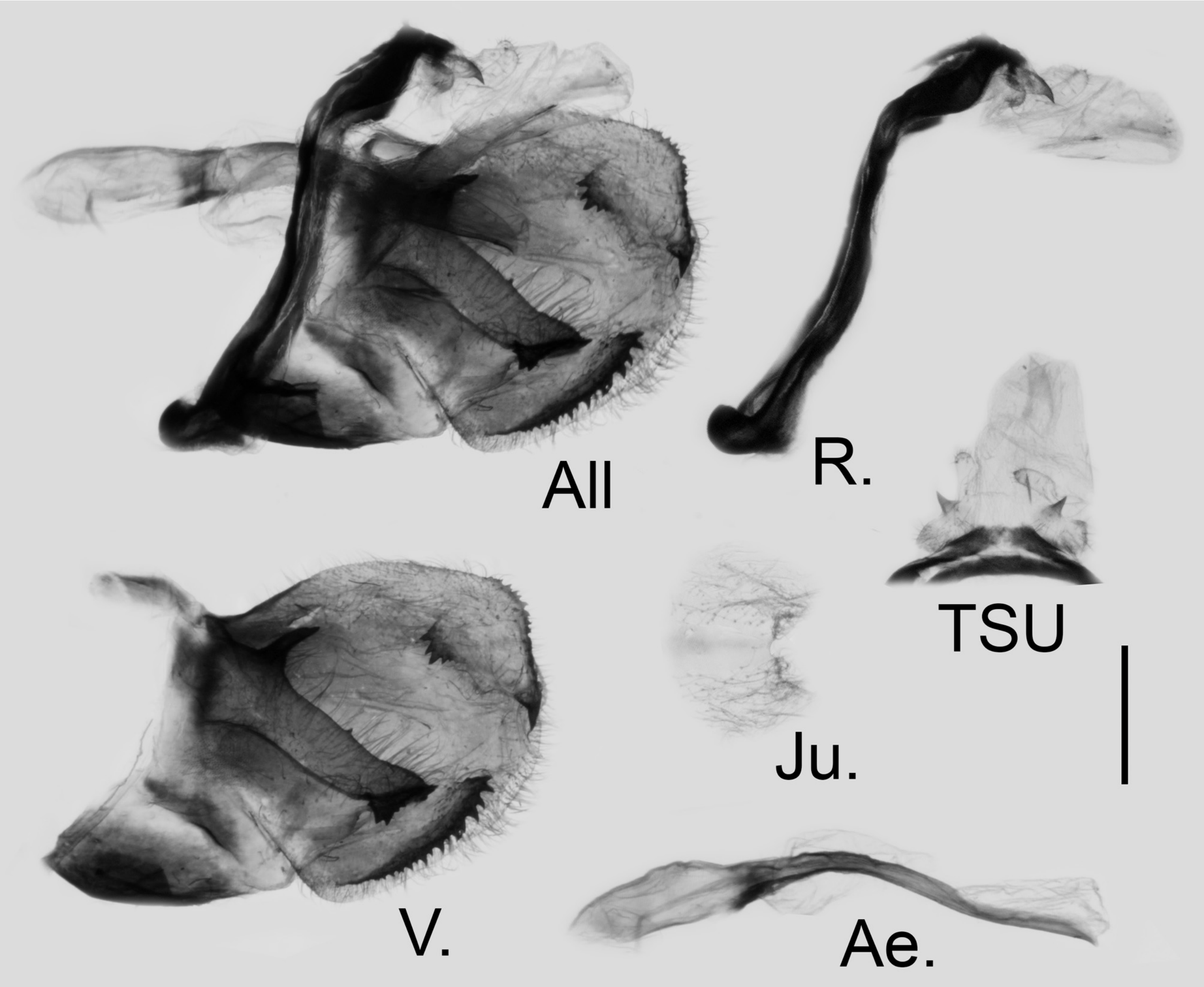

FIGURE 12. Male genitalia of *G.* (*P.*) *paphus* (de Nicéville, 1886) stat. nov. from Metok, S. Tibet, China; scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

***Graphium* (*Pazala*) *sichuanica* (Koiwaya, 1993)**

(Figure 14, A–C)

Pazala sichuanica Koiwaya, 1993; Stud. Chinese Butt., 2: 77, f. 126–127, 132–133; TL: "Dujiang Yan, Sichuan" [= Dujiangyan, W. Sichuan, China]

Diagnostic characters: A small species, forewing length: male 32.0–40.0 mm (mean = 35.4 ± 2.3 mm, *n* = 24), female 42 mm [only one female examined; 37–38 mm stated by Koiwaya (1993)]. Both wings narrower, with a yellowish tinge and well developed black markings. Forewing, the 9th black band reaches vein 2A and joins with the 8th black band with equal width (a). Hindwing, short submarginal black lines well connected to each other, almost forming straight lines (b); the discocellular veins almost free of black scales on the underside (c).

Distribution: N. to W. Sichuan, China.

Phenology: Univoltine. The type specimens in Koiwaya (1993) were collected from April to May. Our examined specimens from N. Sichuan were all collected in mid to late April.

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

Male genitalia (Figure 15)**:** In total six male genitalia were dissected, the general characters are consistent, with slight variation in the harpes. Moderately sclerotised. Ring wavy in the upper half; saccus well developed; distance between the base of socii 0.80–0.84 mm (mean = 0.81 ± 0.02, *n* = 6). Valve elongate, oval in general, the dorsal terminal harpe extends obliquely outwards with produced but non-elongate tip; the dorsal subterminal harpe rather small and completely isolated; the medial harpe long and curved, the dorsal projection flat; no tooth in the middle of the medial harpe.

Female genitalia (Figure 16)**:** Only one female was available for genitalia dissection. Lamella postvaginalis round petal-shaped; lamella antevaginalis covered with sclerotised wrinkles; ostial lobe heavily sclerotised, broad at the base and slightly curved into a sharp end in lateral view, while the posterior margin shallowly bifurcated into a pair of spurs in ventral view.

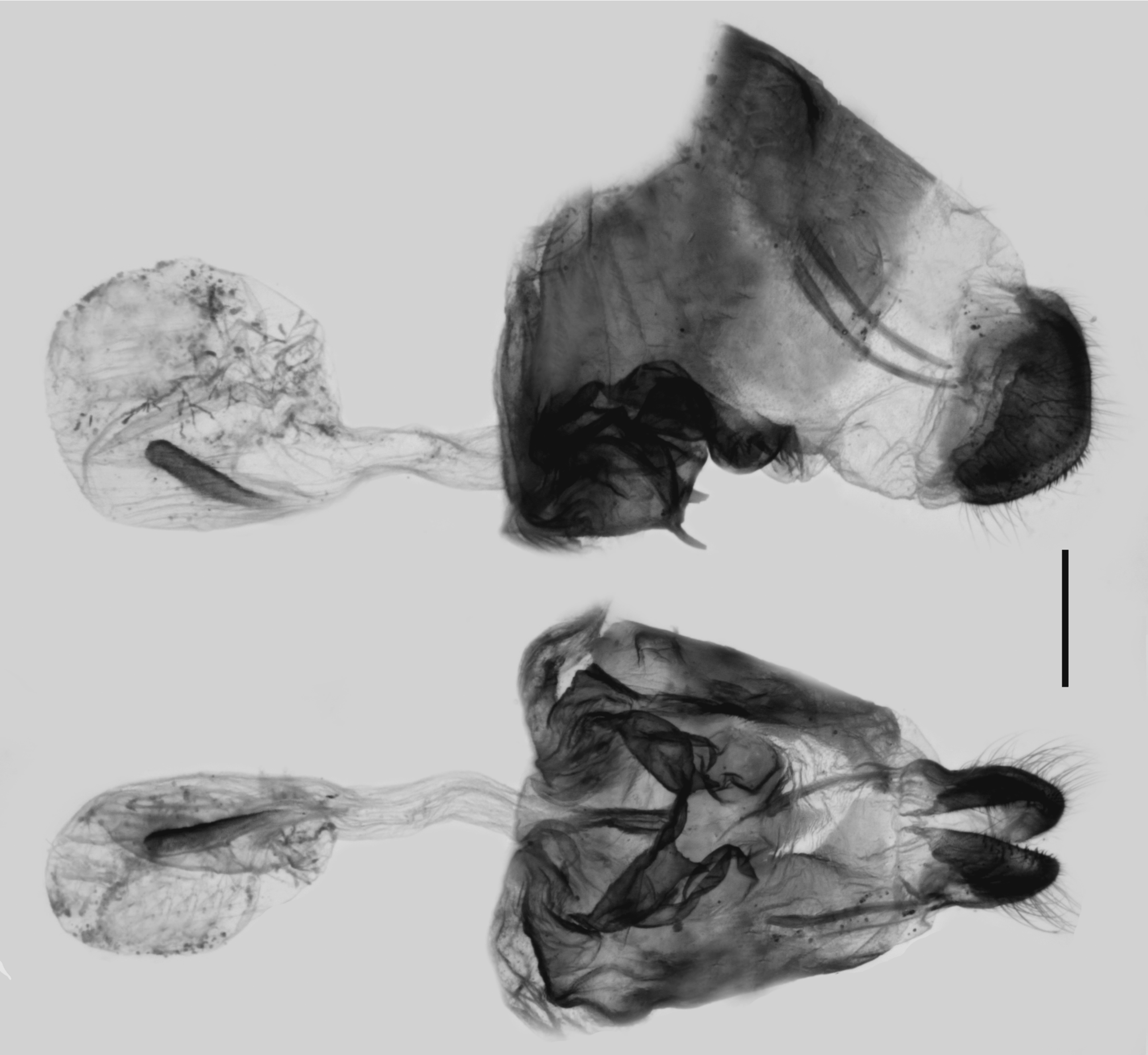

FIGURE 13. Female genitalia of *G.* (*P.*) *paphus* (de Nicéville, 1886) stat. nov. from Tiger Hill, Darjeeling, N. India; lateral view above, ventral view below; scale bar = 1.0 mm.

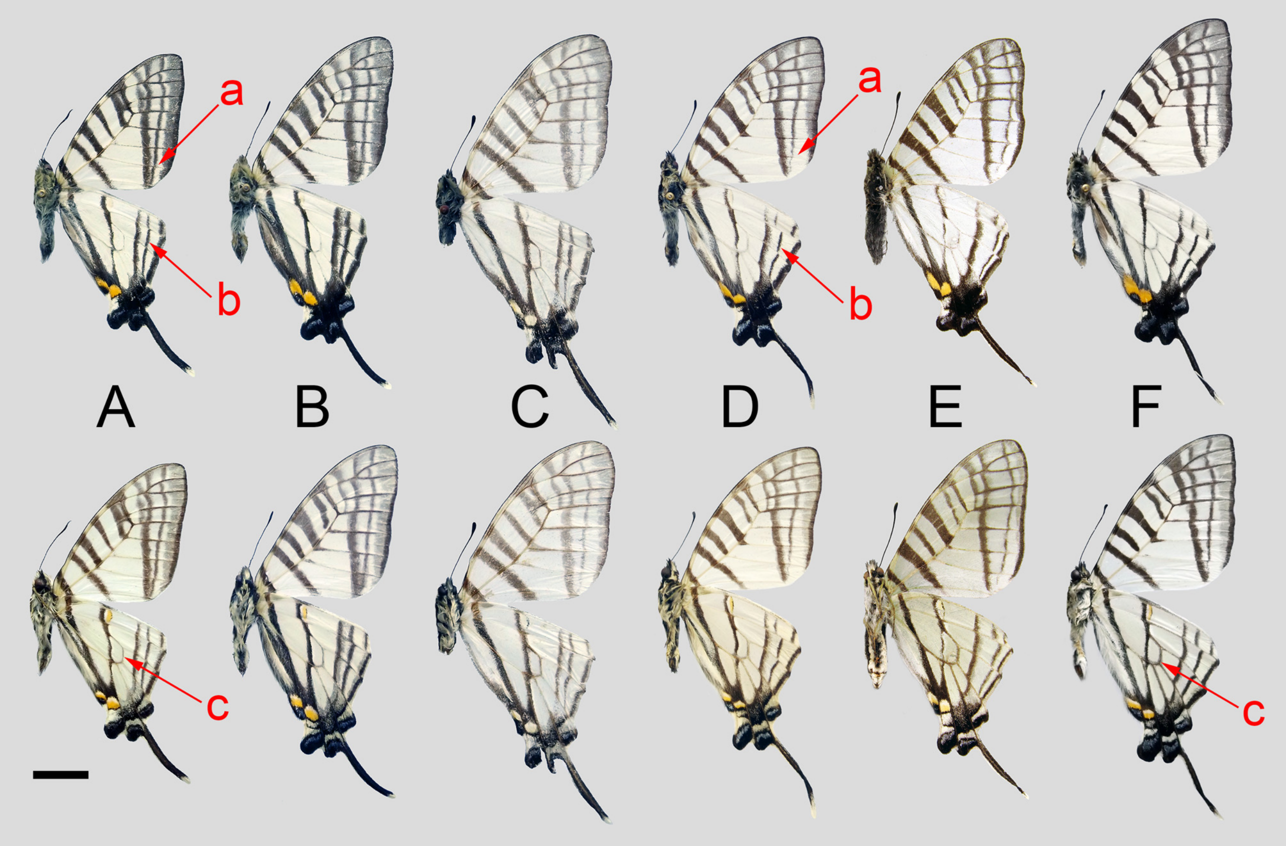

FIGURE 14. *G.* (*P.*) *sichuanica* (Koiwaya, 1993) (A–C) and *G.* (*P.*) *hoeneanus* Cotton & Hu nom. nov., stat. rev. (D–F); upperside in the first row, underside in the second row; scale bar = 10 mm. A and B: ♂, Laohegou, Pingwu, Sichuan, W. China, © Peking University & Laohegou Nature Reserve; C: ♀, Tangjiahe, Qingchuan, Sichuan, W. China, © Peking University & Tangjiahe Nature Reserve; D: ♂, W. Tianmu Shan (350 m), Zhejiang, E. China; E: ♀, Tiantong (400 m), Ningbo, Zhejiang, E. China, © Jian-Qing Zhu (Shanghai Zoological Park, Shanghai, China); F: ♂, Lingui (360 m), Guilin, Guangxi, S.W. China.

Graphium* (*Pazala*) *hoeneanus **Cotton & Hu nom. nov., stat. rev.**

(Figure 14, D–F)

Papilio tamerlanus hoenei Mell, 1935 (junior primary and secondary homonym of *Papilio agetes hönei* Mell, 1923 [Papilionidae: *Graphium*: *Pathysa*]); Mitt. D. Ent. Ges., 6 (3/4): 36; TL: "Chekiang: West- und Ost-Tienmoshan (Fukien, Südkiangsi), Nordkwangtung" [= West and East Tianmu Shan, Zhejiang (Fujian, S. Jiangxi), N. Guangdong].

This taxon has previously been treated as synonymous with *Graphium* (*Pazala*) *sichuanica* (Koiwaya, 1993) (Racheli & Cotton 2009), but is here shown both on molecular and morphological characters to be worthy of separate specific status (**stat. rev.**). Since the only name applicable to the taxon is a junior homonym and thus unavailable, we hereby propose the new replacement name *hoeneanus* Cotton & Hu **nom. nov.** as the valid taxon name.

Diagnostic characters: Larger than the preceding species, forewing length: male 34.0–41.0 mm (mean = 37.6 ± 1.6 mm, $n = 29$), female 36.0–38.0 mm (mean = 37.0 ± 0.91 mm, $n = 4$). Both wings broader, rather whitish, with reduced black markings. Forewing, the 9th black band only reaches space cu_2 and is only faintly indicated near the 8th black band, not clearly joining it (a). Hindwing, short submarginal black lines often disconnected from each other (b); the discocellular veins often tinged with black scales on the underside (c).

Distribution: Widely distributed in S. to E. China (i.e., Guangxi, Guangdong, Zhejiang; probably in Hunan, Hubei, Anhui, and Jiangxi).

Phenology: Univoltine. Adults were collected from early April to late May in Zhejiang, E. China (Jian-Qing Zhu, pers. comm.), as well as in Guangdong, S. China (Jia-Lin Chen, pers. comm.).

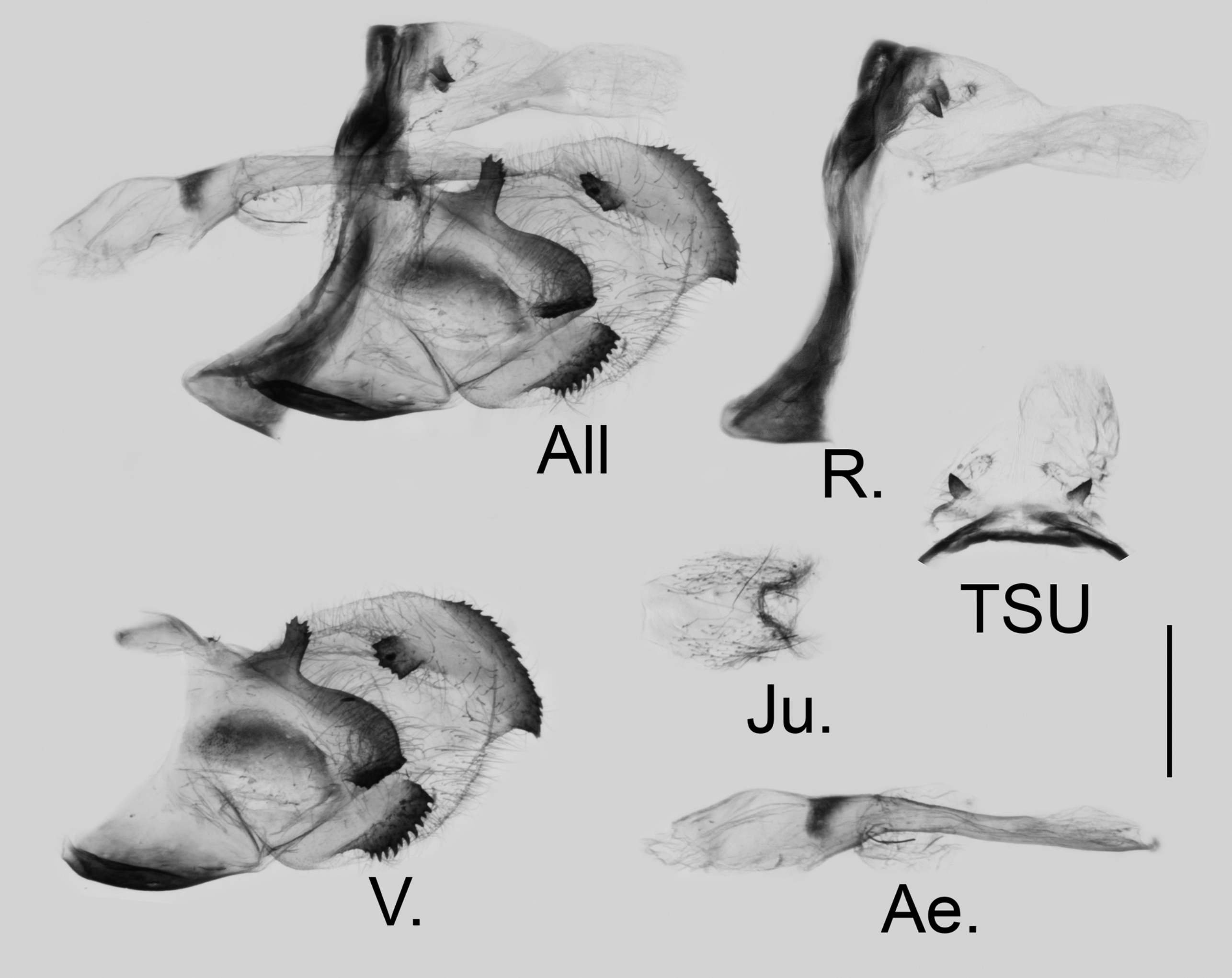

FIGURE 15. Male genitalia of *G.* (*P.*) *sichuanica* (Koiwaya, 1993) from Laohegou, Pingwu, Sichuan, W. China; scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

Host plant: According to Jian-Qing Zhu (pers. comm.), the host plant is *Lindera reflexa* of family Lauraceae in Zhejiang, E. China; while Wang & Gu (2017) recorded *Machilus phoenicis* of family Lauraceae in Nanling, S. China.

Derivatio nominis: The replacement name is dedicated to Hermann Höne, following the intention of Rudolf Mell in his original description of '*Papilio tamerlanus hoenei*', and is treated as a noun in apposition.

Male genitalia (Figure 17)**:** In total eight male genitalia were dissected, the general characters are consistent, with the teeth on medial harpe variable. Moderately sclerotised. Ring slightly wavy in the upper half; saccus small; distance between the base of socii 0.84–0.90 mm (mean = 0.89 ± 0.02, *n* = 8). Valve elongate, oval in general, the dorsal terminal harpe with produced but non-elongate tip (as in *sichuanica*); the dorsal subterminal harpe medium-sized (obviously larger than that in *sichuanica*) and completely isolated; the medial harpe straight, the dorsal projection flat (as in *sichuanica*); a variable number of small teeth (0–2) occur in the middle of the medial harpe.

Female genitalia (Figure 18)**:** Only two females were available for genitalia dissection, the characters are consistent. Lamella postvaginalis round petal-shaped; lamella antevaginalis broad horizontally, covered with sclerotised wrinkles (as in *sichuanica*); ostial lobe heavily sclerotised, broad at the base and curved upwards into a sharp end in lateral view, while the posterior margin strongly bifurcated into a pair of large spurs deviating away from each other at the base in ventral view (smaller in *sichuanica*).

FIGURE 16. Female genitalia of *G.* (*P.*) *sichuanica* (Koiwaya, 1993) from Tangjiahe, Qingchuan, Sichuan, W. China; lateral view above, ventral view below; scale bar = 1.0 mm.

***Graphium* (*Pazala*) *daiyuanae* Hu, Zhang & Cotton sp. nov.**

(Figure 19)

Description: Male: Forewing length: 32.0–35.5 mm (mean = 34.0 ± 1.1 mm, *n* = 16). Forewing triangulate, broad, apex not produced, termen wavy or slightly dented at the end of veins, oblique outwards from apex to tornus. Forewing upperside: whitish, the upper and outer 1/3 (mostly the discocellular, the subterminal, and the terminal areas) hyaline; 10 black bands lined from the humeral to the termen, among which the 1st to the 6th almost run parallel; the 1st and the 2nd bands reach the tornal margin, the 3rd to the 5th bands extend beyond the discal cell along veins Cu_2, Cu_1, and M_3, the 6th band at the end of cell, often connected with the 5th band by a transverse black fine line, the 7th band joins the 8th band just at vein M_2, extends to the tornus and joins the 9th band at vein Cu_2 or just below it in space cu_2, the 9th band curved inward in space r_4, the 10th band independent, extending from the apex to vein Cu_2 or just below it in space cu_2; the veins R_{4+5} to Cu_1 are black after meeting the 6th and 7th bands and then divide the whitish-hyaline areas between the 6th to 10th bands into spots. Forewing underside: colour and markings as upperside, but the hyaline areas are glossy. Hindwing triangulate in general, vein M_3 extends into a sword-like tail, termen slightly dented at the end of veins, the end of spaces m_1 to cu_1 expand like petals. Hindwing upperside: whitish with long white hair covering the inner 1/3; tornal margin blackish, with a small brown androconial patch near the humeral, a thick black band extends from the costal towards the tornus and joins the tornal blackish area just above two obliquely neighbouring yellow spots; the discal bands usually absent but can be seen through the underside; the submarginal black band coupled and interrupted by veins Rs and M_1, reaching space rs or $sc+r_1$; the terminal band single, also interrupted by veins Rs and M_1, reaching space rs or $sc+r_1$; all black bands mentioned above are rather discontinuous, breaking into several short bands in each space, and the ends of each short band seldom touch each other; all black bands join in the black area at the end of spaces m_2 to cu_1, with a greyish-blue lunule in each space; tail black with white tip. Hindwing underside: colour and markings similar to upperside but with a creamy yellow hue, all black bands and markings well defined, especially the discal band, two black lines twisting into an "8"-shaped pattern, the outer half of the upper of ring "8" yellow and the inner half white, the edge of the lower ring extends along veins M_1 to Cu_1; a square creamy white spot above each greyish-blue lunule in the tornal area, the yellow spots at the tornus somewhat reduced and crowned by fine white lines.

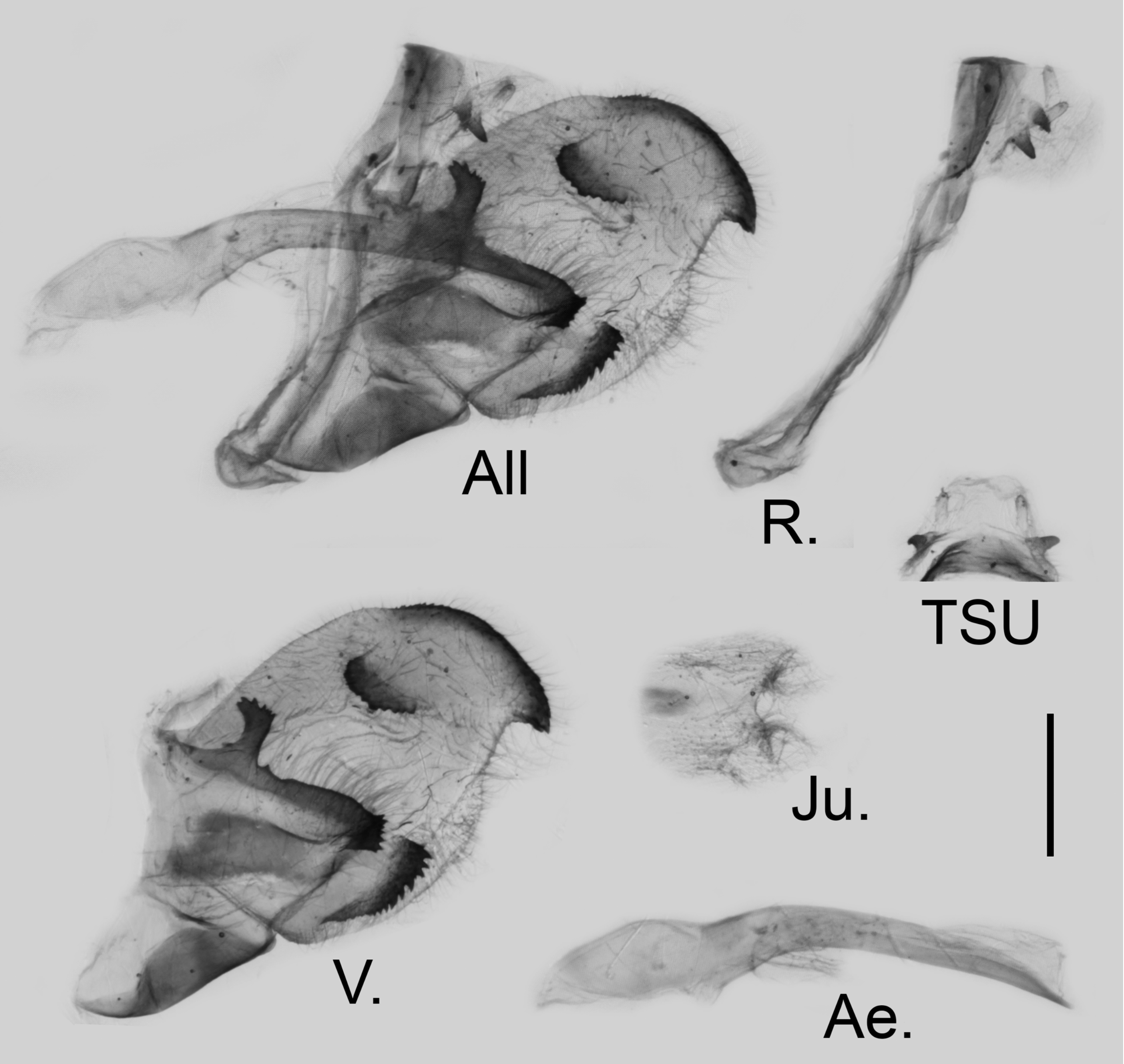

FIGURE 17. Male genitalia of *G.* (*P.*) *hoeneanus* Cotton & Hu nom. nov., stat. rev. from W. Tianmu Shan, Zhejiang, E. China; scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

FIGURE 18. Female genitalia of *G.* (*P.*) *hoeneanus* Cotton & Hu nom. nov., stat. rev. from W. Tianmu Shan, Zhejiang, E. China; lateral view above, ventral view below; scale bar = 1.0 mm.

Female: Forewing length 33.5–38.5 mm (mean = 36.4 ± 1.7 mm, *n* = 14). General appearance similar to male but larger. the forewing termen oblique outwards from the apex to the tornus, the underside of forewing almost as glossy as that in male, the 4th black band on the forewing may be reduced or absent in some individuals, the hindwing androconial patch absent, discal band faintly defined or absent.

Male genitalia (Figure 20): In total 12 male genitalia were dissected, the general characters are consistent, with the teeth on the medial harpe variable. Moderately sclerotised. Ring wavy in the upper half; saccus small; distance between the base of socii 0.40–0.60 mm (mean = 0.49 ± 0.07, *n* = 12). Valve oval in general, the dorsal terminal harpe with mostly straight (only in 1 case curved) edge and acute tip; the edge of dorsal subterminal harpe almost touching the base of the tip of the dorsal terminal harpe; the medial harpe mostly straight, the dorsal projection bayonet-shaped (some with blunt or dented end); a variable number of small teeth (0–3) occur in the middle of the medial harpe.

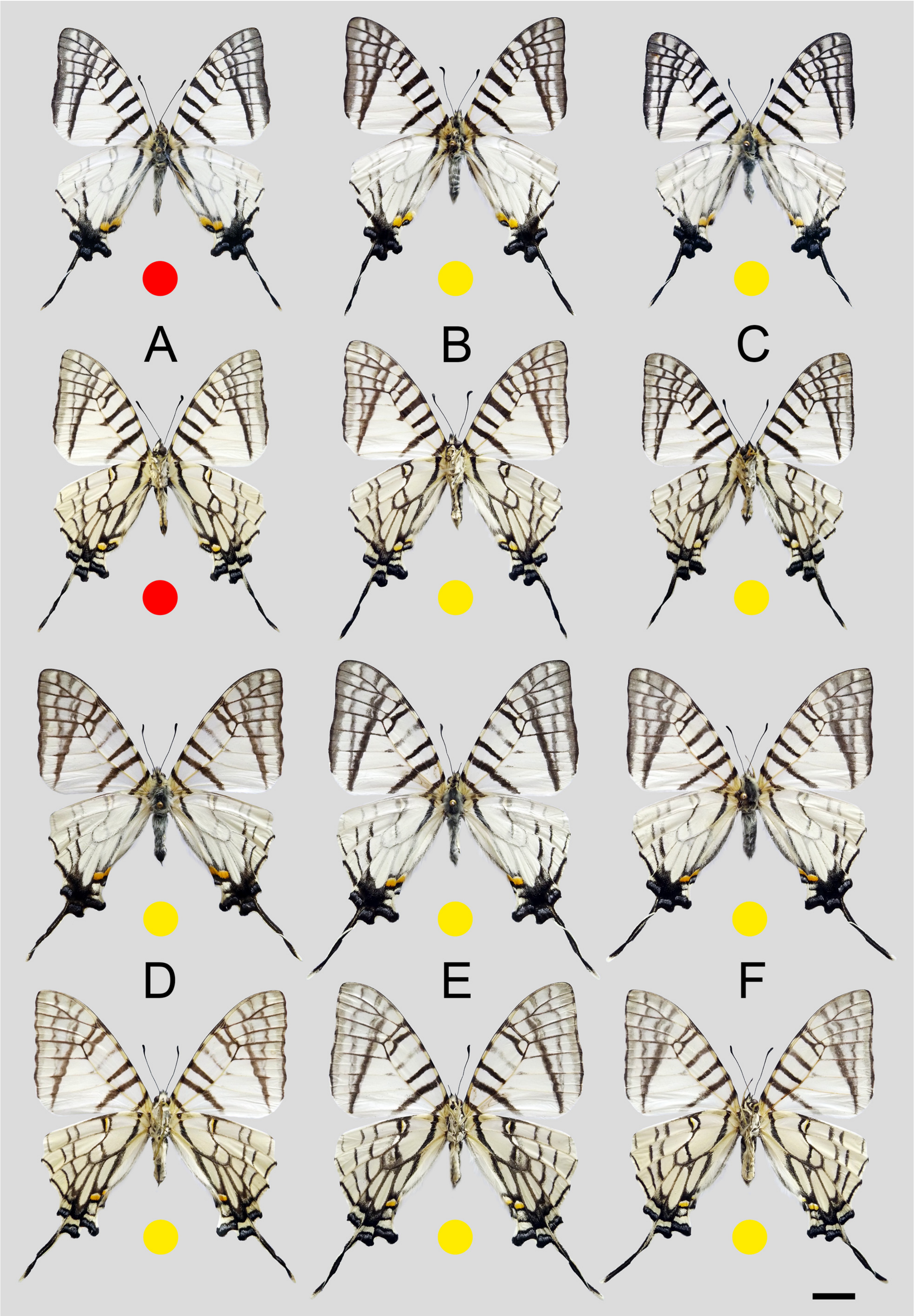

FIGURE 19. *Graphium* (*Pazala*) *daiyuanae* Hu, Zhang & Cotton, **sp. nov.**; red dot: holotype, yellow dots: paratypes; upperside on the first row, underside on the second row; A–C: ♂, D–F: ♀, Sapa, Lao Cai, N. Vietnam; scale bar = 10 mm.

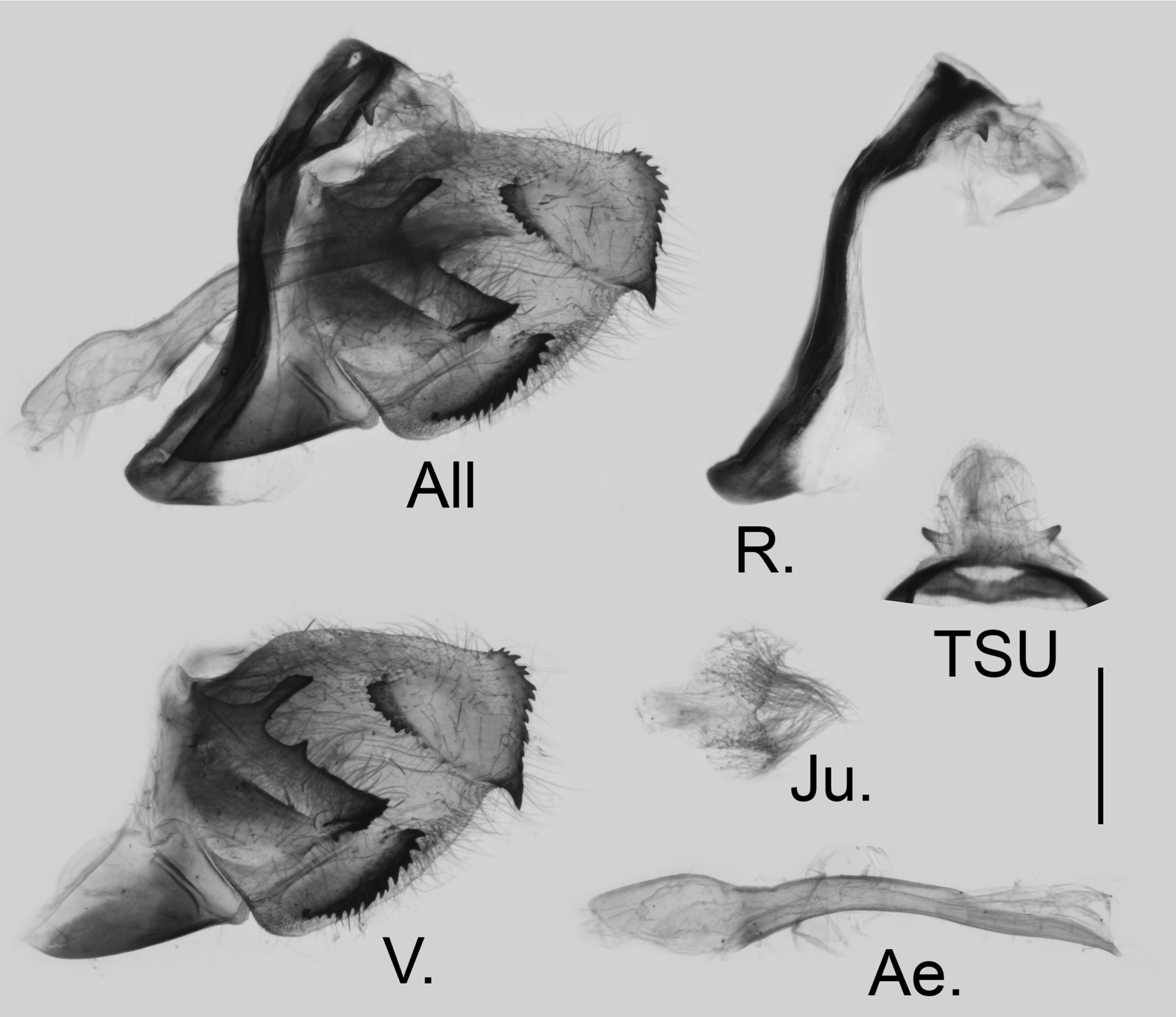

FIGURE 20. Male genitalia of *G.* (*P.*) *daiyuanae* Hu, Zhang & Cotton **sp. nov.**, scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

Female genitalia (Figure 21)**:** In total 10 female genitalia were dissected, the general characters are consistent with slight variation as mentioned below in particular. Lamella postvaginalis round petal-shaped; lamella antevaginalis broad horizontally, lined with moderately sclerotised longitudinal striae; ostial lobe heavily sclerotised, forming a straight sharp spur in lateral view, while the posterior margin straight or slightly concave with a pair of acute spurs in ventral view, the length of these spurs can vary, but never absent in examined specimens.

Differential Diagnosis: The new species closely resembles *G.* (*P.*) *mandarinus*, but can be distinguished by careful examination of the following characters: 1) smaller than nominate *mandarinus* and the subsequent new taxon *G.* (*P.*) *confucius* Hu, Duan & Cotton **sp. nov.**; 2) forewing apex as *G.* (*P.*) *mandarinus*, termen oblique outwardly from apex to tornus; 3) upperside hindwing very pale, the discal band usually absent, especially in male; 4) the yellow tornal spots on the underside of hindwing obviously paler than *G.* (*P.*) *mandarinus* and the following species; 5) the submarginal and terminal bands on the underside of hindwing more interrupted and discontinuous than *G.* (*P.*) *mandarinus* and the following species. In male genitalia, the tip of dorsal terminal harpe acute but not elongated (as in *mandarinus*), dorsal subterminal harpe large, joining dorsal terminal harpe and forming a triangle, dorsal projection bayonet-shaped (Figure 20), distance between the base of socii 0.40–0.60 mm. The ostial lobe forming a straight sharp spur in lateral view, the posterior margin straight or slightly concave with a pair of acute spurs in ventral view (Figure 21).

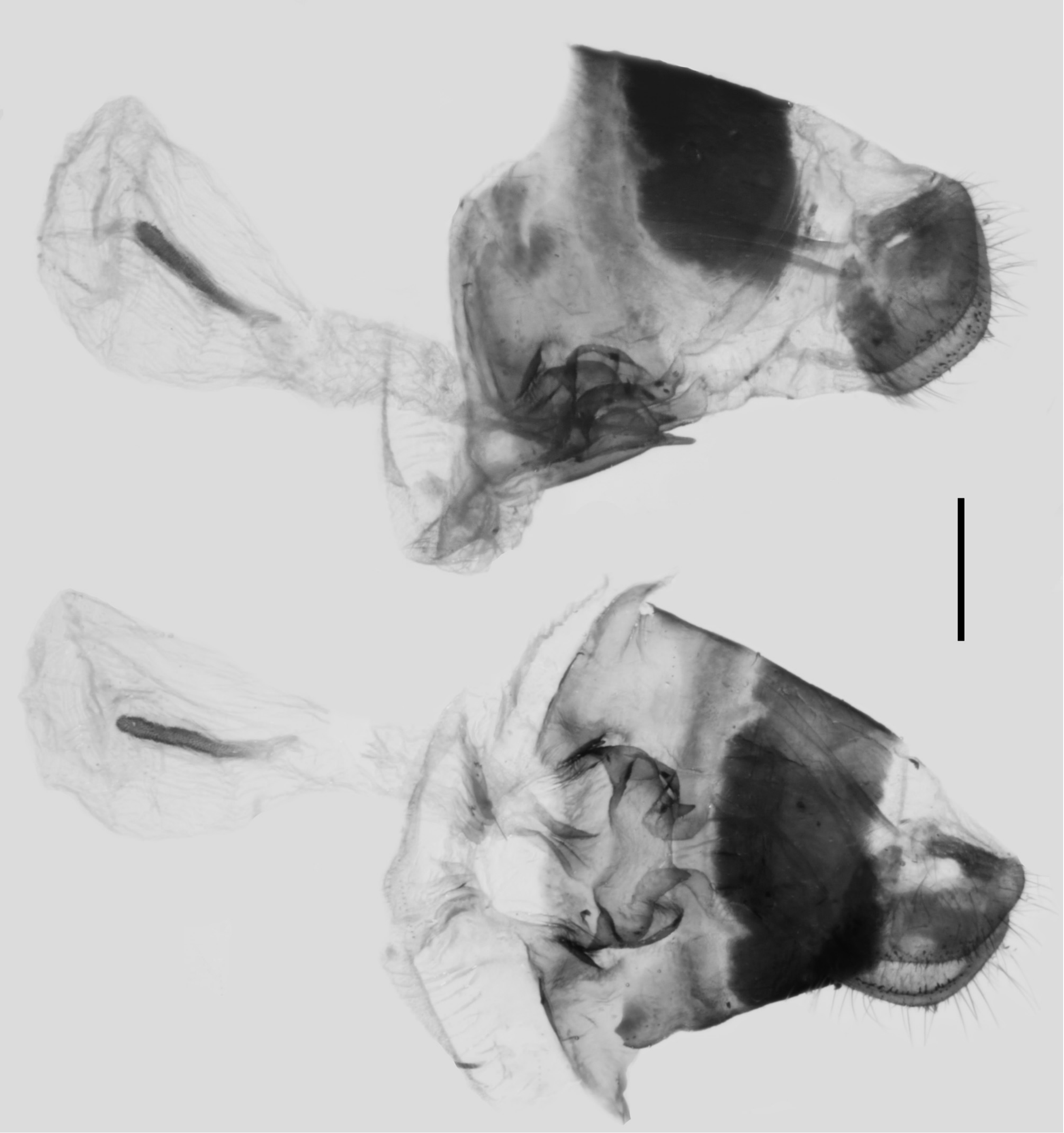

FIGURE 21. Female genitalia of *G.* (*P.*) *daiyuanae* Hu, Zhang & Cotton **sp. nov.**; lateral view above, ventral view below; scale bar = 1.0 mm.

Type Material: Holotype: VIETNAM: ♂, Sapa (1,600 m), Lao Cai Province, 2015–VI, L. T. Le leg [KIZ, 0100000].

Paratypes: VIETNAM: 3♂, 2♀, same collecting data as holotype (1,600–1,700 m) [KIZ, 0100001–0100005]; 8♂, 8♀, same collecting data as holotype (1,600–1,700 m) [SJH]; 1♂, 4♀, the same locality, 2006–IV, local catcher leg. [AMC]; 2♂, the same locality, 2007–V, local catcher leg. [AMC]; 1♂, the same locality, 2007–VI, local catcher leg. [AMC]. 2♂, Mucangchai (1,700 m), Yen Bai Province, 2017–V, L. T. Le leg. [KIZ, 0100006–0100007]; 3♂, 1♀, same collecting data, [SJH].

The holotype and seven paratypes were deposited in Kunming Institute of Zoology (KIZ), Chinese Academy of Sciences (Li *et al.* 2015).

Distribution: Currently known from the mountains in N. Vietnam (Sapa, Lao Cai; Mucangchai, Yen Bai), but very likely extends to the bordering area of S. Yunnan, China (Honghe Prefecture).

Phenology: Probably univoltine, but further survey on the biological and ecological aspects of the new taxon is required in future.

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

Derivatio nominis: The specific name of this new taxon was dedicated to the first author's beloved wife, Ms. Yuan Dai, with the order of surname and first name as per Chinese tradition. The species name is to be treated as a noun in apposition.

***Graphium* (*Pazala*) *confucius* Hu, Duan & Cotton sp. nov.**

(Figure 22)

Description: Male: Forewing length: 35.0–46.0 mm (mean = 39.4 ± 2.2 mm, *n* = 79). Forewing triangulate, apex produced, termen almost smooth or slightly wavy at the end of veins, concave between apex and tornus. Forewing upperside: whitish, the upper and outer 1/3 (mostly the discocellular, the subterminal, and the terminal areas) hyaline; 10 black bands between the base and the termen, of which the 1st to the 6th almost run parallel; the 1st and the 2nd bands reach the tornal margin, the 3rd to the 5th bands extend beyond the discal cell along veins Cu_2, Cu_1, and M_3, the 6th band at the end of cell is often connected with the 5th band by a transverse black fine line, the 7th band joins the 8th band just at vein M_2, extends to the tornus and joins the 9th band at vein Cu_2 or just below it in space cu_2, the 9th band curved inward in space r_4, interrupted by vein M_2 and the remaining section below displaced inwardly, the 10th band independent, extending along the margin from the apex to vein Cu_2 or just below it in space cu_2, the area between the 8th and 9th bands can be irrigated with blackish scales in some individuals; veins R_{4+5} to Cu_1 are black after meeting the 6th and 7th bands and then divide the whitish-hyaline areas between the 6th to 10th bands into spots. Forewing underside: colour and markings as upperside, but the hyaline areas are glossy. Hindwing triangulate in general, vein M_3 extends into a sword-like tail, termen slightly dented at the end of veins, the ends of spaces m_1 to cu_1 expand like petals. Hindwing upperside: whitish with long white hair covering the inner 1/3; tornal margin blackish, with a small brown androconial patch near the base, a thick black band extends from the costa towards the tornus and joins the tornal blackish area just above two obliquely neighbouring yellow spots; the discal bands incomplete but well developed; the submarginal black band coupled and interrupted by veins Rs and M_1, reaching space rs or $sc+r_1$; the terminal band single, also interrupted by veins Rs and M_1, reaching space rs or $sc+r_1$; despite being interrupted by veins, the ends of each short band in each space touch or directly connect each other; all black bands mentioned above join in the black area at the end of spaces m_2 to cu_1, with a greyish-blue lunule in each space; tail black with white tip. Hindwing underside: colour and markings similar to upperside but with a creamy yellow hue, all black bands and markings well defined, especially the discal band, two black lines twist into an almost "8"-shaped pattern, with a short connection between the rings, the outer half of the upper ring of the "8" yellow and the inner half white, the edge of the lower ring extends along veins M_1 to Cu_1; a square creamy white spot above each greyish-blue lunule in the tornal area, the yellow spots at the tornus somewhat reduced and crowned by fine white lines.

Female: Forewing length: 38.0–45.0 mm (mean = 40.5 ± 1.8 mm, *n* = 30). General appearance similar to male but evidently larger and paler, the underside of forewing less glossy, the 4th black band on the forewing often reduced or even absent in some individuals.

Male genitalia (Figures 23)**:** In total male genitalia of 12 specimens were dissected. Moderately sclerotised. Ring wavy in the upper half; saccus small; distance between the base of socii 0.50–0.64 mm (mean = 0.56 ± 0.05, *n* = 12). Valve round shaped, the dorsal terminal harpe with curved edge and acute tip (less pointed than *daiyuanae* **sp. nov.**); the dorsal subterminal harpe mostly isolated; the medial harpe mostly straight, the dorsal projection bayonet-shaped (some with blunt or serrate tip) (as in *daiyuanae* **sp. nov.**); a variable number of small teeth (0–1) occur in the middle of the medial harpe.

Female genitalia (Figure 24)**:** In total female genitalia of 13 specimens were dissected, the general characters are consistent, with slight variation as mentioned below. Lamella postvaginalis round petal-shaped; lamella antevaginalis broad horizontally, lined with moderately sclerotised longitudinal striae; ostial lobe heavily sclerotised, forming a triangular lobe with sharp end in lateral view, while the posterior margin concave in the

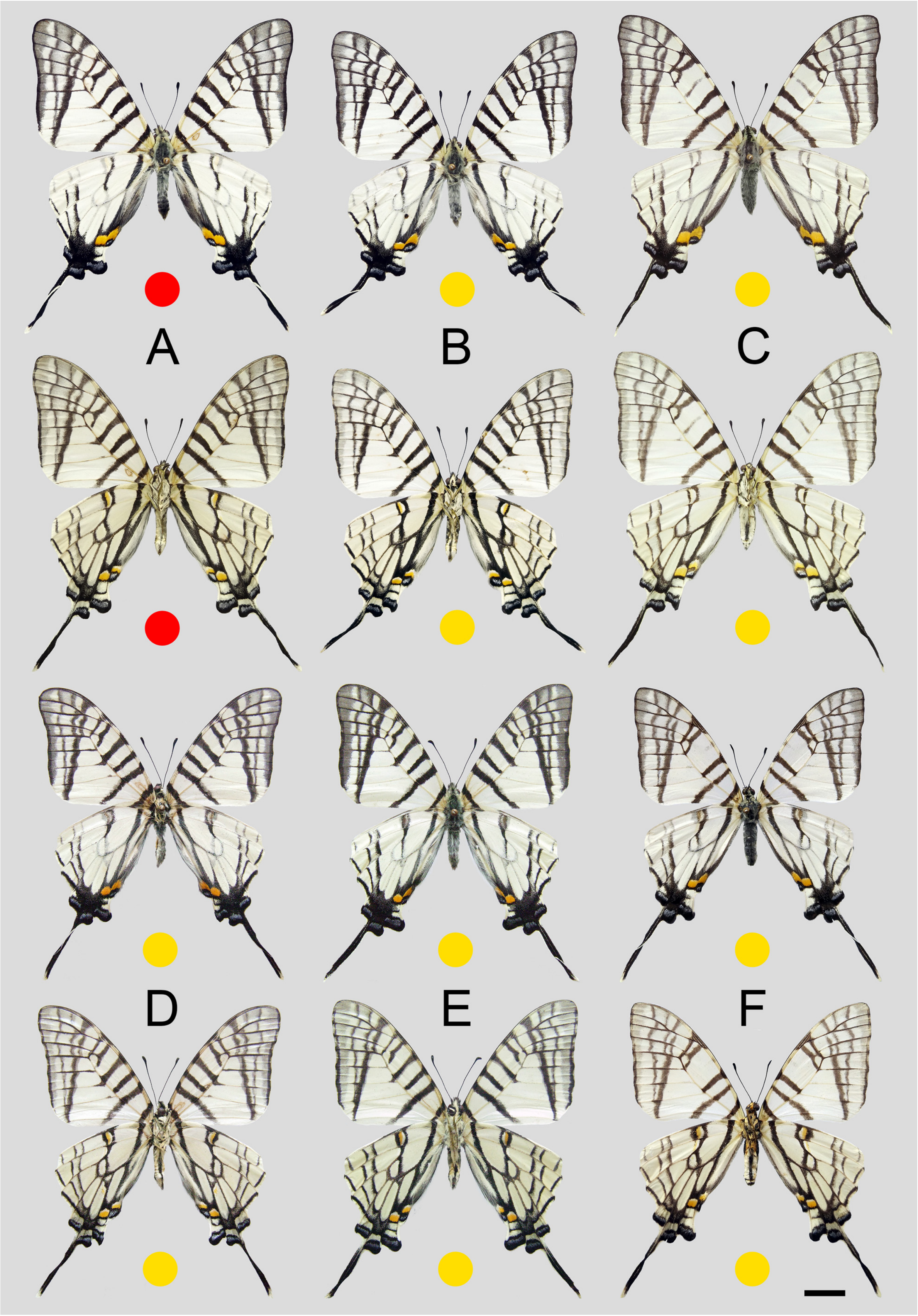

FIGURE 22. *Graphium* (*Pazala*) *confucius* Hu, Duan & Cotton, **sp. nov.**; red dot: holotype, yellow dots: paratypes; upperside on the first row, underside on the second row; A and B: ♂, Kunming, Yunnan, China; C: ♀, Kunming, Yunnan, China; D and E: ♂, Dongchuan, Yunnan, China; F: ♀, Guiyang, Guizhou, China; scale bar = 10 mm.

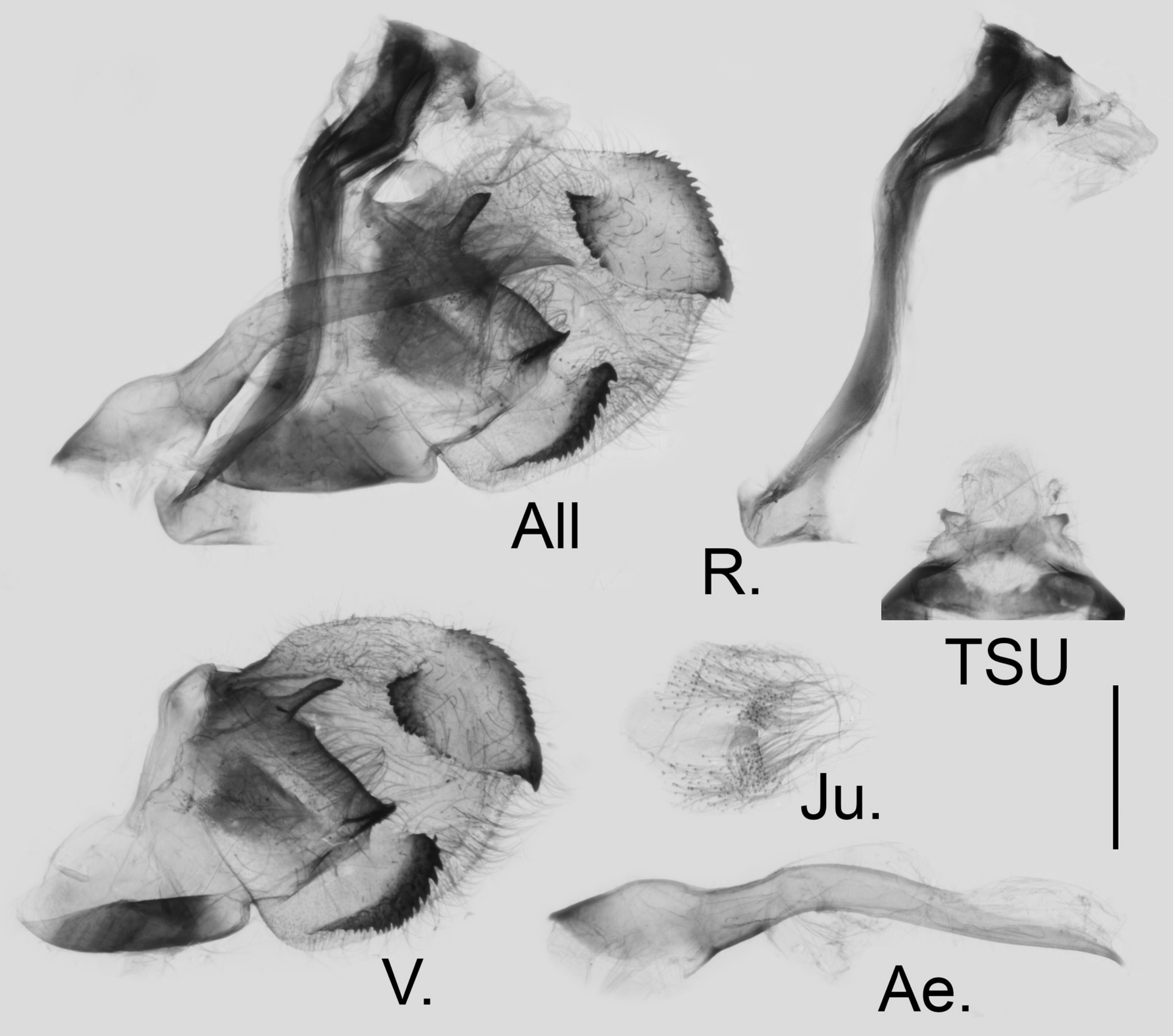

FIGURE 23. Male genitalia of *G.* (*P.*) *confucius* Hu, Duan & Cotton **sp. nov.**, scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

middle, separating it into a "W" shape in ventral view, a short or blunt spur may be present at the end of each triangular part in some specimens, making the end more acute.

Differential Diagnosis: The new species closely resembles *G.* (*P.*) *mandarinus* and *G.* (*P.*) *daiyuanae* sp. n., but can be generally distinguished by the following characters: 1) obviously larger size and distinctly produced forewing apex; 2) the black discal band on the upperside of hindwing well developed; 3) the tornal spots on the underside of hindwing are usually bright yellow. In male genitalia, dorsal subterminal harpe large, almost reaching dorsal terminal harpe and forming a heart-shape, dorsal projection bayonet-shaped (Figures 23), distance between the base of socii 0.50–0.62 mm. The ostial lobe forming a triangular lobe in lateral view, while the middle part of posterior margin concave in a "W" shape in ventral view with a very short or blunt spur at each tip (Figure 24).

Type Material: Holotype: CHINA: ♂, Xi Chong (2,000 m), Kunming, C. Yunnan, 2015–V–31, S. J. Hu leg [KIZ, 0100010].

Paratypes: CHINA: 1♂, Zhujiang Yuan (the headwater of Pearl River), Zhanyi, N.E. Yunnan, 2016–III–19, Z. Chang leg. [SJH]; 1♂, Qingjiang Er Qiao (near G318 highway) (1,500 m), Lianglu, Tianquan, W. Sichuan, 2015–VII–27, Z. B. Chen leg. [ZBC]; 3♂, Huanghu Ping (1,350–1,450 m), Ziyun, Baoxing, W. Sichuan, 2015–VII–15, Z. B. Chen leg. [ZBC]; 1♂, Kouy-Tchéou Abbe Largeteau [leg.], Ex Oberthür Coll., Brit. Mus. 1927—3, Para-lecto-type [round pale blue edged label], **PARALECTOTYPE** [in blue] *Papilo* [sic] *glycerion* var. *Mandarinus*

Oberthür C.R. Smith det. 2003, BMNH(E) #146242 [BMNH]; 1♂, Kouy-Tchéou Abbe Largeteau [leg.], China Kouytcheou [hand written], Pap. glycerion, var. Mandarinus, Oberthür Etud. d' Entomol. IV^{e} livraison - appendice variété géographique chinoise [hand written], Levick Bequest B.M.1941-83, Type [round red edged label], Para-lecto-type [round pale blue edged label], **PARALECTOTYPE** [in blue] *Papilo* [sic] *glycerion* var. *Mandarinus* Oberthür C.R. Smith det. 2003, BMNH(E) #149385 [BMNH]; 1♂, Siao-Lou, 1893, Chasseurs indigènes, Rothschild Bequest, BMNH(E) # 220118 [BMNH]; 1♂, Siao-Lou, 1901, Chasseurs indigènes du P. Déjean, Ex Oberthür Coll., BMNH(E) # 146048 [BMNH]; 1♂, Siao-Lou, 1893, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146063 [BMNH]; 1♂, Siao-Lou, 1893, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146065 [BMNH]; 1♂, Siao-Lou, 1900, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146110 [BMNH]; 1♂, Siao-Lou, 1900, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146101 [BMNH]; 1♂, Siao-Lou, 1900, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146106 [BMNH]; 1♂, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145814 [BMNH]; 1♂, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145820 [BMNH]; 1♂, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145821 [BMNH]; 1♂, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145822 [BMNH]; 1♀, Ichang, Rothschild Bequest, BMNH(E) # 220120 [BMNH]; 1♂, Jinfushan, Exp. Stotzner leg. [ZFMK]; 1♂, Siao-Lou, 1893, Chasseurs indigènes [ZFMK]; 1♂, Rou Bi Gou, Baoxing, Sichuan, 2006–VII–10, Ming Yue leg. [AMC]; 2♂, 1♀, Ya'an, Sichuan, 2006–VII, local catcher leg. [AMC]; 22♂, Wu Shi He, Hanyuan County, Sichuan, 2005–VII–5-20, local catcher leg. [AMC]; 1♂, 1♀, Daba Shan, E Sichuan, 2006–VII, local catcher leg. [AMC]; 1♂, Gioncheng, Guangxi, 1996–VI–17, local catcher leg. [AMC]; 4♂, 1♀, Luzhou, Sichuan, 2007–V, local catcher leg. [AMC]; 2♂, Kangding, Sichuan, 2006–VII, local catcher leg. [AMC]; 1♂, Qingshuilang Shan, Yunlong, W. Yunnan, 1998–VII-VIII, Qin et al leg., ex Coll. Jan Moonen [NBC]; 1♂, Jinxiu, Dayao Shan, Guangxi, 1998–VII-VIII, Liang et al leg., ex Coll. Jan Moonen [NBC]; 2♂, Xi Chong (2,000 m), Kunming, C. Yunnan, 2015–V–19, S. J. Hu leg. [KIZ]; 1♀, ditto, 2015–V–31, S. J. Hu leg. [KIZ, 0100011]; 1♂, Xiao Moyu, Kunming, C. Yunnan, 2015–IV–18, S. J. Hu leg. [SJH]; 2♂, Forest Park (1,570 m), Dongchuan, N.E. Yunnan, 2014–V–17, local catcher leg. [KIZ, 0100012–0100013]; 1♂, the same collecting data, [SJH]; 16♂, 1♀, Luzhou, Sichuan, 2013–VII, local catcher leg. [SJH]; 2♀, Xiaoche He Park, Guiyang, Guizhou, 2013–VI–11, S. J. Hu leg. [SJH]; 1♂, 1♀, Zuogong, E. Tibet, 2013–VI, local catcher leg. [SJH]; 2♂, 3♀, Jigong Shan (1,940 m), Shimian, W. Sichuan, 2013–VI–13, Q. Zeng leg. [SFU]; 3♂, Ziyun Xiang, Baoxing, W. Sichuan, 2012–VIII, local catcher leg. [SJH]; 1♂, Panzhihua, W. Sichuan, 2001–VIII–5, E. T. Ye leg. [SJH]; 1♂, Huize, N.E. Yunnan, 1998–IV, local catcher leg. [SFU]; 1♂, Zhongdian, N.W. Yunnan, 1992–VI–20, D. Z. Dong leg. [KIZ]; 1♂, Qianjiang (1,780), Sichuan, 1989–VII–14, S. Lin leg. [KIZ]; 4♂, Lichuan (800 m), Hubei, 1988–VIII–3, X. C. Liang, D. Z. Dong, and S. Lin leg. [KIZ]; 1♀, Leigong Shan, Guizhou, 1988–VIII–15, S. Lin leg. [KIZ]; 3♂, Emei Shan (1,400 m), W. Sichuan, 1984–IV–13, local catcher leg. [DB]; 1♂, ditto, 1982–IV–13, local catcher leg. [DB]; 1♂, Xi Shan, Kunming, C. Yunnan, 1979–VIII–9, J. Xiong leg. [KIZ]; 1♂, Jinghong, Xishuangbanna, S. Yunnan, 1979–VII–28, D. Z. Dong leg. [KIZ]. VIETNAM: 8♂, 10♀, Sapa (1,500 m), Lao Cai, 2015–V, L. T. Le leg. [SJH], 2♂, Ha Giang, 2008–VII, local catcher leg. [SJH]; 6♂, 8♀, Ha Giang, 2006–V, local catcher leg. [AMC]; 2♂, Ha Giang, 2007–VII, local catcher leg. [AMC]; 1♂, Ha Giang, 2008–VII, local catcher leg. [AMC].

The holotype and three paratypes were deposited in Kunming Institute of Zoology (KIZ), Chinese Academy of Sciences (Li *et al.* 2015).

Distribution: This species is commonly found in China (E. Tibet, Sichuan, Yunnan, Guizhou, Guangxi, Hubei, Hunan, Jiangxi, and Zhejiang); it is also collected from Sapa and Ha Giang, N. Vietnam, which could be the southernmost point of its range.

The two Kouy-Tchéou paralectotypes of *Papilio glycerion* var. *mandarinus* Oberthür actually belong to *G.* (*P.*) *confucius* Hu, Duan & Cotton **sp. nov.**, and are designated as paratypes of the new species above. The precise location of Kouy-Tchéou is unclear. Several alternatives have been included in publications, sometimes stating that the name is equivalent to the modern Guizhou Province, but this seems unusually vague for a locality cited by Oberthür. Racheli & Cotton (2009) stated that Kiunglai [= Qionglai], W. Sichuan is the modern equivalent of Kouy-Tchéou without citing a source, and Racheli (pers. comm.) is unable to recall the origin of this interpretation. Baker (1995) listed a male specimen of *Euaspis basalis* from Kouy-Tchéou, stating the location to be "Kwangsi, Ku-i chou [= Guyi, N. Guangxi], 25°46'N 109°26'E". Since Donald Baker is deceased it was not possible to ascertain the reasoning behind this conclusion; but James Hogan, currently Collections Manager at Oxford

University Museum of Natural History where Baker conducted his study, stated (pers. comm.) that probably this was based on Baker's investigations of the location where Abbé Largeteau (the Catholic missionary cited in Oberthür's original description of *mandarinus*) collected specimens. Hogan stated that Baker was particularly interested in the history of entomology and old collectors, so he may possibly have found evidence to pinpoint the identity of the location. The current authors refrain from choosing a location for Kouy-Tchéou due to lack of precise evidence in favour of any one possibility. All of the alternatives fall within the known range of the new taxon.

Phenology: This species is multivoltine (three generations) in its type locality, the 1st generation flies in late April to early May, the 2nd generation flies from early June to July, and the 3rd generation flies in August. The phenology in other localities requires further study.

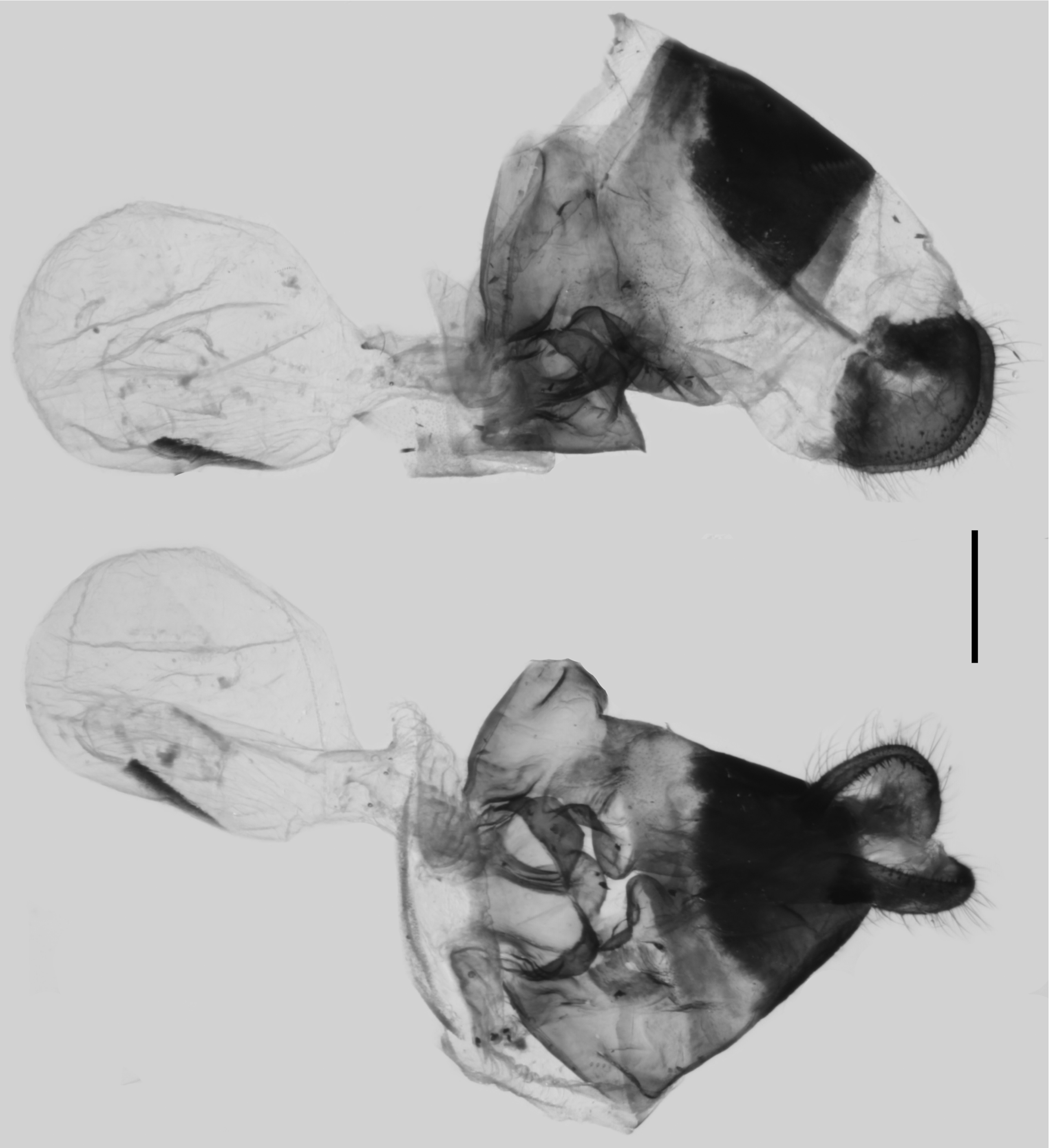

FIGURE 24. Female genitalia of *G.* (*P.*) *confucius* Hu, Duan & Cotton **sp. nov.**; lateral view above, ventral view below; scale bar = 1.0 mm.

Host plant: A female was observed ovipositing on *Litsea rubescens* (Lauraceae) at Xi Shan, Kunming, and the subsequent rearing experiment confirmed the identity of the butterfly. The species may use other plants of genus *Litsea* in other localities across China.

Derivatio nominis: The specific name of this new taxon is dedicated to Confucius (Chinese name Qiu Kong, courtesy name Zhongni; 551–479 BC), a Chinese teacher, editor, politician, and philosopher of the Spring and Autumn Period of Chinese history. The species name is treated as a noun in apposition.

***Graphium* (*Pazala*) *mandarinus* (Oberthür, 1879)**

(Figure 25)

[*Papilio*] *Glycerion* variété géographique *Mandarinus* Oberthür, 1879, Étud. d'Ent., 4: 115; TL: "Moupin" [= Baoxing, W. Sichuan, China]. Type locality restricted to Moupin by lectotype designation as stated above. The name *mandarinus* is treated as a noun meaning a Mandarin rather than an adjective, as recommended by Gerardo Lamas (pers. comm.) since there is no clear indication in the original description.

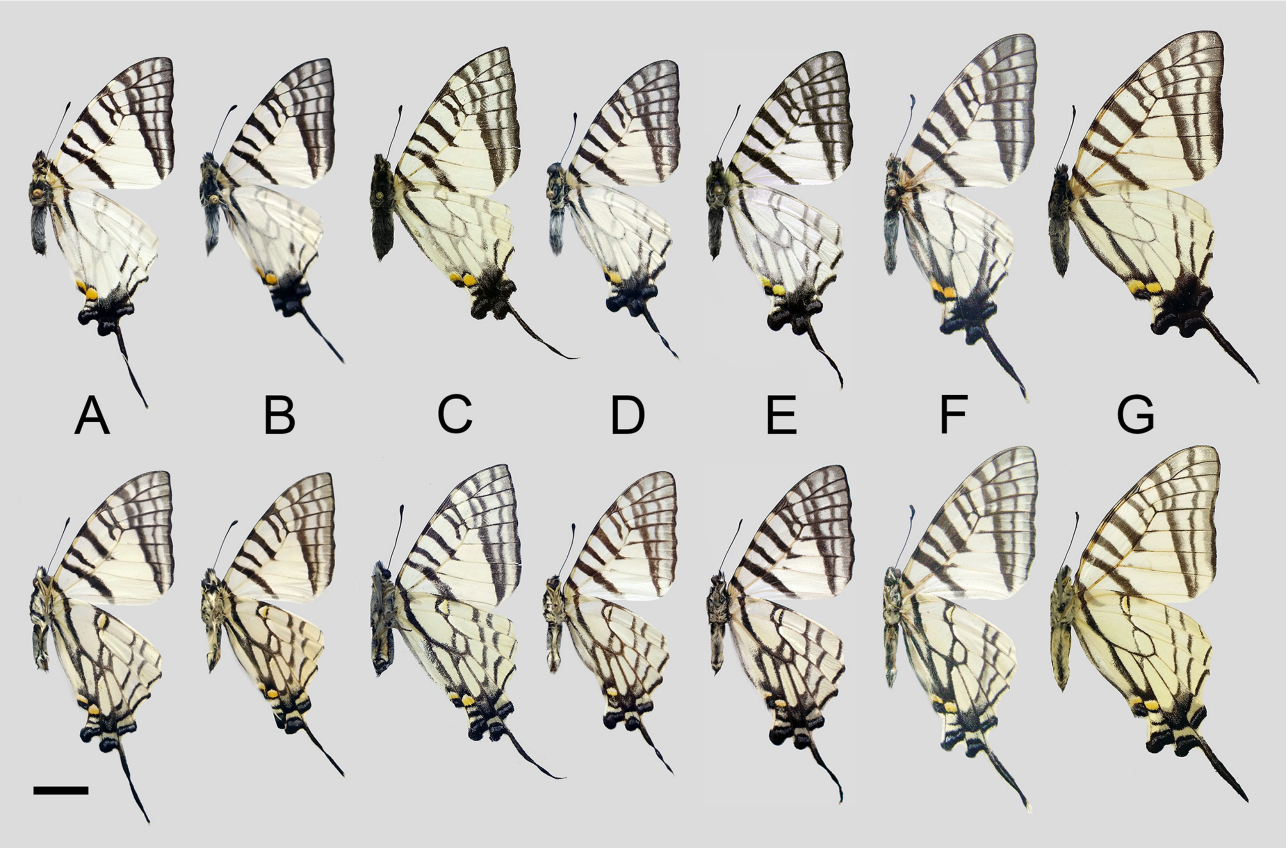

FIGURE 25. Three known subspecies of *G.* (*P.*) *mandarinus* (Oberthür, 1879) from Sichuan and Indo-China; upperside in the first row, underside in the second row; scale bar = 10 mm. A: ssp. *kimurai* Murayama, 1982, ♂, Doi Inthanon, Chiang Mai, N. Thailand; B: ssp. *kimurai* Murayama, 1982, ♂, Mt. Ashaemyinanaukmyin, W. Shan State, Myanmar; C: ditto, ♀; D: ssp. *fangana* (K. Okano, 1986), ♂, Doi Pu Meun, Chiang Mai, N. Thailand; E: ditto, ♀; F: ssp. *mandarinus*, ♂, Baoxing, W. Sichuan. China; G: ssp. *mandarinus*, ♀, Daba Shan, W. Sichuan. China.

Diagnostic characters: Size varies among subspecies, the nominate subspecies is the largest, ssp. *kimurai* very slightly larger than ssp. *fangana* which is the smallest, and ssp. *stilwelli* **ssp. nov.** is intermediate and variable in size, some specimens are quite small and some larger. Both wings whitish and less glossy. Forewing, termen straight or slightly concave in the middle; greyish scales scattered between the 8th and 9th forewing bands. Hindwing, the "8"-shaped twisted discal black bands complete on the underside.

Male genitalia (Figure 26)**:** In total male genitalia of 19 specimens, comprising two individuals of ssp. *fangana*, five individuals of ssp. *kimurai*, six individuals of ssp. *stilwelli* **ssp. nov.**, and six individuals of ssp.

mandarinus, were dissected. Moderately to heavily sclerotised. Ring wavy in the upper half; saccus well developed; distance between the base of socii 0.50–0.64 mm (mean = 0.56 ± 0.05, n = 19), without significant variation between subspecies. Valve round shaped, the dorsal terminal harpe with almost straight edge and acute but not elongate tip (blunt in *sichuanica* and *hoeneanus* nom. nov., stat. rev. and elongate in *garhwalica* stat. nov.); the dorsal subterminal harpe moderate in size (similar to that of *daiyuanae* **sp. nov.**), isolated or reaching the base of the tip of the dorsal terminal harpe (joining the tip of dorsal terminal harpe in *garhwalica* stat. nov.; smaller and completely isolated in *paphus* stat. nov., *sichuanica*, and *hoeneanus* nom. nov., stat. rev.; larger in *confucius* **sp. nov.**), the medial harpe straight, the dorsal projection finger-shaped (some with blunt or serrate end) (similar to that of *paphus* stat. nov. and *daiyuanae* **sp. nov.**; flat in *garhwalica* stat. nov., *sichuanica*, and *hoeneanus* nom. nov., stat. rev.); with or without a small tooth in the middle of the medial harpe.

Female genitalia (Figure 27)**:** In total female genitalia of 4 specimens (including two ssp. *kimurai*, one ssp. *fangana*, and one ssp. *mandarinus*) were dissected, the general characters among subspecies are consistent. Lamella postvaginalis small; lamella antevaginalis broad horizontally, lined with weakly sclerotised longitudinal striae; ostial lobe heavily sclerotised, forming a triangular lobe with sharp end in lateral view, while the posterior margin shallowly concave in the middle, with a small short spur at each tip.

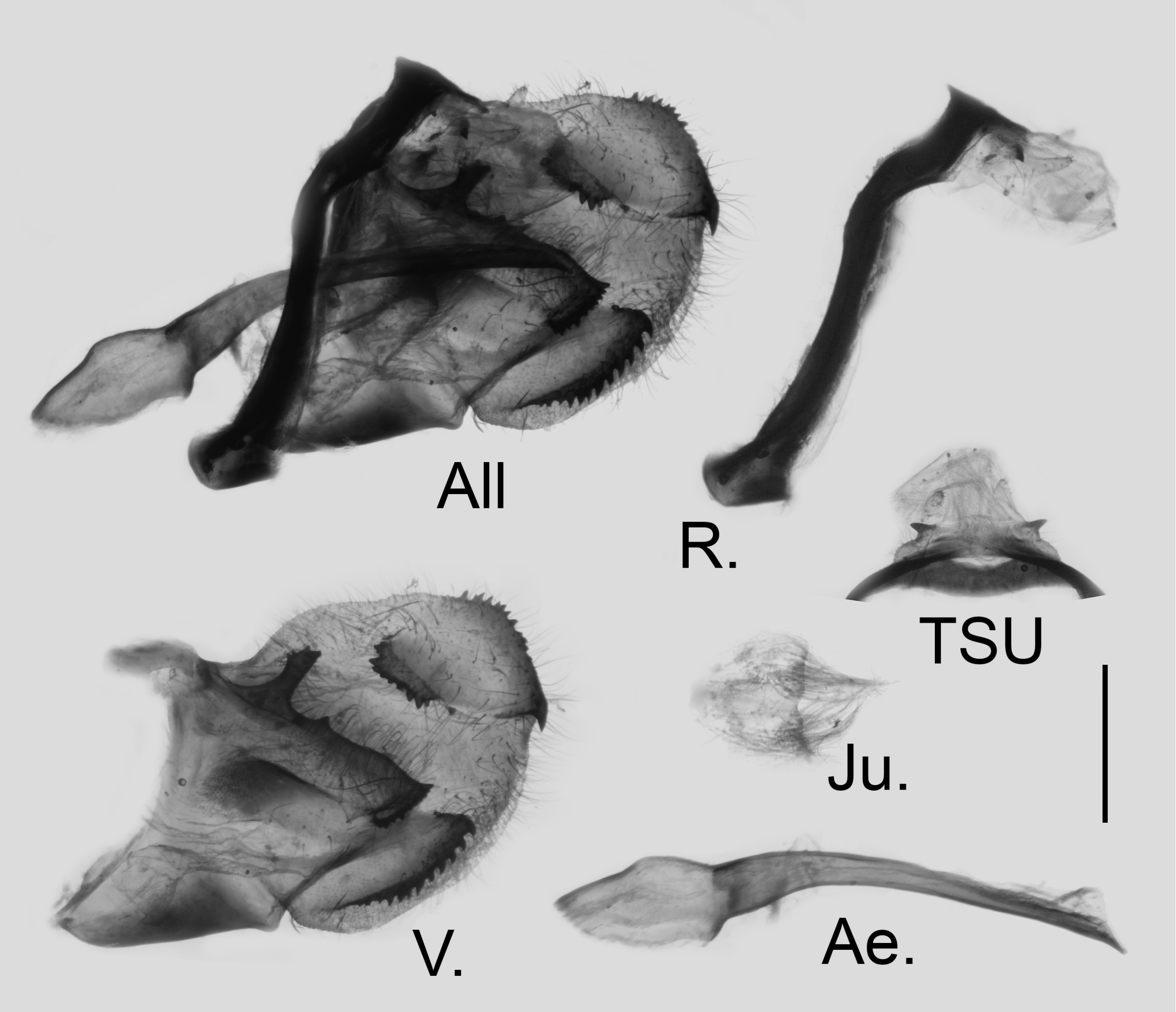

FIGURE 26. Male genitalia of *G.* (*P.*) *mandarinus mandarinus* (Oberthür, 1879) from Baoxing, Sichuan, W. China; scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

Graphium (*Pazala*) *mandarinus kimurai* Murayama, 1982

(Figure 25, A–C)

Graphium glycerion kimurai Murayama, 1982; New Entomologist, 31 (4): 1, f. 1; TL: "Doi Inthanon, N. Thailand" [Doi Inthanon, Chiang Mai Province, N. Thailand].

Diagnostic characters: Very small in size, forewing length: male 27.0–32.0 mm (mean = 29.5 ± 1.4 mm, *n* = 33), female 32.0–33.0 mm (only two females examined). Both wings rather whitish. Forewing, apex acute but not produced, termen straight; veins M_3 to Cu_2 usually free of black scales in male, but with only trace of black in female. Hindwing, black discal band on the upperside usually completely reduced in both sexes, submarginal black short lines also reduced on the upperside in both sexes, only reaching space m_1.

Distribution: C. Myanmar, N. Thailand, and C. Laos.

Phenology: Subspecies *kimurai* flies from late October through the cool season, peaking at the type locality in December and again in February. Whether this is a staggered single generation with two peaks of emergence or represents two separate generations is unknown. Murayama (1982), in the original description of the taxon, also lists two paratypes from Doi Inthanon caught on 7 April 1978 and a third paratype from Thung Salengluang, N. Thailand [= Thung Salaeng Luang National Park, Phitsanulok Province, N. Thailand] with date 10 July 1976. This is the only known record of a specimen of ssp. *kimurai* captured anywhere during the rainy season.

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

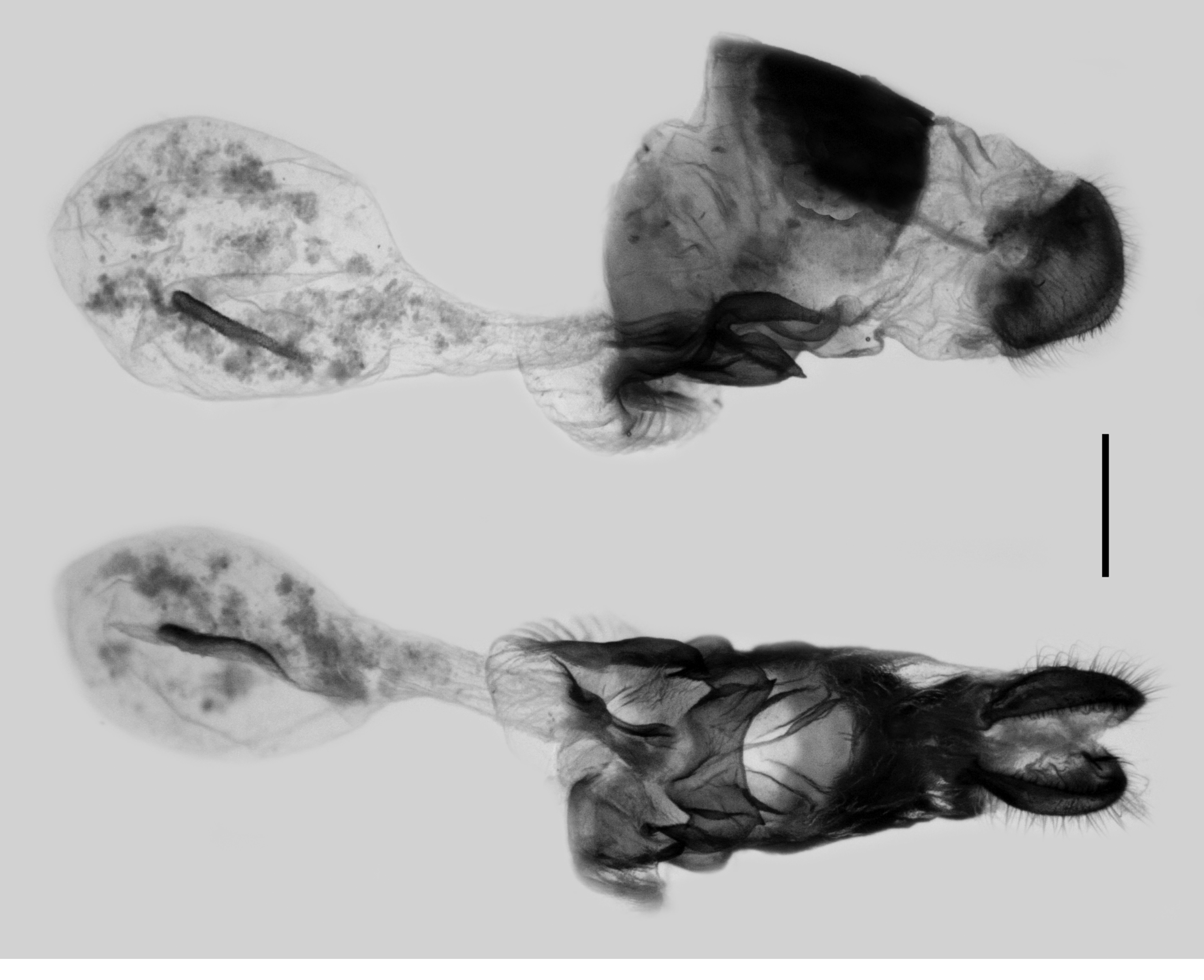

FIGURE 27. Female genitalia of *G.* (*P.*) *mandarinus mandarinus* (Oberthür, 1879) from Daba Shan, Sichuan, W. China; lateral view above, ventral view below; scale bar = 1.0 mm.

***Graphium* (*Pazala*) *mandarinus fangana* (K. Okano, 1986)**

(Figure 25, D and E)

Pazala glycerion fangana K. Okano, 1986; Tokurana, 11 (3): 1, f. 3; TL: "near Fang, alt. 2,200 m, (about 20°20′ N, 99°50′ E), Chieng Mai Prov., North Thailand" [The co-ordinates stated in the original description are inaccurate, the correct co-ordinates are approximately 20°05′ N, 99°08′ E].

Diagnostic characters: Very similar to the preceding subspecies in appearance, forewing length: male 26.0–31.0 mm (mean = 29.2 ± 1.2 mm, *n* = 29), female 32.0 mm (only one female). Forewing, apex slightly blunt, also not produced, termen straight; vein M_3 and the base of vein Cu_1 tinged with black scales in both sexes. Hindwing, submarginal black short lines better developed than the preceding subspecies, which may reach space $sc+r_1$ in some specimens.

Distribution: Only known from a few mountains in northern Thailand near Mae Ai and Fang districts. The restricted range of this taxon effectively inside the potential range of the previous subspecies needs further study. It is notable that ssp. *kimurai* is absent from the mountains where *fangana* occurs, and the taxa are genetically distinct as well as separable on wing pattern.

Phenology: This subspecies is univoltine, flying only in February and March, unlike ssp. *kimurai*. Recently deceased Prasobsuk Sukkit (pers. comm.) confirmed that he and local collectors have looked for ssp. *fangana* throughout the year over many years, and never found it other than in February to March.

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

***Graphium* (*Pazala*) *mandarinus stilwelli* Cotton & Hu ssp. nov.**

(Figure 28)

Description: Male: Forewing length: 29.0–37.0 mm (mean = 33.8 ± 1.5 mm, *n* = 81). Forewing triangulate, apex blunt and not produced, termen straight or slightly concave in the middle. Forewing upperside: whitish, the upper and outer 1/3 (mostly the discocellular, the subterminal, and the terminal areas) hyaline and glossy; 10 black bands between the base and the termen, of which the 1st to the 6th almost run parallel; the 1st and the 2nd bands reach the tornal margin; the 3rd band does not cross the cell vein and the 4th band crosses just beyond the discal cell but usually does not extend along vein CuA_1; the 5th band reaches the margin of the discal cell and usually extends along vein M_3; the 6th band at the end of cell is often connected with the 5th band by a transverse black fine line; the 7th band joins the 8th band just at vein M_2, extends to the tornus and joins the 9th band at vein Cu_2 or just below it in space cu_2; the 9th band curved inward in space r_4; the 10th band independent, extending along the margin from the apex to space cu_2; the area between the 8th and 9th bands without black scales; veins R_{4+5} to Cu_1 are black after meeting the 6th and 7th bands and then divide the whitish-hyaline areas between the 6th to 10th bands into spots. Forewing underside: colour and markings as upperside, but the hyaline areas are glossier. Hindwing triangulate in general, vein M_3 extends into a thin sword-like tail, termen slightly indented at the end of veins, the ends of spaces m_1 to cu_1 expand into lobes. Hindwing upperside: whitish with long white hair covering the inner 1/3; tornal margin blackish, with a small brown androconial patch near the base, a thick black band extends from the costa towards the tornus and joins the tornal blackish area just above two obliquely neighbouring yellow spots; the discal bands absent or indicated by a faint black streak near the cell; the submarginal black band coupled, reaching space rs or m_1; the terminal band single, reaching space $sc+r_1$; despite being interrupted by veins, the ends of each short band in each space touch or directly connect each other; all black bands mentioned above join in the black area at the end of spaces m_2 to cu_1, with a greyish-blue lunule in each space; tail black with white tip. Hindwing underside: colour and markings similar to upperside but with a creamy yellow hue, all black bands and markings well defined, especially the discal band, two black lines twist into an almost "8"-shaped pattern, with a short connection between the rings, the outer half of the upper ring of the "8" pale yellow and the inner half white, the edge of the lower ring extends along veins M_1 to Cu_1; a square creamy white spot above each greyish-blue lunule in the tornal area, the yellow spots at the tornus somewhat reduced and crowned by fine white lines.

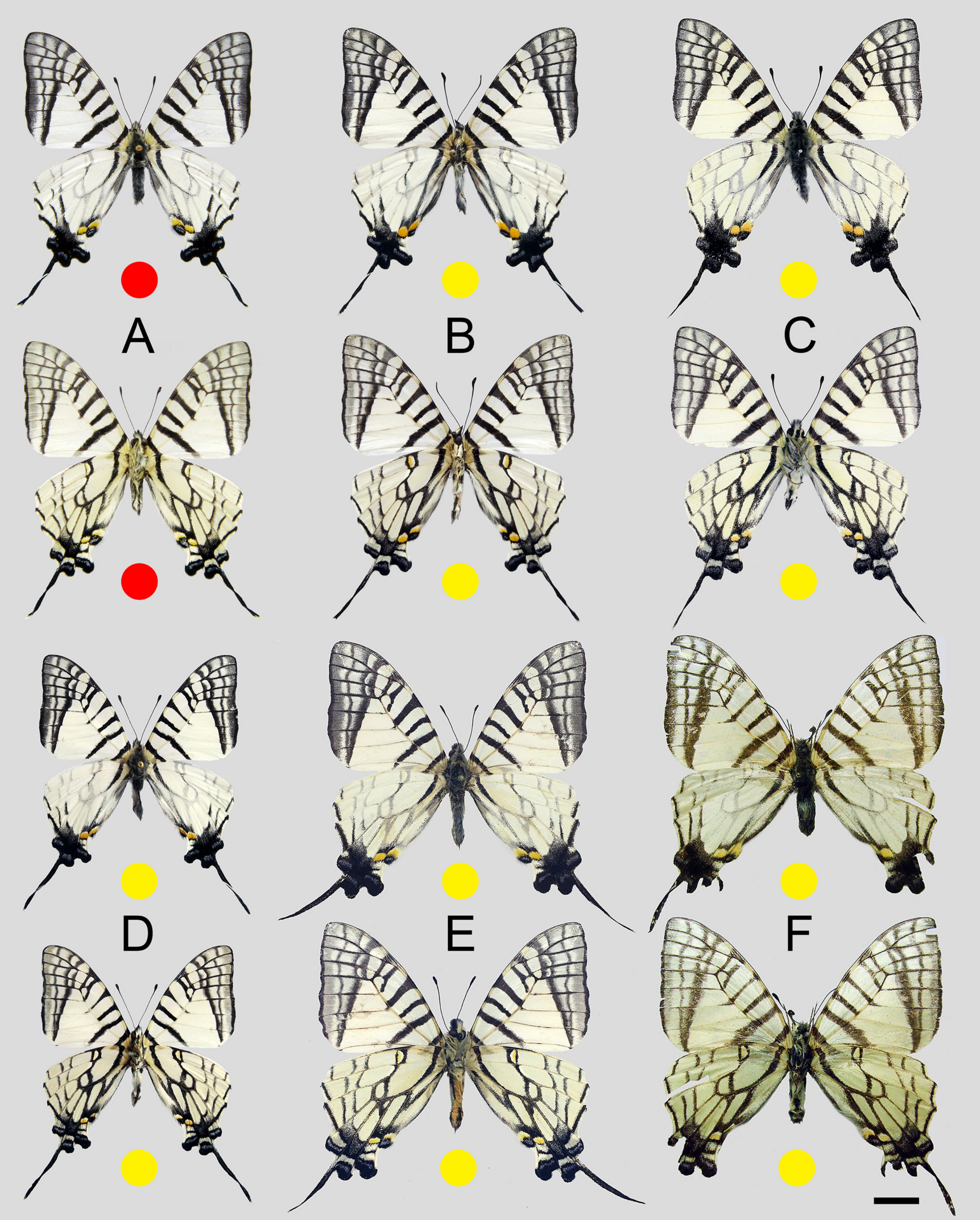

FIGURE 28. *Graphium* (*Pazala*) *mandarinus stilwelli* Cotton & Hu **ssp. nov.**; red dot: holotype, yellow dots: paratypes; upperside on the first row, underside on the second row; A: ♂, Weixi, N.W. Yunnan, China; B: ♂, Yunxian, S.W. Yunnan, China; C: ♂, Tengchong, W. Yunnan, China, © Philip Yik-Fui Lo (Kadoorie Farm and Botanic Garden, Hong Kong, China); D: ♂, Yingjiang, W. Yunnan, China; E: ♂, Chudu Razi Hills, Kachin State, Myanmar; F: ♀, Loutsekiang, © Zoologisches Forschungsinstitute und Museum Alexander Koenig (ZFMK), Bonn, Germany; scale bar = 10 mm.

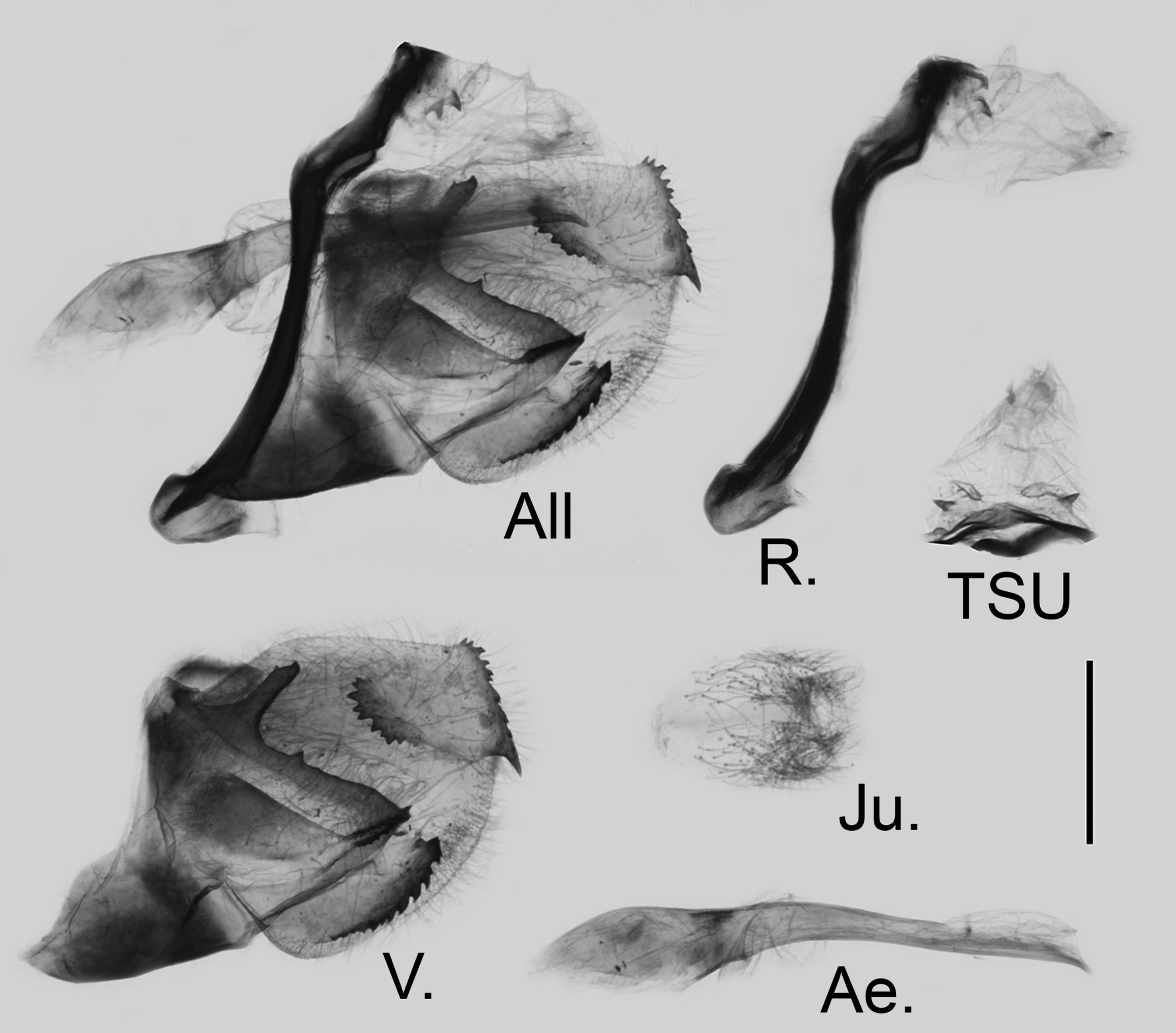

FIGURE 29. Male genitalia of *G.* (*P.*) *mandarinus stilwelli* Cotton & Hu s**sp. nov.** from Tacheng, Weixi, N.W. Yunnan, China; scale bar = 1.0 mm. All: genitalia as a whole, R.: lateral view of ring, TSU: dorsal view of tegumen, socii, and uncus, V. right valve, Ae.: lateral view of aedeagus, Ju.: ventral view of juxta.

Extensive examination and comparison between the new subspecies of *Graphium mandarinus* and *Graphium paphus* stat. nov., which may be sympatric, showed the following difficulties of distinguishing them on morphological characters: (1) variable size: although on average *stilwelli* **ssp. nov.** is smaller than *paphus* stat. nov., the smallest individuals of the latter taxon are almost the same size as the largest individuals of the former, making it rather hard to apply size solely to identify individual specimens; (2) variable shape of forewing termen: generally the middle part of the forewing termen in *paphus* stat. nov. is concave while in all subspecies of *mandarinus* this is straighter, however some individuals of *stilwelli* **ssp. nov.** also showed this character, and some *paphus* stat. nov. have a straight termen. Fortunately, genitalic dissection showed no overlapping characters between the two taxa. Hence, currently, the most reliable method in distinguishing *Graphium paphus* stat. nov. and *Graphium mandarinus stilwelli* **ssp. nov.** is genitalic dissection.

Female: Only a single specimen from Loutsekiang [= upper Salween or upper Mekong valleys (Fisher, 1948), N.W. Yunnan] in ZFMK, Bonn, known to us. Similar to the male, wings broader and more rounded. Forewing length ~40 mm, estimated from photograph (Figure 34F).

Male genitalia (Figure 29)**:** Similar to those of the other three subspecies, namely ssp. *mandarinus*, ssp. *kimurai*, and ssp. *fangana*.

Differential Diagnosis: Intermediate between the nominotypical subspecies, ssp. *kimurai* and ssp. *fangana*, from which it can be distinguished by the following characters: 1) forewing apex blunt, not produced, termen straight or slightly concave in the middle; 2) the postdiscal area of forewing very clear, mostly with only a trace of black scales near the base of vein M_3, although occasionally well marked; 3) the black discal band on the upperside of hindwing absent or indicated before the end of the cell; 4) hindwing submarginal black lines reaching spaces m_1 or $sc+r_1$.

While molecular analysis does not definitively separate this taxon from the nominate subspecies it is morphologically distinct and thus worthy of subspecific status.

Type Material: Holotype: CHINA: ♂, Tacheng (1,900 m), Weixi, W. Yunnan, 2015–IV–29, S. J. Hu leg., [KIZ, 0100008].

Paratypes: CHINA: 1♂, Gazhi River (1,050 m), Yunxian, W. Yunnan, 2016–V–9, Z. C. Xiong leg., [KIZ, 0100009]; 2♂, Gaoligong Shan, Tengchong, W. Yunnan, 2015–V–20, P. Y. F. Lo leg. [SJH]; 1♂, Liuku (100 m), W. Yunnan, 2002–IV–20, unknown leg. [SFU]; 1♂, Zhongdian, N.W. Yunnan, 1992–VI–20, D. Z. Dong leg. [KIZ]; 1♂, Ailao Shan, Jingdong, W. Yunnan, 1992–V–29, D. Z. Dong leg. [KIZ]; 1♂, Xujia Ba, Jingdong, W. Yunnan, 1984–III–16, unknown leg. [KIZ]; 6♂, west of Fugong, NW. Yunnan, 2009–IV–2-29, local catcher leg. [AMC]; 3♂, Pingpo, Dali, Yunnan, 2016–IV–25-V–20, local catcher leg. [AMC]; 1♂, Qingshuilang Shan, Yunlong, W. Yunnan, 1998–VII-VIII, Qin et al. leg., ex Coll. Jan Moonen, [NBC]; 1♀, Loutsekiang [ZFMK]. MYANMAR: 3♂, Chudu Razi Hills, Kachin State, 2008–IV–21, local catcher leg. [SJH]; 1♂, ditto, 2008–IV–23, local catcher leg. [SJH]; 1♂, ditto, 2008–IV–28, local catcher leg. [SJH]; 1♂, ditto, 2008–V–9, local catcher leg. [SJH]; 29♂, ditto, 2008–IV–10-V–5, local catcher leg. [AMC]; 4♂, ditto, 2009–IV–30, local catcher leg. [AMC]; 8♂, ditto, 2007–V–5-9, local catcher leg. [AMC]; 5♂, ditto, 2006–V–9, local catcher leg. [AMC]; 2♂, ditto, 2006–VI–7, local catcher leg. [AMC]; 1m#, ditto, 2012–V–15, local catcher leg. [AMC]; 1m#, ditto, 2012–V–26, local catcher leg. [AMC]; 8♂, Kushin, E. of Renam, N. Kachin State, 1998–IV–25-V–4, local catcher leg. [AMC]; 5♂, ditto, Kushin, E. of Renam, N. Kachin State, 1998–IV–19-27, local catcher leg. [PS].

The holotype and a paratype were deposited in Kunming Institute of Zoology (KIZ), Chinese Academy of Sciences (Li *et al.* 2015).

Distribution: Currently recorded in W. Yunnan and N.E. Myanmar.

Phenology: It appears to be bivoltine based on the collecting data of specimens examined, the first generation from April to June, and the second from July to August. More surveys are required to confirm the phenology.

Host plant: Unknown, presumably a plant species belonging to family Lauraceae.

Derivatio Nominis: The subspecific name of this new taxon is dedicated to General Joseph W. Stilwell (1883–1946) of the U.S. Army, who served in the China Burma India (CBI) Theatre and was instrumental in the liberation of W. Yunnan and Myanmar during World War II. The name is to be treated as a noun in apposition.

Graphium (*Pazala*) *mandarinus mandarinus* (Oberthür, 1879)

(Figure 25, F and G)

[*Papilio*] *Glycerion* variété géographique *Mandarinus* Oberthür, 1879, Étud. d'Ent., 4: 115; TL: "Moupin" [= Baoxing, W. Sichuan, China].

Pazala mandarina; Chou, 1994; Monographia Rhopalocerorum Sinensium: 55, 176 (unjustified emendation).

Diagnostic characters: The largest subspecies of *mandarinus*, forewing length: male 31.0–39.0 mm (mean = 36.4 ± 1.5 mm, *n* = 48), female 39.5 mm (only one female examined). Forewing, apex blunt, not produced, termen straight or slightly concave in the middle; veins M_1 to Cu_2 usually tinged with black scales, especially near the base. Hindwing, black discal band on the upperside well developed in male but often reduced in female, submarginal black short lines well developed on the upperside in both sexes, reaching costa or at least space $sc+r_1$.

Distribution: Sichuan and W. Hubei, China.

Phenology: Probably bivoltine like the preceding subspecies; further surveys are required in future.

Host plant: This subspecies feeds on *Litsea populifolia* (Lauraceae) in W. Sichuan, China (Zhi-Bing Chen, pers. comm.).

Discussion

This study divided the two previously recognised species in the *mandarinus* group into seven species, based on morphological evidence and molecular phylogeny. It is also the first publication to provide photos of female genitalia of subgenus *Pazala*, and a case example for the classification of such morphologically similar species.

After such a revision, it is important to re-establish the distribution range of all *mandarinus* group species. On commencement of our study we recognised two species, *Graphium* (*Pazala*) *mandarinus* as a Sino-Himalayan element with five subspecies, plus *G.* (*P.*) *sichuanica* restricted to China proper (Racheli & Cotton 2009). Our study remapped the distribution range of the seven herein recognised species in the *mandarinus* group (Figure 30), and the pattern can be concluded as follows. 1) The entire species group remains a Sino-Himalayan element, extending from W. Himalaya to E. and S. China and N. Indochina. 2) Strong geographical endemism of taxa was observed: *G.* (*P.*) *garhwalica* stat. nov. in W. Himalaya of N.W. India and Nepal; *G.* (*P.*) *paphus* stat. nov. in E. Himalaya of Nepal, N. India, Bhutan, N.W. Myanmar, and S. Tibet of China; *G.* (*P.*) *sichuanica* in N. Sichuan and N. Hubei of China; *G.* (*P.*) *hoeneanus* nom. nov., stat. rev. in S. to E. China proper; *G.* (*P.*) *daiyuanae* **sp. nov.** currently only known from N. Vietnam; *G.* (*P.*) *confucius* **sp. nov.** in most of C. and W. China and N. Vietnam; and *G.* (*P.*) *mandarinus* in Myanmar, N. Indochina, W. Yunnan, W. Sichuan to N. Hubei of China with four subspecies.

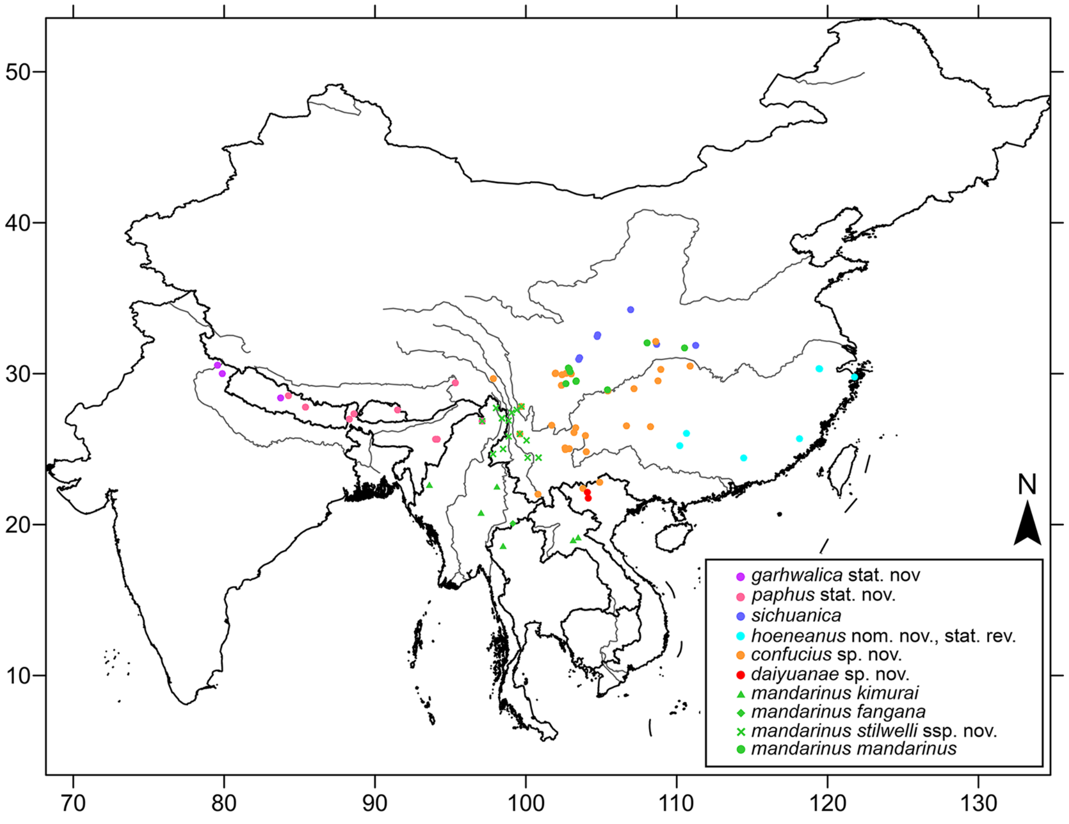

FIGURE 30. Distribution map of the seven species in the *Graphium* (*Pazala*) *mandarinus* group, only the ten relevant countries, comprising India, Nepal, Bhutan, Bangladesh, China, Myanmar, Thailand, Laos, Vietnam, and Cambodia, are shown on this map.

In overall external appearance, the seven species in the *mandarinus* group recognised in this revision are similar, except for the shape of the discal band on the hindwing, which has long been used for distinguishing the old '*mandarinus*' and '*sichuanica*' (Racheli & Cotton 2009). Our analysis of a long series of specimens has discovered that some 'micro' morphological characters, including ground colour (dark or light), the extent of black tinge on forewing veins M_1 to Cu_2, the extent of hindwing subterminal and terminal black bands, the colour of hindwing tornal yellow spots, size (measured as forewing length), and wing shape, can be adopted in association with genitalic structure to distinguish species and subspecies in the *mandarinus* group.

Similar examples were also commonly reported in genera like *Heliophorus* Geyer, 1832 (Riley 1929; Eliot

1963; Yago 2002; Yago *et al*. 2000, 2002), *Ahlbergia* Bryk, 1946, *Novosatsuma* Johnson, 1992, and *Cissatsuma* Johnson, 1992 of Lycaenidae, as well as genera like *Ypthima* Hübner, 1818 (Elwes & Edwards 1893; Shirôzu 1979; Takahashi 2000), *Euthalia* Hübner, [1819] (Yokochi 2010, 2011, 2012), and *Neptis* Fabricius, 1807 (Bozano 2008) of Nymphalidae. Many new taxa were recognised in these butterfly groups in recent decades based on thorough analysis of certain known taxa with wide distribution range and morphological variation (e.g., Huang 1999; Huang 2002; Yago 2002; Yago *et al.* 2002; Yago 2003; Yokochi 2011, 2012; Huang *et al.* 2016; Huang & Sun 2016; Huang & Zhu 2016). Within subgenus *Pazala*, *Graphium* (*Pazala*) *eurous* (Leech, 1893) and *G.* (*P.*) *mullah* (Alphéraky, 1897) also exhibit morphological variation in their distribution range, which in total almost mirror that of the *mandarinus* group (Racheli & Cotton 2009).

The present study benefited largely from molecular biology to highlight and initially distinguish morphologically similar species of the *mandarinus* group. The partial mitochondrial gene (*cox1*) used in our study, namely the 'DNA barcode' sequence, is a powerful tool in identifying biological species (Hebert *et al.* 2003) and unveiling cryptic species (Hebert *et al.* 2004). The 'DNA barcoding' proposed a threshold for species delineation at 2–3% of nucleotide differentiation (K2P distance), and that for subspecies between 1–2% (Hebert *et al.* 2003). In our genetic distance analysis, the distances between most taxon pairs were above the threshold, except for a pair of species, *G.* (*P.*) *daiyuanae* **sp. nov.** and *G.* (*P.*) *confucius* **sp. nov.**, with the K2P distance at 1.71% (Table 2). Nonetheless, the K2P distances between subspecies of *G.* (*P.*) *mandarinus*, except for those related to ssp. *kimurai*, were also under the threshold, ranging from 0.46–0.95% (Table 2). Judging from this criterion solely, it seemed that *daiyuanae* **sp. nov.** and *confucius* **sp. nov.** should be conspecific, and the three subspecies of *mandarinus* were inseparable. However, apart from their constant morphological and genitalic differences between each other, geographical distribution also supplied additional evidence to separate them. We examined specimens of both *daiyuanae* **sp. nov.** and *confucius* **sp. nov.** from Sapa, N. Vietnam, indicating that they cannot be conspecific with such constant morphological and genitalic differences. The geographic range of each of the three subspecies of *mandarinus* is clearly separated from the next, without any cline of morphological transition; therefore, these populations are isolated from each other by geographical barriers such as low altitude areas. Based on the above-mentioned evidence, we were eventually able to separate them as distinct species or subspecies, regardless of limited genetic distances. Similar cases in Asian Papilionidae were also reported for *Papilio maackii* Ménétriès, 1859 vs. *P. syfanius* Oberthür, 1886 and *P. elwesi* Leech, 1889 vs. *P. maraho* Shiraki & Sonan, 1934, subspecies of *Bhutanitis thaidina* (Blanchard, 1871) and *P. bianor* Cramer, 1777 (Tsao & Yeh 2008; Lu *et al.* 2009; Zhu & Wu 2011; Condamine *et al.* 2013b; Zhao *et al.* 2017). Hence, although 'DNA barcoding' is a powerful analytical tool for taxonomy, one must keep in mind that the resolution of that sole short molecular marker can be limited in some congeneric species groups, especially infraspecific taxa. As widely discussed before, morphological, genitalic, and geographical evidence should also be taken into consideration equally with molecular evidence in modern taxonomy (Moritz & Cicero 2004; Will & Rubinoff 2004; Hajibabaei *et al.* 2007).

Limited genetic distances between certain taxa might be explained by our phylogenetic and molecular dating analyses. Using molecular dating, we estimated that the *mandarinus* group originated in the late Miocene (*ca.* 11.8 Ma), and that most phylogenetic events occurred in the late Pliocene to early Pleistocene: the divergence times between *G.* (*P.*) *sichuanica* and *G.* (*P.*) *hoeneanus* nom. nov., stat. nov. occurred *ca.* 2.9 Ma, the divergence times between *G.* (*P.*) *daiyuanae* **sp. nov.** and *G.* (*P.*) *confucius* **sp. nov.** occurred *ca.* 2.6 Ma, and the divergence times of the subspecies complex of *G.* (*P.*) *mandarinus* occurred *ca.* 2.8 Ma (Figure 4). This period was characterised by synchronous speciation in many other terrestrial organisms, as demonstrated by previous works in butterflies (Condamine *et al.* 2013a; Condamine *et al.* 2013b). Such speciation pattern in the late Pliocene and throughout the Pleistocene can be largely attributed to past geological and climatic events such as the change in the Eastern Himalayas or glaciation cycles initiated at the end of the Pliocene (see Sanmartín *et al.* 2001 for a review). Frequent tectonic shifts coupled with climatic oscillations contributed to allopatric (vicariance) divergences either due to physical barriers like mountains and valleys or isolations caused by dispersal within the distribution range of ancestral species. Such pattern of allopatric divergences has likely played the role of an initial driving force of speciation during this period. From the distribution map, we can see that most phylogenetic events that occurred in the late Pliocene throughout the Pleistocene are concentrated in the E. Himalaya—Hengduan Mountains and the adjacent N. Indochinese highlands (Figure 36). This area has been impacted by tectonic shifts and climate oscillations, which could have led to high speciation (Xing & Ree 2017). Taking the subspecies divergence of *G.* (*P.*) *mandarinus* for instance, all infraspecific divergence times estimated by the molecular dating happened between 0.8 and 2.8 Ma, which coincides with tectonic and climatic events that occurred on the region (Lü *et al.* 2014).

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APPENDIX 1. List of *Graphium* (*Pazala*) *mandarinus* group specimens examined.

Names of depositories are given in alphabetical order, with institutions listed after private collections, and are abbreviated as follows: AMC: collection of Adam M. Cotton (Chiang Mai, Thailand); DB: collection of Danny Burk (South Bend, Indiana, USA); SJH: collection of Shao-Ji Hu (Kunming, China); JQZ: collection of Jian-Qing Zhu (Shanghai, China); PKU: Peking University, Beijing, China; PS: collection of Prasobsuk Sukkit (†) (Chiang Mai, Thailand), now housed in AMC collection; PYFL: collection of Philip Yik-Fui Lo (Kadoorie Farm and Botanic Garden, Hong Kong, China); TR: collection of Tommaso Racheli (Rome, Italy); XZ: collection of Xin Zhang (Kunming, China); ZBC: collection of Zhi-Bing Chen (Shanghai, China); BMNH: collections of the Natural History Museum, (London, United Kingdom); KIZ: Kunming Institute of Zoology, Chinese Academy of Sciences (Kunming, Yunnan); NBC: Naturalis Biodiversity Center, Leiden, The Netherlands; SFU: collection of Southwest Forest University (Kunming, China); ZFMK: collection of Zoologisches Forschungsinstitute und Museum Alexander Koenig (Bonn, Germany).

***Graphium* (*Pazala*) *garhwalica* (Katayama, 1988) stat. nov.**

INDIA: 1♂, **PARATYPE**, Joshimath, Uttaranchal, 1987–IV–26, Toshihiko Katayama leg. [AMC]; 1♀, Joshimath, Uttaranchal, 2007–IV–28, Peter Smetacek leg. [AMC].

NEPAL: 1♂, Banthanti, 2300 m., Annapurna District, 1988–V–5-7, Toshihiko Katayama leg. [AMC].

***Graphium* (*Pazala*) *paphus* (de Nicéville, 1886) stat. nov.**

NEPAL: 1♂ **SYNTYPE** [of *Papilio glycerion* Gray, 1831], 'Nepaul, Hardwicke Bequest', BMNH(E) # 149384, [BMNH] [designated as **LECTOTYPE** herein]; 1♂, Shivapuri Hill, 2700 m., Kathmandu, 1988–IV–29-V–2, Toshihiko Katayama leg. [AMC].

CHINA: 2♂, Jiefang Qiao (700–800 m), Bipung, Metok, S.E. Tibet, 2016–IV–15-17, X. W. Zhao leg. [SJH];

INDIA: ♂ **HOLOTYPE** [of *Papilio paphus* de Nicéville, 1886], Sikkim, BMNH(E) # 145642, [BMNH]; 1♂, Air to Gna-tong, Sikkim, 7-12500ft, 1894–IV, Bingham leg., Rothschild Bequest, BMNH(E) # 220230 [BMNH]; 1♂, Sikkim, Dudgeon leg., Moore Bequest [BMNH]; 1♀, Sikkim, 1-4000 ft., Möller leg., Rothschild Bequest [BMNH]; 1♂, Tiger Hill, Darjeeling, 1979–V–19, Yutaka Inayoshi leg. [AMC], 10♂, 1♀, ditto, 1996–IV–21-V–5, Prasobsuk Sukkit leg. [AMC].

MYANMAR: 2♂, Tarung Hka River, N. Sagaing State, 2008–V–6-9, local catcher leg. [SJH]; 1♂, ditto, 2008–IV–28, local catcher leg. [SJH], 8♂, ditto, 2008–IV–22-V–17, local catcher leg. [AMC].

***Graphium* (*Pazala*) *sichuanica* (Koiwaya, 1993)**

CHINA: 1♂, Bashan (Chengkou Xian), Daba Shan Mts. 1600-1900 m, 32° 09' N/ 108° 04' E, 1994–V–9, Native collector leg. [BMNH]; 1♀, Chengkou, Daba Shan, 1994–V–17, local catcher leg. [BMNH]; 1♂, Baokang, Hubei, 1996–V-VI, local catcher leg. [BMNH]; 2♂, Shabazi, Laohegou, Pingwu, N.E. Sichuan, 2013–IV–15, Y. Lei leg., [PKU]; 1♂, Shuijing Ping, Laohegou, Pingwu, N.E. Sichuan, 2013–IV–16, Y. Lei leg., [PKU]; 1♂, Roadside of Shuangshitou, Laohegou, Pingwu, N.E. Sichuan, 2013–IV–16, Q. Wen leg., [PKU]; 4♂, Xiao Hezigou, Laohegou, Pingwu, N.E. Sichuan, 2013–IV–20, J.L. Li leg., [PKU]; 1♂, Xiao Hezigou, Laohegou, Pingwu, N.E. Sichuan, 2013–V–7, Y. Gao leg., [PKU]; 1♂, Zhenggou to Gangou, Laohegou, Pingwu, N.E. Sichuan, 2013–V–9, Y. Lei leg., [PKU]; 3♂, Sigou, Tangjiahe, Qingchuan, N. Sichuan, 2014–IV–16, D. Zhang & C. Fan leg., [PKU]; 4♂, Guozishugou, Tangjiahe, Qingchuan, N. Sichuan, 2014–IV–18, D. Zhang & C. Fan leg., [PKU]; 2♂, Shibangou, Tangjiahe, Qingchuan, N. Sichuan, 2014–IV–19, D. Zhang & C. Fan leg., [PKU]; 1♂, Xiao Hewankou, Tangjiahe, Qingchuan, N. Sichuan, 2014–V–4, C. Fan leg., [PKU]; 1♂, Baixiong Ping, Tangjiahe, Qingchuan, N. Sichuan, 2014–V–5, C. Fan leg., [PKU]; 3♂, ditto, 2014–V–17, C. Fan leg., [PKU]; 1♂, Shibangou, Tangjiahe, Qingchuan, N. Sichuan, 2014–V–18, C. Fan leg., [PKU]; 1♀, ditto, 2014–V–18, C. Fan leg., [PKU].

***Graphium* (*Pazala*) *hoeneanus* Cotton & Hu nom. nov., stat. rev.**

CHINA: 1♂ **SYNTYPE** [of *Papilio tamerlanus hoenei* Mell, 1935], Ost Tien Mu Shan, 1500 m., Prov. Chekiang, 1931–IV–18, H. Höne leg., BMNH(E) # 149381, [BMNH]; 1♂ **SYNTYPE** [of *Papilio tamerlanus hoenei* Mell, 1935], Ost Tien Mu Shan, Prov. Chekiang, 1931–IV–16, H. Höne leg. [TR]; 24♂ **SYNTYPES** [of *Papilio tamerlanus hoenei* Mell, 1935], Ost

Tien Mu Shan, Prov. Chekiang, 1931–IV–6-V–16, H. Höne leg. [ZFMK]; 6♂ **SYNTYPES** [of *Papilio tamerlanus hoenei* Mell, 1935], West Tien Mu Shan, Prov. Chekiang, 1931–IV–20-29, H. Höne leg. [ZFMK]; 4♂, Lingui (360 m), Guilin, Guangxi, 2013–IV–22, local catcher leg. [SJH]; 5♂, Lingui County, Guilin, Guangxi, 2013–III, local catcher leg. [AMC]; 15♂ Yue Cheng Ling, 1000 m., Ziyuan (Dahe), Guangxi, 2007–IV-V, local catcher leg. [AMC]; 1♂, W. Tianmu Shan (400 m), Zhejiang, 2009–IV–10, J. Q. Zhu leg. [JQZ]; 2♂, W. Tianmu Shan (350 m), Zhejiang, 2009–IV–11, J. Q. Zhu leg. [SJH]; 1♀, W. Tianmu Shan, Zhejiang, 2009–IV–21 (reared), J. Q. Zhu leg. [JQZ]; 2♂, W. Tianmu Shan (400 m), Zhejiang, 2009–V–7, J. Q. Zhu leg. [JQZ]; 3♂, 1♀, Ningbo, Zhejiang, 2009–IV–18, J. Q. Zhu leg. [JQZ]; 3♂, 1♀, Tiantong (400 m), Ningbo, Zhejiang, 2008–IV–8, J. Q. Zhu leg. [JZQ]; 2♂, 1♀, W. Tianmu Shan (400 m), Zhejiang, 2008–IV–24-25, J. Q. Zhu leg. [JQZ].

***Graphium* (*Pazala*) *daiyuanae* Hu, Zhang & Cotton sp. nov.**

VIETNAM: ♂ **HOLOTYPE**, Sapa (1,600 m), Lao Cai Province, 2015–VI, L. T. Le leg. [KIZ, 0100000]; 3♂, 2♀ **PARATYPES**, same collecting data as holotype (1,600–1,700 m) [KIZ]; 8♂, 8♀ **PARATYPES**, same collecting data as holotype (1,600–1,700 m) [SJH]; 1♂, 4♀ **PARATYPES**, Sapa, Lao Cai Province, 2006–IV, local catcher leg. [AMC], 2♂ **PARATYPES**, ditto, 2007–V, local catcher leg. [AMC], 1♂ **PARATYPE**, ditto, 2007–VI, local catcher leg. [AMC]. 2♂ **PARATYPES**, Mucangchai (1,700 m), Yen Bai Province, 2017–V, L. T. Le leg. [KIZ, 0100006–0100007]; 3♂, 1♀ **PARATYPES**, same collecting data, [SJH].

***Graphium* (*Pazala*) *confucius* Hu, Duan & Cotton sp. nov.**

CHINA: 1♂ **HOLOTYPE**, Xi Chong (2,000 m), Kunming, C. Yunnan, 2015–V–31, S. J. Hu leg. [KIZ, 0100010]; 1♂ **PARATYPE**, Zhujiang Yuan (the headwater of Pearl River), Zhanyi, N.E. Yunnan, 2016–III–19, Z. Chang leg. [SJH]; 1♂ **PARATYPE**, Qingjiang Er Qiao (near G318 highway) (1,500 m), Lianglu, Tianquan, W. Sichuan, 2015–VII–27, Z. B. Chen leg. [ZBC]; 3♂ **PARATYPES**, Huanghu Ping (1,350–1,450 m), Ziyun, Baoxing, W. Sichuan, 2015–VII–15, Z. B. Chen leg. [ZBC]; 2♂ **PARATYPE**, Xi Chong (2,000 m), Kunming, C. Yunnan, 2015–V–19, S. J. Hu leg. [SJH]; 1♀ **PARATYPES**, ditto, 2015–V–31, S. J. Hu leg. [KIZ, 0100011]; 1♂ **PARATYPE**, Xiao Moyu, Kunming, C. Yunnan, 2015–IV–18, S. J. Hu leg. [SJH]; 2♂ **PARATYPES**, Forest Park (1,570 m), Dongchuan, N.E. Yunnan, 2014–V–17, local catcher leg. [KIZ, 0100012–0100013]; 1♂ **PARATYPES**, the same collecting data, [SJH]; 6♂, 1♀ **PARATYPES**, Luzhou, Sichuan, 2013–VII, local catcher leg. [SJH]; 2♀ **PARATYPES**, Xiaoche He Park, Guiyang, Guizhou, 2013–VI–11, S. J. Hu leg. [SJH]; 1♂, 1♀ **PARATYPES**, Zuogong, E. Tibet, 2013–VI, local catcher leg. [SJH]; 2♂, 3♀ **PARATYPES**, Jigong Shan (1,940 m), Shimian, W. Sichuan, 2013–VI–13, Q. Zeng leg. [SFU]; 3♂ **PARATYPES**, Ziyun Xiang, Baoxing, W. Sichuan, 2012–VIII, local catcher leg. [SJH]; 1♂ **PARATYPE**, Panzhihua, W. Sichuan, 2001–VIII–5, E. T. Ye leg. [SJH];_1♂ **PARATYPE**, Huize, N.E. Yunnan, 1998–IV, local catcher leg. [SFU]; 1♂ **PARATYPE**, Zhongdian, N.W. Yunnan, 1992–VI–20, D. Z. Dong leg. [KIZ]; 1♂ **PARATYPE**, Qianjiang (1,780), Sichuan, 1989–VII–14, S. Lin leg. [KIZ]; 4♂ **PARATYPES**, Lichuan (800 m), Hubei, 1988–VIII–3, X. C. Liang, D. Z. Dong, and S. Lin leg. [KIZ]; 1♀ **PARATYPE**, Leigong Shan, Guizhou, 1988–VIII–15, S. Lin leg. [KIZ]; 3♂ **PARATYPES**, Emei Shan (1,400 m), W. Sichuan, 1984–IV–13, local catcher leg. [DB]; 1♂ **PARATYPE**, ditto, 1982–IV–13, local catcher leg. [DB]; 1♂ **PARATYPE**, Xi Shan, Kunming, C. Yunnan, 1979–VIII–9, J. Xiong leg. [KIZ]; 1♂ **PARATYPE**, Jinghong, Xishuangbanna, S. Yunnan, 1979–VII–28, D. Z. Dong leg. [KIZ]; 1♂ **PARATYPE**, Kouy-Tchéou Abbe Largeteau [leg.], Ex Oberthür Coll., Brit. Mus. 1927—3, Para-lecto-type [round pale blue edged label], **PARALECTOTYPE** [in blue] *Papilo* [sic] *glycerion* var. *Mandarinus* Oberthür C.R. Smith det. 2003, BMNH(E) #146242 [BMNH]; 1♂ **PARATYPE**, Kouy-Tchéou Abbe Largeteau [leg.], China Kouytcheou [hand written], Pap. glycerion, var. Mandarinus, Oberthür Etud. d' Entomol. IV^{e} livraison - appendice variété géographique chinoise [hand written], Levick Bequest B.M.1941-83, Type [round red edged label], Para-lecto-type [round pale blue edged label], **PARALECTOTYPE** [in blue] *Papilo* [sic] *glycerion* var. *Mandarinus* Oberthür C.R. Smith det. 2003, BMNH(E) #149385 [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1893, Chasseurs indigènes, Rothschild Bequest, BMNH(E) # 220118, [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1901, Chasseurs indigènes du P. Déjean, Ex Oberthür Coll., BMNH(E) # 146048, [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1893, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146063, [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1893, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146065, [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1900, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146110, [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1900, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146101, [BMNH]; 1♂ **PARATYPE**, Siao-Lou, 1900, Chasseurs indigènes, Ex Oberthür Coll., BMNH(E) # 146106, [BMNH]; 1♂ **PARATYPE**, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145814, [BMNH]; 1♂ **PARATYPE**, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145820, [BMNH]; 1♂ **PARATYPE**, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145821, [BMNH]; 1♂ **PARATYPE**, Chasseurs indigènes de Ta-tsien-lou. Récolte de 1910, Ex Oberthür Coll., BMNH(E) # 145822, [BMNH]; 1♀ **PARATYPE**, Ichang, Rothschild Bequest, BMNH(E) # 220120, [BMNH]; 1♂ **PARATYPE**, Jinfushan, Exp. Stotzner leg. [ZFMK]; 1♂ **PARATYPE**, Siao-Lou, 1893, Chasseurs indigènes [ZFMK]; 1♂ **PARATYPE**, Rou Bi Gou, Baoxing, Sichuan, 2006–VII–10, Ming Yue leg. [AMC]; 2♂, 1♀ **PARATYPES**, Ya'an, Sichuan, 2006–VII, local catcher leg. [AMC]; 22♂ **PARATYPES**, Wu Shi He, Hanyuan County, Sichuan, 2005–VII–5-20, local catcher leg. [AMC]; 1♂, 1♀ **PARATYPES**, Daba Shan, E Sichuan, 2006–VII, local catcher leg. [AMC]; 1♂ **PARATYPE**, Gioncheng, Guangxi, 1996–VI–17, local catcher leg. [AMC]; 4♂, 1♀ **PARATYPES**, Luzhou, Sichuan, 2007–V, local catcher leg. [AMC]; 2♂ **PARATYPES**, Kangding, Sichuan, 2006–VII, local catcher leg. [AMC]; 1♂ **PARATYPE**, Qingshuilang Shan, Yunlong, W. Yunnan, 1998–VII-VIII, Qin et al leg., ex Coll. Jan Moonen [NBC]; 1♂ **PARATYPE**, Jinxiu, Dayao Shan, Guangxi, 1998–VII-VIII, Liang et al leg., ex Coll. Jan Moonen [NBC].

VIETNAM: 8♂, 10♀ **PARATYPES**, Sapa (1,500 m), Lao Cai, 2015–V, L. T. Le leg. [SJH]; 2♂ **PARATYPES**, Ha Giang, 2008–VII, local catcher leg. [SJH]; 6♂, 8♀ **PARATYPES**, Ha Giang, 2006–V, local catcher leg. [AMC]; 2♂ **PARATYPES**, Ha Giang, 2007–VII, local catcher leg. [AMC]; 1♂ **PARATYPE**, Ha Giang, 2008–VII, local catcher leg. [AMC].

***Graphium* (*Pazala*) *mandarinus kimurai* Murayama, 1982**

LAOS: 3♂, Nam Cha (1250 m), ~5 km N of Xaysomboun, 2006–II–28, Hiroyuki Wakahara leg. [AMC].

MYANMAR: 1♂, Mt. Kennedy, N. Chin State, 2000–III–21, local catcher leg. [AMC]; 1♂, ditto, 2000–V–5, local catcher leg. [AMC]; 5♂, Mt. Ashaemyinanaukmyin (2,363 m), W. Shan State, 2008–III–18-22, local catcher leg. [SJH]; 11♂, 2♀, ditto, 2008–III–15-29, local catcher leg. [AMC]; 1♂, Mong Pat, N. Shan State, 2000–III–20, local catcher leg. [AMC].

THAILAND: 1♂, Doi Internon [sic], North Thailand, 1985–II–10, K. Okano leg., BMNH(E) # 220231 [BMNH]; 2♂, Doi Inthanon (2200 m), Chiang Mai Province, 1976–XII–4-5, Bro. Amnuay Pinratana leg. [AMC]; 5♂, Observatory entry road (2,446 m), Doi Inthanon, Chiang Mai Province, 2012–XII–14, local catcher leg. [SJH]; 5♂, ditto, 2012–XII–14-15, local catcher leg. [AMC].

***Graphium* (*Pazala*) *mandarinus fangana* (K. Okano), 1986**

THAILAND: 2♂, Doi Pu Meun, Chiang Mai, 2007–II, local catcher leg. [SJH]; 1♂1♀, ditto, 2016–III, local catcher leg. [SJH]; 1♂, ditto, 1989–II, local catcher leg. [AMC]; 3♂, ditto, 1990–II, local catcher leg. [AMC]; 4♂, ditto, 1992–III, Prasobsuk Sukkit leg. [AMC]; 3♂, ditto, 1988–II–10-14, local catcher leg. [AMC]; 5♂, ditto, 2002–II, local catcher leg. [AMC]; 3♂, ditto, 2007–II, local catcher leg. [AMC]; 4♂, ditto, 2013–II–26, Prasobsuk Sukkit leg. [AMC]; 1♂, Chiang Mai, 1989–II, local catcher leg., ex Coll. Jan Moonen [NBC].

***Graphium* (*Pazala*) *mandarinus stilwelli* Cotton & Hu ssp. nov.**

CHINA: 1♂ **HOLOTYPE**, Tacheng (1,900 m), Weixi, W. Yunnan, 2015–IV–29, S. J. Hu leg. [KIZ, 0100008]; 1♂ **PARATYPE**, Gazhi River (1,050 m), Yunxian, Lincang, S.W. Yunnan, 2016–V–9, Z. C. Xiong leg. [KIZ, 0100009]; 2♂ **PARATYPES**, Gaoligong Shan, Tengchong, W. Yunnan, 2015–V–20, P. Y. F. Lo leg. [SJH]; 1♂ **PARATYPE**, Liuku (100 m), W. Yunnan, 2002–IV–20, unknown leg. [SFU]; 1♂ **PARATYPE**, Zhongdian, N.W. Yunnan, 1992–VI–20, D. Z. Dong leg. [KIZ]; 1♂ **PARATYPE**, Ailao Shan, Jingdong, W. Yunnan, 1992–V–29, D. Z. Dong leg. [KIZ]; 1♂ **PARATYPE**, Xujia Ba, Jingdong, W. Yunnan, 1984–III–16, unknown leg. [KIZ]; 6♂ **PARATYPES**, west of Fugong, NW. Yunnan, 2009–IV–2-29, local catcher leg. [AMC]; 3♂ **PARATYPES**, Pingpo, Dali, Yunnan, 2016–IV–25-V–20, local catcher leg. [AMC]; 1♂ **PARATYPE**, Qingshuilang Shan, Yunlong, W. Yunnan, 1998–VII-VIII, Qin et al leg., ex Coll. Jan Moonen, [NBC]; 1♀ **PARATYPE**, Loutsekiang [ZFMK].

MYANMAR: 3♂ **PARATYPES**, Chudu Razi Hills, Kachin State, 2008–IV–21, local catcher leg. [SJH]; 1♂ **PARATYPE**, ditto, 2008–IV–23, local catcher leg. [SJH]; 1♂ **PARATYPE**, ditto, 2008–IV–28, local catcher leg. [SJH]; 1♂ **PARATYPE**, ditto, 2008–V–9, local catcher leg. [SJH]; 29♂ **PARATYPES**, ditto, 2008–IV–10-V–5, local catcher leg. [AMC]; 4♂ **PARATYPES**, ditto, 2009–IV–30, local catcher leg. [AMC]; 8♂ **PARATYPES**, ditto, 2007–V–5-9, local catcher leg. [AMC]; 5♂ **PARATYPES**, ditto, 2006–V–9, local catcher leg. [AMC]; 2♂ **PARATYPES**, ditto, 2006–VI–7, local catcher leg. [AMC]; 8♂ **PARATYPES**, Kushin, E. of Renam, N. Kachin State, 1998–IV–25-V–4, local catcher leg. [AMC]; 1m# **PARATYPE**, ditto, 2012–V–15, local catcher leg. [AMC]; 1m# **PARATYPE**, ditto, 2012–V–26, local catcher leg. [AMC]; 5♂ **PARATYPES**, ditto, Kushin, E. of Renam, N. Kachin State, 1998–IV–19-27, local catcher leg. [PS].

***Graphium* (*Pazala*) *mandarinus mandarinus* (Oberthür, 1879)**

CHINA: 1♂, **LECTOTYPE**, Moupin [=Baoxing, Sichuan], A. David leg., ex Oberthür Coll., BMNH(E) # 146241 [BMNH]; 7♂, Ziyun, Baoxing, W. Sichuan, 2012–VIII, local catcher leg. [SJH]; 2♂, Lokshan [= Leshan], W. Sichuan, 1991–VI–15, local catcher leg. [DB]; 1♂, Rou Bi Gou, Baoxing, Sichuan, 2006–V–19, Ming Yue leg. [AMC]; 1♂, ditto, 2006–VII–16, Ming Yue leg. [AMC]; 6♂, ditto, 2006–VIII–10, Ming Yue leg. [AMC]; 23♂, Lu Shan, 800-1500 m, Sichuan, 2006–IV–15-20, local catcher leg. [AMC]; 2♂, Emei Shan, Sichuan, 1996–VI, local catcher leg. [AMC]; 1♂, Ya'an, Sichuan, 2007–IV, local catcher leg. [AMC]; 4♂, Wu Shi He, Hanyuan County, Sichuan, 2005–VII–5-20, local catcher leg. [AMC]; 2♂, 1♀, Daba Shan, E Sichuan, 2006–VII, local catcher leg. [AMC]; 1♂, Luzhou, Sichuan, 2007–V, local catcher leg. [AMC]; 2♂, Songbai (S. of Fang Xian), 1800 m, Shennongjia, W. Hubei, 1998–VI–1-18, Tang leg., ex Coll. Jan Moonen [NBC]; 1♂, Lu Shan, Baoxing, Sichuan, 1999–VII, Wan leg., ex Coll. Jan Moonen [NBC]; 1♂, Fongtongzhai, Baoxing, Sichuan, 1998–VII-1-15, Wan et al. leg., ex Coll. Jan Moonen [NBC].