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Taxonomic notes on the antlion tribe Myrmeleontini Latreille (Neuroptera, Myrmeleontidae, Myrmeleontinae) from Pakistan, with description of a new species

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Abstract. A new species of the myrmeleontine antlion genus *Baliga* Navás, 1912 (Neuroptera: Myrmeleontidae), *Baliga kashmirensis* sp. nov., from Azad Kashmir and Khyber Pakhtunkhwa Province of Pakistan is described and illustrated, representing the first record of *Baliga* from Pakistan. Three species of *Myrmeleon* Linnaeus, 1767 are re-described: *M. hyalinus hyalinus* Olivier, 1811, *M. tenuipennis* Rambur, 1842, and *M. trivialis* Gerstaecker, 1885. *Myrmeleon bimaculatus* Yang, 1999 syn. nov. originally described from China is considered to be a junior synonym of *Myrmeleon tenuipennis* Rambur, 1842. In addition, an annotated catalogue of all species of *Myrmeleon* known from Pakistan along with their distribution map, taxonomical notes and updated identification key to known genera and species are provided.

Keywords. Antlion, lacewings, new taxa, Oriental Region, Kashmir.

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Introduction

The tribe Myrmeleontini Latreille, 1802 is the most species-rich tribe of the subfamily Myrmeleontinae (Neuroptera: Myrmeleontidae), and currently comprises ten genera, i.e., *Australeon* Miller & Stange, 2012, *Baliga* Navás, 1912, *Dictyoleon* Esben-Petersen, 1923, *Euroleon* Esben-Petersen, 1919, *Hagenomyia* Banks, 1911, *Kirghizoleon* Krivokhatsky & Zakharenko, 1994, *Megistoleon* Navás, 1931, *Myrmeleon* Linnaeus, 1767, *Porrerus* Navás, 1913, and *Weeleus* Navás, 1912, and 228 described species (Machado *et al.* 2019; Hayashi *et al.* 2020). Among these, *Myrmeleon* is the only cosmopolitan antlion genus and comprises the highest proportion of species, with 189 extant described species (Machado *et al.* 2019). *Myrmeleon* is the only genus of Myrmeleontini known from Pakistan, including eight

species that are widely distributed throughout the Oriental and Palearctic parts of the country (Iqbal & Yousuf 1997; Akhtar *et al.* 2018; Hassan *et al.* 2019).

An interesting result in the recent phylogenetic analysis of Myrmeleontidae by Machado *et al.* (2019) suggested that *Baliga*, *Hagenomyia*, together with six genera (*Australeon*, *Dictyoleon*, *Euroleon*, *Kirghizoleon*, *Megistoleon,* and *Weeleus*) are potential synonyms of *Myrmeleon*. The results of Machado *et al.* (2019) could also be interpreted that *Myrmeleon*, as currently circumscribed, is massively paraphyletic. Despite the recent efforts on phylogeny and the larval taxonomy of antlions (Badano *et al.* 2017b; Machado *et al.* 2019), there are a few studies that inferred morphological affinities which used adult characters to infer antlion phylogeny (Stange 1994; Badano *et al.* 2017c, 2018; Machado & Oswald 2020). The larvae of all known genera of Myrmeleontini are pit-builders and exhibit a striking similar morphology. For example, the larvae of *Myrmeleon* and *Euroleon* are remarkably similar, but their adults can be distinguished based on wing venational characters (Mansell 1996; Stange 2004; Badano & Pantaleoni 2014; Badano *et al.* 2017b). In fact, many myrmeleontine genera, especially *Baliga* and *Hagenomyia*, are based on variable morphological characters, questioning the affinities of several taxa. Navás (1912b) originally described *Baliga* based on the presence of interconnected crossveins in the costal area proximal to the forewing pterostigma. Later, Esben-Petersen (1913) synonymized this genus with *Hagenomyia* and remarked that the description of *Baliga* solely based on the presence of interconnected crossveins is not justified. This view was later followed by Markl (1954), Kuwayama (1962), Oswald & Penny (1991), Ghosh (2000), Bao *et al.* (2007), Wang *et al.* (2018), and Yang *et al.* (2018). However, Stange & Wang (1998), Stange (2004), and Hayashi *et al.* (2020) considered *Baliga* as a valid genus based on the shorter length of anterior gonocoxites 8 than posterior gonocoxites 8 (= anterior and posterior gonapophyses in Stange 2004) in the female genitalia (these two sclerites are nearly equal in length in *Hagenomyia*).

In this paper, we first report *Baliga* from Pakistan based on a new species, namely *Baliga kashmirensis* sp. nov. Then, we summarize the present information of Myrmeleontini from Pakistan and add some new findings of this tribe from our recent field surveys in the northern parts of Pakistan. Finally, we also use molecular data, i.e., the partial DNA sequences of the mitochondrial COI and 16S rRNA genes, to verify the validity of the new species herein described. A dichotomous key as well as a distribution map are provided for *Baliga* and *Myrmeleon* species in Pakistan.

Material and methods

Taxonomy

The adult specimens were collected at day time (around 10.00 am in the morning to evening at 6 pm) by using a sweeping net along the mountainous regions in Azad Kashmir, Khyber Pakhtunkhwa and Punjab provinces of Pakistan. Samples were preserved in 95% ethanol or pinned. The specimens examined are deposited in the Entomological Museum, China Agricultural University (CAU), Beijing, China and the following institutes in Pakistan: Pakistan Museum of Natural History (PMNH), and the National Insect Museum (NIM), Islamabad. A male of *Baliga sagax* (Walker, 1853) (collecting information: "CHINA: Fujian, Xiamen, Siming District, Huandao Road, Wanyuepo, 0 m, 25.vi.2021, leg. Yuchen Zheng") was used for morphological comparison with *Baliga kashmirensis* sp. nov.

For the species identification, the abdominal segments 7–10 were macerated for 5–6 h in a cold, saturated KOH solution. After rinsing the KOH with acetic acid and water, the apex of the abdomen was transferred to glycerin for further dissection and examination. Terminology mainly follows Badano *et al.* (2017a) for body morphology and wing venation, and Aspöck & Aspöck (2008) for genital sclerites. The species were identified based on following literature: Ohm (1965), Hölzel (1972, 1987), Aspöck *et al.* (1980), Ghosh (1983, 1984, 1990, 2000), Bao *et al.* (2009), Zhan *et al.* (2011), Akhtar *et al.* (2018),

Ábrahám & Giacomino (2020), and Hajiesmaeilian *et al.* (2020). A key is provided for all known and new records of species of *Myrmeleon* from Pakistan.

Photographs of the adult habitus were taken with a Nikon D800 or D850 digital camera with a Nikon Micro-Nikkor 105 mm lens, while the genital photographs were taken with a Canon 7D Mark II or D850 digital camera with a Nikon SMZ18 microscope. Photographs were cleaned up and laid out with Helicon focus (ver. 6.7.1), and Adobe Photoshop CS 6.0. The distribution map was prepared with ArcGIS 10.5 software (Esri, Redlands, CA) by using the original base map of Pakistan.

Molecular identification

Representatives of species of *Baliga* and *Myrmeleon* sampled from Pakistan and the published data of the Japanese and Chinese species of these two genera (Hayashi *et al.* 2020) were included for the molecular identification of the species from Pakistan. Moreover, the available COI data of six species of *Myrmeleon* from Pakistan (Akhtar 2018), *Myrmeleon hyalinus* from Egypt and Greece, and two subspecies of *Myrmeleon hyalinus* Olivier, 1811 from Azerbaijan retrieved from the NCBI GenBank were also included for molecular analysis. Since no 16S rRNA gene sequences were available in GenBank for those six species of *Myrmeleon* from Pakistan and two subspecies of *Myrmeleon hyalinus* from Azerbaijan, we used solely the 16S RNA gene sequences to generate the phylogenetic tree for species of *Baliga* and *Myrmeleon* sampled in the present study and those from the Chinese and Japanese species. *Norfolius howensis* (Tillyard, 1917) and *Nymphes myrmeleonoides* Leach, 1814 (Neuroptera: Nymphidae) were selected as outgroups (Winterton *et al.* 2010). The species list, along with their corresponding GenBank accession numbers and collecting data, are provided in Table 1.

The adult specimens were stored in 95% ethanol and refrigerated at -20°C. The genomic DNA was extracted from the thoracic muscle or several legs of each individual sample preserved in ethanol. The samples were incubated in the extraction buffer/proteinase-K mixture at 56°C for 12 h. We used the DNeasy Blood & Tissue kit (QIAGEN, Beijing, China) or TIANamp Micro DNA Kit (TIANGEN BIOTECH CO., LTD, Beijing, China), following manufacturers' instructions. Partial sequences of two mitochondrial genes, i.e., COI and 16S rRNA, were amplified and sequenced. PCR was carried out in a Bio-Rad/T100™ Thermal Cycler (Hercules, CA, USA) by using an AccuPower PCR Premix (Bioneer, Daejeon, Korea) with 12.5 L in a reaction volume of 25 L, which included 1.0 L DNA templet, 1.0 L forward primer, 1.0 L reverse primer and 9.5 L distilled water.

Primer sequences used to amplify the two gene fragments as: LEP-F1 (5′-ATTCAAC CAATCATAAAGATATTGG-3′) and LEP-R1 (5′-TAAACTTCTGGATGTCCAAAAAATCA-3′) for COI (Hebert *et al.* 2003), and LR-J-12887 (5′-CCGGTTTGAACTCAGATCATGT-3′) and SR-N-13398b (5′-CRCYTGTTTAWCAAAAACAT-3′) for 16S rRNA (Simon *et al.* 1994). The PCR was carried out under the following amplification conditions: an initial denaturation step at 94°C (30 s), followed by 39 cycles of denaturation at 95°C (10 s), annealing at 45–50°C (50 s) (depending on primer pair used: 45°C for 16S; 50°C for COI), and elongation at 65°C (1 min), and a final elongation step at 65°C (10 s). The PCR products were electrophoresed in 1% TAE agarose gel stained with Gold View. Sequence assembly was done by using the ContigExpress application. The fragments of COI and 16S rRNA genes were translated into amino acid under the invertebrate mitochondrial genetic code and aligned based on their amino acid sequences by ClustalW in MEGA 7 (Kumar *et al.* 2016). Genetic distances were calculated using the Kimura 2 Parameter (K2P, Kimura 1980) model in MEGA 7.0 (Kumar *et al.* 2016). The phylogenetic study included the following three analyses: Neighbour-joining (NJ, Saitou & Nei 1987) was performed in MEGA 7 under the Kumera-2-Parameter (K2P) model; Bayesian inference (BI) analysis was performed using MrBayes on XSEDE (ver. 3.2.7a) (Ronquist *et al.* 2012) as implemented in the CIPRES science gateway portal (Miller *et al.* 2010); Maximum likelihood (ML) analyses were performed using the IQ-TREE (Nguyen *et al.* 2015) as implemented on

Table 1 (continued on next page)**.** List of specimens included in this study.

Family	Species	GenBank accession number		Locality	Reference
		16S	COI		
Myrmeleontidae	*Baliga kashmirensis* sp. nov.	ON263264	ON260954	Pakistan: Azad Kashmir	Present study
	Baliga asakurae	LC582310	LC582458	China: Taiwan	Hayashi *et al*. 2020
	Baliga asakurae	LC582312	LC582460	China: Taiwan	Hayashi *et al*. 2020
	Baliga kimurai	LC582297	LC582435	Japan: Iriomote Island	Hayashi *et al*. 2020
	Baliga kimurai	LC582275	LC582413	Japan: Ishigaki Island	Hayashi *et al*. 2020
	Baliga kimurai	LC582255	LC582450	Japan: Iriomote Island	Hayashi *et al*. 2020
	Baliga ryukyuensis	LC582272	LC582410	Japan: Amami Island	Hayashi *et al*. 2020
	Baliga ryukyuensis	LC582269	LC582406	Japan: Okinawa Island	Hayashi *et al*. 2020
	Baliga ryukyuensis	LC582263	LC582477	Japan: Okinawa Island	Hayashi *et al*. 2020
	Baliga micans	LC582264	LC582483	Japan: Fukuejima Island	Hayashi *et al*. 2020
	Baliga micans	LC582300	LC582437	Japan: Hokkaido	Hayashi *et al*. 2020
	Baliga micans	LC582288	LC582426	Japan: Nagano	Hayashi *et al*. 2020
	Myrmeleon tenuipennis	ON263263	ON260959	Pakistan: Islamabad	Present study
	Myrmeleon h. hyalinus	ON255708	ON254389	Pakistan: Islamabad	Present study
	Myrmeleon trivialis	ON255928	ON254214	Pakistan: Azad Kashmir	Present study
	Myrmeleon bore	LC582239	LC582509	Japan: Awashima Island	Hayashi *et al*. 2020
	Myrmeleon bore	LC582279		Japan: Fukushima	Hayashi *et al*. 2020
	Myrmeleon bore	LC582277	LC582415	Japan: Hokkaido	Hayashi *et al*. 2020
	Myrmeleon formicarius	LC582290	LC582428	Japan: Hokkaido	Hayashi *et al*. 2020
	Myrmeleon formicarius	LC582287	LC582425	Japan: Nagano	Hayashi *et al*. 2020
	Myrmeleon formicarius	LC582262	LC582454	Japan: Saitama	Hayashi *et al*. 2020
	Myrmeleon taiwanensis	LC582237	LC582440	Japan: Iriomote Island	Hayashi *et al*. 2020
	Myrmeleon taiwanensis	LC582247	LC582446	Japan: Iriomote Island	Hayashi *et al*. 2020
	Myrmeleon taiwanensis	LC582296	LC582434	Japan: Ishigaki Island	Hayashi *et al*. 2020
	Myrmeleon solers	LC582265	LC582484	Japan: Fukuejima Island	Hayashi *et al*. 2020
	Myrmeleontidae sp.		KP845997	Pakistan: Azad Kashmir	Akhtar 2018
	Neuroptera sp.		JF839535	Pakistan: Punjab	Akhtar 2018
	Neuroptera sp.		JF839541	Pakistan: Sindh	Akhtar 2018
	Myrmeleontidae sp.		KP846015	Pakistan: Azad Kashmir	Akhtar 2018
	Neuroptera sp.		HQ990310	Pakistan: Punjab	Akhtar 2018
	Neuroptera sp.		JF839546	Pakistan: Punjab	Akhtar 2018
	Myrmeleontidae sp.		KP845978	Pakistan: Punjab	Akhtar 2018
	Myrmeleontidae sp.		KP845928	Pakistan: Punjab	Akhtar 2018
	Myrmeleon h. distinguendus		MT621176	Azerbaijan	Kerimova *et al*. 2020
	Myrmeleon h. distinguendus		MT621177	Azerbaijan	Kerimova *et al*. 2020
	Myrmeleon h. hyalinus		MT621174	Azerbaijan	Kerimova *et al*. 2020

Table 1 (continued)**.** List of specimens included in this study.

Family	Species	GenBank accession number		Locality	Reference
		16S	COI		
	Myrmeleon hyalinus		KC182603	Greece	Directly submitted
	Myrmeleon hyalinus		KC182604	Egypt	Directly submitted
	Myrmeleon hyalinus		KC182605	Egypt	Directly submitted
Nymphidae	*Norfolius howensis*	EU734882	EU839749	Australia: Queensland	Winterton 2010
	Nymphes myrmeleonoides	EU734884	EU839751	Australia: Queensland	Winterton 2010

the webserver (http://iqtree.cibiv.univie.ac.at/). Trees were visualized and edited with FIGTREE ver. 1.3.1 (Rambaut 2009).

Results

Taxonomy

Tribe **Myrmeleontini** Latreille, 1802

Key to genera of Myrmeleontini from Pakistan

1. Antenna slightly swollen; wings generally broad; forewing costal area usually with interconnected crossveins proximal to pterostigmal area (Fig. 2A–B) ..... ***Baliga*** Navás , 1912
– Antenna obviously swollen; wings relatively narrow; forewing costal area without interconnected crossveins proximal to pterostigmal area (Fig. 7) ..... ***Myrmeleon*** Linnaeus , 1767

Genus ***Baliga*** Navás, 1912

Baliga Navás, 1912b: 110. Type species: *Myrmeleon asakurae* Okamoto, 1910: 297. Original designation.
Balaga Navás, 1912b: 111. Type species: *Myrmeleon micans* McLachlan, 1875: 176. Original designation.
Baga Navás, 1930a: 37. Type species: *Balaga montana* Navás, 1930a: 38. Monotypy.

Diagnosis

Baliga is quite similar to *Hagenomyia* and *Myrmeleon* but can be distinguished from *Hagenomyia* by the female anterior gonocoxites 8 relatively shorter than posterior gonocoxites 8 (these two female genital sclerites are nearly equal length in *Hagenomyia*) and from *Myrmeleon* by the presence of interconnected crossveins in the costal area of forewing (these interconnected crossveins are absent in *Myrmeleon*).

Distribution

Baliga currently includes 17 described species, predominantly distributed in the Oriental (12 species) and Palaearctic regions (4 spp.: China, Japan, and Korea) with a single species in Australia (Queensland). It is widely distributed in the Oriental region: Bangladesh, China, India, Myanmar, Sri Lanka, Vietnam, and the main islands of Indonesia, Malaysia, Micronesia, Philippines, Japan, and Korea (Ghosh 2000; Stange 2004; Bao *et al.* 2007; Hayashi *et al.* 2020).

Baliga kashmirensis sp. nov.
urn:lsid:zoobank.org:act:50FFB0E4-1CC4-40DC-B088-D29329F0A1CF
Figs 1–5, 20

Diagnosis

Larger-sized species (forewing length: 34.5–44.8 mm), superficially resembling to *Baliga sagax* (Walker, 1853) based on similar yellow markings on vertex but can be distinguished by the yellow pronotum, with a pair of well separated median longitudinal dark brown stripes and frons mostly shining black, but medially with a narrow longitudinal yellow marking and a narrow median U-shaped yellow marking at ventral corner (Fig. 3B–D).

Etymology

The new species is named after its type locality, i.e., Azad Kashmir, Pakistan.

Type material

Holotype

PAKISTAN • ♂; Azad Kashmir, District Poonch, Rawalakot Valley, Khai Gala; 33°51′4.3194″ N, 73°49′46.3434″ E; 1802 m a.s.l.; 4 Jun. 2019, Hassan M.A. leg.; CAU.

Paratypes

PAKISTAN • 7 ♂♂, 7 ♀♀; Azad Kashmir, District Poonch, Rawalakot Valley, Khai Gala; 33°51′4.3194″ N, 73°49′46.3434″ E; 1802 m a.s.l.; 4 Jun.–19 Aug.–3 Sep. 2019 • 2 ♂♂, 2 ♀♀; Khyber Pakhtunkhwa Province, District Mansehra, Bajna; 34°27′45.036″ N, 73°15′26.028″ E; 1000 m a.s.l; 19 Jul. 2019; Hassan M.A. leg.; CAU.

Description

Measurements (♂n = 5, ♀n = 6). Forewing: length ♂ 34.5–38.5 mm, ♀ 37.7–44.8 mm; width ♂ 9.0–10.6 mm, ♀ 10.0–12.0 mm. Hind wing: length ♂ 36.0–39.0 mm, ♀ 39.0–46.0 mm; width ♂ 7.8–8.6 mm, ♀ 10.0 mm. Body length: ♂ 32.0–35.2 mm, ♀ 34.0–39.5 mm.

Head (Fig. 3A–D). Vertex moderately raised, dark brown with yellow markings; in frontal view dark brown, dorsally with a pair of C-shaped yellow markings, which are connected to ocular rim; in dorsal view dark brown but medially yellow, with a rounded dark brown marking at middle; epicranial area black, with longitudinal transverse grooves, covered with short brownish pubescence. Frons shining black, but medially with a narrow longitudinal yellow marking and a narrow median U-shaped yellow marking at ventral corner, covered with short brownish pubescence. Occiput and postorbital sclerites yellow. Clypeus pale yellow (Fig. 3B) or medially with two small rounded dark brown spots in some specimens (Fig. 3C), and with four median long brown setae. Labrum brownish yellow, with erected brownish setae at proximal margin. Genae pale yellow. Maxillary and labial palps pale yellow, with terminal labial palpomere spindle-shaped, palpimacula brownish, small and circular, with short pale yellow setae. Antennae black, covered with short black setae, dorsal ring of scape and pedicel yellowish brown, flagellum black with several distal flagellomeres widened and moderately flattened. Antennal sclerite yellow (Fig. 3B).

Thorax (Fig. 3A). Pronotum slightly wider than long, yellow, with two median longitudinal dark brown stripes; lateral margins narrowly dark brown after anterior transverse furrow in lateral view; covered with long sparse black setae, but anterolateral margins with short, black and pale yellow setae. Mesonotum yellow with a median and lateral dark brown stripe; prescutum laterally with a pair of rounded yellow spots, covered with long sparse black setae; mesoscutum with a median and lateral dark brown stripe, lateral stripes limited to proximal ⅔, covered with short yellow setae; metascutellum yellow with a broad median longitudinal

dark brown stripe, covered with long sparse yellow setae. Metanotum yellow with a median and lateral dark brown stripe, lateral stripes limited to proximal half of metascutum, covered with short yellow setae. Pleuron yellow, with a median longitudinal dark brown stripe, covered with short sparse yellow setae (Fig. 3F).

Legs (Fig. 3F). Foreleg: coxa and trochanter yellow, covered with short yellow setae. Femur yellow, covered with short, black and brownish yellow setae, proximal half with a few long black setae; femoral sense hair as long as proximal ½ of profemora. Tibia yellow, with mixed, short and thick black setae,

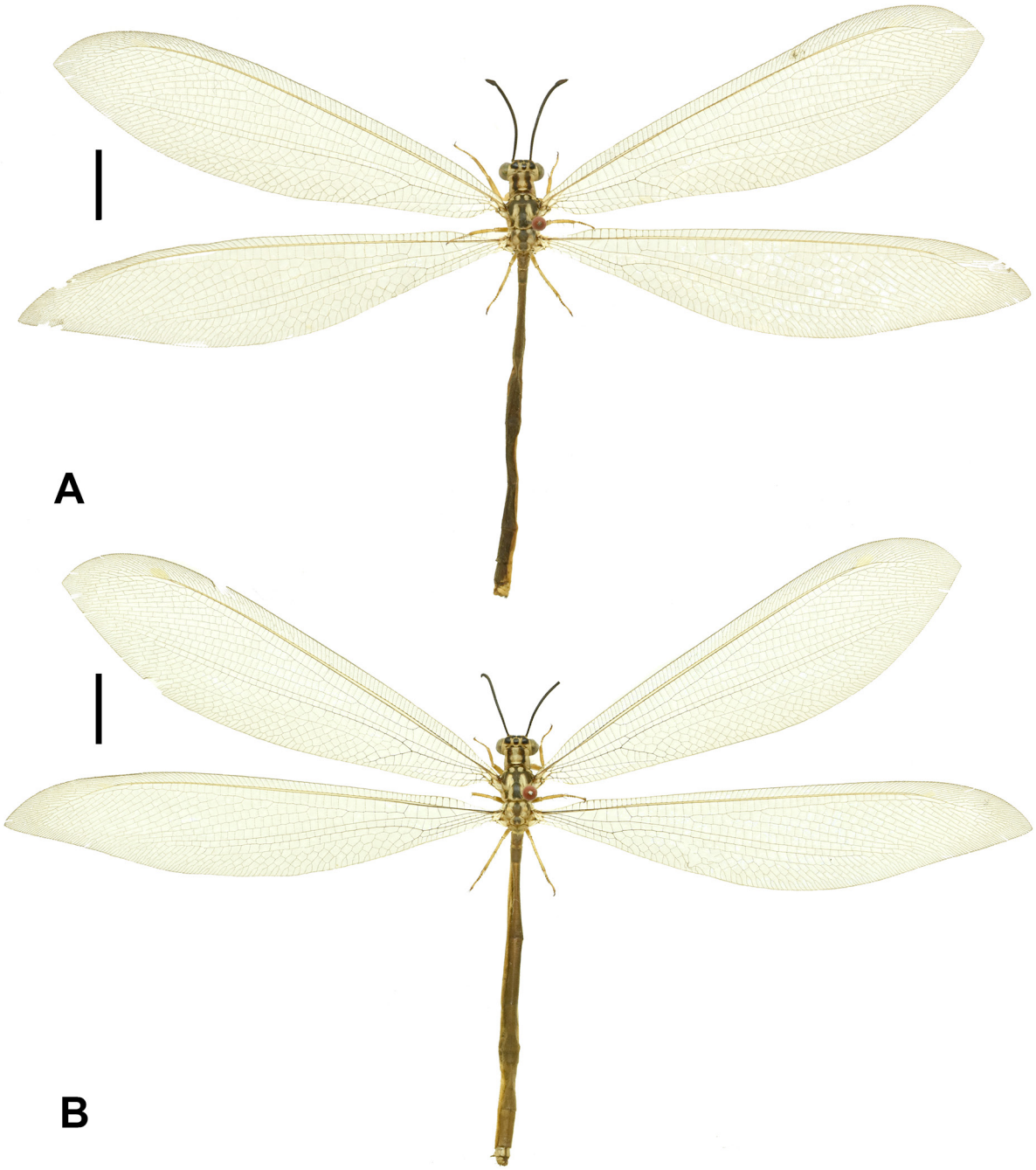

Fig. 1. *Baliga kashmirensis* sp. nov. Dorsal habitus. **A**. Male (CAUPK00001). **B**. Female (CAUPK00002). Scale bars = 5.0 mm.

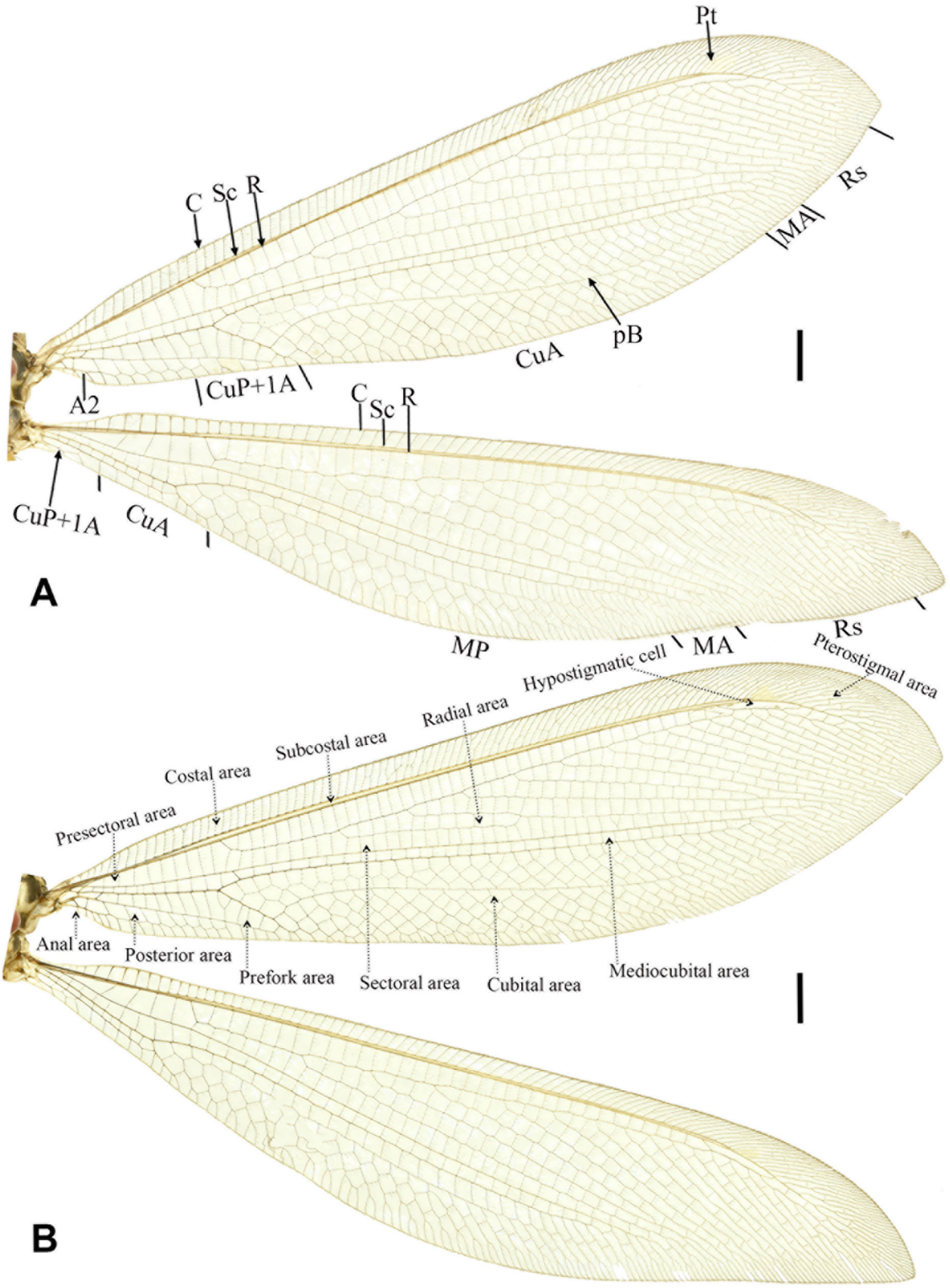

Fig. 2. *Baliga kashmirensis* sp. nov. Right fore- and hind wing. **A**. Male (CAUPK00001). **B**. Female (CAUPK00002). Abbreviations: A = anal vein; C = Costa; CuA = cubitus anterior; CuP = cubitus posterior; MA = media anterior; MP = media posterior; pB = posterior Banksian line; Pt = pterostigma; Sc = subcosta; R = radius.Scale bars = 2.0 mm.

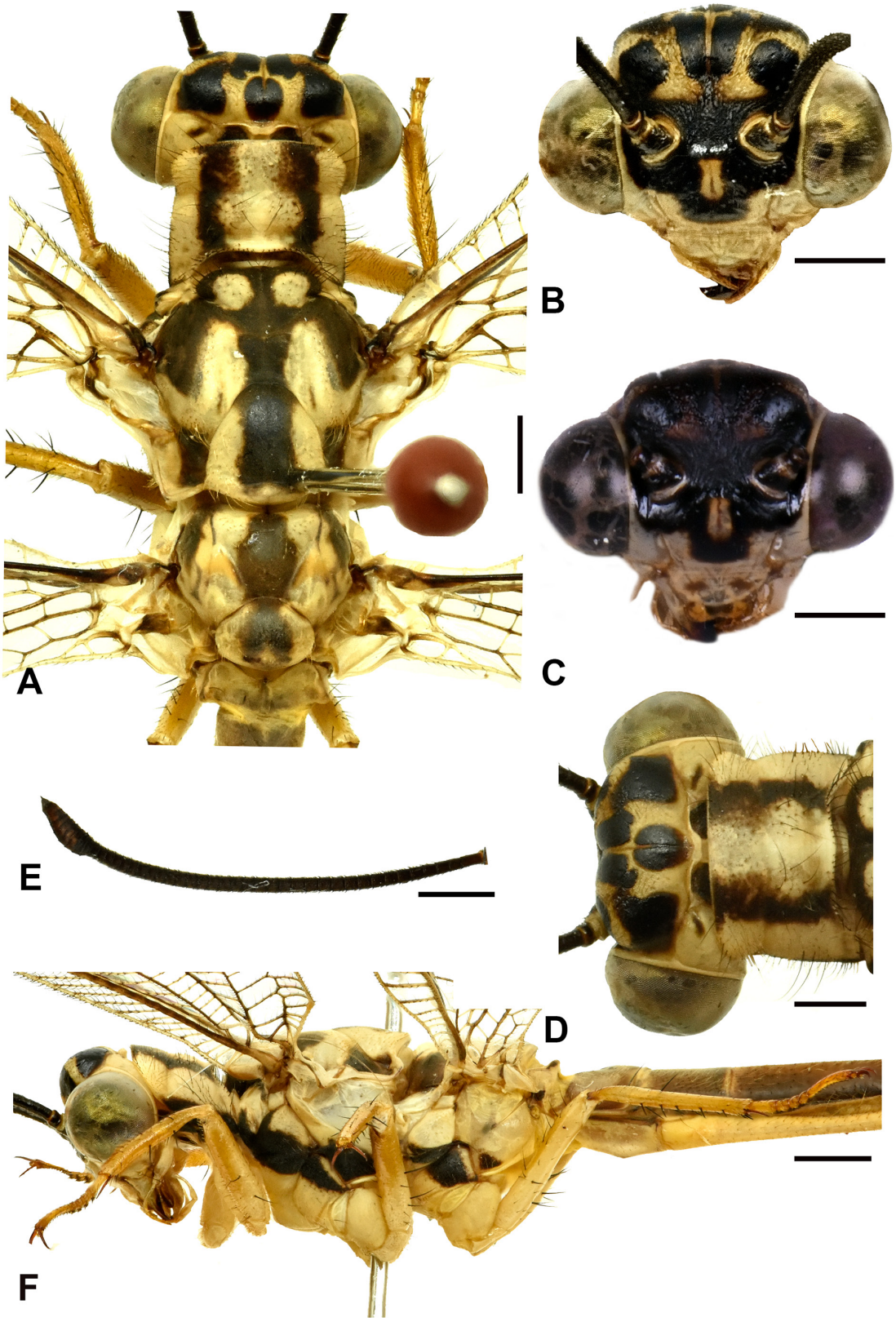

Fig. 3. *Baliga kashmirensis* sp. nov. **A**. Dorsal habitus of head and thorax. **B–C**. Head, frontal view. **D**. Head and pronotum, dorsal view. **E**. Antenna. **F**. Lateral view. A–B, D–F: ♂ (CAUPK00001); C: ♂ (CAUPK00003). Scale bars: A = 2.0 mm; B–E = 1.0 mm; F = 3.0 mm.

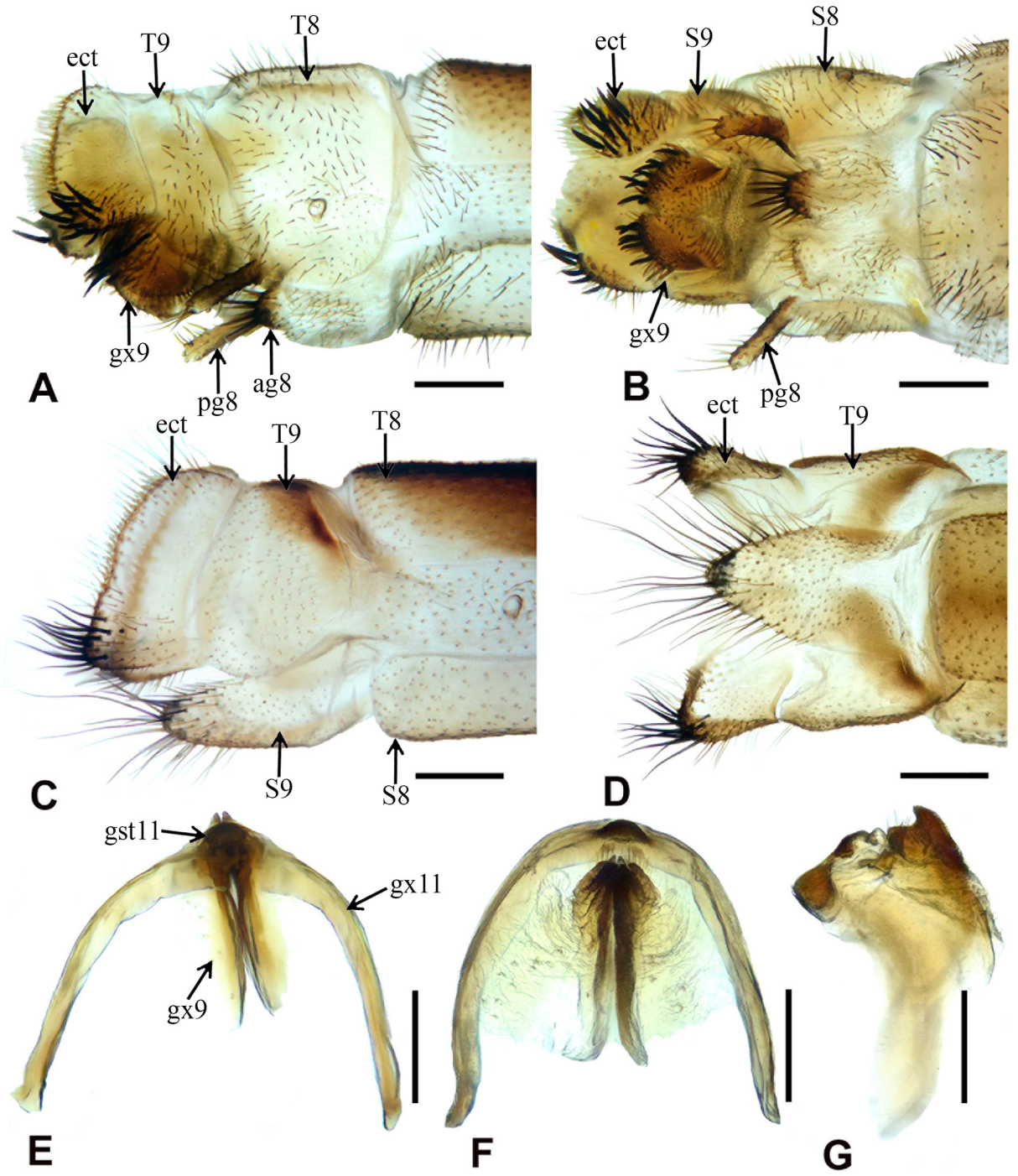

Fig. 4. *Baliga kashmirensis* sp. nov. **A**. Female genitalia, lateral view. **B**. Same, ventral view. **C**. Male genitalia, lateral view. **D**. Same, ventral view. **E**. Complex of gonocoxites 9 + gonocoxites 11, dorsal view. **F**. Same, ventral view. **G**. Same, lateral view. Abbreviations: ag8 = anterior gonocoxites 8; ect = ectoproct; gst11 = gonostylus 11; gx9 = gonocoxites 9; gx11 = gonocoxites 11; pg8 = posterior gonocoxites 8; pp = pregenital plate; S = sternites; T = tergites. A–B: ♂ (CAUPK00002); C–G: ♀ (CAUPK00001). Scale bars = 0.5 mm.

antennal cleaning setae yellow; tibial spurs brownish, straight, as long as Ta1. Tarsomeres yellow, covered with short black setae; Ta1 equal to combined length of Ta2–Ta3; Ta2, Ta3 and Ta4 nearly equal in size; Ta5 equal to combined length of Ta1–Ta4. Pretarsal claws brownish, curved. Mid leg similar to foreleg. Hind leg similar to mid leg, but femoral sense hair absent.

Wings (Fig. 2). Forewing: relatively broad, subacute at apex; membrane hyaline; longitudinal veins dark brown, except Sc with alternate dark brown and yellow patches, covered with sparse short black setae; costal area with interconnected crossveins proximal to pterostigma for at least ⅓ of forewing length; seven to nine presectoral crossveins; initial branching point of CuA at same level to Rs origin; Rs with 12–16 branches; pterostigma milky white; anterior Banksian line absent; posterior Banksian line present. Hind wing: slightly longer than forewing, acutely pointed at apex; membrane hyaline; longitudinal veins dark brown, except Sc with alternate dark brown and yellow patches, covered with sparse short black setae; costal veinlets simple, except a few marginally forked crossveins around poststigmal area; five presectoral crossveins; median fork proximal to Rs origin; Rs with 14–18 branches; pterostigma milky white, relatively smaller than that on forewing; anterior Banksian line absent; posterior Banksian line present; pilula axillaris with rounded knob, covered with dense brown setae.

Abdomen (Fig. 1). Tergites brownish, covered with short brownish yellow setae. Sterites brownish yellow, covered with short brownish yellow setae.

Fig. 5. Habitat of *Baliga kashmirensis* sp. nov. **A–B**. Khyber Pakhtunkhwa: Bajna. **C–D**. Azad Kashmir: Khai Gala.

Male genitalia (Fig. 4C–G). Tergum 9 trapezoidal, with anterior margin slightly prominent in lateral view. Sternum 9 slenderly triangular in ventral view, covered with long black setae at distal half. Ectoproct nearly rectangular in lateral view, posterodorsal margin rounded, covered with yellow setae, posteroventral corner slightly prominent, covered with long thick black setae. Gonocoxites 11 highly sclerotized, lateral arms straight, apex curved ventrad in dorsal view. Gonostylus 11 slightly prominent in ventral view. Gonocoxites 9 broad and elongate, curved with pointed apex in lateral view.

Female genitalia (Fig. 4A–B). Tergum 9 quadrate in lateral view, with short black setae. Ectoproct subquadrate, posterodorsal margin rounded, with short yellow setae, but proximal ⅓ with robust digging setae. Anterior gonocoxites 8 short, as long as wide, with thick long black setae. Posterior gonocoxites 8 long, digitiform, with long black setae. Gonocoxites 9 broad and rounded, with robust digging setae, anterolaterally with a bunch of erected short black setae at proximal ⅓.

Distribution

Pakistan (Azad Kashmir and Khyber Pakhtunkhwa).

Genus ***Myrmeleon*** Linnaeus, 1767

Myrmeleon Linnaeus, 1767: 913: Type species: *Myrmeleon formicarium* Linnaeus, 1767: 914. Subsequent designation by Latreille, 1810: 435.
Macroleon Banks, 1909: 4. Type species: *Myrmeleon validus* McLachlan, 1894: 515. Original designation.
Enza Navás, 1912b: 113. Type species: *Enza otiosus* Navás, 1912b: 114. Monotypy.
Myrmeleodes Navás, 1912c: 242. Type species: *Myrmeleodes medius* Navás, 1912c: 243. Monotypy.
Moreyus Navás, 1914b: 55. Type species: *Moreyus brasiliensis* Navás, 1914b: 55. Monotypy.
Morter Navás, 1915a: 466. Type species: *Myrmeleon hyalinus* Olivier, 1811: 126. Original designation.
Neleon Navás, 1915b: 53. Type species: *Myrmeleon immaculatum* De Geer, 1773: 564. Original designation.
Neseurus Navás, 1916: 53. Type species: *Myrmeleon alternans* Brullé in Webb & Berthelot, 1839: 83. Original designation.
Cocius Navás, 1919: 296. Type species: *Cocius angustatus* Navás, 1919: 297. Monotypy.
Leptoleon Esben-Petersen, 1918: 18. Type species: *Leptoleon regularis* Esben-Petersen, 1918: 18. Monotypy.
Myrmeleonellus Esben-Petersen, 1918: 17. Type species: *Myrmeleonellus pallidus* Esben-Petersen, 1918: 18. Monotypy.
Dicholeon Navás, 1920: 193. Type species: *Dicholeon nigritarsis* Navás, 1920: 193. Monotypy.
Tafanerus Navás, [1921] 1919: 62. Type species: *Tafanerus indicus* Navás, [1921] 1919: 63. Original designation.
Talosus Navás, 1923a: 35. Type species: *Talosus oberthuri* Navás, 1923a: 35. Monotypy.
Banya Navás, 1923b: 145. Type species: *Banya trifasciata* Navás, 1923b: 145. Monotypy.
Grocus Navás, 1925: 185. Type species: *Grocus gerstaeckeri* Navás, 1925: 185. Original designation.
Colinus Navás, 1925: 187. Type species: *Colinus philippinus* Navás, 1925: 187. Monotypy.
Afroleon Navás, 1927: 13. Type species: *Afroleon basutus* Navás, 1927: 13. Monotypy.
Neurocolinus Navás, 1930b: 42. Type species: *Colinus philippinus* Navás, 1925: 187. Monotypy.
Nemeyus Navás, 1934a: 502. Type species: *Nemeyus sanaanus* Navás, 1934a: 503. Monotypy.
Nezuela Navás, 1934b: 155. Type species: *Nezuela geayana* Navás, 1934b: 156. Monotypy.
Bordus Navás, 1936a: 165. Type species: *Bordus temeratus* Navás, 1936a: 166. Monotypy.
Congoleon Navás, 1936b: 337. Type species: *Congoleon sociatus* Navás, 1936b: 337. Monotypy.
Hypsoleon Navás, 1936c: 103. Type species: *Hypsoleon chappuisinus* Navás, 1936c: 103. Monotypy.

Nelneja Navás, 1936c: 104. Type species: *Nelneja guttata* Navás, 1936c: 105. Monotypy.

Diagnosis

Myrmeleon is similar to *Baliga* by the presence of anterior gonocoxites 8 relatively shorter than posterior gonocoxites 8 in the female genitalia (Fig. 9A–B) but can be distinguished by the absence of interconnected crossveins in the costal area of forewing (Fig. 7).

Key to species of the genus *Myrmeleon* from Pakistan*

1. Vertex wholly black, without yellow markings (Fig. 18C) 2
– Vertex black, distally with yellow markings in dorsal view (Fig. 8C) 3

2. Clypeus yellow with two median rounded brownish markings; pronotum dark brown, medially with a narrow longitudinal complete yellow stripe, rounded in center, laterally with a narrow yellow stripe at proximal half (Hölzel 1972: fig. 97); male gonocoxite 9 arcuate at distal margin in ventral view (Hölzel 1972: fig. 101) ..... ***M. paghmanus*** Hölzel , 1972
– Clypeus yellow without distinct brownish markings (Fig. 18B); pronotum yellow, medially with two longitudinal dark brown stripes (Fig. 18C); male gonocoxite 9 pointed at distal margin in ventral view (Fig. 19E–G) ..... ***M. trivialis*** Gerstaecker , 1885

3. Pronotum predominantly dark brown 4
– Pronotum yellow, medially with two longitudinal dark brown stripes, separated by a narrow yellow line or yellow with a median longitudinal and lateral transverse dark brown stripe 5

4. Pronotum dark brown, medially with two yellow stripes on anterior half at proximal to anterior transverse furrow, laterally with a narrow yellow stripe at proximal half (Iqbal & Yousuf 1992: fig. 1A) ..... ***M. clothilde*** Banks , 1913
– Pronotum dark brown, medially with a narrow longitudinal yellow stripe at proximal half and two rounded yellow markings at distal half, laterally with a narrow yellow stripe at proximal ⅔ (Aspöck *et al.* 1980: fig. 820; Hajiesmaeilian *et al.* 2020: fig. 12) ..... ***M. inconspicuus*** Rambur , 1842

5. Pronotum yellow, medially with two longitudinal dark brown stripes, narrowly separated by central yellow line (Fig. 8A) 6
– Pronotum yellow, medially with a longitudinal dark brown stripe, anterior transverse furrow with medially dark brown stripe, distal margin with two transverse dark brown stripes (Fig. 14C) .... ***M. hyalinus hyalinus*** Olivier , 1811

6. Vertex black, posteromedially with a pair of longitudinal yellow markings (Fig. 8C) .... ***M. tenuipennis*** Rambur , 1842
– Vertex black, posteriorly with four yellow markings, two at medially and two at lateral margins (Ghosh 1984: fig. 38; Iqbal & Yousuf 1992: fig. 2A) ..... ***M. assamensis*** Ghosh , 1984

* excluding *Myrmeleon bore* and *M. noacki*.

Myrmeleon tenuipennis Rambur, 1842
Figs 6–11, 20

Myrmeleon tenuipennis Rambur, 1842: 405. Type locality: India (Maharashtra: Mumbai).
Myrmeleon fryeri Navás, 1914c: 135. Type locality: Sri Lanka.
Myrmeleon bimaculatus Yang, 1999: 149. Type locality: China (Fujian: Nanping). **Syn**. **nov**.

Diagnosis

Myrmeleon tenuipennis can be distinguished based on the presence of two narrow median longitudinal yellow markings at posteromedially on vertex (Fig. 8C) and with a pair of median dark brown stripes on pronotum, which is narrowly separated by a central yellow line.

Material examined

PAKISTAN – **Islamabad Capital Territory** • 11 ♂♂, 3 ♀♀; Margalla Hills; 33°43′53.76″ N, 73°2′9.96″ E; 562 m a.s.l.; 16 Aug. 2019, Hassan M.A. leg.; CAU • 1 ♀; Faiz Abad; 33°39′50.6154″ N, 73°9′9.36″ E; 480 m a.s.l.; 11 Aug. 2019, Hassan M.A. leg.; CAU. – **Khyber Pakhtunkhwa Province** • 1 ♂, 3 ♀♀; District Swat; 35°3′14.7306″ N, 72°33′53.4492″ E; 760 m a.s.l.; 11 Sep. 2019; Fazullah leg.; NIM • 1 ♀; District Haripur, Sarai Saleh; 33°59′07.64″ N, 72°59′20.97″ E; 610 m a.s.l.; 12 Aug. 2019; Hussain R. leg.; PMNH. – **Punjab Province** • 1♀; District Faisalabad, UAF; 31°25′46.8048″ N, 73°4′14.3112″ E; 192 m a.s.l.; 28 Aug. 2019; Hassan M.A. leg.; NIM.

CHINA – **Fujian Province** • 1 ♀ (paratype of *Myrmeleon bimaculatus*); Sha County; 27 Aug. 1979; Bangkan Huang leg.; CAU • 3 ♂♂, 3 ♀♀; 6 larvae reared to adults; Longyan, Xinluo District, Mt. Tiangongshan; 15 Mar. 2020; Yuchen Zheng leg.; CAU • 1 ♂; Xiamen, Siming District, Hudietan; 11 Jun. 2021; Yuchen Zheng leg.; CAU. – **Hainan Province** • 1 ♂; Ledong, Jianfengling; 14 Jun. 1983; Maobin Gu leg.; CAU. –**Guangdong Province** • 1 ♂, 1 ♀; Guangzhou, Fanyu District, Sun Yat-sen University; Jun. 1987; Xuanda Zhang leg.; CAU. – **Guangxi Province** • 1 ♂, 3 ♀♀; Nanning; 23 May 1982; Fasheng Li leg.; CAU • 1 ♂; Congzuo, Pingxiang; 10 May 1963; Chikun Yang leg.; CAU.

Re-description

Measurements (♂n = 5, ♀n = 6). Forewing: length ♂ 24.5–31.0 mm, ♀ 25.0–32.5 mm; width ♂ 5.5–6.8 mm, ♀ 5.6–6.6 mm; hind wing: length ♂ 24.5–30.0 mm, ♀ 27.5–32.0 mm; width ♂ 4.2–5.4 mm, ♀ 4.7–5.5 mm; body length: ♂ 24.5–25.5 mm, ♀ 22.5–28.0 mm.

Head (Fig. 8B–C). Vertex moderately raised; in frontal view black, without yellow markings; dorsally black, posteromedially with two longitudinal yellow markings; epicranial area shining black. Frons shining black, but ventral corner yellow, covered with short brownish pubescence. Occiput shining black. Postorbital sclerite yellow. Clypeus pale yellow, distally with four long black setae. Labrum yellow, covered with erected brownish setae at proximal margin. Genae pale yellow. Maxillary and labial palps pale yellow, terminal labial palpomere spindle-shaped, palpimacula brownish, small and circular, with short black setae. Antennae black, scape mostly yellow, pedicel yellow at proximal ⅓, flagellum dark brown, covered with short black setae. Antennal sclerite yellow (Fig. 8C–D).

Thorax (Fig. 8A, C). Pronotum slightly wider than long, yellow, with two median longitudinal dark brown stripes, separated by a narrow yellow central stripe, lateral margins yellow, covered with long yellow setae. Mesonotum dark brown, medially with faintly brownish yellow marking, distal margin yellow, covered with sparse yellow setae, but prescutum with long dark brown setae. Metanotum dark brown, medially with faintly brownish yellow markings, distal margin of metascutellum yellow, covered with sparse yellow setae. Pleuron dark brown, covered with sparse yellow setae (Fig. 8E).

Legs (Fig. 8E). Foreleg: coxa and trochanter yellow, covered with short yellow setae. Femur yellow, posterolaterally brownish at apex, covered with short black setae, but posterolaterally with a few long black setae at proximal ½ and ventrally with short yellow setae; femoral sense hair shorter than proximal ½ of profemora. Tibia yellow, anterolaterally brownish, covered with short black setae, posterolaterally with a few long black setae, antennal cleaning setae yellow; tibial spurs brownish, straight, as long as Ta1. Tarsomeres yellow, covered with short black setae; Ta1 equal to combined length of Ta2–Ta4; Ta2, Ta3 and Ta4 nearly equal in size; Ta5 equal to combined length of Ta1–Ta3. Pretarsal claws brownish, moderately

curved. Mid leg: coxa and trochanter similar to foreleg. Femur yellow, anterolaterally brownish, covered with short black setae, ventrally with soft yellow and laterally with a few long black setae at proximal half; femoral sense hair shorter longer than proximal half of mid femora. Tibia similar to foreleg, but laterally

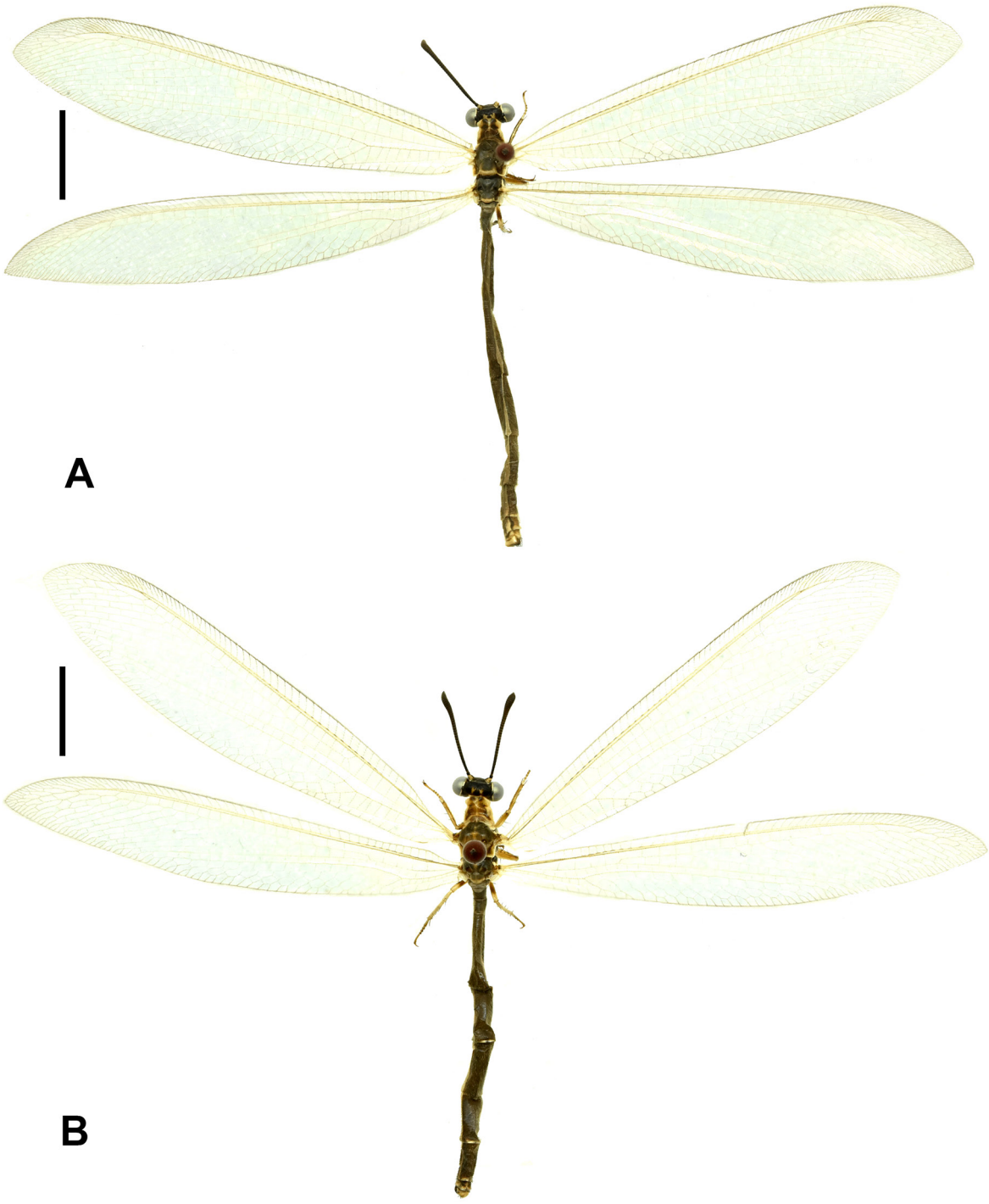

Fig. 6. *Myrmeleon tenuipennis* Rambur, 1842. Dorsal habitus. **A**. Male (CAUPK000010). **B**. Female (CAUPK000011). Scale bars = 5.0 mm.

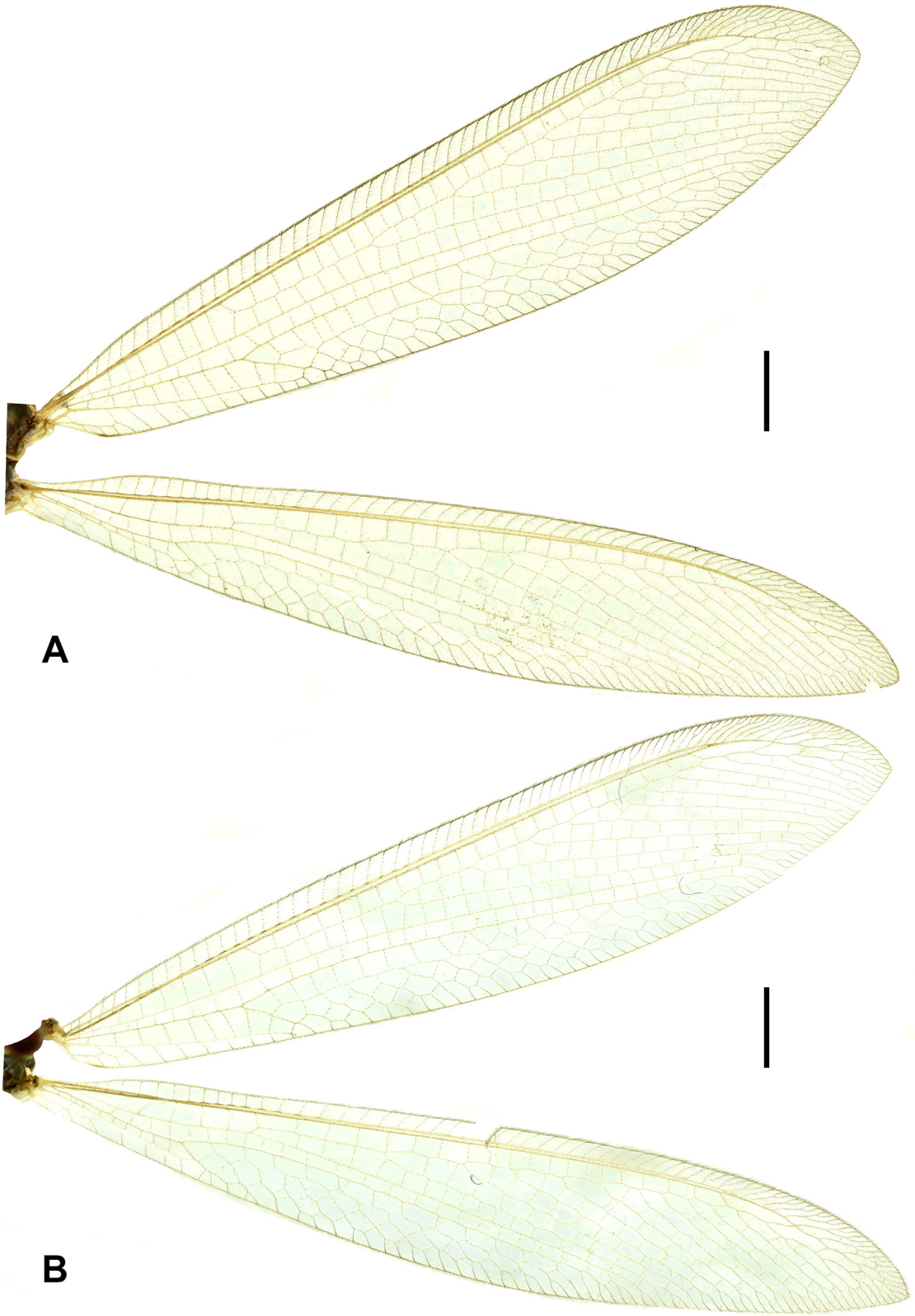

Fig. 7. *Myrmeleon tenuipennis* Rambur , 1842. Right fore- and hind wing. **A**. Male (CAUPK000010). **B**. Female (CAUPK000011). Scale bars = 2.0 mm.

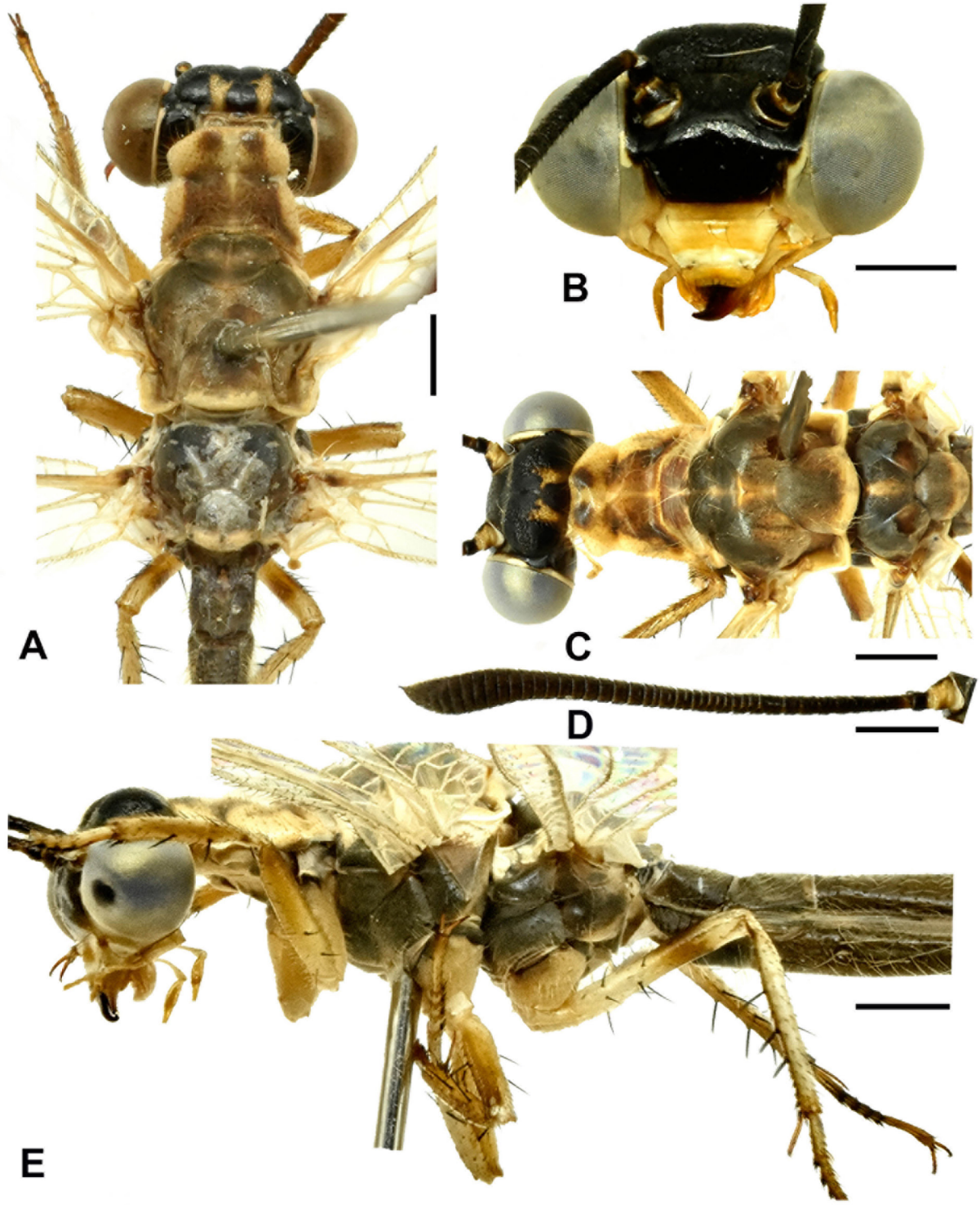

Fig. 8. *Myrmeleon tenuipennis* Rambur, 1842. **A**. Dorsal habitus of head and thorax. **B**. Head, frontal view. **C**. Head and pronotum, dorsal view. **D**. Antenna. **E**. Lateral view. A–B, D–E: ♂ (CAUPK000010); C: ♀ (CAUPK000011). Scale bars: A = 2.0 mm; B–D = 1.0 mm; E = 3.0 mm.

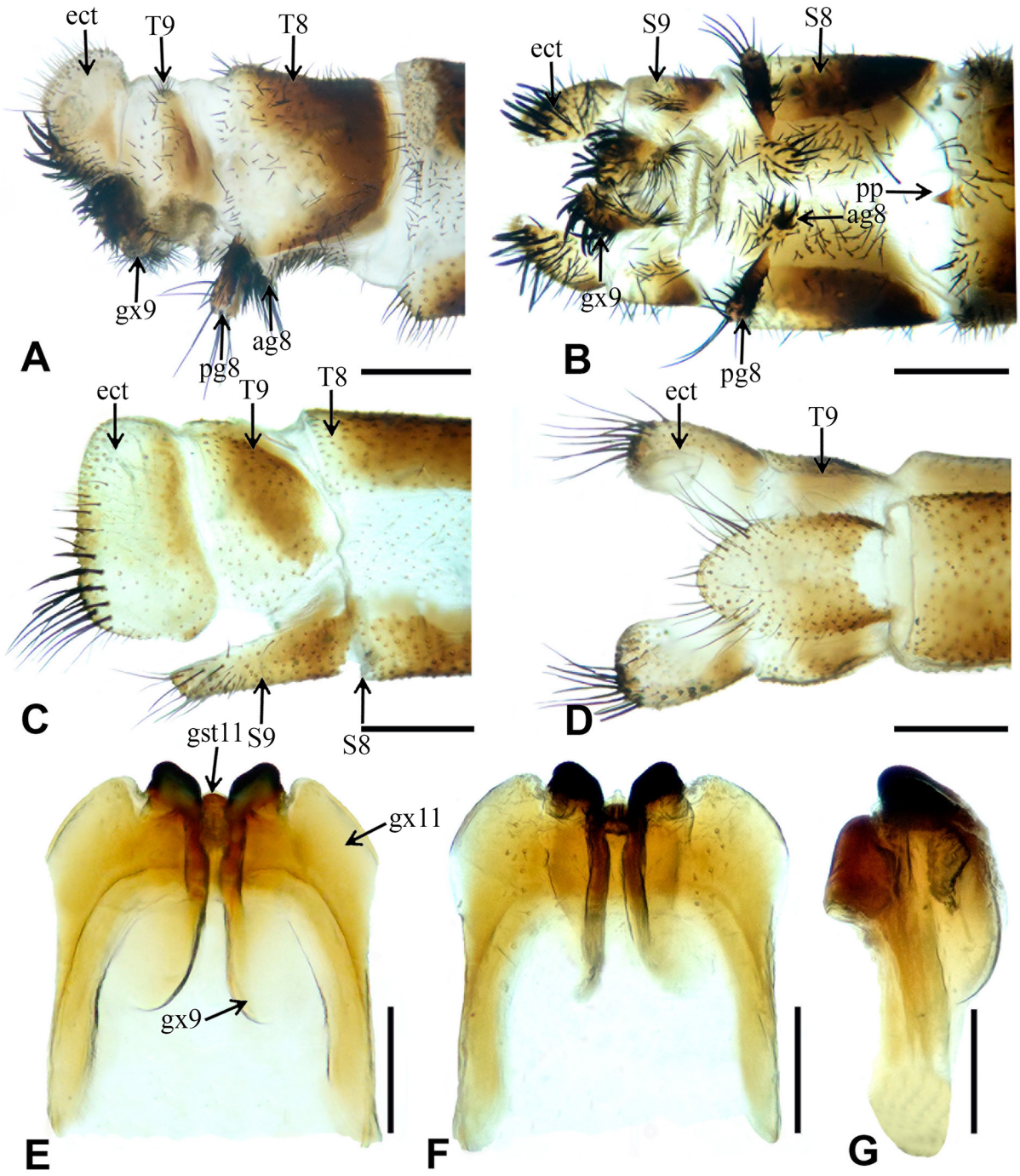

Fig. 9. *Myrmeleon tenuipennis* Rambur, 1842. **A**. Female genitalia, lateral view. **B**. Same, ventral view. **C**. Male genitalia, lateral view. **D**. Same, ventral view. **E**. Complex of gonocoxites 9 + gonocoxites 11, dorsal view. **F**. Same, ventral view. **G**. Same, lateral view. A–B: ♀ (CAUPK000011); C–G: ♂ (CAUPK000010). Abbreviations: ag8 = anterior gonocoxites 8; ect = ectoproct; gst11 = gonostylus 11; gx9 = gonocoxites 9; gx11 = gonocoxites 11; pg8 = posterior gonocoxites 8; pp = pregenital plate; S = sternites; T = tergites. Scale bars = 0.5 mm.

Fig. 10. Holotype of *Myrmeleon fryeri* Navás, 1914 (NHMUK). **A**. Male, dorsal habitus. **B**. Head, frontal view. **C**. Lateral view.

with a few long black setae; tibial spurs similar to foreleg. Tarsomeres and pretarsal claws similar to foreleg. Hind leg: coxa and trochanter similar to mid leg. Femur yellow, with distinct subapical brownish ring, covered with short black setae, but at proximal half with a few long black setae; femoral sense hair absent. Tibia yellow, ventrally brownish, covered with short black setae, ventrally with a row of long black setae; tibial spurs similar to middle leg. Tarsomeres and pretarsal claws similar to mid leg.

Wings (Fig. 7). Forewing: slightly longer and wider than hind wing, subacute at apex; membrane hyaline; costal area slightly narrow at proximal region; venation yellow, except Sc with alternate brownish and yellow patches at proximal half, covered with sparse short black setae; poststigmal area with a few interconnected crossveins; seven to nine presectoral crossveins; initial branching point of CuA at same level or proximal to Rs origin; Rs with 10–13 branches; CuP origin at same level to basal crossveins, fused with 1A after a short free base; pterostigma small, milky white; anterior Banksian line absent; posterior Banksian line present. Hind wing: relatively narrower than forewing, acute at apex; membrane hyaline; venation similar to forewing; four presectoral crossveins; median fork proximal to Rs origin; Rs with 12–14 branches; pterostigma indistinct; anterior Banksian line absent; posterior Banksian line present; pilula axillaris small, with rounded knob, covered with dense brown setae.

Abdomen (Fig. 6). Tergites dark brown, but in some specimen with a narrow transverse yellow stripe at distal margin of terga 4–8, covered with short brownish yellow setae. Sternites dark brown, covered with short brownish yellow setae.

Male genitalia (Fig. 9C–G). Tergum 9 trapezoidal, with anterior margin slightly prominent in lateral view. Sternum 9 ovoid in ventral view, covered with elongated black setae at distal half. Ectoproct nearly rectangular in lateral view, covered with yellow setae at distal half, posteroventral corner at proximal half with long thick black setae in lateral view. Gonocoxites 11 highly sclerotized, lateral arms straight, posterolaterally wide and rounded in dorsal view. Gonostylus 11 slightly prominent in dorsal view. Gonocoxites 9 broad and elongated, proximally diverged in dorsal view, distally rounded in lateral view.

Female genitalia (Fig. 9A–B). Tergum 9 quadrate in lateral view, covered with short black setae. Ectoproct rounded in lateral view, posterodorsal margin rounded, with short yellow setae, but proximal ⅓ with robust digging setae. Anterior gonocoxites 8 short, as long as wide, covered with thick long black setae. Posterior gonocoxites 8 long, digitiform, covered with long black setae. Gonocoxites 9 broad and

Fig. 11. Paratype of *Myrmeleon bimaculatus* Yang, 1999, ♀ (CAU-N 100589), dorsal habitus.

rounded, covered with robust digging setae, anterolaterally with a bunch of erected short black setae at proximal ⅓. Pregenital plate small, pointed at apex in ventral view.

Note

Myrmeleon tenuipennis is rarely mentioned in literature since its original description (Rambur 1842; Ghosh 1983; Stange 2004). Previously, it was only known from India, Sri Lanka, and Vietnam (Stange 2004; Oswald 2020). But we thought this is the most common antlion species in Pakistan, previously misidentified as *M. assamensis*. The marking patterns on frons and pronotum of *M. assamensis* reported from Pakistan (Akhtar *et al.* 2018: fig. 1a) and the paratype of *Myrmeleon bimaculatus* Yang, 1999 (Fig. 11) from China are almost identical to the type photographs of *M. fryeri* Navás, 1914 (Fig. 10). However, it can be distinguished from these closely related species by the presence of two yellow markings on vertex in dorsal view (with four yellow markings in *M. assamensis*: two at median and two at lateral margins in dorsal view). After careful examination of the holotype photographs of *M. fryeri* (Fig. 10), which is a junior synonym of *M. tenuipennis* proposed by Esben-Petersen (1931), it is concluded that the specimens presently collected from Pakistan are *M. tenuipennis* based on the presence of two yellow markings on vertex, instead of four in *M. assamensis*. We also examined the paratype of *M. bimaculatus* Yang, 1999 (holotype lost), and confirm that this species is a synonym of *M. tenuipennis*. *Myrmeleon tenuipennis* is widely distributed in coastal areas of southern China.

Distribution

Pakistan: Punjab Province (Islamabad Capital Territory: District Jhelum); China (Fujian, Guangdong, Guangxi, Hainan, Taiwan), India (Maharashtra), Sri Lanka, Vietnam (Ghosh 1983; Yang 1999; Stange 2004; Bao & Wang 2006; Bao *et al.* 2009; Oswald 2020).

Myrmeleon hyalinus hyalinus Olivier, 1811
Figs 12–15, 20

Myrmeleon hyalinus hyalinus Olivier, 1811: 126. Type locality: Saudi Arabia.

Diagnosis

It can be distinguished by the distinctive head and thoracic markings: frons black, except for ventral corner yellow (Fig. 14B); vertex black, median and posterior portions with yellow markings in dorsal view; pronotum yellow, medially with a longitudinal brownish stripe, anterior transverse furrow dark brown, distally with a pair of well-separated transverse brownish stripes (Fig. 14C); wings narrowly elongated, acutely pointed at apex, initial branching point of CuA distad Rs origin (Fig. 13). Moreover, male genitalia is distinctive among species of *Myrmeleon* in Pakistan: gonocoxites 11 highly sclerotized, lateral arms elongated; gonostylus 11 rounded in lateral view; gonocoxites 9 narrow and elongated, wider in lateral view with pointed apex.

Material examined

PAKISTAN – **Islamabad Capital Territory** • 1 ♂; Quaid-e-Azam University, Shahdarah; 33°45′5.1474″ N, 73°9′40.1754″ E; 555 m a.sl.; 24 Aug. 2019; Hassan M.A. leg.; CAU.

Re-description

Measurement (♂n = 1). Forewing: length 26.2 mm, width 5.5 mm; hind wing: length 26.2 mm, width 4.6 mm; body length: 24.0 mm.

Head (Fig. 14B–C). Vertex moderately raised; in frontal view black, without yellow markings; in dorsal view black, medially with a pair of transverse and posteriorly with a pair of longitudinal yellow markings;

epicranial area black, with longitudinal grooves, covered with short brownish pubescence. Frons black, but ventral corner yellow, covered with short yellowish pubescence. Occiput and postorbital sclerites yellow. Clypeus yellow, medially with two indistinct dark brown markings. Labrum yellow, covered with erected brownish setae at proximal margin. Genae pale yellow. Maxillary and labial palps pale yellow, terminal labial palpomere spindle-shaped, palpimacula brownish, small and circular, with short black setae. Antennae brownish, dorsal ring of scape and pedicel yellow, covered with short black setae, flagellum brownish with proximal and distal margin dark brown. Antennal sclerites yellow (Fig. 14B).

Thorax (Fig. 14A). Pronotum slightly wider than long, yellow, medially with a longitudinal brownish stripe, slightly interrupted at anterior transverse furrow; dark brown stripe along anterior transverse furrow, not reaching at lateral margins; distally with a pair of well-separated transverse brownish stripes; covered with sparse yellow setae. Mesonotum dark brown; prescutum laterally with a narrow yellow stripe; mesoscutum with yellow markings on median and posterolateral margins; mesoscutellum at distal ⅔ yellow; covered with sparse yellow setae, but prescutum with long dark brown setae. Metanotum dark brown; prescutum medially with faintly brownish longitudinal yellow marking; metascutum distally with a pair of large yellow markings; metascutellum laterally and distally brownish yellow; covered with sparse yellow setae. Pleuron dark brown, with yellow markings, covered with sparse yellow setae (Fig. 14E).

Legs (Fig. 14E). Foreleg: coxa and trochanter yellow, with short yellow setae. Femur yellow, light brownish at distal ½, with short black setae, but posterolaterally with a few long black setae at proximal

Fig. 12. *Myrmeleon hyalinus hyalinus* Olivier, 1811 (CAUPK000024). Male, dorsal habitus. Scale bar = 0.5 mm.

half; femoral sense hair shorter than proximal ½ of profemora. Tibia yellow, with mixed, short and long black setae at proximal half, antennal cleaning setae yellow; tibial spurs brownish, straight, as long as Ta1. Tarsomeres yellow, with short black setae; Ta1 equal to combined length of Ta2–Ta3; Ta2, Ta3 and Ta4 nearly equal in size; Ta5 equal to combined length of Ta1–Ta3. Pretarsal claws brownish, curved. Mid leg: coxa yellow, slightly brownish at proximal ½, with yellow setae. Trochanter yellow, with short black setae. Femur yellow, light brownish at distal ½, covered with short black setae, laterally with a few long black setae at proximal half; femoral sense hair shorter than proximal half of mid femora. Tibia yellow, covered with mixed, short and long black setae; tibial spurs similar to foreleg. Tarsomeres and pretarsal claws similar to foreleg. Hind leg: coxa and trochanter similar to mid leg. Femur yellow, light brownish at distal ⅓, covered with short black setae, proximal half with a few long black setae; femoral sense hair absent. Tibia, tarsomeres, and pretarsal claws are similar to mid leg.

Wings (Fig. 13). Forewing as long as hind wing, acute at apex; membrane hyaline; costal area slightly narrow at proximal region; venation brownish yellow, covered with sparse short black setae; poststigmal

Fig. 13. *Myrmeleon hyalinus hyalinus* Olivier, 1811 (CAUPK000024). Right fore- and hind wing. Scale bar = 5.0 mm

area with a few interconnected crossveins; nine presectoral crossveins; initial branching point of CuA proximal to Rs origin; Rs with 11 branches; CuP origin at the same level to basal crossveins, fused with 1A after a short free base; pterostigma indistinct; anterior Banksian line absent; posterior Banksian

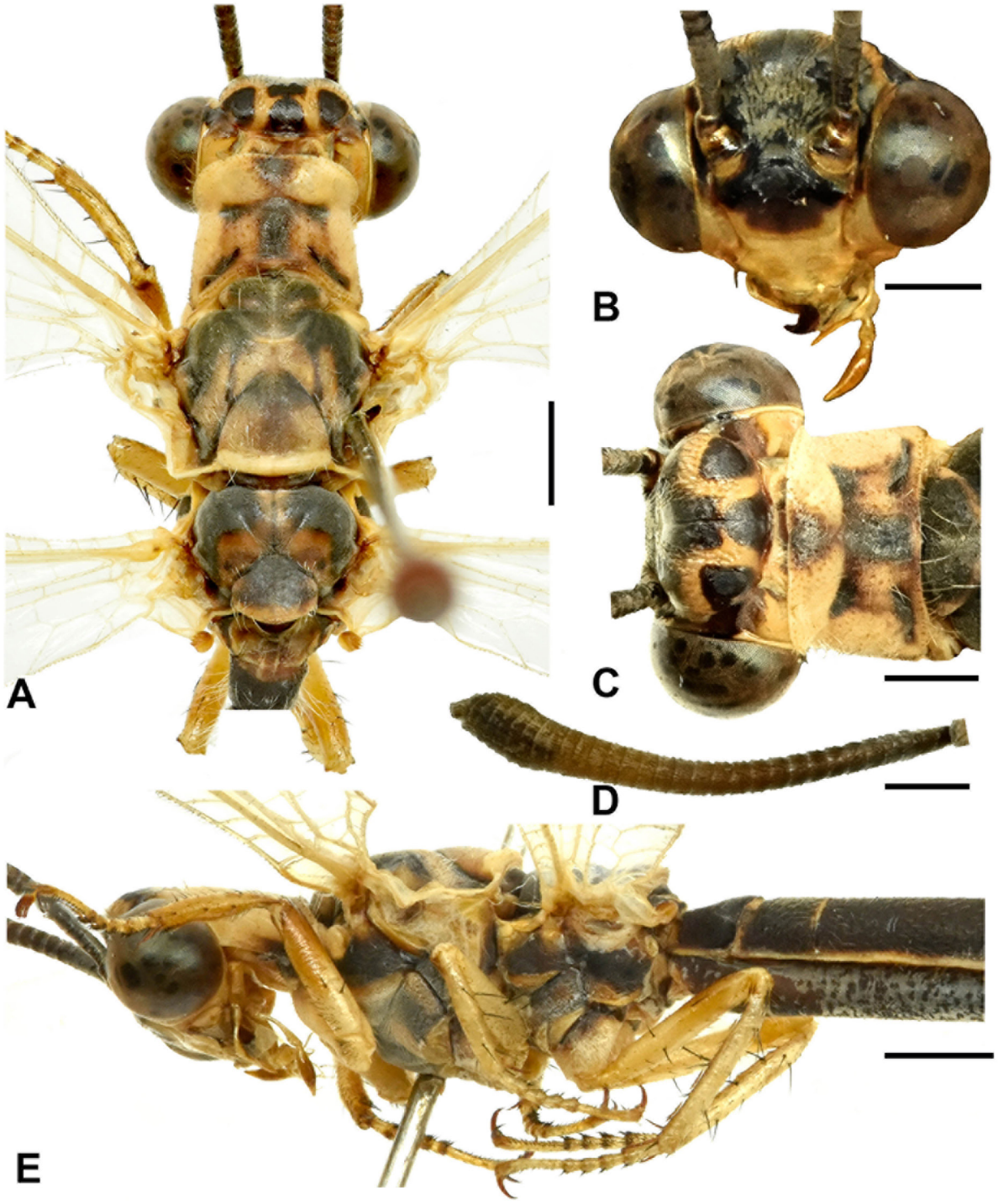

Fig. 14. *Myrmeleon hyalinus hyalinus* Olivier, 1811 (CAUPK000024). **A**. Dorsal habitus of head and thorax. **B**. Head, frontal view. **C**. Head and pronotum, dorsal view. **D**. Antenna. **E**. Lateral view. Scale bars: A = 2.0 mm; B–D = 1.0 mm; E = 3.0 mm.

present. Hind wing: relatively narrow, acute at apex; membrane hyaline; venation similar to forewing; five presectoral crossveins; median fork at proximal to Rs origin; Rs with 12 branches; pterostigma indistinct; anterior Banksian line absent; posterior Banksian indistinct; pilula axillaris small, with rounded knob covered with dense brown setae.

Abdomen (Fig. 12). Tergites dark brown, distally with a narrow yellow stripe on terga 1–8, lateral margins yellow, covered with short brownish yellow setae. Sternites dark brown, distally with a narrow yellowish stripe, covered with short brownish yellow setae.

Male genitalia (Fig. 15). Tergum 9 subtrapezoidal in lateral view. Sternum 9 ovate-shaped, covered with long black setae at distal ⅓. Ectoproct nearly rectangular in lateral view, posteroventral corner

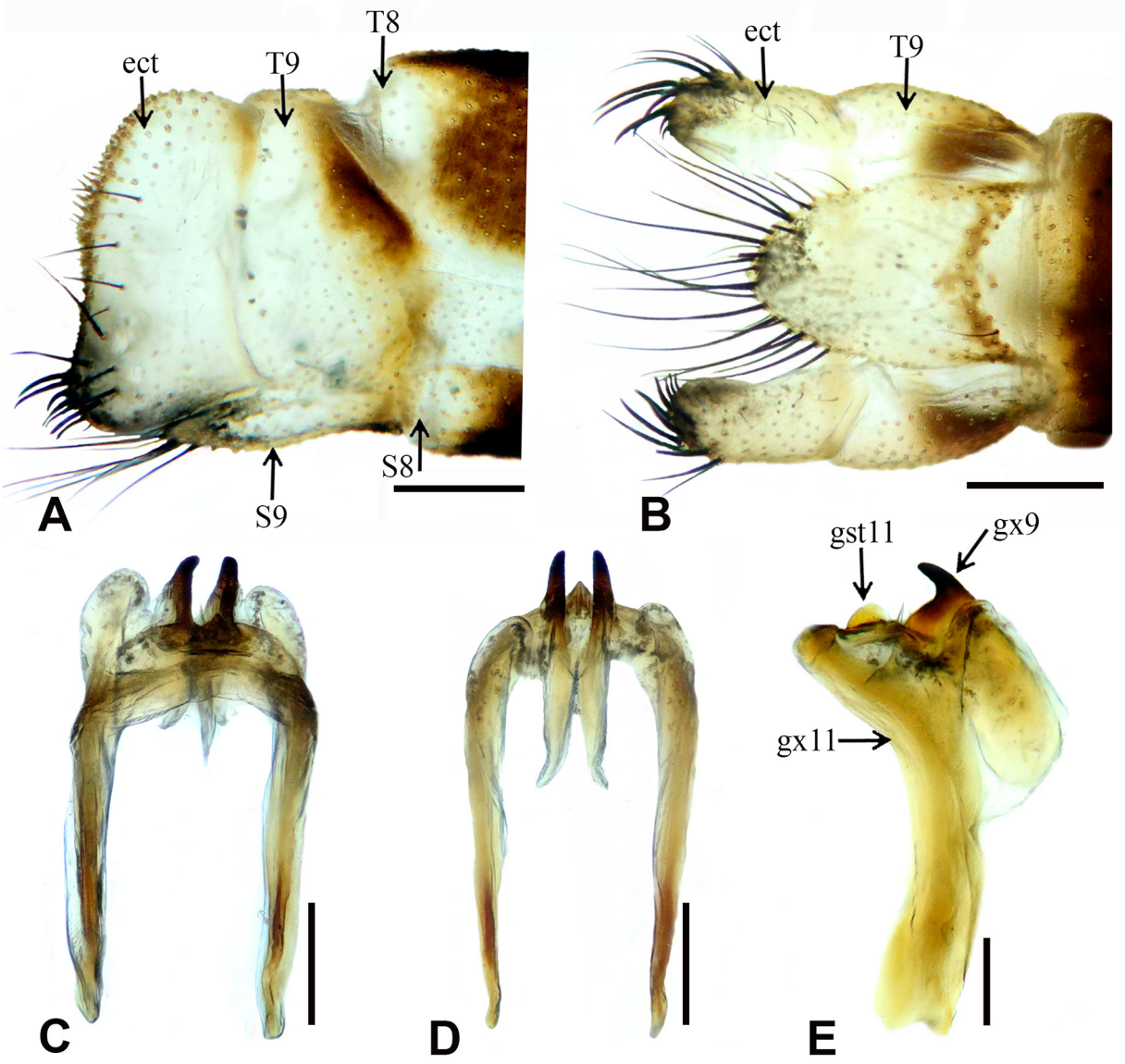

Fig. 15. *Myrmeleon hyalinus hyalinus* Olivier, 1811 (CAUPK000024). **A**. Male genitalia, lateral view. **B**. Same, ventral view. **C**. Complex of gonocoxites 9 + gonocoxites 11, dorsal view. **D**. Same, ventral view. **E**. Same, lateral view. Abbreviations: ect = ectoproct; gst11 = gonostylus 11; gx9 = gonocoxites 9; gx11 = gonocoxites 11; S = sternites; T = tergites. Scale bars = 0.5 mm.

slightly prominent, covered with long thick black setae. Gonocoxites 11 highly sclerotized, lateral arms elongated, apex broad and curved ventrad in dorsal view. Gonostylus 11 rounded in lateral view. Gonocoxites 9 narrow and elongated, wider in lateral view with pointed apex.

Note

Myrmeleon hyalinus currently includes five subspecies: *M. h. hyalinus* Olivier, 1811 (widespread in Northern Africa and the Middle East, Atlantic islands, India, and Pakistan), *M. h. afghanus* Hölzel, 1987 (Afghanistan), *M. h. caboverdicus* Hölzel, 1987 (Cape Verde Islands), *M. h. cabrerai* Navás, 1912 (Canary Islands), and *M. h. distinguendus* Rambur, 1842 (widespread in Southern Europe to the Middle East), which can be distinguished in adult morphology and geographical distribution (Hölzel 1987). The morphological characters to delimit the subspecies of *M. hyalinus* are largely unreliable, particularly the frontal and prothoracic marking patterns (Fig. 14A–C; Hölzel 1987: fig. 2; Akhtar *et al.* 2018: fig. 3a; Hajiesmaeilian *et al.* 2020: fig. 11). For example, the marking pattern of frons in our examined specimen is similar to *M. h. cabrerai* with lower margin of frons narrowly yellow (Fig. 13B; Hölzel 1987: fig. 10), but different from *M. h. hyalinus* that is distinguished by a median yellow marking on frons at lower margin (Fig. 14B; Hölzel 1987: fig. 8; Akhtar *et al.* 2018: fig. 7a; Hajiesmaeilian *et al.* 2020: 20). However, the intraspecific divergence herein observed for *M. h. hyalinus* and *M. h. distinguendus* was 0.021–0.049 based on COI gene data. Furthermore, the monophyly of *M. h. hyalinus* was not recovered based on our analysis (Fig. 21). In conclusion, a combined morphological and molecular data should be applied for all subspecies to resolve the status of these geographically isolated subspecies.

Distribution

Pakistan: (Punjab Province: District Bahawalpur, Lal Sohanra National Park); widespread: Southern Europe, Northern Africa, Middle East, East to Western India and Macaronesia (Aspöck *et al.* 2001; Stange 2004; Ábrahám 2010, 2011, 2017; Akhtar *et al.* 2018; Hassan *et al.* 2019; Oswald 2020).

Myrmeleon trivialis Gerstaecker, 1885
Figs 16–20

Myrmeleon trivialis Gerstaecker, [1885] 1884: 23. Type locality: India (Himalayas).
Myrmeleon montanus Navás, 1914a. 234. Type locality: India (Darjeeling).

Diagnosis

Body coloration generally dark brown; frons and vertex wholly black, without yellow markings (Fig. 18B–C); pronotum slightly wider than long, mostly yellow, with two broad median dark brown stripes, narrowly separated by a central yellow line; meso- and metanotum dark brown, posteriorly yellow, covered with scattered fine yellowish setae (Fig. 18A).

Material examined

PAKISTAN – **Islamabad Capital Territory** • 1 ♀; Faiz Abad; 33°39′50.6154″ N, 73°9′9.36″ E; 480 m a.s.l.; 11 Aug. 2019; Hassan M.A. leg.; CAU. – **Azad Kashmir** • 4 ♂♂, 3 ♀♀; District Bagh, Bagh City; 33°58′18.29″ N, 73°47′37.45″ E; 1150 m a.s.l.; 3–7 Aug. 2019 • 1 ♂; District Pooch, Goi Nala, 33°50′8.1594″ N, 73°44′9.9594″ E; 1580 m a.s.l.; 5 Sep. 2019 • 2 ♂♂, 1 ♀; Rawalakot Valley, the University of Poonch; 33°50′58.776″ N, 73°46′26.5434″ E; 1645 m a.s.l.; 1 Aug. 2019 • 1 ♀; Banjosa Lake; 33°48′36.10″ N, 73°48′58.89″ E; 1828 m a.s.l.; 3 Sep. 2019; Hassan M.A. and Hussain S. leg.; CAU. – **Khyber Pakhtunkhwa Province** • 6 ♂♂, 9 ♀♀; District Mansehra, Pakistan Forest Institute Filed Station, Shinkiari; 33°28′58.41102″ N, 73°17′37.43297″ E; 1334 m a.s.l.; 19 Aug. 2019

• 1 ♀; Garhi Habibullah; 34°24′23.0394″ N, 73°22′28.1994″ E; 770 m a.s.l.; 22 Aug. 2019; Hassan M.A. leg.; NIM • 1 ♀; Swat, 35°3′14.7306″ N, 72°33′53.4492″ E; 760 m a.s.l.; 11 Sep. 2019; Fazullah leg.; NIM • 1 ♀; District Orakzai, Tirah Valley; 33°43′48″ N, 71°0′36″ E; 2300 m a.s.l.; 23 Jun. 2016; Syed leg.; NIM.

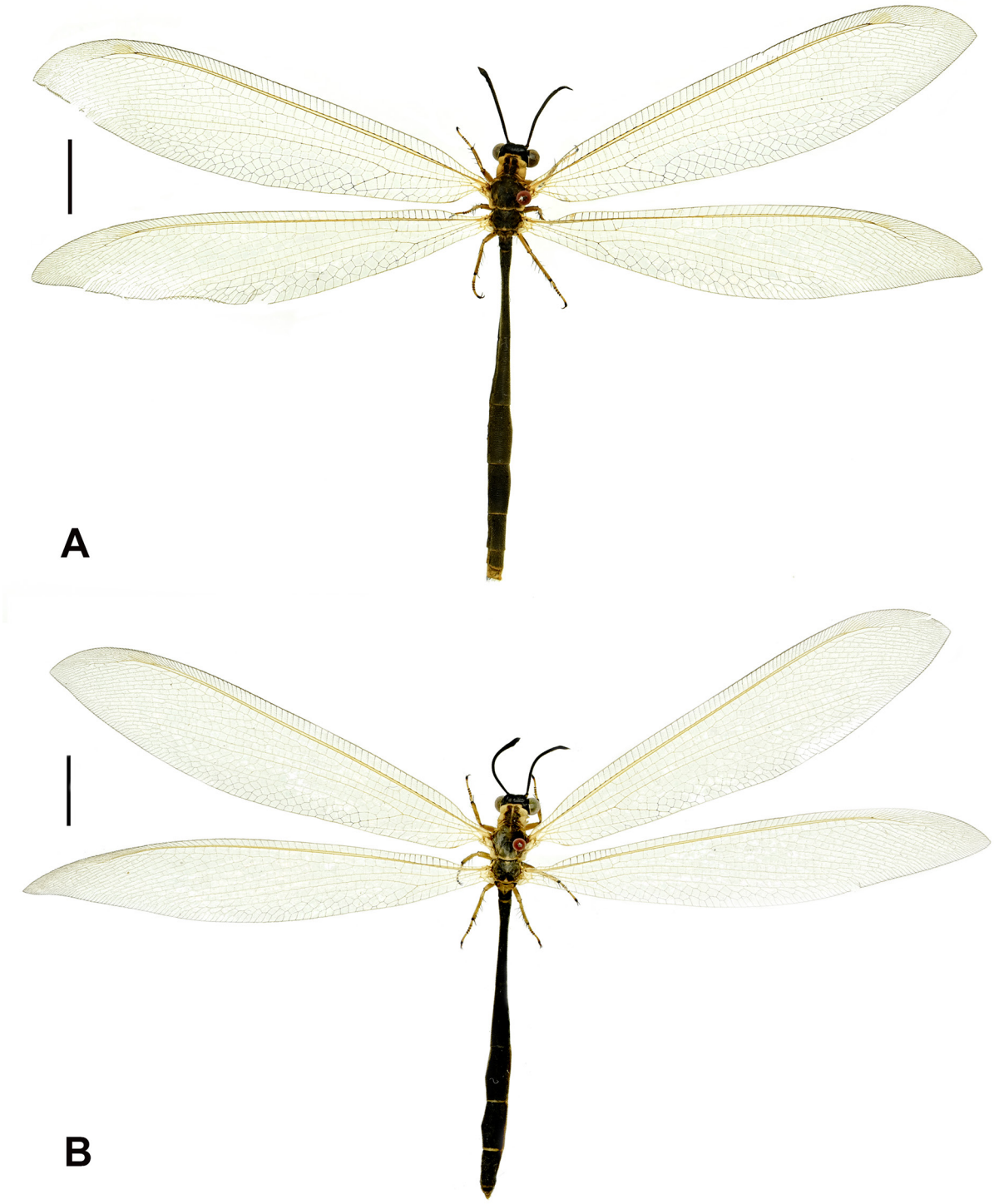

Fig. 16. *Myrmeleon trivialis* Gerstaecker, 1885. Dorsal habitus. **A**. Male (CAUPK000025). **B**. Female (CAUPK000026). Scale bars = 5.0 mm.

CHINA – **Tibet** • 10 ♂♂, 13 ♀♀; Shigatse, Gyirong County, Gyirong Town; 2650 m a.s.l.; 25 Jun. 2020; Yuchen Zheng leg.; CAU. – **Yunnan Province** • 2 ♂♂; Baoshan, Longyang District, Mangkuan Township, Baihualing Village, Hanlong Camp; 1400 m a.s.l.; 7 Jun. 2020; Yuchen Zheng and Jiazhi Zhang leg.; CAU.

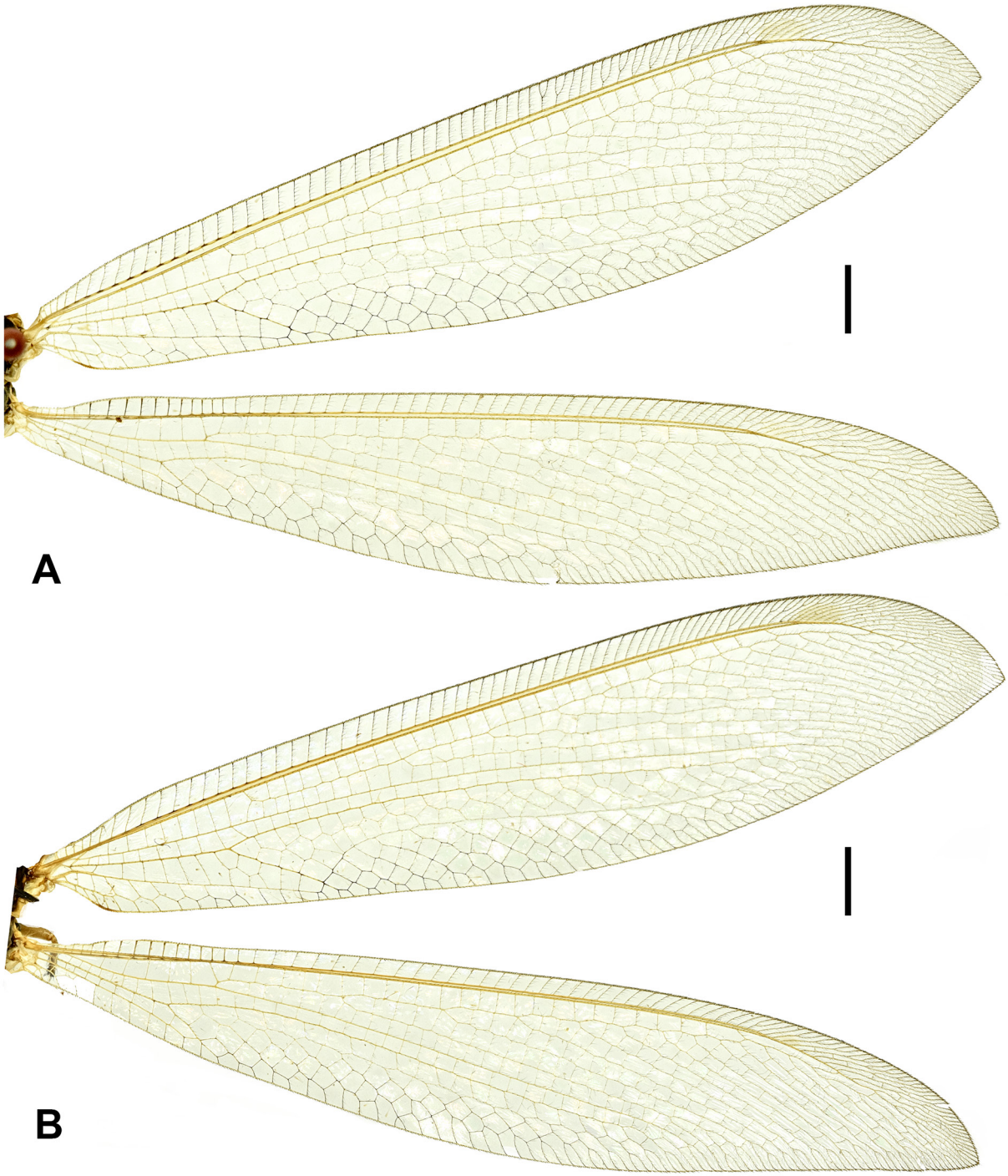

Fig. 17. *Myrmeleon trivialis* Gerstaecker, 1885. Right fore- and hind wing. **A**. Male (CAUPK000025). **B**. Female (CAUPK000026). Scale bars = 2.0 mm.

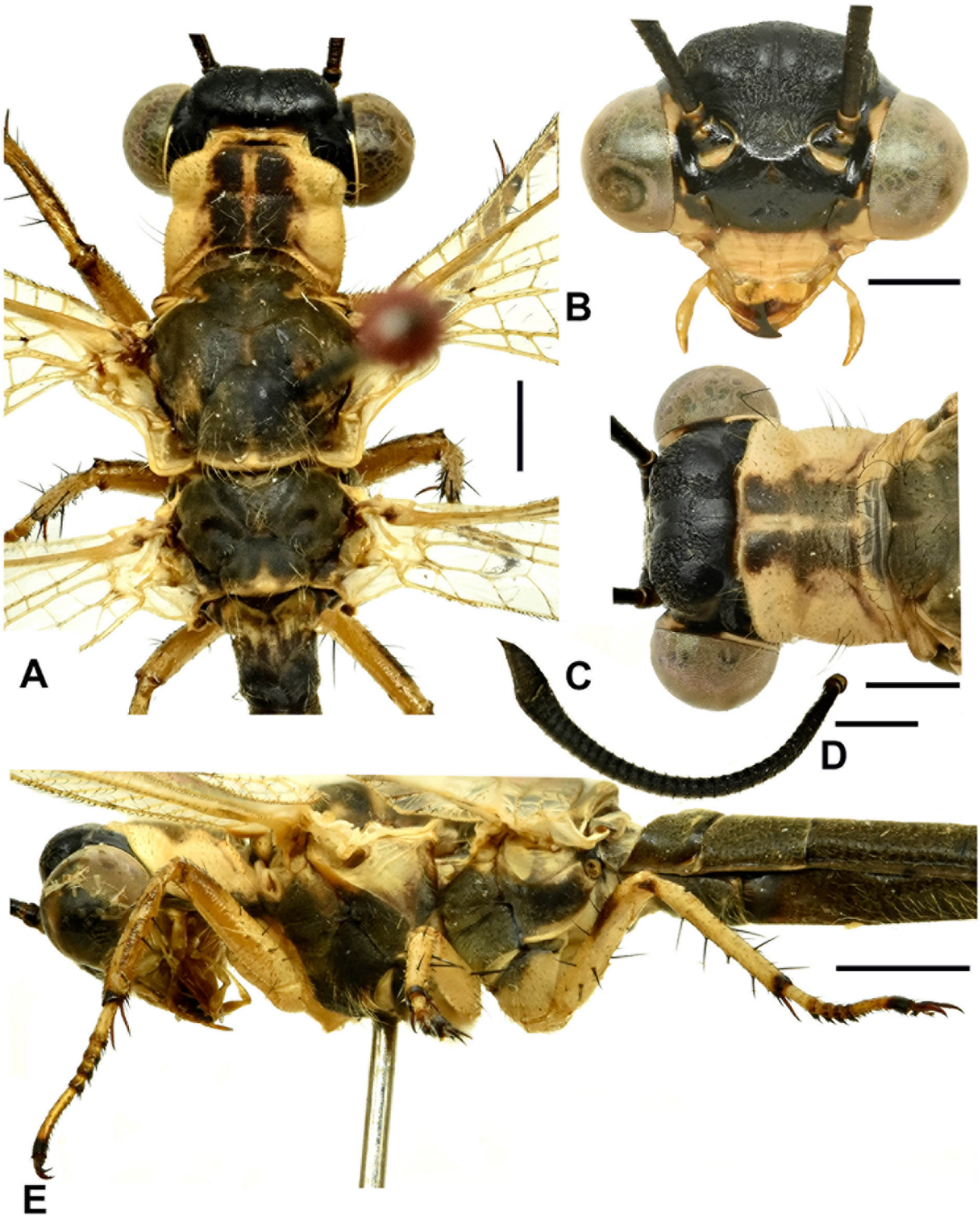

Fig. 18. *Myrmeleon trivialis* Gerstaecker, 1885 (CAUPK000025). **A**. Dorsal habitus of head and thorax. **B**. Head, frontal view. **C**. Head and pronotum, dorsal view. **D**. Antenna. **E**. Habitus, lateral view. Scale bars: A = 2.0 mm; B–D = 1.0 mm; E = 3.0 mm.

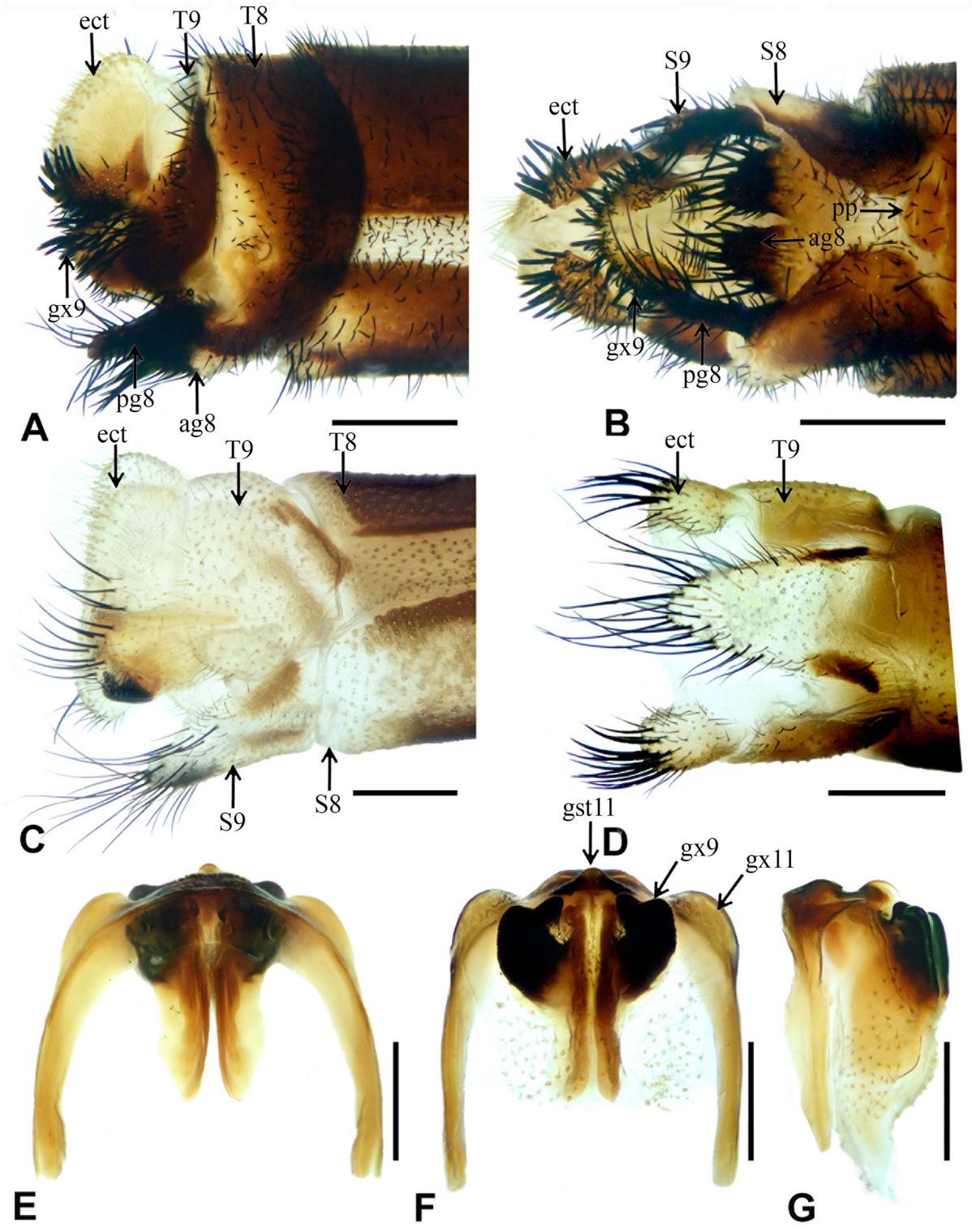

Fig. 19. *Myrmeleon trivialis* Gerstaecker, 1885. **A**. Female genitalia, lateral view. **B**. Same, ventral view. **C**. Male genitalia, lateral view. **D**. Same, ventral view. **E**. Complex of gonocoxites 9 + gonocoxites 11, dorsal view. **F**. Same, ventral view. **G**. Same, lateral view. A–B: ♀ (CAUPK000026); C–G: ♂ (CAUPK000025). Abbreviations: ag8 = anterior gonocoxites 8; ect = ectoproct; gst11 = gonostylus 11; gx9 = gonocoxites 9; gx11 = gonocoxites 11; pg8 = posterior gonocoxites 8; pp = pregenital plate; S = sternites; T = tergites. Scale bars = 0.5 mm.

Re-description

Measurement (♂n=4, ♀n=5). Forewing: length ♂ 36.0–39.0 mm, ♀ 36.0–43.5 mm; width ♂ 7.5–9.0 mm, ♀ 8.2–9.5 mm; hind wing: length ♂ 35.5–38.5 mm, ♀ 35.4–42.5 mm; width ♂ 7.0–7.3 mm, ♀ 6.3–7.8 mm; body length: ♂ 32.0–37.0 mm, ♀ 31.4–38.0 mm.

Head (Fig. 18B–C). Vertex moderately raised; in frontal and dorsal view black, without yellow markings; epicranial area with longitudinal grooves, covered with short yellowish pubescence. Frons shining black, with short yellowish pubescence. Occiput shining black. Postorbital sclerite yellow. Clypeus yellow, with four long black setae on proximal margin. Labrum yellow, covered with erected brownish setae at proximal margin. Genae pale yellow. Maxillary and labial palps pale yellow, terminal labial palpomere spindle-shaped, palpimacula brownish, small and circular, with short black setae. Antennae black, with distal ring of scape and pedicel yellow, flagellum dark brown with several distal flagellomeres pointed at apex, covered with short black setae. Antennal sclerites yellow (Fig. 18D).

Thorax (Fig. 18A). Pronotum slightly wider than long, yellow, medially with pair of longitudinal dark brown stripes, separated by a narrow central yellow line, covered with short sparse yellow setae, anterolaterally with short black setae, posterolaterally and distally with a few long black setae. Mesonotum dark brown, covered with sparse yellow setae; posterolateral margins on pre- and mesoscutum with yellow markings, prescutum covered with long dark brown setae; metascutellum distally with a narrow yellow stripe, covered with sparse yellow setae. Metanotum dark brown, metascutellum distally with a narrow yellow stripe, covered with sparse yellow setae. Pleuron dark brown, covered with sparse yellow setae (Fig. 18E).

Legs (Fig. 18E). Foreleg: coxa yellow, slightly brownish at proximal ⅓, with short yellow setae. Trochanter yellow, covered with mixed, short, black and yellow setae. Femur yellow, posterolaterally brownish at apex, covered with short black setae, proximal half with a few long black setae, proximal ⅓ with short yellow setae; femoral sense hair shorter than proximal half of profemora. Tibia yellow, laterally brownish in some specimens, distally shiny black, with short black setae, posterolaterally with a few long black setae, antennal cleaning setae yellow; tibial spurs brownish, straight, as long as Ta1. Tarsomeres yellow, distally each tarsomere dark brown, with short black setae; Ta1 longer than Ta2; Ta2, Ta3 and Ta4 nearly equal in size; Ta5 nearly equal to combined length of Ta1–Ta4. Pretarsal claws brownish, moderately curved. Mid leg: coxa and trochanter similar to foreleg. Femur yellow, anterolaterally dark brown, covered with short black setae, proximal ⅓ with short yellow setae but proximal half with a few long black setae; femoral sense hair shorter than proximal half of mid femora. Tibia yellow, anterolaterally brownish, distally shiny black, covered with short and long black setae; tibial spurs, tarsomeres and pretarsal claws similar to foreleg. Hind leg: coxa and trochanter similar to mid leg. Femur yellow, anterolaterally at distal ⅓ brownish, covered with long black setae, but proximal half with short yellow setae; femoral sense hair absent. Tibia, tibial spurs, tarsomeres, and pretarsal claws similar to mid leg.

Wings (Fig. 17). Forewing: relatively broad, slightly longer than hind wing, subacute at apex; membrane hyaline; costal area slightly narrow at proximal region; longitudinal veins yellow, except Sc and Cu at proximal half with alternate dark brown and yellow patches; crossveins yellow, except cubital area after posterior Banksian line with crossveins black; six to nine presectoral crossveins; initial branching point of CuA proximal to Rs origin; Rs with 11–14 branches; pterostigma small, milky white; anterior Banksian line indistinct as compared to more prominent posterior Banksian line which is proximally brownish black. Hind wing: relatively narrower than forewing, acute at apex; membrane hyaline; longitudinal veins yellow except Sc at proximal half with alternate dark brown and yellow patches; crossveins yellow, but median area after posterior Banksian line with crossveins black; five to six presectoral crossveins; median fork proximal to Rs origin; Rs with 12–14 branches; pterostigma milky

white; anterior Banksian line absent; posterior Banksian line indistinct; pilula axillaris with rounded knob, covered with dense brown setae.

Abdomen (Fig. 16). Tergites dark brown, distally with a narrow yellow stripe on terga 4–8; terga 4–7 relatively broader in both sexes; covered with short yellowish setae, but posterior and posterolateral margins of terga 6–7 with mixed, short, black and brownish setae, tergum 8 with short black setae. Sternites dark brown, sterna 7–8 each with distally a narrow yellow stripe; covered with short yellowish setae.

Male genitalia (Fig. 19C–G). Tergum 9 trapezoidal, with anterior margin slightly prominent in middle in lateral view. Sternum 9 triangular in ventral view, covered with long and elongated black setae. Ectoproct nearly rectangular in lateral view, posterodorsal margin rounded, covered with yellow setae, posteroventral corner slightly prominent, covered with long thick black setae. Gonocoxites 11 highly sclerotized, lateral arms straight, rounded at apex in ventral view, apex curved ventrad in dorsal view. Gonostylus 11 cone-shaped, prominent in ventral view. Gonocoxites 9 separated, narrow and straight proximally, wide and curved distally with pointed apex in lateral view.

Female genitalia (Fig. 19A–B). Tergum 9 subquadrate, covered with short black setae. Ectoproct rounded in lateral view, distal ⅔ yellow with short yellow setae, proximal ⅓ dark brown with robust digging setae. Anterior gonocoxites 8 short, as long as wide, covered with thick long black setae. Posterior gonocoxites 8 long, digitiform, covered with elongated black setae. Gonocoxites 9 broad and

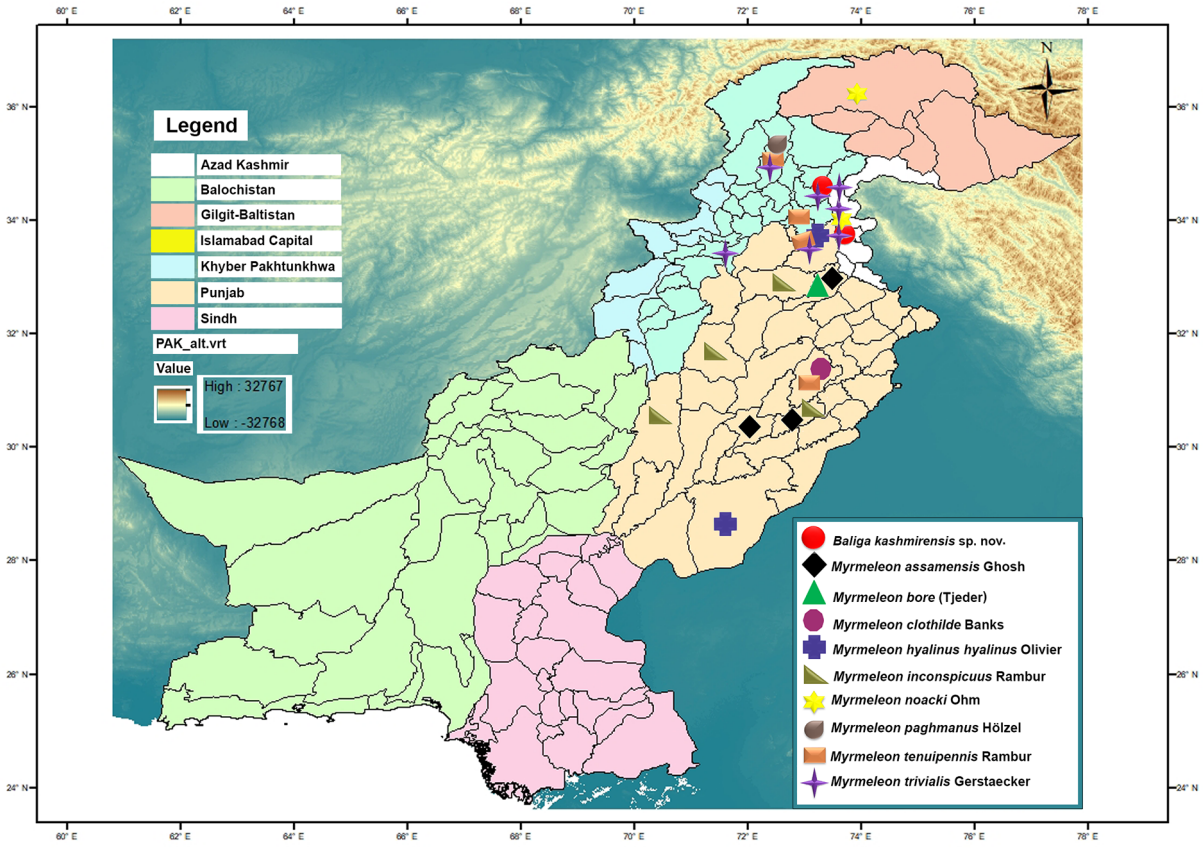

Fig. 20. Distribution map of species of *Baliga* Navás, 1912 and *Myrmeleon* Linnaeus, 1767 from Pakistan.

rounded, covered with robust digging setae, anterolaterally with a bunch of erected short black setae at proximal ⅓. Pregenital plate small, heart-shaped.

Distribution

Pakistan: Khyber Pakhtunkhwa Province (District Mansehra, Garhi Habib Ullah), Azad Kashmir (District Muzaffarabad, Peer Chanasi), Punjab Province (District Rawalpindi, Murree); China (Guangxi, Guizhou, Henan, Shaanxi, Tibet, Yunnan), India (Arunachal Pradesh, Darjeeling, Himachal Pradesh, Sikkim, West Bengal), Nepal, Thailand, Vietnam (Ghosh 1984, 2000; Zhan *et al.* 2011; Akhtar *et al.* 2018; Yang *et al.* 2018; Hassan *et al.* 2019; Ábrahám & Giacomino 2020; Oswald 2020).

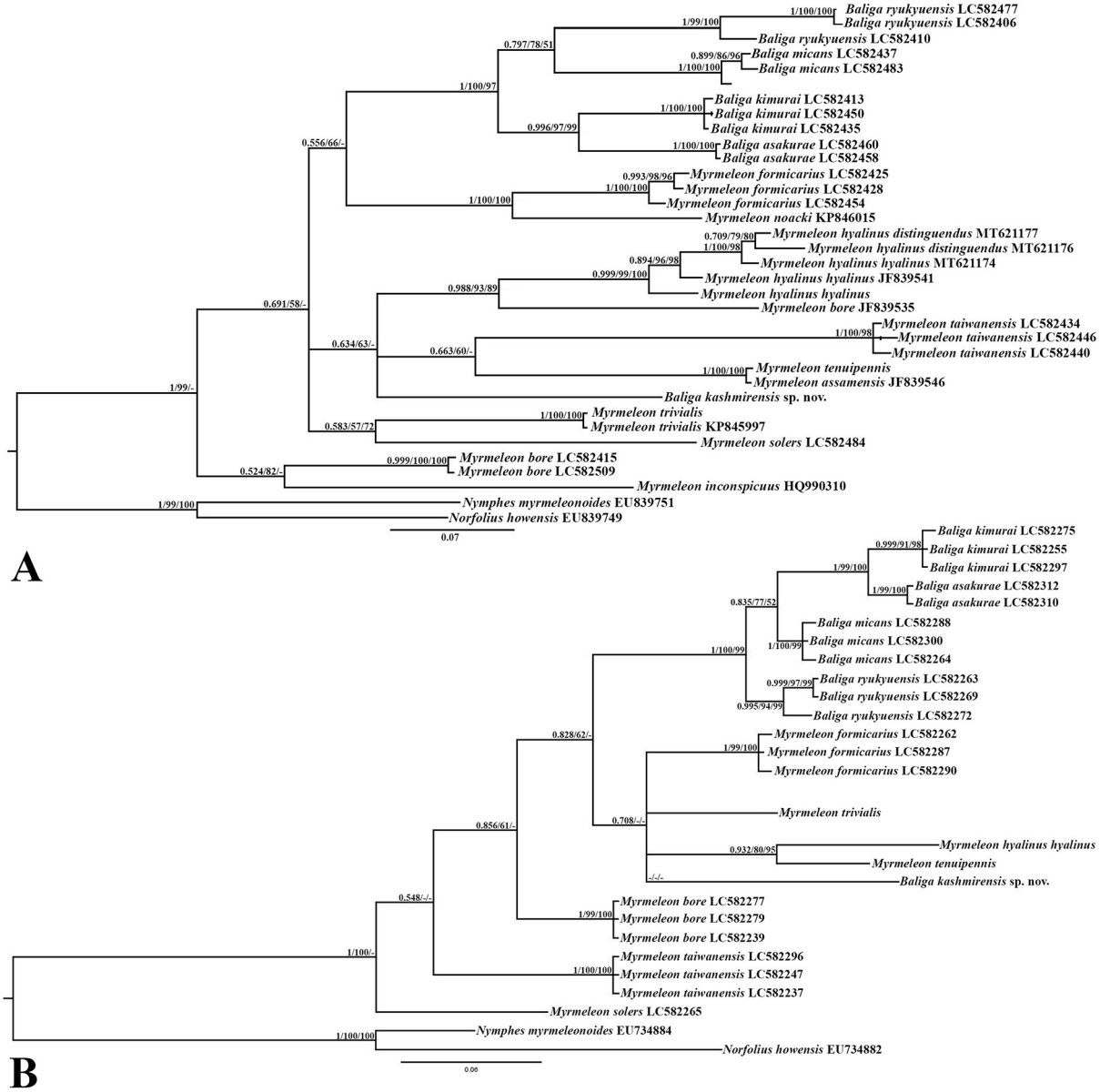

Fig. 21. Phylogenetic relationships among the species of *Baliga* Navás, 1912 and *Myrmeleon* Linnaeus, 1767 from Pakistan, China, Egypt, Greece, and Japan, based on COI (A) and 16S rRNA (B) genes. The numbers at each node show the posterior probabilities and bootstrap values more than 50% in BI/ML/NJ analysis.

Myrmeleon assamensis Ghosh, 1984

Myrmeleon assamensis Ghosh, 1984: 23. Type locality: India (Assam).

Diagnosis

Myrmeleon assamensis can be distinguished by the marking patterns on vertex and pronotum: vertex black, posteriorly with four yellow markings, two at middle and two at lateral margins in dorsal view; pronotum yellow, medially with a pair of dark brown stripes, which are separated by a narrow median yellow line.

Note

In the original description (solely based on male), Ghosh (1984) characterized this species based on the presence of two black stripes on the pronotum and the number of presectoral crossveins and the radial branches in both wings. Subsequently, Ghosh (1990) described the female of this species and found that the number of presectoral crossveins and the radial branches are different from that in the male previously described by him. Later, Iqbal & Yousuf (1992: fig. 2) re-described this species based on specimens from Pakistan and provided the line drawings of the head and pronotum in dorsal view as well as the male genitalia. Recently, Akhtar *et al.* (2018: fig. 1a) also recorded this species in Pakistan, which, however, is a case of misidentification of *M. tenuipennis* (see Note to this species). In the original description of *Myrmeleon assamensis*, the marking patterns on vertex are as follows: vertex at distally with two longitudinal and two transverse dark spots in dorsal view (vertex with only two longitudinal yellow markings in *M. tenuipennis*). No new specimens of this species were found in this study.

Distribution

Pakistan: Punjab Province (District Jhelum, District Khanewal, District Sahiwal); India (Assam State) (Ghosh 1984, 1992, 2000; Iqbal & Yousuf 1992, 1997; Stange 2004; Akhtar *et al.* 2018; Hassan *et al.* 2019; Oswald 2020).

Myrmeleon bore (Tjeder, 1941)

Grocus bore Tjeder, 1941: 74. Type localities: Sweden and Norway.
Myrmeleon exigus Yang, 1999: 148. Type locality: China (Fujian: Dongshan).
Myrmeleon tschernovi Krivokhatsky & Shapoval, 2014: 173. Type locality: Russia.

Diagnosis

Myrmeleon bore can be characterized by wholly dark brown vertex without yellow markings and the pronotum with lateral margins narrowly yellow on proximal half (Aspöck *et al.* 1980: fig. 822; Ábrahám & Papp 1991: fig. 2; Monserrat & Acevedo 2013: fig. 39; Tillier *et al.* 2013: fig. 13; Ábrahám & Giacomino 2020: fig. 3), while the species recorded from Pakistan have yellow markings on a vertex in dorsal view and the pronotum medially brownish yellow (Akhtar *et al.* 2018: fig. 2a). This character suggests that the specimens from Pakistan identified as *Myrmelon bore* belong to a different species.

Remarks

Myrmeleon bore seems widely distributed in the Palaearctic Region and was recently recorded from Pakistan. Notably, *Enza otiosus* Navás, 1912 has long been considered a secondary synonym of *M. bore* (Stange 2004; Sekimoto 2014; Wang *et al*. 2018). However, based on the priority of the nomenclature of the ICZN (International Code of Zoological Nomenclature), the validity of *E. otiosus* should be restored and transferred to *Myrmeleon*, then *M. bore* should be treated as a synonym of the former. Meanwhile, Kuwayama (1962) did not treat *E. otiosus* as a synonym for *M. bore* formally. Considering the type

localities between *E. otiosus* (holotype in Japan) and *M. bore* (syntypes in Sweden and Norway) have great distance, the relationship between both species needs to be further investigated. Hence, we do not include *E. otiosus* in the citation of *M. bore*.

Distribution

Pakistan? Widespread in Palaearctic Region (Röhricht 1998; Aspöck *et al.* 2001; Bao & Wang 2006; Akhtar *et al.* 2018; Yang *et al.* 2018; Hassan *et al.* 2019; Ábrahám & Giacomino 2020; Oswald 2020).

Myrmeleon clothilde Banks, 1913

Myrmeleon clothilde Banks, 1913: 223. Type locality: India (Bihar: Samastipur, Pusa).

Diagnosis

Myrmeleon clothilde can be characterized by wholly dark brown vertex with yellow markings at distal half in dorsal view; pronotum dark brown, laterally slightly narrow yellow at proximal half; medially with two narrow longitudinal yellow stripes at proximal to anterior transverse furrow (Iqbal & Yousuf 1992: fig. 1a).

Note

Since its original description, this species was rarely mentioned in literature (Iqbal & Yousuf 1992, 1997; Ghosh 2000; Stange 2004). After reviewing the aforementioned literature from Pakistan and India, we found that the male genitalia of this species have not been described so far. However, further additional data on the male genitalia and distribution of this rarely known species in Pakistan need to be updated in further studies. No new specimens of this species were found in this study.

Distribution

Pakistan: Punjab Province (District Faisalabad); India, Sri Lanka (Iqbal & Yousuf 1992, 1997; Ghosh 2000; Stange 2004; Hassan *et al.* 2019; Oswald 2020).

Myrmeleon inconspicuus Rambur, 1842

Myrmeleon inconspicuus Rambur, 1842: 406. Type locality: unknown.
Myrmeleon incertus Rambur, 1842: 406. Type locality: probably from Southern France.
Myrmeleon erberi Brauer, 1868: 190. Type locality: unknown.
Myrmeleon ariasi Navás, 1913b: 114. Type locality: Morocco.
Myrmeleon inconspicuus leoninus Navás, 1912d: 30. Type locality: unknown.

Diagnosis

Myrmeleon inconspicuus can be characterized by a wholly dark black vertex with yellow markings at distal half in dorsal view; pronotum dark brown with a narrow median longitudinal yellow marking at proximal to anterior transverse furrow and two rounded yellow markings at distal half (Akhtar *et al.* 2018: fig. 4a; Hajiesmaeilian *et al.* 2020: figs 11–12). No new specimens of this species were found in this study.

Distribution

Pakistan: Punjab Province (District Chakwal, Lal Sunahara National Park, District Bhakkar, Darya Khan, Mithi, District Dera Ghazi Khan, Chak Talpur, District Sahiwal, Harappa); Southern Europe (widespread), Northern Africa (widespread), Middle East to Iran (Aspöck *et al.* 1980, 2001; Akhtar *et al.* 2018; Hassan *et al.* 2019; Hajiesmaeilian *et al.* 2020; Oswald 2020).

Myrmeleon noacki Ohm, 1965

Myrmeleon noacki Ohm, 1965: 108. Type locality: Greece (West Greece: Zachlorou).

Diagnosis

Myrmeleon noacki can be characterized by a wholly dark brown vertex, without yellow markings; pronotum dark brown, laterally yellow, medially with a narrow longitudinal yellow line at proximal half wings lack pipula axillaris in males; apex of male gonocoxites 9 narrowly arcuated at anterolateral margins in ventral view.

Note

Myrmeleon noacki is known from the southeastern parts of Europe to Turkey, and was recently reported from Iran and Pakistan (Akhtar *et al.* 2018; Hajiesmaeilian *et al.* 2020). The reports of *Myrmelon noacki* from Pakistan need to be re-evaluated and compared with European specimens. Typically, this species is characterized by a narrow median longitudinal yellow marking at proximal half of pronotum and the male genitalia with gonocoxites 9 at anterolateral margins arcuated at anterolateral margins at apex in ventral view (see Ohm 1965: figs 2, 6; Hajiesmaeilian *et al.* 2020: figs 10, 14). The prothoracic markings and the shape of male genitalia of this species recorded from Pakistan match the typical diagnosis for *M. paghmanus*: pronotum dark brown, medially with a narrow longitudinal yellow marking, rounded at middle; male gonocoxites 9 arcuate at distal margin in ventral view (see Akhtar *et al.* 2018: fig. 5a–b; Hölzel 1972: figs 97, 101–102). No new specimens of this species were found in this study.

Distribution

Pakistan: Azad Kashmir (District Bagh); Gilgit-Baltistan (District Gilgit); Bulgaria, Greece, Macedonia, Iran, Turkey (Aspöck *et al.* 2001; Pantaleoni & Badano 2012; Akhtar *et al.* 2018; Hassan *et al.* 2019; Hajiesmaeilian *et al.* 2020; Oswald 2020).

Myrmeleon paghmanus Hölzel, 1972

Myrmeleon paghmanus Hölzel, 1972: 37. Type locality: Pakistan (Khyber Pakhtunkhwa: Swat; Gabral-Tal).

Diagnosis

Myrmeleon paghmanus can be characterized by the combination of the following characters: clypeus yellow, medially with two rounded brownish markings; pronotum dark brown, medially with a narrow longitudinal complete yellow stripe, laterally with a narrow yellow stripe at proximal half wings lack pipula axillaris in males; male gonocoxites 9 arcuate at distal margin in ventral view.

Note

Up till now, this species is only known from Afghanistan and Pakistan. No new specimens of this species were found in this study.

Distribution

Pakistan: Khyber Pakhtunkhwa Province (District Swat, Gabral-Tal); Afghanistan (Hölzel 1972; Stange 2004; Hassan *et al.* 2019; Oswald 2020).

Molecular identification

The present phylogenetic analysis based on COI and 16S rRNA genes shows that there is strong support for the monophyly of *Baliga* clade for Japanese species by BI, ML, and NJ methods, which, however, did not

comprise *Baliga kashmirensis* sp. nov. from Pakistan. Based on COI genes, *Baliga kashmirensis* sp. nov. was assigned to be within a monophylum with *M. tenuipennis* and *M. taiwanensis* Miller & Stange, 1999. However, the monophyly of *Baliga kashmirensis* sp. nov. with *M. tenuipennis*, *M. hyalinus*, *M. trivialis*, and the *M. formicarius* clade is recovered with relatively low nodal support values. For now, the present phylogenetic analysis is largely focused on species identification due to incomplete taxon sampling. The genetic divergence between *B. kashmirensis* sp. nov. and the species of *Myrmeleon* was 0.139–0.188 and that between this new species and the other species of *Baliga* was 0.153–0.186. The greatest intraspecific divergence (0.049) was found respectively in *B. ryukyuensis* Hayashi & Matsumoto, 2020 and *M. hyalinus*. The minimum and maximum interspecific genetic divergence between species of *Baliga* and *Myrmeleon* ranged from 0.074–0.186, and 0.123–0.188, respectively.

Discussion

In most recent taxonomic and molecular studies on Myrmeleontini from Japan, Hayashi *et al.* (2020) considered *Baliga* as a valid genus based on the generic classification system proposed by Stange (2004). According to Stange (2004), *Baliga* can be characterized by the presence of interconnected crossveins proximal to pterostigma in the forewing and the anterior gonocoxites 8 shorter than the posterior gonocoxites 8 in the female genitalia. However, the BI, ML and NJ trees herein reconstructed respectively based on COI and 16S rRNA genes for six species of *Baliga* and 11 *Myrmeleon* (Table 1; Fig. 21) albeit receiving low supports at deep-level nodes recovered *Myrmeleon* as paraphyletic. Similar results were also recovered in the recent molecular phylogenetic studies by Michel *et al.* (2017) and Machado *et al.* (2019). In Hayashi *et al.* (2020), the species of *Baliga* and those of *Myrmeleon*, respectively, constituted a monophylum, which, however, might be due to incomplete taxon sampling. Nevertheless, here we do not propose any new generic synonym but still follow the generic classification system of Stange (2004). The validity of *Baliga* needs a major phylogenetic revision with larger datasets in future studies. Furthermore, the additional proposed synonymized genera by Machado *et al.* (2019) need to be deciphered in future studies. In addition, concerning the great intraspecific divergence, it is necessary to clarify the taxonomic status of all subspecies of *M. hyalinus* and the two insular populations of *B. ryukyuensis* (Amami/Tokunoshima and Okinawa) based on both morphological and molecular data.

With respect to the distribution of antlions in Pakistan, our results corroborate the mixed fauna from the Oriental and Palaearctic regions in the northern parts of Pakistan (Fig. 20) due to the unique geographical position – the extreme edge of western Himalayas and the junction point of the world's two largest zoogeographical regions: the Oriental and the Palaearctic. The present diversity and distribution of antlions in Pakistan is consistent with our recent studies on the subfamily Ascalaphinae (Neuroptera: Myrmeleontidae) and the following genera of Myrmeleontidae and Megaloptera from northern Pakistan: *Distoleon* Banks, 1910 (Neuroptera: Myrmeleontidae), *Nevromus* Rambur, 1842 and *Protohermes* van der Weele, 1907 (Megaloptera: Corydalidae) (Hassan *et al.* 2019, 2020a, 2020b; Hassan & Liu 2021). Nevertheless, this pattern may be also due to the present limitation of sampling (extensive collecting primarily confined to the northern parts of Pakistan). Broader sampling across the country, particularly for the southern parts, may reveal the true diversity and distribution of antlions in the future.

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