

RESEARCH PAPER

Dictyopharidae of Nepal (Hemiptera: Fulgoromorpha), with description of a new genus

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Abstract. Four species in four genera of Dictyopharidae (Hemiptera: Fulgoromorpha) are recorded from Nepal, including *Dictyohimalaya nepalensis* Song & Liang, gen. & sp. nov. which is described and illustrated herein, *Orthopagus lunulifer* Uhler, 1897, *Raivuna* sp., and *Tenguna medogensis* Song & Liang, 2007. An identification key to the species of Dictyopharidae currently known from Nepal is provided. The dictyopharid fauna of the country remains poorly studied and further efforts are required to discover its real diversity.

Key words. Hemiptera, Auchenorrhyncha, Fulgoroidea, Dictyopharini, Orthopagini, new species, new records, taxonomy, Nepal, Oriental Region

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Introduction

The planthopper family Dictyopharidae is one of twenty-one currently recognized extant families of Fulgoroidea (Hemiptera: Fulgoromorpha) (SONG et al. 2018a, 2019; BOURGOIN 2020). With more than 720 species in 155 extant and extinct genera, this family is currently divided into two subfamilies Dictyopharinae Spinola, 1839 and Orgeriinae Fieber, 1872 (SONG et al. 2018a). Dictyopharidae are present in all biogeographic regions, however, most species are distributed in tropical and subtropical zones, e.g. in the Neotropical and Oriental Regions (METCALF 1946, BOURGOIN 2020).

Nepal, a roughly trapezoid-shaped Himalayan country, lies between the latitudes of 26° and 31° N, and longitudes of 80° and 89° E. Owing to the world's greatest altitude range and the interface between two major zoogeographic regions, i.e., the Palaearctic and Oriental Regions, this country is known for various climate zones as well as ecological belts (THAPA 1997, DUWAL et al. 2010, NAGEL 2018). Its size, location, and historical interaction of the complex topographic, climatic and ecological factors,

make Nepal to possess high levels of insect species diversity and endemism. The wealth of insect fauna in Nepal was enumerated to 5,175 species at the end of the last century (THAPA 2000), and more new taxa and new records were added in the past two decades (e.g., FIKÁČEK & HEBAUER 2005, YOSHIZAWA et al. 2007, WYNIGER 2008, DUWAL et al. 2010, NAGEL 2018). However, the dictyopharid fauna of Nepal has never been investigated in detail. Only one species, *Orthopagus lunulifer* Uhler, 1897, has been recorded from Nepal so far (SONG et al. 2018b). This obviously represents only a small fraction of the actual diversity of the regional dictyopharid fauna, considering the various habitats present in Nepal.

While sorting and identifying dictyopharid material from various collections, we found an undescribed genus and species and two other known species collected but previously unreported from Nepal. Herein, we describe and illustrate the new genus and species as *Dictyohimalaya nepalensis* Song & Liang, gen. & sp. nov., and provide a key to the four species of Dictyopharidae currently known from Nepal.



Material and methods

The specimens studied in this work are deposited in the following institutions with the names abbreviated in the text as follows:

HNHM Hungarian Natural History Museum, Budapest, Hungary;
 EIHU Laboratory of Systematic Entomology, Hokkaido University, Sapporo, Japan;

USNM National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA.

The post-abdomen of the specimen used for dissections was cleared in 10% KOH at room temperature for ca. 6–12 hours, rinsed and examined in distilled water and then transferred to 10% glycerol and stored in a microvial to be preserved with the specimen. Morphological characters were

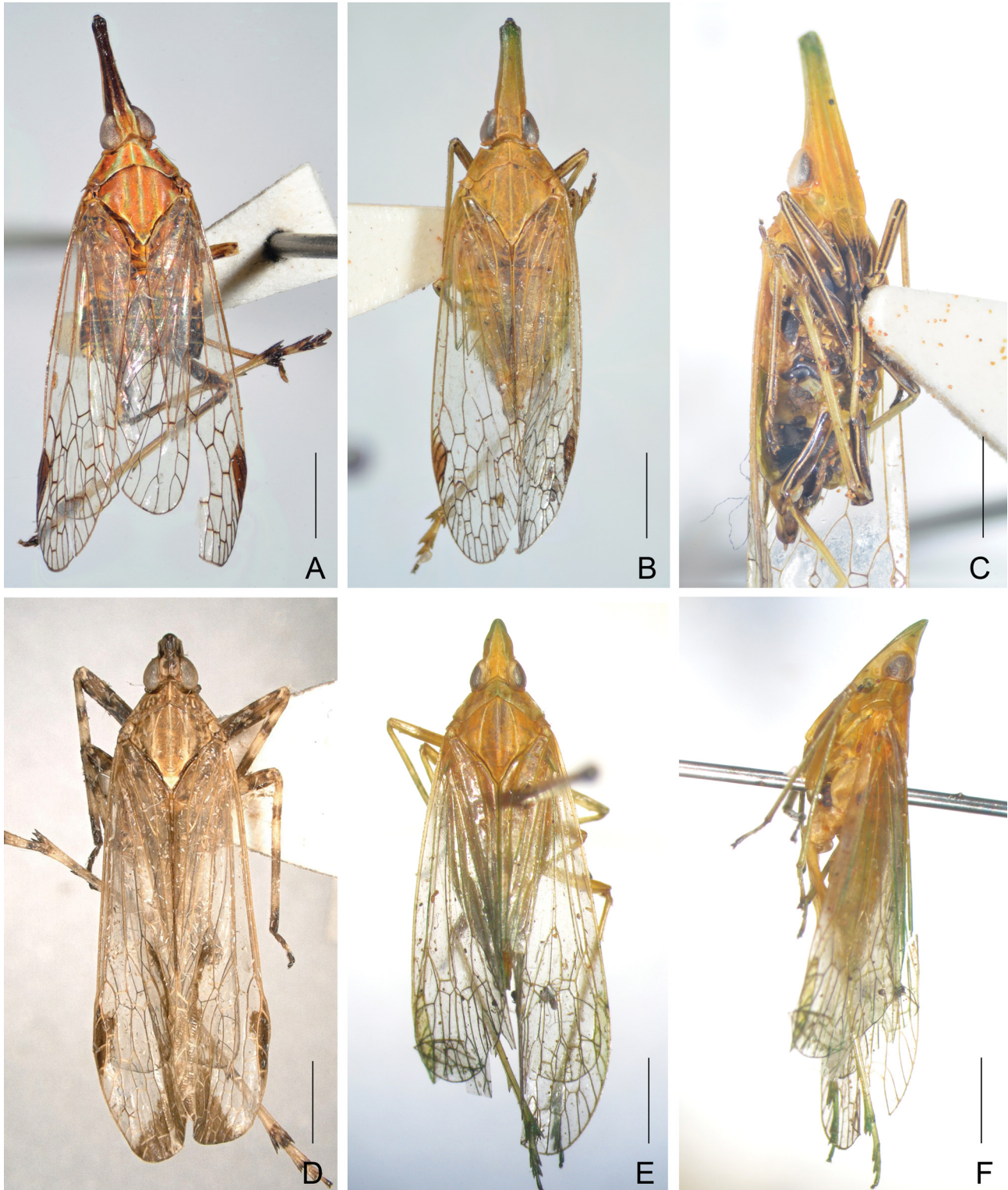


Fig. 1. Habitus of Dictyopharidae in Nepal. A – *Dictyohimalaya nepalensis* Song & Liang, sp. nov., dorsal view; B–C – *Raivuna* sp. (B – dorsal view; C – ventro-lateral view). D – *Orthopagus lunulifer* Uhler, 1897, dorsal view. E–F – *Tenguna medogensis* Song & Liang, 2007 (E – dorsal view; F – lateral view). Scale bars: 2 mm.

observed with a Zeiss Stemi SV II optical stereomicroscope and illustrated with the aid of a drawing tube attached to the microscope; measurements were made with the aid of an eyepiece micrometer at the Institute of Zoology, Chinese Academy of Sciences, China. The morphological terminology and measurements used in this study follow SONG et al. (2016a, b, 2018a) for most characters and BOURGOIN et al. (2015) for the forewings.

Taxonomy

Key to the Dictyopharidae known from Nepal

- 1 Mesonotum with lateral carinae nearly straight and parallel (Figs 1A, B; 2A); lobes of phallobase on aedeagus with long sclerotized spines around (Figs 3D–F) (Dictyopharini). 2
 - Mesonotum with lateral carinae incurved and convergent (Figs 1D, E); lobes of phallobase on aedeagus without long sclerotized spines (Orthopagini). 3
- 2 Cephalic process in front of eyes narrowed and distinctly slender; vertex with basal width narrower than transverse diameter of eyes (Figs 1A, 2A–C).
 - *Dictyohimalaya nepalensis* gen. & sp. nov.
 - Cephalic process in front of eyes not narrowed and distinctly robust; vertex with basal width equal to or wider than transverse diameter of eyes (Fig. 1B).
 - *Raivuna* sp.
- 3 Apex of cephalic process truncated; forewings with a large sublunate fuscous streak on posterior margin of apical area; fore femora flattened and dilated (Fig. 1D), with a large blunt spine near apex.
 - *Orthopagus lunulifer* Uhler, 1897
 - Apex of cephalic process acuminate; forewings without sublunate fuscous streak; fore femora not flattened and dilated (Figs 1E, F), with a small acute spine near apex.
 - *Tenguna medogensis* Song & Liang, 2007

Tribe Dictyopharini Spinola, 1839

Dictyohimalaya Song & Liang, gen. nov.

Type species. *Dictyohimalaya nepalensis* Song & Liang sp. nov., by present designation.

Diagnosis. *Dictyohimalaya* gen. nov. can be distinguished by the following combination of characters: cephalic process elongate and distinctly slender; vertex narrow, basal width slightly narrower than transverse diameter of eyes, posterior plane horizontal with pronotum, median carina relatively distinct on a bulge between eyes; frons with intermediate carinae approaching to anterior margin of eyes; pronotum with only median carina sharp and high, a short carina extending obliquely across paranotal lobes for about one-third of its length; mesonotum tricarinate, lateral carinae nearly straight and sub-parallel; forewings with pterostigmal area quadrilateral; fore femora not flattened and dilated, hind tibiae with seven apical teeth; aedeagus with endosomal processes very short, not extended from phallobase and invisible from outside; phallobase with an elongate sclerotized process from ventral base, directed ventrad, and inflated membranous apical lobes with long sclerotized spines.

Description. Coloration. General color brownish ochraceous marked with pale green and purplish-red on head and thorax, and dark brown on abdomen in dorsal view (Fig. 1A). Ocelli reddish.

Head produced into elongate, distinctly slender cephalic process. Vertex (Fig. 2A) narrow, basal width slightly narrower than transverse diameter of eyes; posterior plane horizontal with pronotum; lateral carinae strongly elevated, sub-parallel and broadly sulcate between eyes, distinctly narrowed in front of eyes, and nearly parallel to apex; posterior margin arcuately concave; median carina only relatively distinct on a bulge between eyes, with a lateral oblique depression on each side. Frons (Fig. 2C) widest below antennae, lateral carinae slightly converging towards base; frontoclypeal suture somewhat concave; median carina distinct and complete, intermediate carinae not sharp, sub-parallel, approaching to anterior margin of eyes. Postclypeus and anteclypeus convex medially, with distinct median carina. Rostrum moderately long, reaching middle of hind femora. Eyes oval and large. Ocelli relatively large. Antennae with scape very small; pedicel large and subglobose, with more than 50 distinct sensory plaque organs distributed over entire surface; flagellum long, setuliform.

Thorax. Pronotum (Fig. 2A) broad, distinctly shorter than mesonotum medially; anterior margin slightly convex medially, lateral marginal areas straight and sloping with two long longitudinal carinae on each side between eyes and tegulae, posterior margin broadly concave; median carina sharp and high, with a lateral pit on either side of carina; intermediate carinae absent; a short carina extending obliquely across paranotal lobes for about one-third of its length. Mesonotum (Fig. 2A) tricarinate, lateral carinae nearly straight and sub-parallel. Forewings (Fig. 2D) hyaline, venation with sparse transverse veins; MP bifurcating into MP_{1+2} and MP_{3+4} near middle and beyond CuA; number of apical cells between R and CuA equal to 15; Pcu and A_1 veins fused into a long Pcu+ A_1 vein at apical 1/4 in clavus; pterostigmal area quadrilateral, with four cells. Legs moderately long; fore femora not flattened and dilated, without spines; hind tibiae with four or five lateral spines and seven apical teeth; hind tarsomeres I with about 18 apical teeth and hind tarsomeres II with about 15 apical teeth.

Male genitalia. Pygofer (Figs 3A–C), in lateral aspect, wider ventrally than dorsally, posterior margin distinctly convex medially, without process. Gonostyles (Figs 3B, C) symmetrical, base narrow, expanded toward apex, broadest at apical fourth; dorsal margin with upper process very long, acute apically, outer dorsal edge with spiny hook-like process near middle, directed ventrad. Aedeagus (Figs 3D–F) moderately large and symmetrical, endosomal processes very short, not extended from phallobase and not visible from outside; phallobase basally sclerotized and pigmented, produced into long sclerotized process from ventral base, directed ventrad; inflated membranous apical lobes with long sclerotized spines. Segment X (Fig. 3A) oval, in dorsal view, with apex deeply excavated to accommodate anal style; anal style elongate and large.

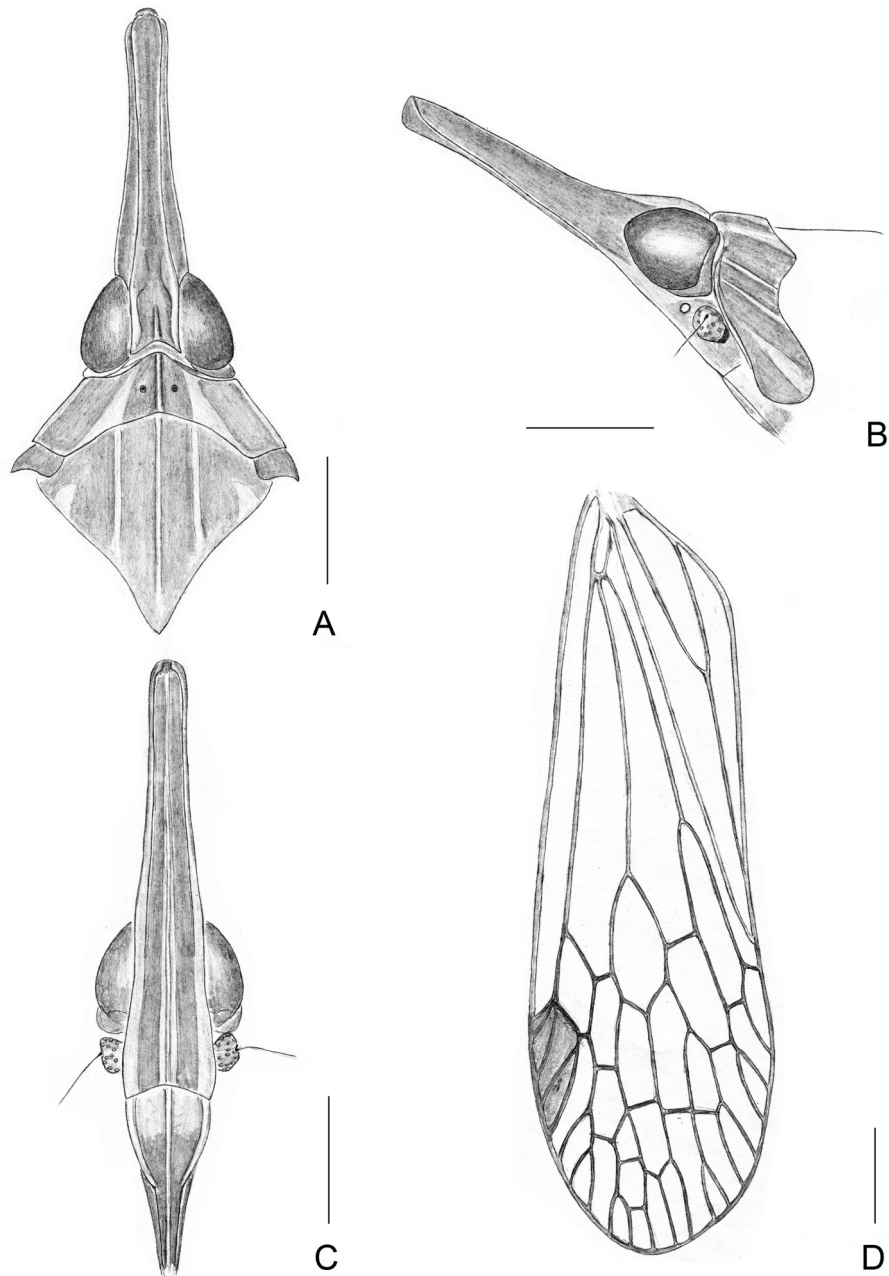


Fig. 2. *Dictyohimalaya nepalensis* Song & Liang, sp. nov. A – head, pronotum and mesonotum, dorsal view; B – head and pronotum, lateral view; C – head and pronotum, ventral view; D – forewing. Scale bars: 1 mm.

Female. Unknown.

Differential diagnosis. *Dictyohimalaya* gen. nov. can be distinguished from all other genera of Dictyopharini by the elongate sclerotized process on ventral base of the phallobase (Figs 3E, F). *Dictyohimalaya* is externally similar to *Putala* Melichar, 1903 (redescribed and illustrated by SONG & LIANG 2011), but can be separated from the latter by the following character states: posterior plane of vertex horizontal with pronotum (posterior plane elevated above pronotum in *Putala*); intermediate carinae of frons approaching to anterior margin of eyes (approaching to frontoclypeal suture in *Putala*); and pronotum with a short carina on paranotal lobes (pronotum without paranotal carina in *Putala*).

Dictyohimalaya is also similar to *Raivuna* Fennah, 1978 but it can be distinguished from the latter by the narrowed and distinctly slender cephalic process (cephalic process in front of eyes distinctly robust in *Raivuna*); basal width of vertex narrower than transverse diameter of eyes (equal to or wider than transverse diameter of eyes in *Raivuna*); and intermediate carinae of frons approaching to anterior margin of eyes (nearly approaching to frontoclypeal suture in *Raivuna*).

Etymology. The generic name is a combination from the Greek noun δίκτυον (diktyon, = net), referring to the Dictyopharidae family, and ‘Himalaya’. The latter is the highest mountain range in South Asia which separates the Indo-Gangetic Plain from the Tibetan Plateau and extends

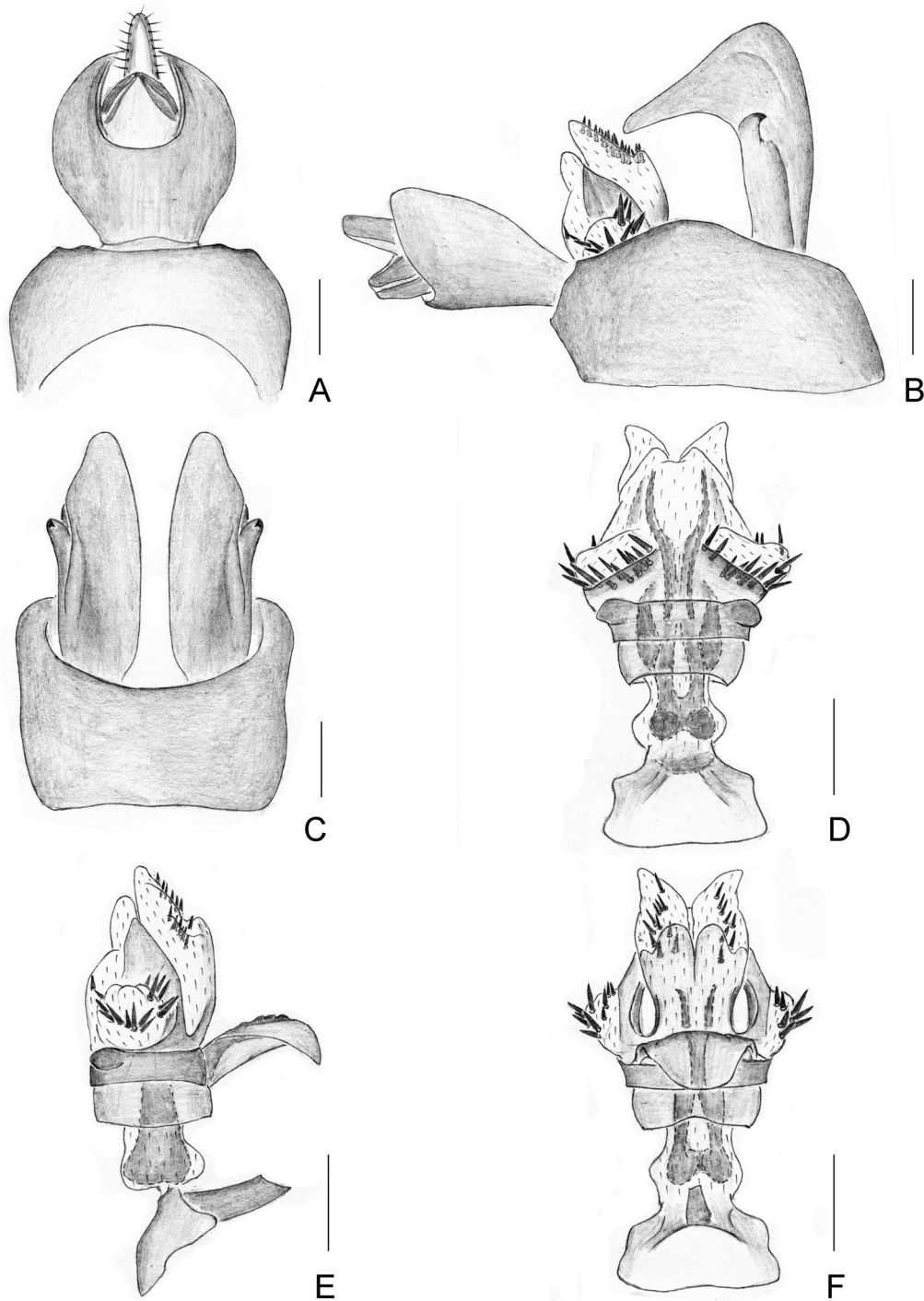


Fig. 3. *Dictyohimalaya nepalensis* Song & Liang, sp. nov. A – male segment X and pygofer, dorsal view; B – male pygofer, gonostyles, and segment X, lateral view; C – male pygofer and gonostyles, ventral view; D – aedeagus, dorsal view; E – aedeagus, lateral view; F – aedeagus, ventral view. Scale bars: 0.5 mm.

across Nepal, the country of origin of the type species. Gender feminine.

Diversity and distribution. The genus is described as monotypic, containing one species so far known only from north-eastern Nepal.

***Dictyohimalaya nepalensis* Song & Liang, sp. nov.**
(Figs 1A, 2A–D, 3A–F)

Type locality. Nepal, Bagmati province, Sindhupalchok district, Bhotekoshi municipality, Kodari village, ca. 27.9735° N 85.9628° E, 2300 m a.s.l.

Type material. HOLOTYPE: ♂, NEPAL: 9 km S. of Kodari, 28.x.1977, G.F. Hevel (USNM, dry-mounted, glued on card point, postabdomen separated in a microvial on the same pin; Fig. 1A).

Description. *Measurements* (in mm). Body length 14.7; head length (from apex of head to base of eyes) 2.7; head width (including eyes) 1.4; forewing length 8.9.

Coloration. General color brownish ochraceous, marked with pale green and purplish-red on head and thorax, and dark brown on abdomen in dorsal view (Fig. 1A). Vertex and genae mostly dark brown in front of eyes, frons

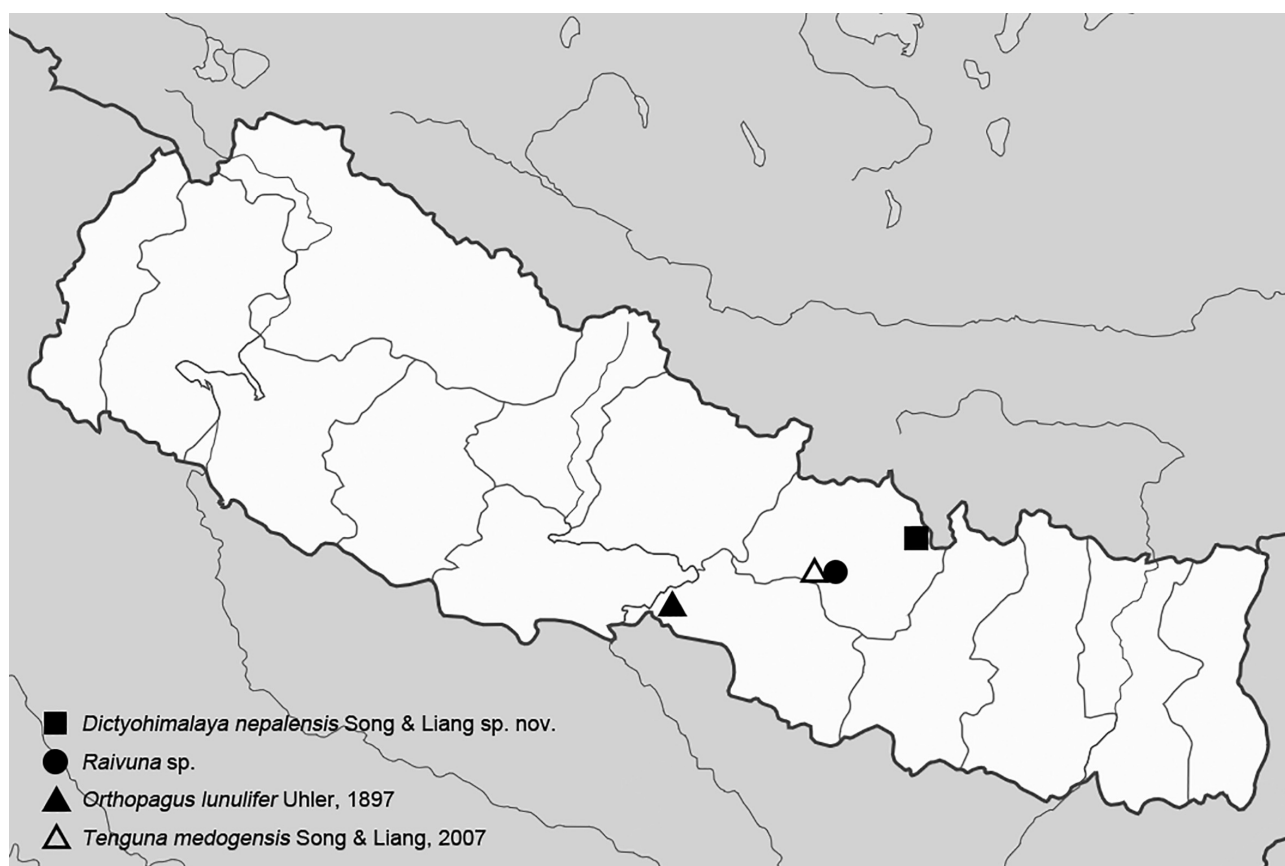


Fig. 4. Distribution of dictyopharid species in Nepal.

yellowish green, broad area between intermediate carinae and median carina reddish ochraceous. Compound eyes brown, ocelli purplish-red. Clypeus ochraceous. Pronotum and mesonotum brownish ochraceous, areas of median, intermediate, lateral marginal, and paranotal carinae of pronotum and median and lateral carinae and lateral marginal areas of mesonotum yellowish green. Forewings with membrane hyaline, veins ochraceous, pterostigmal area dark brown. Thorax yellowish ochraceous ventrolaterally. Legs pale to dark brown, inner surface of fore and middle femora and tibiae with a row of black spots. Abdomen dorsally dark brown and black with numerous paler brownish spots; ventrally mostly blackish brown, posterior margins of sternites yellowish ochraceous; male and female terminalia dark brown.

Structure. Head (Figs 2A–C) distinctly slender and elongate, longer than pronotum and mesonotum combined (about 1.3 : 1). Vertex with ratio of length at midline to width between eyes 6.9 : 1 (Fig. 2A). Frons with ratio of length at midline to maximum width below antennae 4.7 : 1 (Fig. 2C). Forewings hyaline, ratio of length to width about 3.0 : 1 (Fig. 2D).

Male genitalia. Pygofer, in lateral view (Fig. 3B), with dorso-posterior margin more or less convex in middle; in ventral view (Fig. 3C) longer than in dorsal view (Fig. 3A), with ratio of ventral to dorsal width about 1.9 : 1. Gonostyles (Figs 3B, C) elongate, apex strongly expanded, posterior margin nearly straight; upper process very elongate, acute at apex. Aedeagus (Figs 3D–F) relatively small and stout

compared with gonostyles, endosomal processes very short, not extended from phallosome and invisible from outside. Phallosome produced into long sclerotized process from ventral base, directed ventrad; bases of dorsal and lateral parts and most portion of ventral part on phallosome sclerotized and pigmented, the remainder membranous; dorsal part with a large lobe, produced into pair of small processes at apex in dorsal view (Fig. 3D); dorsolateral apical parts produced into pair of stout lobes surrounded by 15–17 large spines subapically in lateral view (Fig. 3E); ventral part with a pair of elongate apical lobes bearing 8–11 long spines in ventral view (Fig. 3F). Segment X, in dorsal view (Fig. 3A), oval and broadest medially, with ratio of length to maximum width 1.1 : 1; in lateral view (Fig. 3B), short and robust, with ventral margin gradually widening from base to apex; anal style large, beyond apical ventral margin of segment X.

Etymology. The new species is named for its occurrence in Nepal. Adjective.

Distribution. So far only known from Kodari, Nepal.

Raivuna Fennah, 1978

Raivuna sp. (Figs 1B, C)

Material examined. NEPAL: 1 ♂, Godawari Kathmandu V., 13,14,17. ix.1987, H. Takizawa (EIHU).

Remarks. This genus is a new record for Nepal. *Raivuna* includes 32 described species distributed in the Afrotropical, Palearctic and Oriental Regions (BOURGOIN 2020).

The single male specimen examined from Nepal is similar to *Raivuna pallida* (Donovan, 1800), but differs from the latter by the pale green body coloration. This specimen needs to be further studied in detail.

Tribe Orthopagini Emeljanov, 1983

Orthopagus Uhler, 1897

Orthopagus lunulifer Uhler, 1897

(Fig. 1D)

Material examined. NEPAL: 1 ♂, Chitwan National Park, Island Jungle reserve, 29–30.x.1995, L. Peregovits (HNHM).

Remarks. The genus *Orthopagus* was revised by SONG et al. (2018b) who also reported the specimen cited here from Nepal. This specimen is identical in external characters to specimens of *O. lunulifer* from Japan, China, Taiwan and Vietnam. However, it differs in the shape of the lobe on the dorso-posterior margin of the pygofer which is smaller (shorter and simply angular) than in the rest of *O. lunulifer* males studied. The phallobase of this specimen could not be sufficiently compared as its membranous lobes failed to inflate during the preparation. More specimens and data are needed to confirm the identification (SONG et al. 2018b).

Tenguna Matsumura, 1910

Tenguna medogensis Song & Liang, 2007

(Figs 1E, F)

Material examined. NEPAL: 1 ♀, Godawari Kathmandu V., 13,14,17. ix.1987, H. Takizawa (EIHU).

Remarks. This species is a new record for Nepal. *Tenguna medogensis* was described from Tibet, China (SONG & LIANG 2007). The single female of *T. medogensis* from Nepal is identical in external characters to the type specimens.

Discussion

Nepal is situated on the southern slopes of the Himalayas. Like in the marginal zones of southeast Tibet, China, the world's greatest altitudinal range, various climate zones and ecological belts result in rich biota of Nepal. The collision of the Indian subcontinent with southern Eurasia, the continuing rise of the Himalayas, and the climate and environmental fluctuations of the Quaternary have been of great significance in promoting speciation and increasing biodiversity in the Himalayan regions (HUANG et al. 2001, 2006). Himalayan endemic species occupy an important place in the regional fauna. Many of these rare species have been preserved in the Himalayan valleys (HUANG et al. 2001, 2006). *Dictyohimalaya nepalensis* Song & Liang, sp. nov. may be one of representatives of presumably numerous endemic planthoppers in the Himalayas. Unfortunately, the planthopper fauna of Nepal, including Dictyopharidae, has never been explored and studied systematically before (THAPA 2000). The four genera and four species of Dictyopharidae currently known from a few sites in Nepal (Fig. 4) may represent only a small fragment of the total number of taxa which are probably present in this country. Further efforts are

required to discover the actual diversity of the Nepalese dictyopharid fauna.

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