Aryalidonta itishreea, a new genus and species of Thoradontini (Orthoptera, Tetrigidae) from Nepal honors the Emperor of Laughter

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Abstract

Aryal's Ten Avatar Groundhopper, *Aryalidonta itishreea* **gen. et sp. nov.**, named in honor of the late Bhairav Aryal, an iconic Nepali satirist, is a new genus and species of Tetrigidae described as a part of the tribe Thoradontini. The species is native to Nepal, a country with a rich tetrigid fauna in need of taxonomic revisions. This monotypic genus can be easily separated from other Thoradontini genera by its enlarged proximal halves of middle femora, a peculiar lateral lobe morphology (small caudal protrusion in its caudal part and a sharp lateral tip), a triangular, anteriorly narrowing vertex, and by its unique head morphology. The species was observed in its natural habitat. It was found to harbor many color variations that are cryptic in nature. It feeds on detritus, algae, lichen, and moss. Specimens heavily infested by mites were found, as well as those in interaction with wasps (possibly Eulophidae), but the nature of the latter could not be determined.

Keywords

Bhairav Aryal, ecology, Eulophidae, Gorkha, groundhopper, Himalayas, Scelimeninae

Introduction

Nepal is a country of rich geography and biodiversity owing to its unique position at the junction of the Palaearctic and Palaeotropical biogeographic realms extending from an altitude of 59 m.a.s.l to the highest point on the Earth, Mount Sagarmatha (8848.86 m.a.s.l) in a mere distance of under 200 km (Udvardy 1975, Paudel et al. 2012). Unfortunately, the fauna of pygmy grasshoppers (Orthoptera: Tetrigidae) is still not well documented. Only a handful of works have been published regarding these beautiful insects, mainly by Chopard and Dreux (1966), Bey-Bienko (1968), Martens (1987), Balderson and Yin (1987), Ingrisch (1987, 2001a, b, 2006), Ingrisch and Garai (2001), Tumbrinck (2015), Subedi (2022), and Subedi (in press). Sigfrid Ingrisch, a father figure to Nepali Orthoptera, published some phenomenal works describing many species new to science, as well as a checklist of Nepali Tetrigidae (along with other Orthoptera families) (Ingrisch 1987, 2001a, b, 2006). The checklist was later updated by Tumbrinck (2015) with the addition of an identification key to the species level. The fauna of Nepali Tetrigidae currently numbers 70 species belonging to 25 genera (Tumbrinck 2015, Cigliano et al. 2022, Subedi in press; this paper) and, as is evident from this paper, more are yet to be described.

The tribe Thoradontini Kevan, 1966 used to belong to the subfamily Scelimeninae, which has been a target of many studies (Skejo 2017, Skejo and Bertner 2017, Muhammad et al. 2018, Adžić et al. 2020). Following work by Adžić et al. (2020), who concluded that Thoradontini do not form a monophyletic clade with Criotettigini Kevan, 1966 and Scelimenini Bolívar, 1887, Thoradontini were left without subfamilial placement. Thoradontini currently consists of the genera *Thoradonta* Hancock, 1909, *Loxilobus* Hancock, 1904, and *Eucriotettix* Hebard, 1930, with the addition of *Aryalidonta* **gen. nov.** in this paper.

The aim of this paper is to describe a new genus and species of Tetrigidae from Nepal and offer insights into its ecology.

Materials and methods

Museum abbreviations.—
ANHM Annapurna Natural History Museum, Pokhara, Nepal

Study area.—The study was conducted in the vicinity of the village of Ghyalchok, Gorkha District, Nepal. The village is situated in a subtropical climate zone that is under the influence of a south-

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easterly monsoon that provides most of the area's precipitation during the summer months. The temperature averages between 0 and 25°C, with a warm period between April and September (Shrestha and Aryal 2011). The species was studied for a whole year (October 2021 to September 2022) in the denoted area. A precise description of its typical habitat is presented under the appropriate section in the Results.

Identification, taxonomy, and nomenclature.—The whole type series, along with several individual adults and nymphs, were photographed, and videos were recorded in situ with a Canon EOS 80D with a Canon EF 100mm f/2.8 USM macro lens. Specimens were also collected for examination. The videos were uploaded to YouTube (channel: Nepali Grasshoppers), and links are provided in the appropriate parts of the text.

The type series was pinned using Phusis stainless steel insect pins (size #1) and deposited in ANHM, Pokhara, Nepal. Measurements were made with ImageJ by calibrating the images with millimeter paper. Species descriptions are based on images taken using the macro lens.

The newly described species was compared to the others present in the region using the material available on the Orthoptera Species File (OSF; Cigliano et al. 2022) and by consulting the original descriptions of the relevant taxa. Morphological terminology follows Tumbrinck (2014), and measurements follow Tumbrinck (2014) and Tan and Artchawakom (2015). Taxonomy follows the OSF (Cigliano et al. 2022). Nomenclature is in accordance with the 4th edition of the International Code of the Zoological Nomenclature (ICZN 1999).

Rearing in captivity.—Four adult individuals (2 males and 2 females) were hand-picked from the wild and reared in a plastic jar (1 L). They were fed with moss and detritus and were examined for their excreta.

Results

Taxonomy

Family Tetrigidae Rambur, 1838
Tribe Thoradontini Kevan, 1966

Genus *Aryalidonta* gen. nov.
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Justification of the tribal assignment and the genus description.—The herein described species shares many similarities with members of Thoradontini, the most notable of which are as follows: (i) the u- or v-shaped carinae of the vertex visible in frontal view, (ii) high-placed frontal costa bifurcation and usually low-placed antennal grooves, (iii) a vertex that is usually triangular and narrowing anteriorly, (iv) eyes adjacent to the anterior margin of the pronotum, (v) bilobate lateral lobes, (vi) wings approximately equally long as the pronotum, and (vii) nodulate surface of the pronotum. Although an overview of the material showed that the tribe requires a thorough revision, we place the new genus and species within it to allow for easier revision in the future.

The new species does not fit with the type species of any of the relevant genera and is thus described under its own genus. It is possible that the subsequent revisions will recognize more species that belong in this genus, so it is important that the genus be defined by a well-documented species.

Etymology.—Patronymic. The genus is named in honor of the late Bhairav Aryal (Nepali: भैरव अर्याल), an iconic satirist of Nepali literature popularly known as the Emperor of Laughter (Nepali: हाँस्य सम्राट). The second part of the name, -donta, derives from the Greek word "ὀδών", meaning "tooth," and is a reference to Bhairav Aryal's iconic smile. The genus name is of feminine gender.

Type species.—*Aryalidonta itishreea* **sp. nov.** by original monotypy.

Species included.—Thus far, only the type species is known.

Distribution.—Currently known only from Nepal, from the type locality (Fig. 1).

Generic diagnosis.—The generic diagnosis is provided as a comparison of the type species of the tribe Thoradontini to better represent the true definitions of each genus.

From *Eucriotettix tricarinatus* (Bolívar, 1887), the type species of the genus *Eucriotettix*, this species is differentiated by the following characters: (i) the flat vertex with a low medial carina instead of well-expressed medial carina as in *E. tricarinatus*; (ii) bifurcation of the frontal costa in the upper quarter of the compound eye height is higher in *E. tricarinatus*; (iii) the prozonal carinae converging caudally instead of running parallel as in *E. tricarinatus*; (iv) rectangular lateral lobes provided with small protrusions instead of with long and sharp protrusions as in *E. tricarinatus*; and (v) the proximal halves of the middle femora are enlarged while the femora are slim throughout in *E. tricarinatus*.

From *Loxilobus acutus* Hancock, 1904, the type species of the genus *Loxilobus*, the new species is differentiated by the following characters: (i) the bifurcation of the frontal costa in the upper quarter of the compound eye height is a little higher in *L. acutus*; (ii) the paired ocelli in *A. itishreea* **sp. nov.** are placed a little below half of the compound eye height while in the upper quarter in *L. acutus*; (iii) the middle-level of the antennal grooves are at the level of the bottom of the compound eyes in the new species while in the bottom third of the compound eye height in *L. acutus*; (iv) the vertex is triangular and gently narrowing in the new species while triangular and more sharply narrowing in *L. acutus*; (v) the surface of the vertex flat with low carinae but convex in *L. acutus*; (vi) rectangular lateral lobes with small protrusions in the new species while with long and sharp protrusions in *L. acutus*; and (vii) the proximal halves of the middle femora are enlarged instead of slim as in the femora in *L. acutus*.

From *Thoradonta dentata* Hancock, 1909, the type species of the genus *Thoradonta*, *A. itishreea* **sp. nov.** is differentiated by the following characters: (i) the paired ocelli are placed a little below half of the compound eye height instead of in the lower third as in *T. dentata*; (ii) the middle-level of the antennal grooves at the level of the bottom of the compound eyes instead of antennal grooves below the level of the compound eyes; (iii) narrow instead of wide vertex; (iv) external carinae straight caudally of the humeral angles instead of incurved; (v) the lateral lobes projected laterally, rectangular with a small protrusion caudally and a sharp tip laterally instead of simple sharp lateral lobes; and (vi) the proximal halves of the middle femora are enlarged instead of slim throughout.

Fig. 1. Map of Nepal with the type locality marked. Gorkha District is shown in red, and the precise place of the type locality is indicated by the blue dot. The map is adapted after Sagarjkhatri, own work, CC BY-SA 4.0, Wikimedia commons.

***Aryalidonta itishreea* sp. nov.**

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Figs 2–6

Etymology.—The specific epithet is derived from the Nepali word "itishree", which is the title of one of Bhairav Aryal's books and translates to "The End". The name is also a reference to the tragic end of Bhairav Aryal's life, as well as to his unyielding belief that an end is an invitation to a new beginning. The name is Latinized with the suffix "-a" to form a noun in the nominative case and is feminine in gender.

Common name.—Aryal's Ten Avatar Groundhopper (Nepali: अर्यालको दश औतारी भुइँफड्के).

Common name etymology.—Named after one of Bhairav Aryal's masterpieces, Dash Autar (Nepali: दश औतार; English transl. Ten Avatars). The name symbolically refers to the many color forms observed among individuals of this species.

Type locality.—Amaldarchaur, Ghyalchok, Gorkha, Nepal (Nepali: अमलदारचौर, घ्याल्चोक, गोरखा, नेपाल) situated at an altitude of 465 ± 10 m asl (approximate) with GPS coordinates 27.809511°N, 84.718849°E. Shown in Fig. 1.

Material examined.—Type material. ***Holotype***: (Fig. 3) NEPAL • ♀; Gandaki Province, Gorkha District, Gandaki Rural Municipality, Ghyalchok, Amaldarchaur; 27.809511°N, 84.718849°E; 465 ± 10 m a.s.l; 30 Aug. 2022; M. Subedi leg.; sub-tropical forest with freshwater stream and agricultural lands, collected by hand; ANHM. ***Paratypes***: (Figs 4–6) NEPAL • 2 ♂, 1 ♀; Gandaki Province, Gorkha District, Gandaki Rural Municipality, Ghyalchok, Amaldarchaur; 27.809511°N, 84.718849°E; 465 ± 10 m.a.s.l; 30 Aug. 2022; M. Subedi leg.; sub-tropical forest with fresh water stream and agricultural lands, collected by hand; ANHM.

Additional material.—Numerous photographs of the individuals in their natural habitat, taken by the first author.

Photographic and video material.—The specimens of the type series in their natural habitat can be seen in Fig. 2 and in the video at https://youtu.be/iQi8iAH_DSQ.

Distribution.—Known only from the type locality and the surrounding areas.

Diagnosis.—This species is differentiated from all other Thoradontini species by the following combination of characters: (i) the bifurcation of the frontal costa in the upper quarter of the compound eye height; (ii) the paired ocelli placed a little below half of the compound eye height; (iii) vertex triangular, narrowing anteriorly, narrower than a compound eye in its anterior part; (iv) surface of the vertex flat with low carinae; (v) lateral lobes projecting laterally, rectangular with a small protrusion caudally and a sharp tip laterally; (vi) low and barely distinct carinae of the pronotum; (vii) prozonal carinae converging caudally; and (viii) proximal halves of middle femora enlarged.

Description.—(Fig. 3) Head: Eyes oval. Top margin of eyes above vertex. Vertex bulging between the carinae of vertex; small areas close to the medial carina are lowest. Frontal costa bifurcates in the upper quarter of the eye height. Facial carinae slightly divergent, forming a narrow scutellum a little wider on bottom. Lateral carinae of vertex follow outline of eye anteriorly, curving at level of frontal costa bifurcation and joining the scutellum a little below that level. Paired ocelli placed a little below half of compound eye height. Top margin of antennal groove above bottom margin of eyes, bottom margin below. Caudal margin of eye not in contact with anterior margin of pronotum. Vertex not visible above eyes. Facial carinae protruding in front of anterior level of eyes in lateral view. Head exserted above level of pronotal surface. Vertex at base of eyes same width as eye; slightly narrowing anteriorly; wider than half a compound eye at its apex. Anterior margin of vertex does not reach anterior margin of eyes; frontal costa at level of the anterior margin of eyes. Medial carina of vertex present in anterior half between eyes. Lateral carinae of vertex

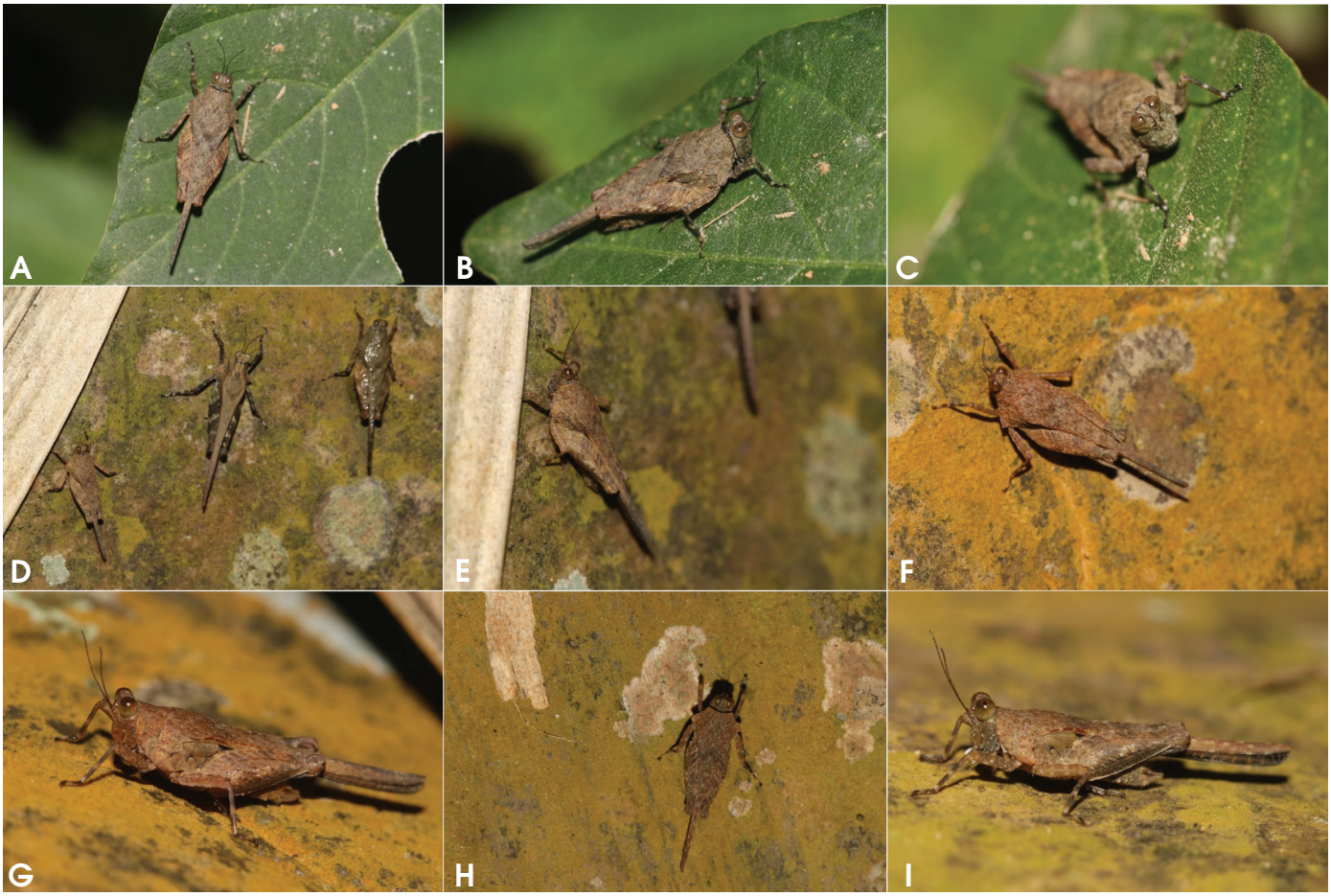

Fig. 2. Type specimens of *Aryalidonta itishreea* **gen. et sp. nov.** in their natural habitat. **A–C**. Holotype (♀); **D**. Paratype 1 (♂) (left) with *Criotettix* sp. (middle) and an individual of *Aryalidonta itishreea* **gen. et sp. nov.** (right); **E.** Paratype 1 (♂) in dorsolateral view; **F–G**. Paratype 2 (♀); **H–I**. Paratype 3 (♂).

present in anterior third between the eyes. Fossulae shallow, elongated, and present in anterior half of vertex between eyes.

Antennae: Filiform. As long as length between anterior margin of head and humeral angles. 14 antennomeres, apical one consisting of fused segments, possibly 2 or 3.

Pronotum: Macropronotal. Lateral surfaces of pronotum moderately converge dorsally. Pronotum widest at humeral angles. Dorsal surface mostly flat. Prozonal carina weakly elevated, slightly visible. Prozona sulcated with sulci of irregular shape. Apex of lateral lobe rectangular with slight protrusion in caudal part. Ventral and tegminal sinus in shape of a right angle. Humero-apical carina moderately visible. Infrascapular area subrectangular, a little narrower in anterior half. Lateral area progressively widening caudally. Median carina slightly elevated at transition between prozona and metazona, otherwise flat. Tubercles present throughout surface of pronotum. Entire surface covered with small nodules and larger tubercules. Anterior margin of pronotum truncated. Prozonal carinae composed of small nodules, weakly visible, converging caudally. Median carina continuous, reaching the apex of the pronotum, weakly visible in some areas. Lateral lobes projected laterally, rectangular with small protrusion caudally and sharp tip laterally. Humeral angles blunt. Last third of pronotum strongly narrowing. Before the narrowing, internal lateral carinae barely concave, revealing very narrow lateral area. Caudally of the narrowing, internal lateral carinae progressively converging towards apex. Apex of pronotum bluntly rounded.

Wings: Alae reaching apex of pronotum. Tegmina oval, entirely visible.

Legs: Front legs: Femora long and slim. Dorsal margin of femora slightly convex; ventral margin straight. Tibiae smooth. Middle legs: Femora long and slim; expanded in the proximal half, narrowing distally. Tibiae smooth. Hind legs: Femora smooth. Dorsal external area with slight parallel elevations. Antegenicular teeth moderately sized, triangular. Genicular teeth moderately sized, rectangular, parallel to bottom margin of femur. Tibiae smooth with several small spines. First tarsal segment longer than third. Pulvilli triangular, sharp; distal one two times larger than proximal two.

Sexual dimorphism.—No dimorphism observed between sexes except for the more expanded proximal parts of mid femora in males, and different terminalia. Female: Ovipositor valves elongated. Bottom valve narrow and serrated. Top valve expanded distally, serrated. Apices of valves acute, hook-like. Male: Elongated subgenital plate enclosing reproductive organs. Blunt apex.

Notes on variability.—Due to the position of the head during the fixation process of the holotype and the way it was pinned, its eyes do not reach the anterior margin of the pronotum. In other observed specimens, the eyes reach (or nearly reach) the anterior margin of the pronotum, which is the way this character appears when the animal is in a resting state.

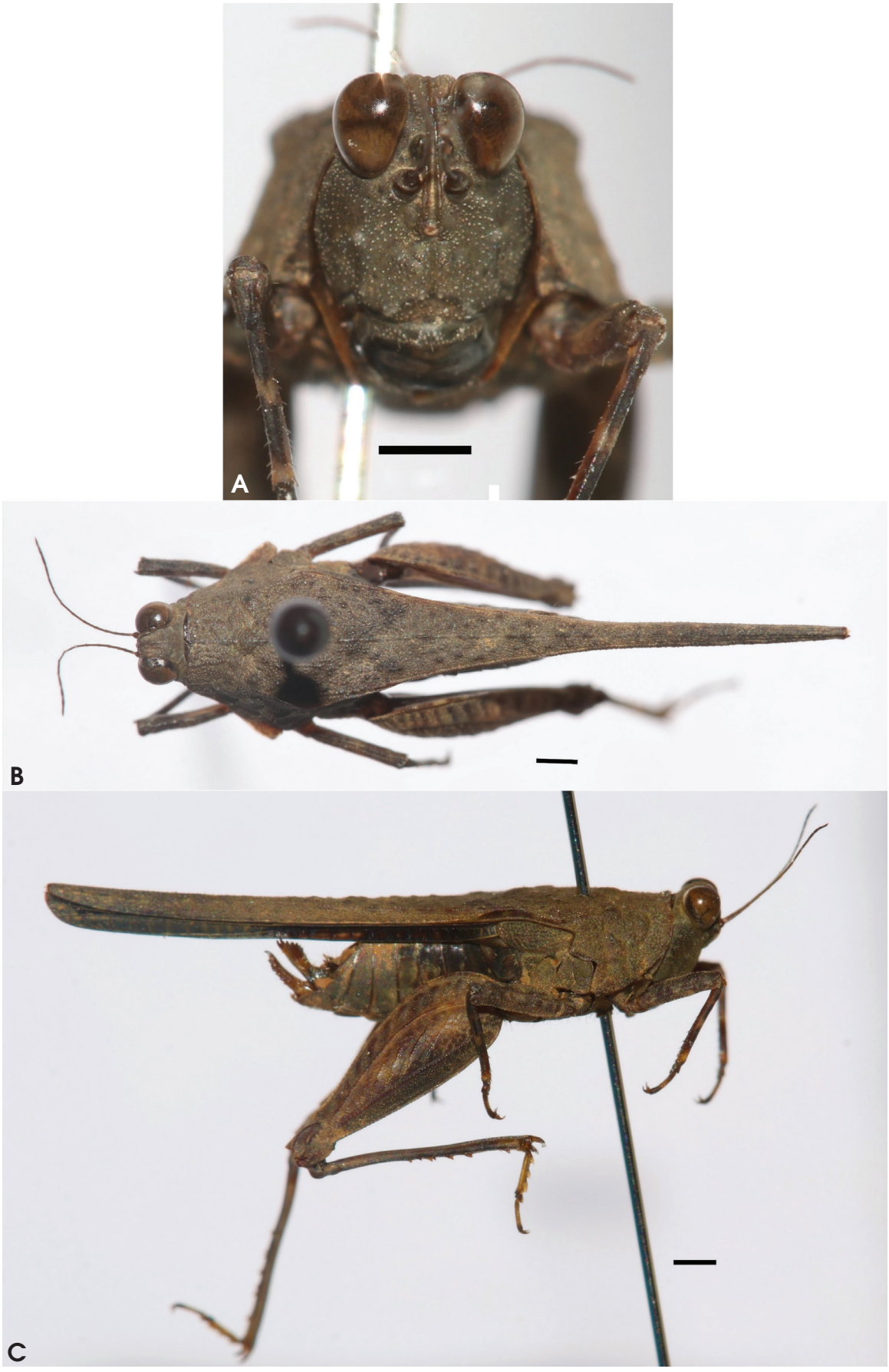

Fig. 3. Holotype (♀) of *Aryalidonta itishreea* **gen. et sp. nov. A.** Frontal view; **B.** Dorsal view; **C.** Lateral view. Scale bars: 1 mm.

Fig. 4. Paratype 1 (♂) of *Aryalidonta itishreea* **gen. et sp. nov. A.** Frontal view; **B.** Dorsal view; **C.** Lateral view. Scale bars: 1 mm.

Fig. 5. Paratype 2 (♀) of *Aryalidonta itishreea* **gen. et sp. nov. A.** Frontal view; **B.** Dorsal view; **C.** Lateral view. Scale bars: 1 mm.

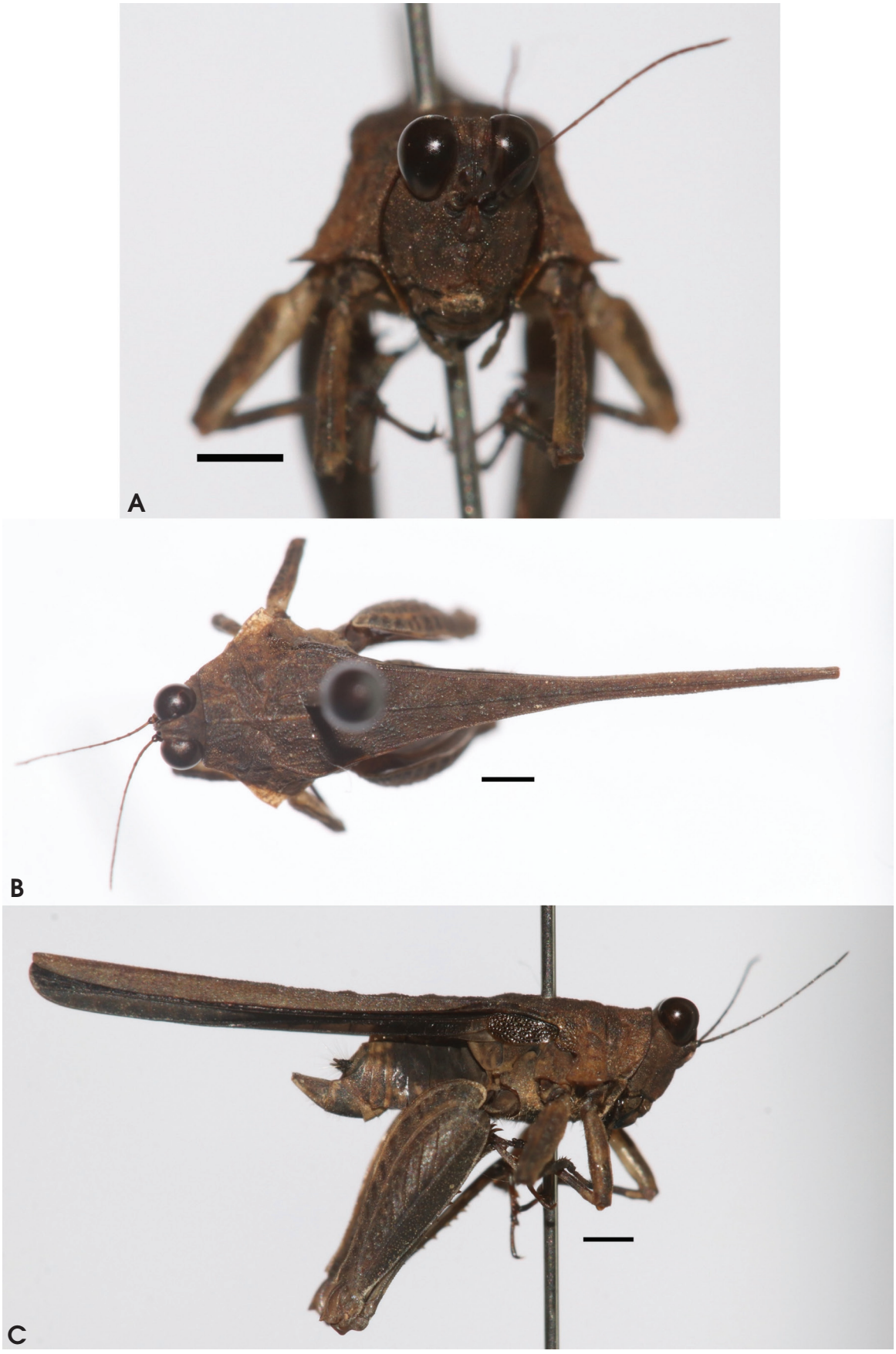

Fig. 6. Paratype 3 (♂) of *Aryalidonta itishreea* **gen. et sp. nov. A.** Frontal view; **B.** Dorsal view; **C.** Lateral view. Scale bars: 1 mm.

The shape of the lateral carinae of the vertex is variable. These carinae usually form a u- or v-shaped structure in the anterior view but the parts of the carinae that are closer to the medial carina can be variably developed, i.e., the length of that part is variable.

The proximal part of the midfemora is expanded in all specimens, but this character is much more apparent in males than in females and can be considered to represent sexual dimorphism.

The basic shape of the lateral lobes is rectangular with more- or less-expressed protrusions laterally and caudally. In some cases, the lateral protrusion can form a short tooth or spine. The variability of this character is presented in Fig. 7.

Nymphs.—For the most part, the nymphs resemble the adults, with the obvious exception of the nymphs being brachypronotal and lacking wings and antegenicular teeth. All carinae in nymphs are better expressed than in adults. The lateral lobes in all the observed nymphs are of a basic shape, lacking the finer structures present in adults. The colors of nymphs are more saturated than those of adults. Nymphs of this species can be seen in Fig. 8.

Coloration.—Many different patterns of coloration have been observed and can be seen in Fig. 9. The coloration is cryptic, with patterns of coloration similar to that of the surrounding surfaces. The individuals of this species can be mostly uniformly colored (Fig. 9D, F, G, H) or have a more complex pattern in the form of a differently colored anterior part of the pronotum (Fig. 9B, C, E, I) or differently colored legs (Fig. 9A).

Measurements.—The key measurements of the holotype and the paratypes are presented in Table 1.

Note.—All measurements follow Tumbrinck (2014) and Tan and Artchawakom (2015), except the vertex width and eye width measured in frontal view (Fig. 10). The measurements of pronotum length were taken from the anterior margin of the pronotum to its tip, which is mistakenly shown from the tip of the head by Tumbrinck (2014).

Habitat description.—(Fig. 11) The habitat is a blend of agricultural land (Fig. 11E, F) and subtropical forest (Fig. 11B) dominated by Sal (*Shorea robusta*) trees with a freshwater stream, Tirtire khola (Nepali: तरितरि खोला) (Fig. 11D). The species is commonly found along the banks of the stream and desires paths—with plenty of algal and moss growth during the rainy season—made through the forest. The area experiences hot and humid spring/rainy seasons (March to September) followed by cool and dry autumn/winter seasons (October to February). The species is found in abundance during the hot and humid seasons that favor the growth of moss and algae (a food source of the species). The habitat stands on the steep slopes of red soil with ground vegetation dominated by *Chromolaena odorata*, *Oplismenus undulatifolius*, *Urena lobata*, *Murraya koenigii*, *Ageratum* sp., *Phyllanthus* sp., *Justicia adhatoda*, *Clerodendrum infortunatum*, *Lygodium microphyllum* under the covers of *Shorea robusta*, *Schima wallichii*, *Castanopsis indica*, and *Bambusa bambos*.

Species found in close proximity.—(Fig. 12) Tetrigids such as *Coptotettix annandalei* Hancock, 1915, *Criotettix* sp., *Hebarditettix quadratus* (Hancock, 1915), *Teredorus carmichaeli* Hancock, 1915,

Table 1. Measurements (in mm) of the holotype (HT) and the paratypes (PT) of *Ayalidonta itishreea* **gen. et sp. nov.**

Body parts	HT(♀)	PT1 (♂)	PT2 (♀)	PT3 (♂)
Body length	10.75	8.39	10.59	7.97
Vertex width	0.50	0.44	0.50	0.38
Eye width	0.80	0.64	0.70	0.63
Scutellum width	0.19	0.14	0.15	0.10
Pronotum length	16.73	14.62	16.24	12.06
Pronotum lobe width	5.00	4.38	5.16	3.63
Pronotum height	2.54	1.86	2.24	1.66
Tegmen length	1.84	1.39	1.89	1.42
Tegmen width	0.69	0.57	0.74	0.57
Alae length	12.44	10.57	13.34	10.62
Fore femur length	2.09	1.58	2.18	1.74
Fore femur width	0.56	0.51	0.55	0.44
Mid femur length	2.30	2.14	2.44	1.78
Mid femur width	0.66	0.50	0.62	0.44
Post femur length	6.15	5.29	6.64	5.56
Post femur width	2.16	1.77	2.24	1.76
Hind tibia length	5.40	4.61	5.59	4.45
First tarsal segment (basal) length	1.10	0.94	`1.07	0.85
Third tarsal segment (apical) length (without claws)	0.73	0.67	0.74	0.60
Subgenital plate length	–	0.80	–	0.84
Subgenital plate width	–	0.47	–	0.50
Ovipositor dorsal valve length	1.68	–	1.32	–
Ovipositor dorsal valve width	0.34	–	0.39	–
Ovipositor ventral valve length	1.43	–	1.21	–
Ovipositor ventral valve width	0.24	–	0.24	–

Fig. 7. The lateral lobe variability of *Aryalidonta itishreea* **gen. et sp. nov.** The basic shape is rectangular with more- or less-expressed protrusions laterally and caudally.

Fig. 8. Different nymphal instars of *Aryalidonta itishreea* **gen. et sp. nov.** (Note: the images are not on the same scale).

Thoradonta sp., *Xistra angusta* Ingrisch, 2001a share the habitat with *Aryalidonta itishreea* **gen. et sp. nov.**

Food source.—(Fig. 13) The species generally feeds on moss (adults feeding: https://youtu.be/rW_f3n_Yhf8, nymphs feeding: https://youtu.be/U7kM0Gme8ms), algae, lichens, and detritus. The individuals of this species can frequently be found on "desire paths"—paths mostly devoid of vegetation, formed by the frequent passage of animals or humans (Fig. 11A)—which have plenty of moss and algal growth during the monsoon period, and on the stones around a source of water, overgrown with moss, algae, and lichens (Fig. 11C).

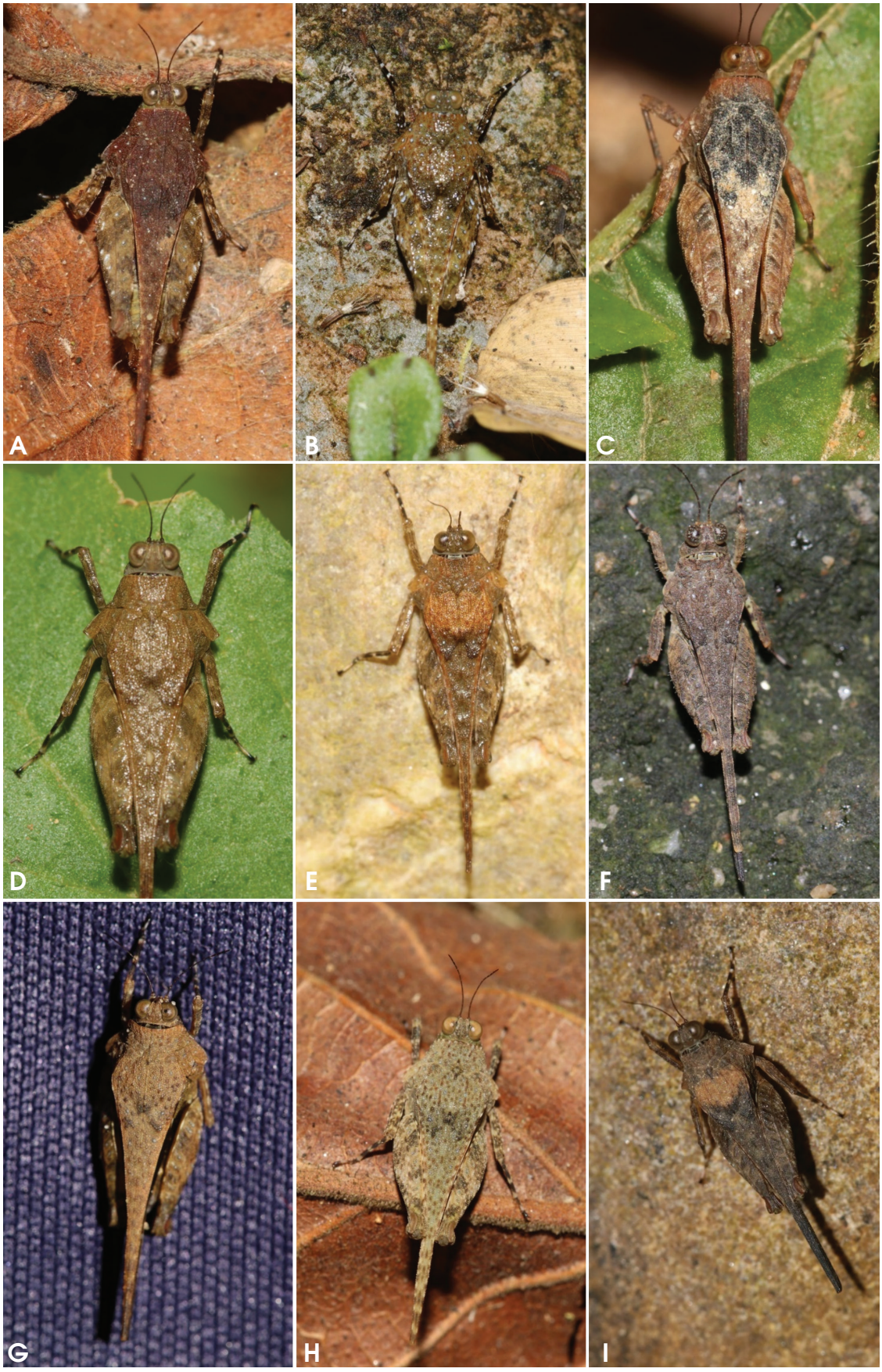

Fig. 9. Variability of coloration in *Aryalidonta itishreea* **gen. et sp. nov.**

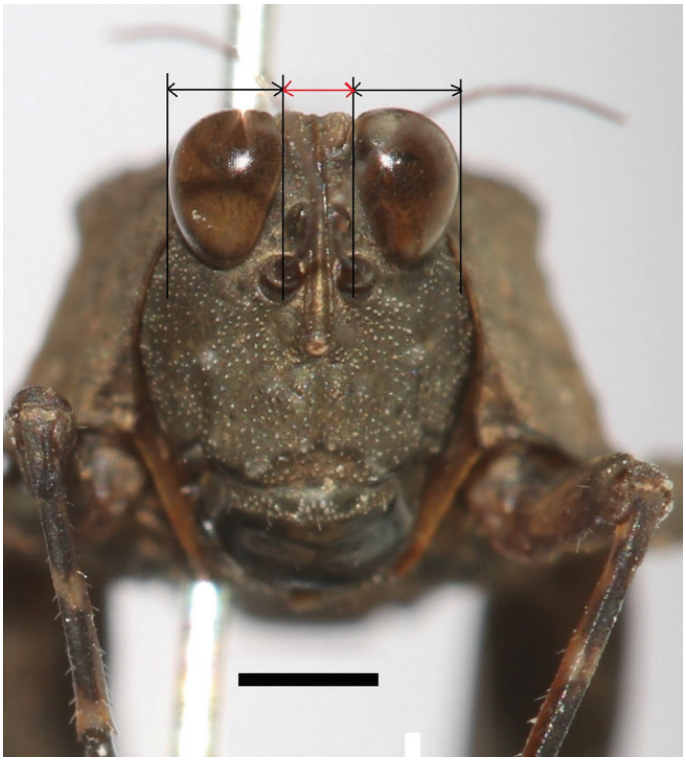

Fig. 10. Frontal view of *Aryalidonta itishreea* **gen. et sp. nov.** holotype showing the measurements of the vertex width (indicated by the red two-headed arrow) and eye width (indicated by the black two-headed arrow). The eye width is the average of the two eyes of the tetrigid. Scale bar: 1 mm.

Feces.—(Fig. 14) The feces are excreted in the form of pellets. The pellets appear as pyriform to oval or elongated balls of mud, suggesting that detritus is a major component of food intake. There may be remnants of undigested fibers in feces (indicated by the black arrow in Fig. 14), which are fragments of mosses or algae.

Interactions with other animals.—Wasps: (Fig. 15) Some individuals of the species were observed carrying adult wasps on their body surfaces. The wasps were not identified, but they possibly belong to the family Eulophidae as individuals belonging to this family have been found on Tetrigidae (Skejo 2017). This interaction was observed only among the individuals found along a desire path inside the Sal forest around 150 m east of the type locality (Fig. 15A). The wasps were observed either single (Fig. 15D) or in groups (Fig. 15B, C), mostly on the pronotum. The wasps were seen tightly holding onto the integument surface and were unmoved even when the groundhopper jumped or flew away. They appeared to be feeding on a substance on the surface of the pronotum, but the substance could not be seen using a macro lens. Video link to the observation: https://youtu.be/PO4gUwlDQbk

Mites: (Fig. 16) Several individuals of *Aryalidonta itishreea* **gen. et sp. nov.** were observed to be heavily infested with mites (Fig. 16B). These observations were made only on the bunds of rice fields in the type locality (Fig. 16A). However, the mites appear not to be species-specific and were also observed on *Thoradonta* sp. (Fig. 16C), which is the only other species observed on the rice bunds alongside the species of interest. The presence of mites created difficulty in the movement of the individuals, and the infested individuals were not as agile as other normal individuals. Interestingly, the groundhopper made kicking movements with its forelegs, presumably in an attempt to remove the mites from the body. Video link: https://youtu.be/i0t36jpxrdM (kicking movements 20 seconds into the video).

Discussion

Ecology.—Tetrigidae are well known for their cryptic coloration (Skejo and Caballero 2016, Skejo et al. 2020), and the new species is no exception. Its color forms are plentiful and reflect the different types of surfaces it inhabits. The nymphs are similar to adults in both coloration and general morphology and are thus easy to separate from other species. The importance of recognizing the nymphal morphology must be stressed, as there have been numerous cases of nymphs being described as separate species (Skejo et al. 2018). Studies on the ecology of Tetrigidae are not common, but some remarkable publications on that front have been produced, with ever-increasing innovations in data gathering and reporting (Paranjape and Bhalerao 1985, Paranjape and Bhalerao 1994, Pushkar 2009, Kočárek et al. 2011).

The gathered data on feeding habits (Fig. 13) conform to the known fact that Tetrigidae use detritus as their main source of food, supplemented by algae, mosses, lichens, and some other minor substances (Kuřavová et al. 2017). The excrement often contains strands of undigested plant matter (Fig. 14), but it is unclear what percentage of the total plant intake it represents, i.e., how well Tetrigidae digest cellulose and hemicellulose. Such research has been conducted on some Caelifera (Wang et al. 2020) and should be conducted on Tetrigidae as well to expand on the work by Kuřavová et al. (2017).

The wasps, tentatively identified as Eulophidae members, interact with *Aryalidonta itishreea* **gen. et sp. nov.** (Fig. 15) in a way that currently cannot be conclusively explained. Eulophidae consist mostly of parasitoids of holometabolous insects, but many other life cycles are represented within that family (Gauthier et al. 2000). There are many species capable of penetrating tree bark to lay eggs in their hosts (Beaver 1966, Abell et al. 2012), so it is entirely possible that a groundhopper can be oviposited in through the hard surface of the pronotum. However, the wasps seemed to be feeding on a substance attached to the pronotum or drinking fluids trapped on it, making the possibility of parasitoidism unlikely. It is likely that the wasps' feeding is opportunistic, but the possibility of them being drawn to a specific symbiotic organism should also be examined.

Mites are commonly spotted on tetrigids, but the taxonomy of the group associated with Tetrigidae is still young (Seeman et al. 2018). The observed specimens of mites (Fig. 16) were not identified, so nothing can be confidently said about host specificity or habitat preference, although it seems that the bund on the edge of a rice field houses an unusual number of mites.

The state of Thoradontini.—The tribe Thoradontini currently stands alone, as it was recently excluded from Scelimeninae due to mounting evidence that it does not form a monophyletic clade with Scelimenini (Adžić et al. 2020). The relationships within the tribe are unclear, and the currently available molecular data are scarce, encompass a small number of genes, and are not representative of the tribe as a whole (Chen et al. 2018, Adžić et al. 2020). Our own examination of the species within this tribe showed that many of its species do not fit completely with the genera under which they are classified. For example, *Loxilobus willemsei* Günther, 1938a, *Loxilobus insularis* (Günther, 1935),

Fig. 11. Type locality and habitat of *Aryalidonta itishreea* **gen. et sp. nov.** (Amaldarchaur, Ghyalchok, Gorkha, Nepal). **A.** Desire path through the type locality (Note: the algal growth is indicated by the arrow); **B.** Subtropical forest; **C.** Stones with moss, lichen, and algal growth (Note: several *Aryalidonta itishreea* **gen. et sp. nov.** individuals on the stone); **D.** Tirtire khola, a freshwater stream in the heart of the locality; **E.** Rice fields with ample greenery during the rainy season; **F.** Rice fields during the fall season.

and *Loxilobus insidiosus* (Bolívar, 1887) have lower-placed antennal grooves and paired ocelli, a distinct convexity in the middle part of the vertex, narrower vertex, narrower space between the prozonal carinae, and simpler lateral lobes than in the type species, *L. acutus*. They could represent a single genus or multiple genera separate from *Loxilobus* and of still undetermined taxo-

Fig. 12. Different Tetrigidae species found in close proximity to *Aryalidonta itishreea* **gen. et sp. nov.** in their natural habitat. **A.** *Coptotettix annandalei*; **B.** *Criotettix* sp. (bottom left) with *Aryalidonta itishreea* **gen. et sp. nov.** (top right); **C.** *Hebarditettix quadratus*; **D.** *Teredorus carmichaeli* (right) with *Aryalidonta itishreea* **gen. et sp. nov.** (left); **E.** *Thoradonta* sp. (bottom right) with *Aryalidonta itishreea* **gen. et sp. nov.** (top left); **F.** *Xistra angusta*.

nomic placement. Furthermore, *Eucriotettix molestus* Günther, 1938b, *Eucriotettix aequalis* (Hancock, 1912), *Eucriotettix spinilobus* (Hancock, 1904), and *Eucriotettix hainanensis* Günther, 1938a each differ from the type species, *E. tricarinatus*, by different combinations of antennal groove placement, shape of the vertex in frontal and dorsal view, and shape of the lateral lobes. It is un-

Fig. 13. Individuals of *Aryalidonta itishreea* **gen. et sp. nov.** on different food sources. **A.** Lichen growing on the stones; **B.** Detritus on a desire path; **C.** Algal growth on the banks of a freshwater stream (Note: soft algal growth on the body surface indicated by greenish–yellow coloration); **D.** Moss growth on the desire path.

Fig. 14. Feces of *Aryalidonta itishreea* **gen. et sp. nov.** (Note: The feces were collected from four individuals (2 males and 2 females) raised in captivity by feeding moss and detritus). The black arrow points to an undigested plant fiber.

Fig. 15. *Aryalidonta itishreea* **gen. et sp. nov.** interaction with a wasp (likely family Eulophidae). **A.** Desire path (indicated by black arrow) inside the Sal forest with moss and algal growth; **B.** Multiple wasps resting on the pronotum of the individual tetrigid; **C.** Closeup of lateral view of wasps; **D.** Closeup of dorsal view of an individual wasp.

clear whether these represent species-level characters or imply that the genus should be split into more genera. The situation is further complicated by the existence of the genus *Criotettix* Bolívar, 1887, assigned under a separate tribe, Criotettigini. Within that genus, there are species such as *Criotettix pallitarsis* (Walker, 1871), *Criotettix armigera* (Walker, 1871), and even the type species *Criotettix bispinosus* (Dalman, 1818) that, with their convex and triangular vertices and their facial morphologies, seem to belong to *Eucriotettix*, which signifies some future nomenclatural acts and further complications within *Eucriotettix* and Thoradontini. It is difficult to determine an extensive set of valuable diagnostic characters for the genera within Thoradontini and Criotettigini, which is why nomenclatural acts are not proposed in this study. A comprehensive revision of these taxa is urgently needed to resolve more than a hundred years of previous taxonomic work (Hancock 1904, Hancock 1909, Günther 1937, Günther 1938a, b, Blackith 1992, Tumbrinck 2018).

The herein described genus and species, *Aryalidonta itishreea* **gen. et sp. nov.**, does not fit with the diagnoses of the other genera of Thoradontini but shares many similarities with them. In this study, we do not transfer any species between genera because this would, in essence, require us to resolve a myriad of problems with the definition of Thoradontini taxa, which is an undertaking that should be approached carefully and thoroughly. We place *Aryalidonta* **gen. nov.** within this tribe, as the morphology of the new species is very similar to many of the recognized species within the tribe but is still distinct enough to warrant a clear separation from them. Additionally, due to the previously mentioned problems, we believe it is important to describe a genus with clear diagnostic characters and with ample material, as this will assist the subsequent revisions and possibly offer a taxon under which some of the existing, more weakly defined species can be classified.

Considering the state of Thoradontini, it is impossible to comment on the way the new genus phylogenetically relates to the other genera within it. A passing comment can be made on the shape of the lateral lobes. These protrusions are well developed in some species of Thoradontini, notably in most *Thoradonta* species. This character in *Aryalidonta* **gen. nov.** is simpler and closer to that of most other Tetrigidae species. This suggests that the shape of lateral lobes in *Aryalidonta* **gen. nov.** represents an ancestral form of that character within Thoradontini and that the complex morphologies of lateral lobes within Thoradontini could have descended from such a shape.

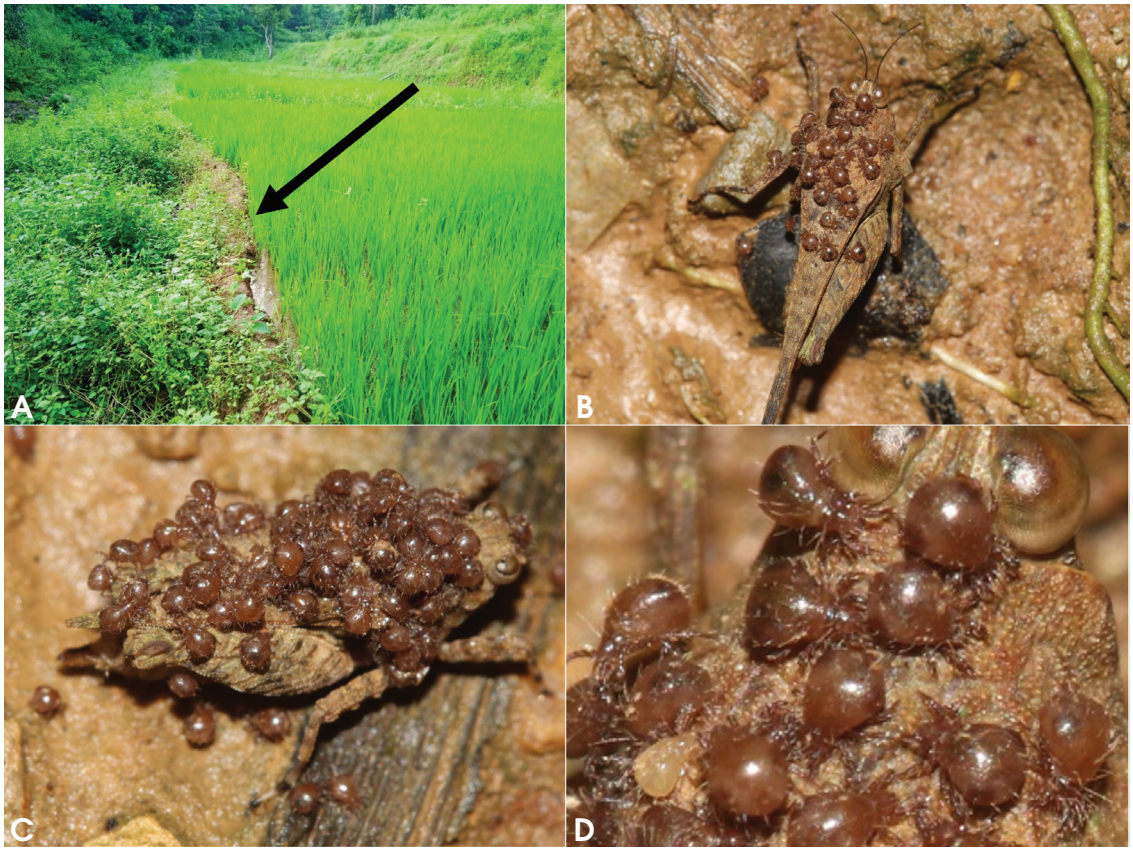

Fig. 16. *Aryalidonta itishreea* **gen. et sp. nov.** interaction with mites: **A.** Bund on the edge of a rice field (indicated by the black arrow); **B.** An individual *Aryalidonta itishreea* **gen. et sp. nov.** infested with mites; **C.** An individual *Thoradonta* sp. infested with mites; **D.** Close-up of mites on the body surface.

Conclusions

In this paper, we presented a detailed account of observations pertaining to *Aryalidonta itishreea* **gen. et sp. nov.** but it is clear that many unknowns remain, within the new species and without it. Thoradontini and Criotettigini are tribes of uncertain placement and in certain need of revision. The conclusion of this study is just a starting point for many to follow, or in the words of Bhairav Aryal, "Itishree is not an approval of the end; just the end of a chapter" (Aryal, 1971). Itishree.

Authors' contributions

MS conducted the fieldwork. MS and NK analyzed the data, wrote the manuscript, and created the figures. Both authors are equal in contribution.

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