Journal of Threatened Taxa

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

COMMUNICATION

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26 July 2019 | Vol. 11 | No. 9 | Pages: 14128–14136
DOI: 10.11609/jott.3193.11.9.14128-14136

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Journal of Threatened Taxa | www.threatenedtaxa.org | 26 July 2019 | 11(9): 14128–14136

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

PLATINUM
OPEN ACCESS

A NOTE ON THE TAXONOMY AND NATURAL HISTORY OF THE SUMMER CLICKER *LAHUGADA DOHERTYI* (DISTANT, 1891) (INSECTA: HEMIPTERA: CICADIDAE) ALONG WITH ITS DISTRIBUTION IN NORTHERN WEST BENGAL, INDIA

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Abstract: *Lahugada dohertyi* is one of the many lesser-known cicadas of northeastern India which has never been studied since its discovery. Recently, a century later, a population of this elusive cicada was discovered in northern West Bengal. This paper gives an account on its distribution in northern West Bengal, taxonomy, and natural history and suggests a common name based on its call and habitat preferences.

Keywords: Cicada, common name, Ochre Summer Clicker.

Bangla abstract: উত্তর পূর্ব ভারতের বহু স্বল্পপরিচিত ঘন্টি পোকার মধ্যে লাহুগাডা দোহেরটিই একটি এমন ঘন্টি পোকা যার আবিষ্কারের পর থেকে কোনো অধ্যায়ন হয়নি। সম্প্রতি, প্রায় এক শতক পরে, এই অলীক ঘন্টি পোকাটি উত্তর বঙ্গে পুনরাবিষ্কার হয়। এই প্রবন্ধ উত্তর বঙ্গে ইহার সংস্থান, বার্গিওকরণ এবং প্রাকৃতিক ইতিহাসের উপর আলোকপাত করবে এবং ইহার শব্দ ও পছন্দের প্রাকৃতিক আবাসের উপর ভিত্তি করে ইহার সাধারণ ইংরেজি নামও উত্থাপন করবে.

DOI: https://doi.org/10.11609/jott.3193.11.9.14128-14136 | **ZooBank:** urn:lsid:zoobank.org:pub:8693BF12-07AA-4789-AECD-16D4A0229881

Editor: K.A. Subramanian, Zoological Survey of India (ZSI), Chennai, India. **Date of publication:** 26 July 2019 (online & print)

Manuscript details: #3193 | Received 12 August 2018 | Final received 02 July 2019 | Finally accepted 09 July 2019

Citation: Sarkar, V. (2019). A note on the taxonomy and natural history of the Summer Clicker *Lahugada dohertyi* (Distant, 1891) (Insecta: Hemiptera: Cicadidae) along with its distribution in northern West Bengal, India. *Journal of Threatened Taxa* 11(9): 14128–14136. https://doi.org/10.11609/jott.3193.11.9.14128-14136

Funding: This work was partially funded by the Rufford Small Grant to the author, and the National Academy of Sciences and USAID's Partnerships for Enhanced Engagement in Research (PEER) Science Grant (#PGA-2000003433), a Ramanujan Fellowship (Department of Science and Technology, Government of India), and an NCBS research grant to Dr Krushnamegh Kunte.

Competing interests: The author declares no competing interests.

Author details: VIVEK SARKAR is pursuing his PhD from North Orissa University on the cicadas of Garo, Khasi and Jaintia hills of Meghalaya State of India parallel to his job as World Heritage Assistant in UNESCO C2C at Wildlife Institute of India.

Acknowledgements: Thanks are due to Mr Bishwajit Dutta Chowdhury and Mr Ayan Chakraborty for logistical support and assistance with the fieldwork and to Dr Anukul Nath for preparing the map. I am grateful to Dr Krushnamegh Kunte for the support with the fieldwork in 2014 and the permission to use the specimen images, to Mr Dipendra Nath Basu for taking the specimen images and genitalia images, to Mr Priyam Chakraborty for collecting a male specimen from Pundibari, and to Mr Manoj V. Nair and Dr Pratap Singh for the help in discussion and modifying the draft in various ways. The type specimen depicted in Fig. 1 is deposited in the Natural History Museum, London, images of which were provided by Dr Kunte, who thanks the Hemiptera curators at the BMNH. The newly collected specimens described in this paper are deposited in the Research Collections of the NCBS Museum and Field Stations Facility. Special thanks to my family for all the support with the fieldwork in 2015–2016.

INTRODUCTION

Lahugada dohertyi is a rusty red-coloured cicada that was described by William Lucas Distant in 1891 from a single male specimen (Image 1) collected by the American entomologist William Doherty from Margherita of Upper Assam (Fig. 1; Distant 1891, 1905). It was initially described as *Pomponia dohertyi* Distant, 1891 (Distant 1891; Sanborn 2014; Price et al. 2016) and later transferred to the monotypic genus *Lahugada* Distant, 1905. Unlike the members of *Pomponia* Stål, 1866, the opercula in the male of the species are short, somewhat globose, wider than abdominal margins, and distinctly visible from above (Distant 1906). For more than a century, nothing was known about its range, distribution, habitat preferences, or activity period. Recently, in 2014, I found the species in and around Coochbehar Town, situated in northern West Bengal State of India, which gave me an opportunity to observe and study this cicada closely. This newly found point location report was mentioned in the recently published annotated provisional catalogue of cicadas of the Oriental region (Price et al. 2016). The catalogue, however, does not give any account on its distribution, biology, or natural history. This paper gives a brief description of the taxonomy, larval morphology, and natural history of this lesser-known cicada along with a note on the distribution of this species in other parts of northern West Bengal.

MATERIAL AND METHODS

Specimen collection: Most of the cicadas in the field were spotted by their calls. Individual cicadas were observed through Canon EOS-600D Rebel T3i Digital SLR with Sigma 70–300 mm APO-Digimacro lens and the observed behaviour was noted down. Though an attempt was made to take the counts of the individuals, due to a lack of uniform and adequate sampling technique, it is not included in the paper. After collection, two legs and part of the thoracic tissues were extracted in order to preserve the DNA for future molecular work. Each insect was fixed with a pin through the mesonotum with wings outstretched after the extraction of the tissue. After fixing the insect, it was kept in a hot air oven for 48 hours at 56°C. The larval exuviae were collected from the habitat situated in the Coochbehar suburbs. This cicada emerges after dark and the adult often settles next to the exuviae till morning, till the body is dry and it develops colour. Only these exuviae, which were confirmed to be of *Lahugada dohertyi*, were collected for this study.

Imaging: Panasonic Lumix DMC FZ-35 and Canon EOS-600D Rebel T3i DSLR with Sigma 70–300 mm APO-Digimacro lens were used to photograph the cicadas in the field. Canon EOS-1200D DSLR with Canon 50mm macro lens was used to photograph the specimen in the collection depository of National Centre of Biological Sciences (NCBS). Labomed Luxeo 2SA microscope was used to take images and examine specimens for morpho-taxonomic work. Canon EOS-600D Rebel T3i DSLR with Canon 100mm macro lens and external flashes were used to photograph the larval exuviae.

Dissection: The last two abdominal segments of the male specimen (NCBS-PZ562) were treated using 10% KOH to dissect the genitalia, which was then preserved in 0.5ml vials containing anhydrous glycerol.

Morpho-taxonomy: The terminology used for the description of the adult cicada and the larval exuviae was adopted from Moulds (2005) and Hou et al. (2014), respectively.

Measurement: Morphometric measurements of the adult cicadas were taken from images using ImageJ (64-bit Java 1.6.0) software. The measurement of the larval exuviae is not produced in this paper as the exuviae tend to shrink while drying, right after the eclosion, distorting the actual measurement of the living last instar larvae.

Location: The species was first found opportunistically in Chakchaka, a suburb of Coochbehar, in May 2014. A few days later it was found in Rasamati Reserve Forest. An attempt was made to conduct more focused active searches for three weeks (22 April–13 May 2014) to check parts of Alipur, Jalpaiguri, and Coochbehar districts of northern West Bengal in order to understand the distribution pattern of this cicada. The same localities were again checked briefly in May 2015. In 2016, all the localities were monitored from April to May in order to record its activity period. All the localities of this cicada found in northern West Bengal are given in Table 1 and shown in Fig. 1. The GPS locations of its precise localities were acquired but only degree and minutes are produced in the paper due to conservation issues. This cicada was not found in the northern part of Alipur District towards Jayanti of Buxa Tiger Reserve, the northwestern part of Jalpaiguri District such as Baikunthapur Reserve Forest, Belacoba, Ambari, Odlabari, and Mal Bazar areas, and the southern part of Jalpaiguri and Coochbehar districts such as Haldibari, Ghugumari, Sitalkuchi, Jiranpur, Balarmpur, and Dinhta despite active search in the forested areas.

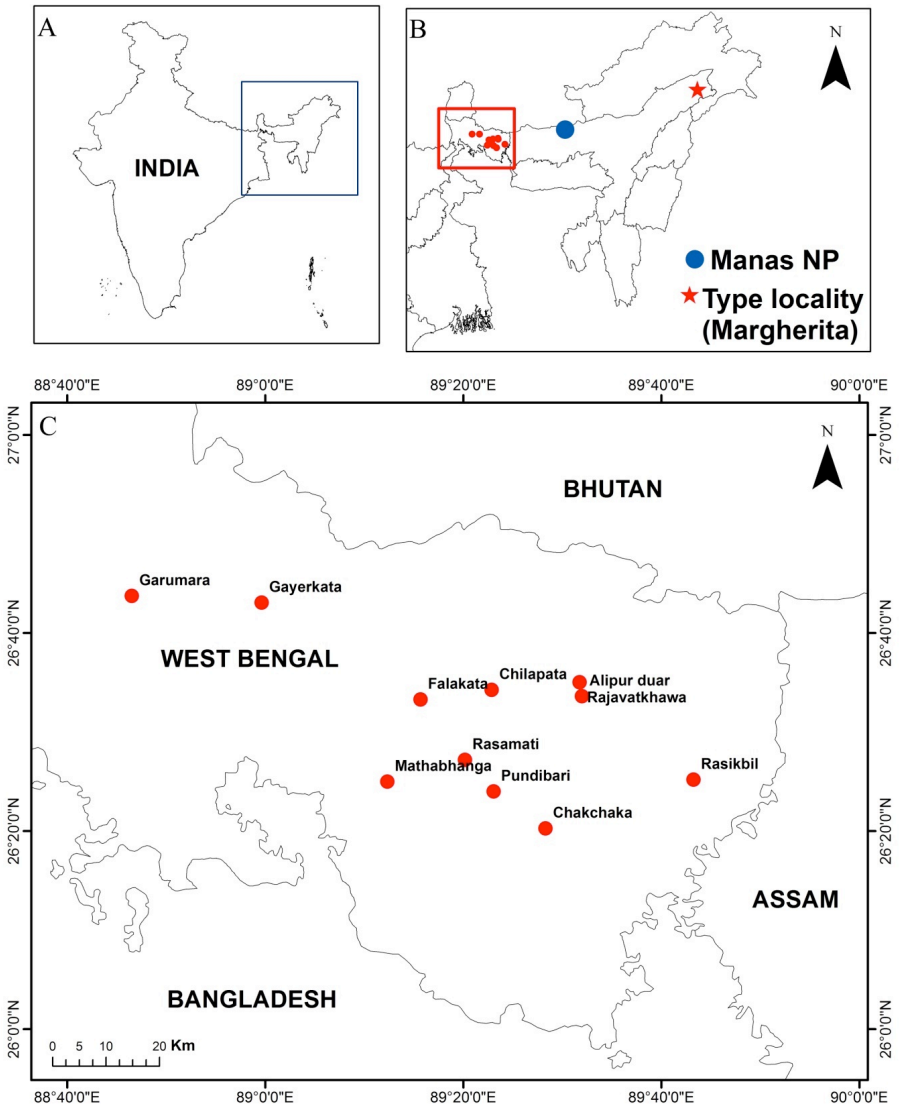

Figure 1. A—Northeastern India, including West Bengal | B—Localities where *Lahugada dohertyi* was recorded in northeastern India | C—Localities where *L. dohertyi* was recorded in northern West Bengal.

Table 1. Localities where *Lahugada dohertyi* was recorded in northern West Bengal, India.

	District	Locality	Latitude	Longitude
1	Coochbehar	Rasamati	26.450	89.333
2	Coochbehar	Pundibari	26.400	89.383
3	Coochbehar	Chakchaka	26.333	89.466
4	Coochbehar	Mathabhanga	26.400	89.200
5	Coochbehar	Rasikbil	26.416	89.716
6	Alipur	Rajavatkhawa	26.583	89.516
7	Alipur	Alipur duar	26.550	89.516
8	Jalpaiguri	Falakata	26.550	89.250
9	Jalpaiguri	Chilapata	26.566	89.366
10	Jalpaiguri	Garumara	26.716	88.766
11	Jalpaiguri	Gayerkata	26.716	88.983

RESULTS

A. Description of *Lahugada* Distant, 1905

Head (including eyes) considerably narrower than base of mesouotum, its length about equal to space between eyes, its lateral margins discontinuous, the lateral margins of front being almost at right angles to those of vertex; pronotum almost as long as mesonotum, narrowed anteriorly, the posterior angles prominent and rounded; metanotum strongly exposed behind the cruciform elevation; abdomen considerably longer than the space between apex of front and base of cruciform elevation; tympana completely covered, tympanal coverings broader than long and transversely rugulose; opercula short, somewhat globose, wider than

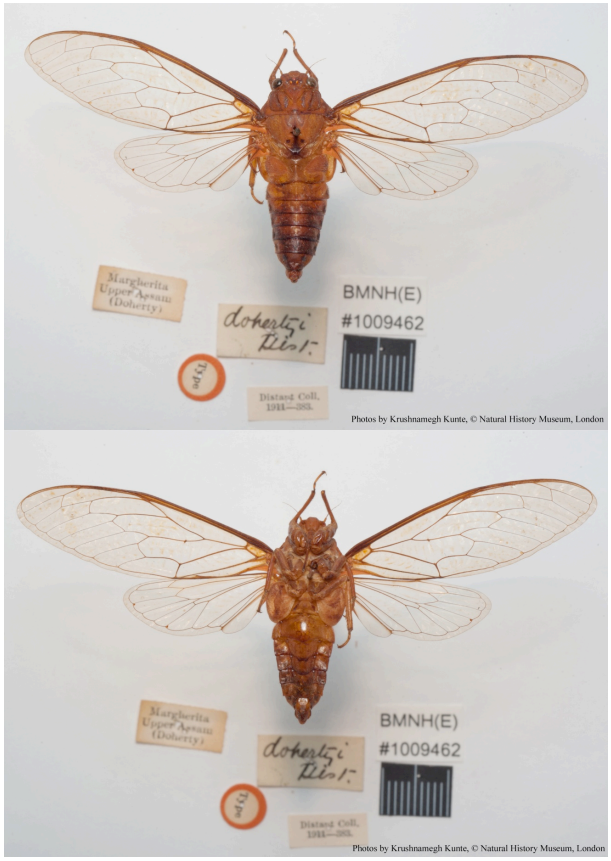

Image 1. *Lahugada dohertyi* (holotype, BMNH(E) 1009462): a—dorsal view | b—ventral view. © Trustees of the Natural History Museum, London. Photographed by BW Price and EL Allan.

abdominal margins, and distinctly visible from above; rostrum about reaching the posterior coxae; forewings and hindwings hyaline, the first with eight apical areas and the basal cell longer than broad (Distant 1906).

Diagnosis of *Lahugada dohertyi*

Head: Head (and pronotum, and mesonotum) dark ochraceous, head with the eyes fuscous, the area of the ocelli and lateral margins of vertex infuscated (Distant 1906). Head is rich ochraceous on the dorsal side along with greenish infuscation at the epicranium in the live specimen which turned darker in the preserved specimen. Ventral and frontal parts such as lorum and gena of the head is pale castaneous. Entire eyes are a rich brown, darker than the head in most of the individuals. In occasional cases, however, a few individuals have eyes that are pale coloured, similar to that of the dorsal part of the head but with fuscous pseudopupil in the centre (Image 2F). The entire postclypeus is rich ochraceous in colour. Postclypeus not concave and rather flat towards the front. Antenna ochraceous. Ocellus pale sanguine in live or newly preserved insect.

Thorax: Pronotum with a subobsolete central fascia, with a dark spot at base and apex, a short discal fuscous streak on each side, the incisures and outer margins also infuscated; mesonotum with two small central obconical spots, some subobsolete fasciae on each side, and with two small blackish spots in front of the cruciform elevation, the centre of which is dark fuscous; tegmiua and wings hyahne, with a slight bronzy tinge and unspotted, the venation dark ochraceous; body beneath and legs dark ochraceous; apex of rostrum and tarsal claws fuscous (Distant 1906). Thorax rich ochraceous. Pronotum have a dark rusty dorsal central infuscation from the back of the head till pronotal collar which tends to darken and form a spot-like appearance adjacent to pronotal collar but does not go inside the collar. Paramedian fissure darkens towards the inside and forms a dark greenish line-like infuscation beyond the fissure, tends to meet adjoining point of lateral fissure infuscation and pronotal collar. Greenish (in live insect) infuscation at lateral fissure straight and broadens towards the pronotal collar. Lateral part of pronotal collar uneven with darker lateral margin. All greenish infuscation turns dark or black in the dried specimen. Mesonotum ochraceous with darker rusty brown lateral sigilla. In live specimen, parapsidal suture is pale ochraceous, bordered with dark rusty brown towards the submedian sigilla (Image 2). In dry specimen, however, the entire submedian sigilla appears darker, same as lateral sigilla. Dark scutal depressions appear as two black spot at the lower part of mesonotum, right above scutellum. Metanotum entirely rich ochraceous with darker scutellum. Both forewings and hindwings are entirely transparent without any infuscation. Veins dark brown, almost black. Basal cell, basal membrane of the forewing and jugal fold, jugum of hindwing pale castaneous. Coxa of all the legs are greyish castaneous. Primary and secondary spine of fore femur is reduced and appears as rudimentary nodule. Tibia in second and third pair of legs are rich ochraceous but paler than the segments beyond it. The tibia in forelegs is darker and more rich in colour compared to the tibia of rest of the legs. Globose operculum uniformly pale castaneous, short and broad, visible from dorsal side.

Abdomen: Abdomen pale castaneous; apical area of abdomen castaneous (Distant 1906). Abdomen uniformly castaneous in live and freshly preserved specimen but in old preserved specimen the colour of apical region appears richer. Timbal entirely covered by round and globose timbal cover. Prominent lateral black spots on both sides of 3rd to 7th tergite. On the 8th tergite, the black spot shifts up and appear as dorsolateral spots.

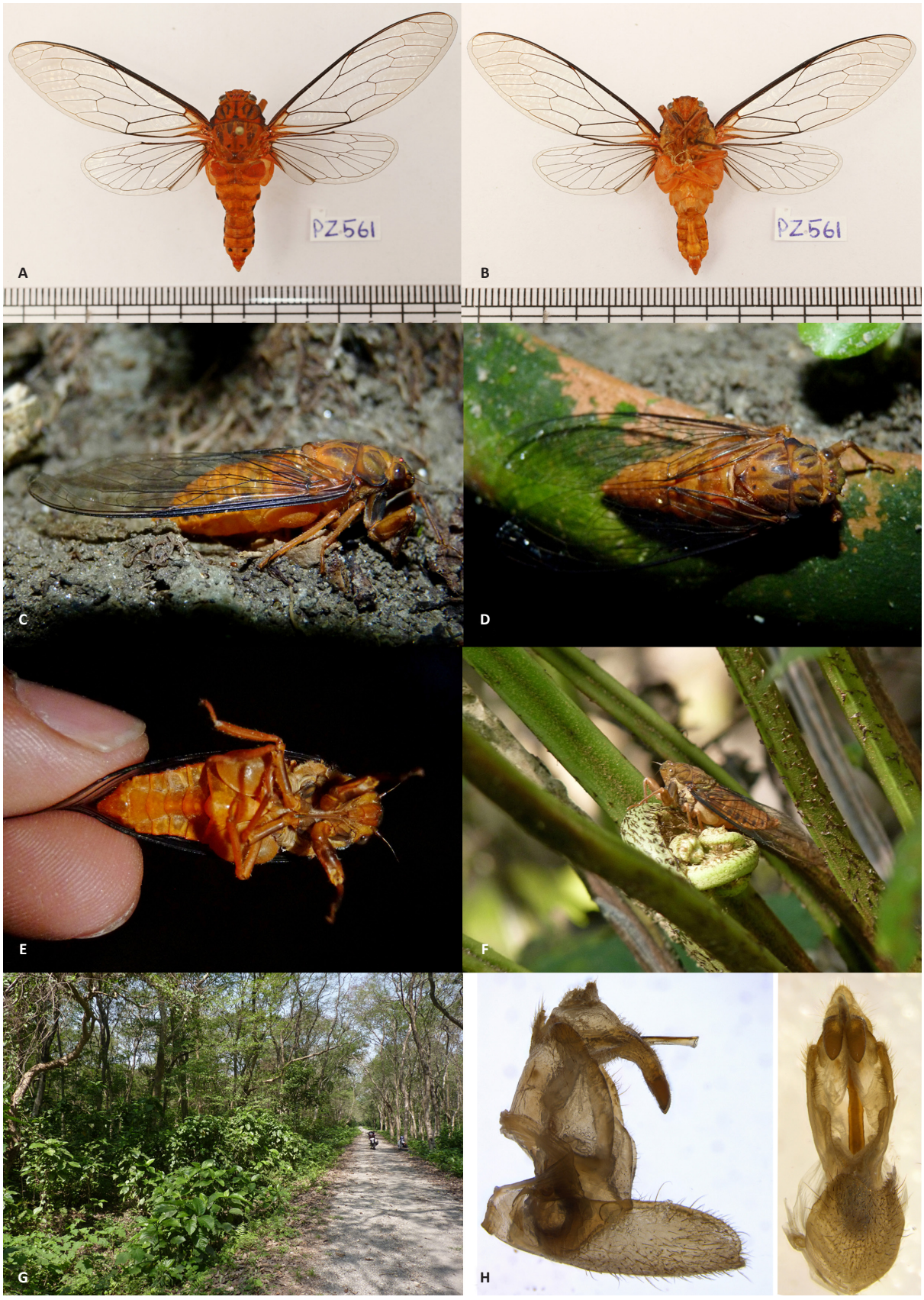

Image 2. *Lahugada dohertyi*: A—dorsal view | B—ventral view | C–E—live specimen | F—species feeding on *Diplazium* sp. | G—habitat | H—male genitalia. (A,B,H © National Centre of Biological Sciences, Bangalore, and photographed by Dipendra Nath Basu; C–G © Vivek Sarkar).

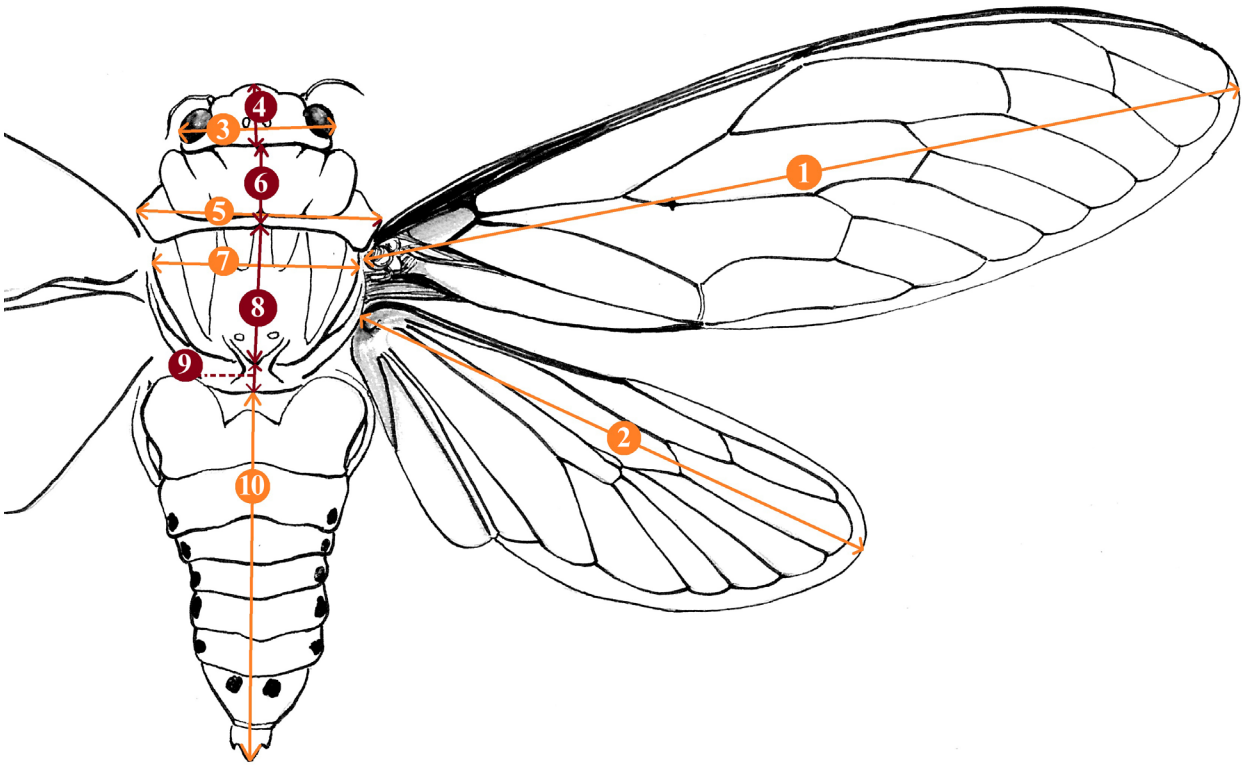

Figure 2. *Lahugada dohertyi*: 1—length of the forewing | 2—length of the hindwing | 3—width of the head from eye to eye | 4—length of the head from the frontal part of postclypeus to the back of the head | 5—width of the pronotum from one lateral angle of pronotal collar to another | 6—length of the pronotum from the back of the head to the lower end of pronotal collar | 7—width of the mesonotum | 8—length of the mesonotum from the lower part of the pronotum collar to the upper groove of the scutellum | 9—length of metanotum | 10—length of abdomen starting from the lower part of scutellum to the tip of the anal style. © Vivek Sarkar.

Table 2. General measurements of the collected specimen.

	Body part	Measurement of NCBS-PZ561	Measurement of NCBS-PZ562
1	Forewing	34.020mm	35.592mm
2	Hindwing	20.996mm	21.620mm
3	Width of the head	6.141mm	6.058mm
4	Length of the head	1.780mm	1.887mm
5	Length of Proboscis	4.704mm	4.606mm
6	Width of pronotum	8.740mm	9.371mm
7	Length of pronotum	3.124mm	3.284mm
8	Width of mesonotum	7.781mm	7.640mm
9	Length of mesonotum	4.842mm	4.580mm
10	Length of metanotum	1.246mm	1.166mm
11	Length of abdomen	17.657mm	14.710mm

Male genitalia: This is the first-ever description of the male genitalia of this species, which has been missing even in the original description. Pygofer looks oblong and triangular laterally with broader base and narrower top towards the distal beak. Basal lobe and upper lobe of pygofer prominent. Basal lobe covering more than one-third of the pygofer length, from base to the distal end ventrally and rest is upper lobe till the distal end. Dorsal beak small, barely touches anal tube. Dorsal shoulder narrowly present between dorsal beak and upper lobe of the pygofer. Anal tube is compressed and appears as a thin disk below anal styles which is at the distal-most end. Median lobe of uncus prominent and protruding out like an anchor. The tip of the median lobe bifurcated, forms to oblong conical claspers. The aedeagus protrudes out from the base of the bifurcation of the median lobe of uncus.

B. Collected specimen

Six specimens (four males and two females) were collected by me from the outskirts of Coochbehar (26.3330N & 89.4660E, 46m) in May 2014. Later in the same month, one male was collected after dark, from the corridor of Panchayet Block office, Pundibari, Coochbehar (26.3330N & 89.4660E, 52m). Two females and three males were preserved in alcohol and two males were pinned and preserved (in dry condition)

which are represented in this paper (Specimen Voucher number: NCBS-PZ561 and NCBS-PZ562).

C. General measurements (Fig. 2; Table 2)

NCBS-PZ561, adult, male, 10.5.2014; NCBS-PZ562, adult, male, 11.5.2014.

D. Bionomics

Habitat type: This cicada is locally common. Due to its high relative abundance, the species was mostly seen throughout northern Bengal but only in a particular habitat, i.e., undisturbed mixed forest with thick undergrowth of *Dendrocnide sinuate* along with *Diplazium* sp. (Image 2). Apart from its type locality, the species was also reported from Manas Tiger Reserve (Price et al. 2016) by Dr Krushnamegh Kunte, who also found it in the same habitat type (Fig. 1).

Activity period: The cicada was opportunistically found in 2014 in northern West Bengal and hence its activity period could not be studied initially. In 2016, an attempt was made to record its activity period. It was observed that the first individual emerges in the third week of April, during the pre-monsoon rains. The maximum individuals were heard between the first and third week of May and the last individual was encountered in the first week of June.

Behaviour: The call is similar to random clicks for some time and the duration of the call varies from 20s to 1min 10s, if not disturbed (n=22). It mostly calls by sitting in one place but it has also been observed to occasionally fly in a circle, 0.6–1.2 m above the ground, with typical clicking-like echemes. It repeats this circling flight five to nine times during one complete call and settles down toward the end of the call. It continues calling for some time and then remains silent until the next calling session starts. The radius of this circular flight varies from 2.5m to 4.5m approximately, and it occasionally takes the same path repeatedly for this circular flight. On occasion, it was observed that the individuals were flying without any particular route or pattern. Mostly, the males rest on the ground or within 0.5m from the ground in the middle of Ground Fern *Diplazium* sp., which makes them difficult to spot. It has also been observed that the males can be as far as 6ft away from the ground, and not beyond, while resting. Females, however, settle in the lower part of the thick bushes of *Dendrocnide sinuate*, which makes them even more difficult to spot. Males and females, have been observed feeding mostly on *Dendrocnide sinuate* and Ground Fern *Diplazium* sp. (Image 2) and occasionally on wild Eggplant *Solanum* sp. This cicada is not often attracted to light but occasionally comes to light if disturbed after dark.

Larval morphology

The final instar nymph climbs the tree trunk for eclosion and settles between 304–457 mm above the ground. The intermediate tooth of the femur is adjacent to the femoral comb and almost appears as the most prominent tooth of the comb. The femoral comb consists of four prominent teeth and one incomplete tooth towards the joining of the femur with tibia. Accessory tooth of femur is rudimentary and appears as a small nod below the tip of stocky posterior tooth of femur. The apical tooth of tibia is not too long but rather short and stout. The point of the blade of the tibia is outwardly depressed in the middle but appears straight from the inner side. Spines are prominent at the apex of mid and hind tibiae of final instar nymph and are almost identical.

Proposed common name

Based on its appearance and behaviour, the name 'Ochre Summer Clicker' seems appropriate for this species.

Justification

- This species of cicada is ochraceous in its general appearance, which literally means ochre-coloured.

- This cicada is broadly found in the mixed forests and wet deciduous forests in summer, right after the April rains.

- The call of this cicada is typically click-like.

Due to these characteristics, the proposed name seems informative and is hence suggested for common use.

DISCUSSION

As of now, according to my understanding, the species has a strong association with its habitat as it was found in the same type of habitat throughout its range in northern West Bengal. It would have been a great help in understanding its biology if one could get an account of the habitat where William Doherty collected the type specimen from. The type locality as well as the other parts of Assam should also be surveyed to know more about the biology of this species. Population data of this cicada could not be collected adequately and uniformly due to its habitat preference with *Dendrocnide sinuate.* Physical contact with the leaf of *Dendrocnide sinuate* causes rashes and skin irritation, restricting the

Image 3. ***Lahugada dohertyi*** **larval exuviae: A—dorsal view | B—lateral view | C—ventral view | D—closeup of head from below | E—foreleg | F—mid-leg | G—hind leg | H—closeup of the abdominal apex. © Vivek Sarkar.**

movement of the observer and limiting access to the interior part of the bushes. A small, isolated population of this cicada was found in Chakchaka suburb in May 2014, as mentioned earlier in the text. Despite being private property, the locality had a similar habitat with very little human activity at that time. In November 2014, the entire patch along its adjacent area was completely cleared and dug up for house construction and Betel Nut *Areca catechu* plantation. In May 2015, no calls of *Lahugada dohertyi* were heard in and around the Chakchaka suburb though the individuals of *Dundubia* sp. remained at large in the same area. Another active search attempt was made in April–May 2016 but no *Lahugada* was heard or spotted in the suburb though multiple individuals were spotted in other localities of northern West Bengal, both in 2015 and in 2016. This is merely an observation and unless more data on its natural history such as host plant and larval behaviour is acquired, it would be impossible to narrow down and identify the potential threats to this species. It would also be a challenge to describe its tymbalization as the cicada calls during its skittish, shuddering, circular flight, which makes it difficult to record its complete call with parabola and microphone, and hence a different method has to be adopted.

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Journal of Threatened Taxa

www.threatenedtaxa.org

PLATINUM OPEN ACCESS

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

July 2019 | Vol. 11 | No. 9 | Pages: 14087–14246
Date of Publication: 26 July 2019 (Online & Print)
DOI: 10.11609/jott.2019.11.9.14087-14246

Publisher & Host

WILD ZOOREACH Threatened Taxa

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