



Taxonomic studies on subfamily Phaneropterinae (Orthoptera: Tettigoniidae) from Uttar Pradesh, India

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Abstract

The present paper dealt the study of subfamily Phaneropterinae. A key to species of genus *Phaneroptera* Serville, (1831) and morphometric ranges of all the species are provided. Illustrations of all the species including the SEM study of stridulatory files of species *Phaneroptera gracilis* is also provided.

Keywords: tettigoniidae, phaneropterinae, *Phaneroptera*, India

Introduction

Tettigoniidae is a family of suborder Ensifera under the superfamily Tettigoniidae. The members of Tettigoniidae are commonly known as katydids and bush-crickets. They are also known as long horned grasshoppers, although, they are more closely related to crickets than to grasshoppers. Tettigoniidae possess long and cylinder antennae, usually longer than the body, four segmented tarsi and usually sword or sickle like ovipositors. There are about 7200 species of Tettigoniidae found in the world belonging to 1070 genera. Out of which only 160 species under 68 genera are reported from India (Shishodia *et al.*, 2010).

Materials and Methods

The first author collected new and known materials from Uttar Pradesh, India. They were caught in a sweep net. The specimens were prepared and pinned. All the type specimens are deposited in the Zoology Department, Aligarh Muslim University, India (ZDAMU). The Digital photographs of dried and recently killed specimens and their body parts were taken by the Discovery V8 Stereozoom Binoculars (Zeiss), male and female habitus images were taken by using an Olympus SLR digital camera. The images of stridulatory files of *Phaneroptera gracilis* was taken from scanning electron microscopy (SEM). Morphological measurements were made by using digital Vernier caliper. All other measurements were taken from the divisions of a linear scale of an ocular micrometer placed in the eyepiece of a Nikon stereozoom microscope. These measurements were taken at [10x eye piece × 1x objective] at zoom 3 of the microscope.

Results and Discussion

Subfamily Phaneropterinae Burmeister, 1838 ^[3]
Phaneropterinae Burmeister, 1838 ^[3]. *Hand buch der Entomologie* 22 (1-8):684.

Type genus: *Phaneroptera* Serville, 1831 ^[6]. *Ann. Sci. nat.* 22(86):158.

Diagnosis

Head rounded, not usually slanted or frontally flattened; Frons

vertical. Vertex not produced forward as tubercle or cone. Eyes small situated close to basal point of antennae. Pronotum short, flat or concave, median carina absent or faint, lateral carinae usually distinct, usually narrowed in front, caudal margin usually rounded. Prosternum unarmed. Fore tibiae in section square especially apically; dorsal apical spine on front tibiae; dorsal surface of fore tibiae flat or slightly concave. Tegmina shorter than hind wings. Ovipositor variable in size and shape usually sickle like, short and upturned, flattened laterally, margins usually serrate or dentate. Color usually a bright green.

Genus *Holochlora* Stal, 1873 ^[7]

Diagnosis

Body large sized, robust and smooth. Head rounded dorsally. Fastigium of vertex triangular, dorsally furrowed; sulcated in upper part; fastigium verticis narrower than scapus, apex obtusely rounded. Fastigium separated from frons by a wide and deep furrow. Eyes oval and bulging. Pronotum smooth dorsally, posterior margin broadly rounded. Lateral lobes higher than long; humeral sinus distinct. Prosternum unarmed. mesosternal lobes rounded, metasternal lobes rounded with truncated apex. Tenth abdominal tergite splitting into two lobes. Subgenital plate long, styles cylindrical, short and stout.

***Holochlora alsigarhensis* Swaminathan & Nagar, 2016** ^[8] (Fig. 1, 2)

Holochlora alsigarhensis Swaminathan & Nagar, 2016 ^[8]. *Zootaxa* 4171(2):267.

Description

Male: Body large sized, robust and smooth. Head rounded dorsally. Fastigium of vertex about 3.06 times as wide as scape; fastigium verticis much narrower than scape, apex obtusely rounded; dorsally furrowed; sulcated in upper part. Fastigium separated from frons by a wide and deep furrow. Eyes oval and bulging. Pronotum with disc broadly rounded, apical area sub-flat and shouldered; anterior margin almost straight, posterior margin broadly rounded; Median carina

visible on posterior pronotal disc; transverse sulcus U shaped; lateral lobes of pronotum higher than long; anterior margin slightly concave, lower margin broadly rounded and posterior margin rounded; humeral sinus distinct and deep. Thoracic auditory spiracle large, elliptical, partially hidden under lateral lobe of pronotum with a finger like downward projection on the upper posterior margin of spiracle. Prosternum unarmed, mesosternal lobes triangular, metasternal lobes rounded with sub truncate apical margin. Tegmina shorter than the hind wings; anterior margin basally convex and apically straight, posterior margin straight; apex obtusely rounded; radius sector branching before middle of tegmina length, forked, radius stem with three more lateral branches. Stridulatory file with 60 lamelliform teeth, file almost straight, teeth of file uniform in thickness, evenly arranged, broad in the middle and smoothly narrowing towards proximal and distal end; hind wings reaching middle of hind tibia. Legs: genicular lobes of all legs armed by bispinose. Fore coxae armed by spines. All femora dorsally unarmed. Fore femora ventrally armed by 4 rudimentary spines on inner margin and unarmed on outer margin. Mid femora ventrally unarmed on inner margin; 2 rudimentary spines on outer margin. Hind femora ventrally armed by 4-5 small spines on inner margin; 7-8 small spines on outer margin. Tympanum on fore tibiae concave on internal side, opened on external side with a pair of small elongated lateral pits below the tympanum, dorsal surface of tibial tympana marked by black band. Fore tibia dorsally armed by single apical spine on inner margin; 3 small spines on outer margin. Fore tibiae ventrally armed by 6 small spines on inner margin; 4 small spines on outer margin. Mid tibiae dorsally armed by 5 small spines on inner margin; single small apical spine on outer margin. Mid tibiae ventrally armed by 8 small spines on inner margin; 15 small spines on outer margin. Hind tibiae dorsally armed by 30-32 small spines on inner margin; 34-36 small spines on outer margin. Hind tibiae ventrally armed by 16-18 small spines on inner margin; 25-28 small spines on outer margin. Single dorsal pair of spurs and two ventral pairs (one small and one large) of spurs present on the apical region of hind tibiae. Tenth abdominal tergite splitting into two broad lobes with convex dorsal and concave ventral surfaces; dorsal surface with internal margins strongly setose; apex of lobes broadly rounded; ventral surface with a low swelling before apex; a thumb like projection present

ventrally on the internal margin of dorsal right lobe. Supra anal plate triangular; broader than long; apex obtuse. Subgenital plate basally broad, median carina visible at apical half; styli cylindrical, short and stout and moderately incurved. Cerci thick, basal area widened and densely covered with long hairs on internal side, apical area strongly incurved into sharp spine.

Table 1: Morphometry (length in mm)

S. No.	Body Parts	♂
1.	Body length	34.18
2.	Body with wing	59.78
3.	Tegmen	47.14
4.	Hind wing	50.14
5.	Pronotum length	06.99
6.	Pronotum height	05.45
7.	Pronotum length (lateral lobe)	04.95
8.	Fore femur	07.25
9.	Fore tibia	09.32
10.	Hind femur	27.90
11.	Hind tibia	31.49

Material Examined: India - Uttar Pradesh, Kanpur, Gopal Nagar (26°24'26.53"N, 80°20'42.81"E), 1♂, 07.X. 2014, on grasses, (coll. M. K. Farooqi).

Distribution: Rajasthan and Uttar Pradesh.

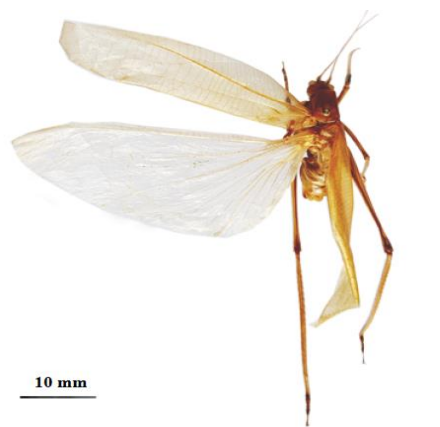


Fig 1: *Holochlora alsigarhensis*. (Male)

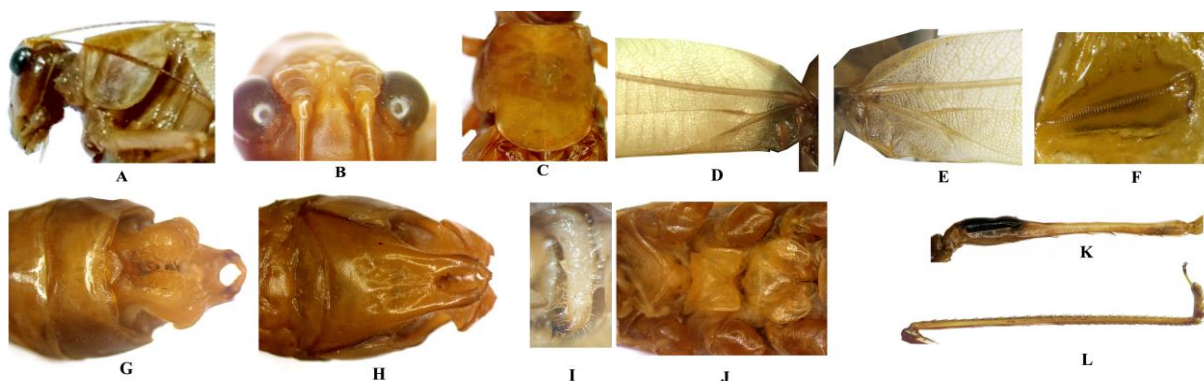


Fig 2: *Holochlora alsigarhensis*. (A–L): A – Lateral view of head and pronotum ♂, B – Dorsal view of fastigium of vertex ♂, C – Dorsal view of pronotum ♂, D – Dorsal view of left basal tegmen ♂, E – Dorsal view of right basal tegmen ♂, F – Stridulatory file ♂, G – Dorsal view of abdominal end ♂, H – Ventral view of sub-genital plate ♂, I – Lateral view of cercus ♂, J – Sternum ♂, K – Lateral view of fore tibia ♂, L – Lateral view of hind tibia ♂.

Genus *Phaneroptera* Serville, 1831 [6]

Diagnosis

Body slender. Fastigium acute, narrow, with thin groove in upper part, sulcated, separated from fastigium of frons with a small furrow. Pronotum with a small V shaped sulcus, markedly flattened in posterior part and without carinae, lateral lobes of pronotum fairly smooth, rounded, not forming angle with disc with deep humeral sinus. Fore coxae armed by a well developed spine. Tibial tumpanum oval, opened on both sides. Hind tibiae with 3 external and 4 internal spurs. Tegmen narrow, apex rounded. Tegmina shorter than hind wings; Sc and R more or less separate from base, but often closely approximated for proximal half of their length and sometimes virtually contiguous. Male tenth abdominal tergite usually unmodified. Cerci of male long, with pointed apex; cerci of female thin, distinctly curved and undulate. Subgenital plate of female short, not longer than cerci, with moderate apical notch. Ovipositor well developed with fine teeth or serration.

Key to species of *Phaneroptera* Serville, 1831 [6] **from India**

Subgenital plate in lateral view strongly curved dorsad in an almost 90° angle; apices of apical lobe curved laterad *P. (Phaneroptera) gracilis* Burmeister, 1838 [3]
 Subgenital plate in lateral view with approaching margins in apical area; apices of apical lobe slightly curved mediad *P. (Phaneroptera) myllocerus* Ragge, 1956 [5]

***Phaneroptera (Phaneroptera) gracilis* Burmeister, 1838** [3]

(Fig. 3, 4, 5)

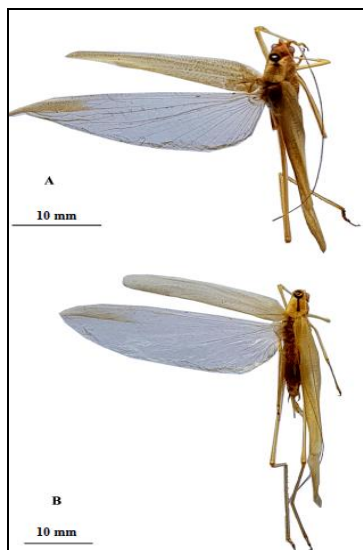


Fig 3: *Phaneroptera gracilis*. A–Male, B – Female

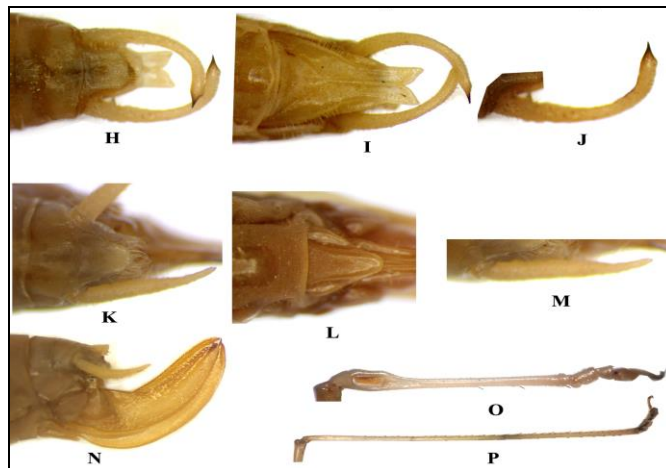
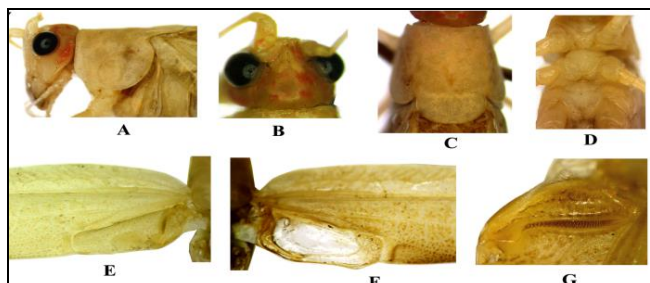


Fig 4: *Phaneroptera gracilis*. (A–P): A – Lateral view of head and pronotum ♂, B –Dorsal view of fastigium of vertex ♂, C – Dorsal view of pronotum ♂, D – Ster-num ♂, E– Dorsal view of left basal tegmen ♂, F – Dorsal view of right basal teg-men ♂, G – Stridulatory file ♂, H – Dorsal view of supra-anal plate ♂, I –Ventral view of subgenital plate ♂, J – Dorsal view of cercus ♂, K –Dorsal view of supra-anal plate ♀, L –Ventral view of subgenital plate ♀, M – Dorsal view of cercus ♀, N – Lateral view of ovipositor ♀, O – Lateral view of fore tibia ♂, P – Lateral view of hind tibia ♂.

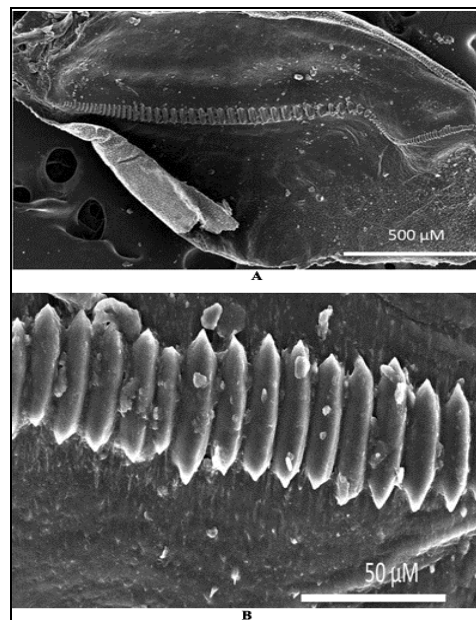


Fig 5: Stridulatory file of *Phaneroptera gracilis*. A – Entire file, B – Enlarged fragment.

***Phaneroptera gracilis* Burmeister, 1838** [3]. *Handbuch der Entomologie* 22 (I–VIII):690.

***Phaneroptera elongate* Brunner von Wattenwyl, 1878.** *Monographie der Phaneropteriden* 210, 217. Syn. By Ragge, 1956 [5]. *Proc. zool. Soc. London* 127(2):250.

***Phaneroptera indica* Brunner von Wattenwyl, 1878.** *Monographie der Phaneropteriden.* 215. Syn. By Uvarov, 1924. *Bull. Minist. Agric. Egypt Tech. & Sci. Serv.* 41:9.

***Phaneroptera marginalis* Brunner von Wattenwyl, 1878.** *Monographie der Phaneropteriden.* 214 Syn. By Ragge. 1956 [5]. *Proc. zool. Soc. London* 127(2):250.

***Phaneroptera roseata* Walker, 1869** [10]. *Catalogue of the*

Specimens of Dermaptera Saltatoria in the Collection of the British Museum. 2:343. Syn. By Ragge, 1956 ^[5]. *Proc. zool. Soc. London* 127(2):250.

Phaneroptera subcarinata Bolivar, 1900. *Ann. Soc. ent. Fr.* 68:764.

Redescription

Male: Body medium sized and slender. Fastigium of vertex triangular; base of fastigium 2.27-2.59 times as wide as scapus; narrow with thin dorsal longitudinal groove in dorsal upper part, sulcated in upper part, verticis sub acute; fastigium separated from the frons with a small notch. Pronotum: dorsal surface of pronotum uneven with a V shaped sulcus; anterior dorsal margin slightly concave, posterior margin rounded; lateral lobes of pronotum longer than high; humeral sinus deep. Thoracic auditory spiracle large, oval, partially hidden under lateral lobe of pronotum without sub apical tooth on posterior edge of spiracle. Prosternum unarmed; mesosternal and metasternal lobes rounded. Tegmina much shorter than hind wings, apex rounded. Stridulatory file with 100 teeth arranged on the ventral side of left tegmen, 60 teeth of file large, thick and evenly spaced except distal end where it is curved and having densely arranged thin teeth. Hind wings reaching before the middle of hind tibiae when straightened. Legs: genicular lobes of all femora armed by bispinose. All femora dorsally unarmed. Fore coxa with forward projected dorsal spine. Fore and mid femora ventrally unarmed on both inner and outer margin. Hind femora ventrally armed by single small spine at centre on inner margin; 9-11 small spines on outer margin. Tympanum on fore tibiae opened on both sides. Fore tibiae dorsally unarmed on inner margin; single apical spine present on outer margin. Fore tibiae ventrally armed by 4 spurs on inner margin; 3 spurs on outer margin. Mid tibiae dorsally armed by single apical spine on inner margin; unarmed on outer margin. Mid tibiae ventrally armed by 7 small spines on inner margin; 9 small spines on outer margin. Hind tibiae dorsally armed by 72-75 spines on inner margin; 72-75 spines on outer margin. Hind tibiae ventrally armed by 16-18 small spines on inner margin; 20-22 small spines on outer margin. Single dorsal pair of spurs and two ventral pairs (inner small and outer large) of spurs present on the apical region of hind tibiae. Supra anal plate quadrate with small basal pits at the middle; apical margin slightly rounded. Subgenital plate long, basally broad, median and lateral ridges well developed; bifurcated apically; apical lobes triangular; styli absent. Cerci long and cylindrical, widened subapically, curved inwardly, apex with pointed spine.

Female: Supra anal plate triangular; apex rounded. Subgenital plate triangular; as long as broad; apex slightly rounded; Subgenital plate in lateral view strongly curved dorsad in an almost 90° angle; apices of apical lobe curved laterad. Cerci long, narrow subapically; slightly upcurved; apex sub-obtuse, slightly incurved. Ovipositor sickle shaped; slightly upturned with fine rounded teeth on the entire dorsal margin and the apical part of ventral margin.

Table 2: Morphometry (length in mm)

S. No.	Body Parts	4♂♂	4♀♀
1.	Body length	20.80–21.89	21.09–22.01
2.	Body with wing	35.86–35.90	35.52–35.58
3.	Body with ovipositor	—	21.94–22.02
4.	Tegmen	21.31–21.38	22.02–22.06
5.	Hind wing	29.81–29.87	29.87–29.91
6.	Pronotum length	03.30–03.33	03.28–03.31
7.	Pronotum height	02.68–02.70	02.53–02.56
8.	Pronotum length (lateral lobe)	02.90–02.93	02.88–02.90
9.	Fore femur	03.48–03.51	03.98–04.00
10.	Fore tibia	05.01–05.04	05.52–05.56
11.	Hind femur	19.23–19.27	20.38–20.41
12.	Hind tibia	20.88–20.93	21.38–21.43
13.	Ovipositor	—	04.60–04.65

Material examined: India - Uttar Pradesh, Azamgarh, Fatehpur (26° 4'51.10"N, 83° 7'31.28"E), 2♂♂, 27.IX.2013, on grasses, (coll. M. K. Farooqi); Ghazipur, Dildarnagar (25°25'45.30"N, 83°39'58.99"E), 2♂♂, 2♀♀, 06.X.2013, on paddy, (coll. M. K. Farooqi); Basti, Kasala (26°47'12.17"N, 82°48'41.49"E), 2♂♂, 2♀♀, 23.IX.2014, on bushes, (coll. M. K. Farooqi); Allahabad, Kherwa (25°22'53.26"N, 81°45'34.40"E), 2♂♂, 3♀, 14.IX.2014, on bushes, (coll. M. K. Farooqi); Faizabad, Firozpur (26°43'40.33"N, 82°11'49.87"E), 2♀♀, 20.IX.2014, on paddy, (coll. M. K. Farooqi); Shahjahanpur, Riswani Bagh (27°53'5.99"N, 79°55'21.96"E), 3♂♂, 3♀♀, 16.IX.2016, on bushes, (coll. M. K. Farooqi).

Distribution: India : Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh and Uttarakhand.

Elsewhere: Africa, Annam, Australia, Celebes, China, Indo-China, Java, Malaysia, Maldives Islands, Myanmar, Solomon, Sri Lanka, Sumatra and Sumba.

Phaneroptera (Phaneroptera) myllocerus Ragge, 1956 ^[5] (Fig. 6,7)



Fig 6: *Phaneroptera myllocera*. (Female)

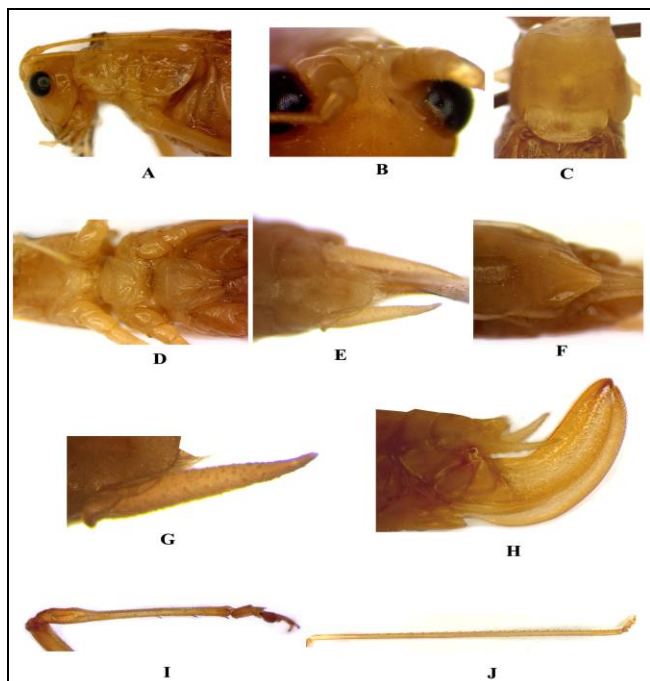


Fig 7: *Phaneroptera myllocera*. (A– J): A – Lateral view of head and pronotum ♀, B – Dorsal view of fastigium of vertex ♀, C – Dorsal view of pronotum ♀, D – Sternum ♀, E – Dorsal view of supra-anal plate ♀, F– Ventral view of subgenital plate ♀, G– Dorsal view of cercus ♀, H–Lateral view of ovipositor ♀, I– Lateral view of fore tibia ♀, J– Lateral view of hind tibia ♀.

Phaneroptera (Phaneroptera) myllocerus Raggae, 1956 ^[5]. *Proc. zool. Soc. London* 127(2):254.

Redescription

Female: Body medium sized and slender. Fastigium of vertex triangular; base of fastigium 2.20 times as wide as scapus narrow with thin dorsal longitudinal groove in dorsal upper part, sulcated in upper part, verticis sub acute. fastigium separated from the frons with a small notch. Pronotum: dorsal surface of pronotum uneven with a V shaped sulcus; anterior dorsal margin concave, posterior margin rounded; lateral lobes of pronotum longer than high; humeral sinus deep. Prosternum unarmed; mesosternal and metasternal lobes rounded. Thoracic auditory spiracle large, oval, partially hidden under lateral lobe of pronotum with a minute sub apical projection on posterior edge of spiracle. Tegmina shorter than hind wings, apex rounded; hind wings reaching before the middle of hind tibia when straightened. Legs: genicular lobes of all legs armed by bispinose. All femora dorsally and ventrally unarmed. Fore coxae armed by forward dorsal projected spine. Tympanum on fore tibiae opened on both side. Fore tibiae dorsally unarmed on inner margin; single apical spine on outer margin. Fore tibiae ventrally armed by 4 spurs on inner margin; 3 spurs on outer margin. Mid tibiae dorsally armed by single apical spine on inner margin; unarmed on outer margin. Mid tibiae ventrally armed by 7 small spines on inner margin; 8 small spines on outer margin. Hind tibiae dorsally armed by 51-54 spines on inner margin; 51-54 spines on outer margin. Hind tibiae ventrally armed by 6-7 small spines on inner margin; 12-14 small spines on outer margin. Single dorsal pair

of spurs and two ventral pairs (one small and one large) of spurs present on the apical region of hind tibiae. Supra anal plate triangular with a small basal pit; apex rounded. Subgenital plate triangular; broader than long; apex with weak middle excision; subgenital plate in lateral view with approaching margins in apical area; apices of apical lobe slightly curved mediad. Cerci long, narrow apically; slightly upcurved; apex sub-obtuse, slightly incurved. Ovipositor sickle shaped; moderately upturned almost whole length, with fine rounded teeth on the entire dorsal margin and the apical part of ventral margin.

Table 3: Morphometry (length in mm)

S. No.	Body Parts	3 ♀♀
1.	Body length	20.42–20.50
2.	Body with wing	35.23–35.29
3.	Body with ovipositor	22.97–23.10
4.	Tegmen	21.92–21.99
5.	Hind wing	28.70–28.78
6.	Pronotum length	03.35–03.38
7.	Pronotum height	02.32–02.36
8.	Pronotum length (lateral lobe)	02.50–02.52
9.	Fore femur	04.36–04.39
10.	Fore tibia	05.00–05.04
11.	Hind femur	21.68–21.72
12.	Hind tibia	22.38–22.42
13.	Ovipositor	04.42–04.48

Material examined: India - Uttar Pradesh: Azamgarh, Mehnagar (25°52'29.76"N, 83° 6'30.94"E), 2 ♀♀, 28.IX.2013, on paddy, (coll. M. K. Farooqi); Ghazipur, Dildarnagar (25°25'45.30"N, 83°39'58.99"E), 1 ♀, 06.X.2013, on paddy, (coll. M. K. Farooqi); Allahabad, Wazidpur (25°27'51.71"N, 81°41'33.28"E), 1 ♀, 14.IX.2014, on bushes, (coll. M. K. Farooqi); Basti, Rudhauri (26°48'57.74"N, 82°45'4.45"E), 2 ♀♀, 21.IX.2014, on grasses, (coll. M. K. Farooqi); Lucknow, Mehora (26°50'53.06"N, 81° 5'21.22"E), 1 ♀, 04.X.2014, on paddy, (coll. M. K. Farooqi); Shahjahanpur, Riswani Bagh (27°53'5.99"N, 79°55'21.96"E), 1 ♀, 15.IX.2016, on bushes, (coll. M. K. Farooqi).

Distribution: India: Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland, Sikkim, Uttar Pradesh and Uttarakhand.

Elsewhere: China and Myanmar.

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