



## DIAGNOSTICS OF THE TETTIGONIID GENUS *CONOCEPHALUS* OCCURRING IN THE RICE FIELDS

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### ABSTRACT

**In this study, the genus *Conocephalus* (Orthoptera: Tettigoniidae) collected from the rice fields of Coimbatore and Bhavanisagar, Tamil Nadu are taxonomically analysed. Three species viz., *C. longipennis*, *C. maculatus* and *C. rentzi* inhabiting rice fields have been redescribed and illustrated. Occurrence of *C. rentzi* in rice with description of male genitalia is reported for the first time.**

**Key words:** Diagnostics, Tettigoniidae, Tamil Nadu, Bhavanisagar, redescribed, *Conocephalus longipennis*, *C. maculatus*, *C. rentzi*, rice, male genitalia, occurrence

Genus *Conocephalus* (Orthoptera: Tettigoniidae: Conocephalinae) was erected by Thunberg in 1815 with *Gryllus (Tettigonia) conocephalus* L., as type species along with description of 24 species. Genus *Conocephalus* is the largest of the tribe Conocephaliini and is cosmopolitan in distribution. *Conocephalus* comprises 151 species worldwide (Cigliano et al., 2021) while in India 10 species have been documented so far (Shishodia et al., 2010; Nagar and Swaminathan, 2016; Farooki and Usmani, 2018) with two species recorded in rice ecosystems (Chitra et al., 2000). The insect diversity and abundance is relatively more in rice compared to other cultivated crops. Genus *Conocephalus* plays an important functional role in rice ecosystem by minimizing the damage incurred by insect pests (Pantua and Litsinger, 1984; Manley, 1985; Rubia et al., 1990a). This study analyses the taxonomy of the species of this genus as inhabiting rice in Tamil Nadu.

### MATERIALS AND METHODS

*Conocephalus* specimens were collected during 2020 and 2021 from the rice fields of Coimbatore (11°00'09 "N 76°55'33 "E; 10°59'44 "N 76°54'59 "E) and Bhavanisagar, Erode (11°28'40 "N 77°08'32 "E; 11°28'59 "N 77°08'22 "E; 11°28'51 "N 77°07'43 "E) in Tamil Nadu. Collected specimens were killed with chloroform (99.8%) and subsequently pinned and labelled. The dry preserved specimens were deposited in the TNAU Insect Museum. Morphological and genitalia characters were examined under stereo zoom microscope (Leica M205A, Software LAS v4.12). Photographs and measurements were taken with LAS X Application suite montage software. Morphological

description and terminologies used to illustrate wings and male genitalia follow Nagar and Swaminathan (2016), Farooki and Usmani (2018), Rentz, (1970) and Cedillo-Salinas et al., (2019). Description of female genitalia follows Torre-Bueno (1989). Genitalia extraction follows the methodology of Rengifo and Andrade (2014). Abdomen was detached with forceps and placed in water for 5 -10 min to facilitate softening of membranes and enable easy handling. Relaxed specimens are then transferred to cavity blocks with (5%) KOH for 10 min and further washings with distilled water carried out. Supra anal plate removed with the aid of entomological pin and genitalia extracted by bending the lamina subgenitalis. The abbreviations used: FW: Fore wing; HW: Hind wing; Male genitalia: Ti: Titillators (Ti. R - Right titillator; Ti. L - Left titillator); Female genitalia: Dv: Dorsal valves; Vv: Ventral valves.

### RESULTS AND DISCUSSION

#### **Genus *Conocephalus* Thunberg (1815)**

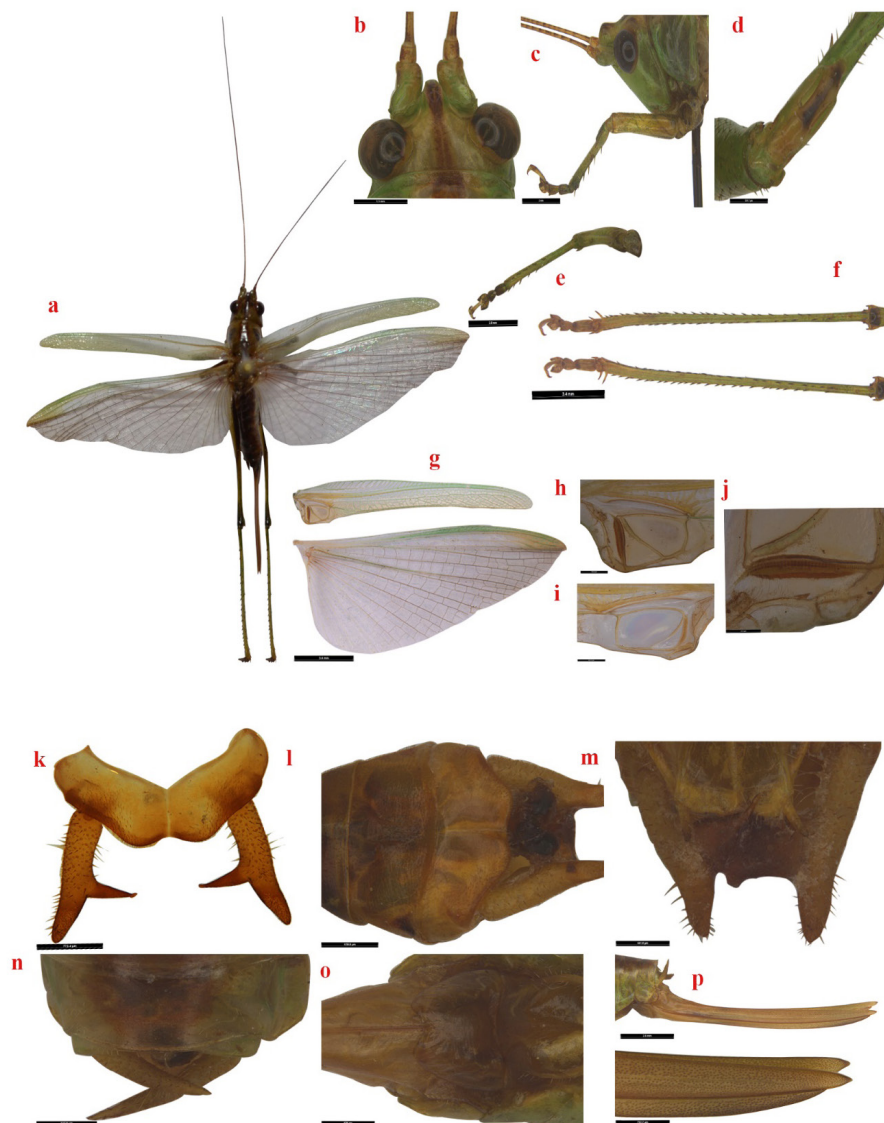
**Diagnosis:** Body small to medium, greenish in colour with wider brown or black patch medially running from vertex to lower margin of pronotum. Compound eyes bulging out and antenna filiform. Brown patches present or absent in tegmen. In FW, costal cell with numerous cross veins; radial vein branch into two veinlets and medial vein branch into 8 veins; cubitus vein dissolve in the mid-basal area. Median and cubitus vein arise from a thick unbranched vein from humeral angle. Left stridulatory file and right mirror well developed. Internally toothed cerci in male whereas in female, cerci lack an internal tooth.

### 1. *Conocephalus longipennis* (de Haan) (Figs. 1a-p)

*Locusta (Xiphidium) longipennis*. Haan, 1843: 188–189; *Conocephalus carolinensis* Willemse, 1942: 98; *Xiphidium (Xiphidium) longicornis* Redtenbacher, 1891: 513; *Conocephalus carolinensis* Willemse, 1942: 99; *Xiphidium spinipes* Stal, 1877: 47.

**Redescription:** ♂ Head yellowish green; a dark brown patch running from mid inter-ocular space to occipital sulcus with margins on both extremes not straight present. Eyes globular, projected outwards and black in colour with bright yellow rim basally. Antenna dull brown throughout with base of each flagellomere

darker. Scapus finely pubescent along inner dorsal margin. Length of scapus two times longer than inter-ocular distance. Fastigium narrower and brownish apically on dorsal side. Frontal ridge on frons distinct. Clypeo-labral suture brownish and distinct. Labrum dark yellowish with apex flattened. Gena not pitted and greenish. Both palps pubescent with tips faint brown in colour. Apex of fifth segment of both palpi enlarged than the base. Thorax with pronotum with upper and lower margins straight and lateral margin rounded. Apical edge of pronotum terminates into a wide rounded lobed extension over mesonotum. Median carina of pronotum and humeral sinus not clearly visible. Lateral



Figs. 1a-p: *Conocephalus longipennis* (de Haan) Female: a. full view; Male: b. head dorsal; c. fore leg; d. tympanum; e. mid leg; f. hind tibia; g. fore and hind wings; h. right mirror and file; i. left mirror and file; j. left stridulatory file; k. cerci; l. supra anal plate; m. sub genital plate; Female: n. cerci and supra anal plate; o. sub genital plate; p. ovipositor

lobes of pronotum trigonal with secondary tympanum along posterior edge. Secondary tympanum oviform with thin cuticular structure and partially cover the thoracic auditory spiracle. Prothoracic spiracle ovate and pubescent along inner edges. Prosternum with a pair of spines. Mesosternal lobes semi-circular and meet in the middle forming no mesosternal interspace. Metasternal lobes feebly rounded with apical excision.

Legs with tibia and femur not spotted basally. Ventral fore coxae with a single spine. Tympanum darker, closed bilaterally and situated basally on fore tibia. Fore- and mid-femur with no armature on ventral side. Hind femur with one sub-basal spine on inner edge and four sub-basal spines on outer edge. Genicular lobes of fore femur with two spines on inner side, mid femur with one spine on inner and two spines on outer side. Hind femur with two spines each on both sides. Fore- and mid-tibia with no dorsal armature but ventrally with six spines each on inner and outer side. Hind tibia with darkened spines along inner margin (30 numbers) and outer margin (33 numbers) dorsally. Ventrally spines present along inner (6 numbers) and outer margin (9 numbers). Hind leg 1.85 times longer than body length. Wings with: FW: Nearly one third region of remigium greenish. Brown patches absent. Subcostal cell from mid to apex appear dark green. Cubitus vein dissolve medially above anal margin into two veinlets. Left stridulatory file with evenly arranged teeth (65 nos). Size of teeth decreases gradually towards both extremities. Stridulatory file on right tegmen comparatively shorter than left file. Right mirror feebly square shaped and left mirror rectangular in shape. HW: Costal cell dull green from mid to apex. Distal region of subcostal and marginal cell dull yellowish.

Abdomen with tergites brownish medially with faded greenish yellow irregular margins on both sides. Sternites pubescent and yellowish. Male: Supra-anal plate wider with slightly incised in the middle and lateral apical edges feebly depressed. Sub-genital plate pubescent with apical margin nearly straight bearing a pair of stylus on lateral extremes. Stylus tipped dull brown and pubescent. A pair of cercus widely at base. Apex of cerci blunt. Cercus toothed internally and tips of the internal tooth globular in shape. Internal tooth present just below middle region of cercus. Female: Supra-anal plate with median excision clearly visible and wider than long. Sub-genital plate triangular, broader than long with medially depressed. Cerci shorter than male with no internal tooth and densely hairy. Ovipositor long, dull yellowish. Dv longer

than Vv. Apex of Dv project as a blunt tip beyond ventral valves and slightly thickened. Outer and inner side of both valves appear pitted throughout. Sexual dimorphism present. Abdomen of male bright yellowish while females greenish.

**Measurements:** Male: 17.09-17.39 mm long; head: 3.16-3.46 mm wide; pronotum: 2.96-3.26 mm long and 2.17-2.47 mm wide; hind leg: 31.7-32.0 mm long; fore wing: 13.83-14.13 mm long; stridulatory file: left: 1.40-1.41 mm long; right: 0.96-1.01 mm long; hind wing: 20.26-20.56 mm long; cerci: 1.51-1.64 mm long. Female: 18.47-18.77 mm long; head: 2.62-2.92 mm long and 3.38-3.68 mm wide; pronotum: 3.34-3.64 mm long and 2.07-2.37 mm wide; hind leg: 33.75-34.05 mm long; fore wing: 20.66-20.96 mm long; hind wing: 22.52-22.82 mm long; cerci: 1.07-1.37 mm long; ovipositor: Dv: 11.29-11.35 mm long; Vv: 11.07-11.21 mm long.

**Materials examined:** 4 specimens: Tamil Nadu, Coimbatore (11°00'09 "N 76°55'33 "E; 10°59'44 "N 76°54'59 "E and 417 masl): 1♂ (03.02.2021), 3♀ (03.02.2021; 16.03.2021), 2 specimens: Tamil Nadu, Erode, Bhavanisagar (11°28'40 "N 77°08'32 "E; 11°28'59 "N 77°08'22 "E; 11°28'51 "N 77°07'43 "E and 256 masl): 2♀ (09.04.2021), leg. Dharini S V

**Distribution:** India (Shisoidia et al., 2010), Pacific regions of the Cariline islands and Somao (Pitkin, 1980).

**Comments:** Rothschild (1970) documented *C. longipennis* as a predator on nymphs and eggs of rice ear bug, *Leptocoris oratorius* (F.) in Sarawak. *C. longipennis* was recorded as a generalist predator of on egg masses of yellow stem borers, leaf folders and rice earhead bugs, nymphs and adults of leafhoppers and plant hoppers and adults of leaf folders, stem borers, whorl maggot and earhead bugs (Pantua and Litsinger, 1984; Rubia et al., 1990b; Ito et al., 1995; Kraker et al., 1996; Chitra et al., 2000). This species was reported as an opportunistic predator on egg masses of stem borers by exposing them to other parasitoids (Manley, 1985). Grist and Lever (1969) recorded this species as a minor pest of rice in Sarawak and New Guinea. Chitra et al. (2000) noticed typical longitudinal slits made by this species on rice leaf blades and its preference for mature rice grains.

## 2. *Conocephalus maculatus* (Le Guillou) (Figs. 2a-r)

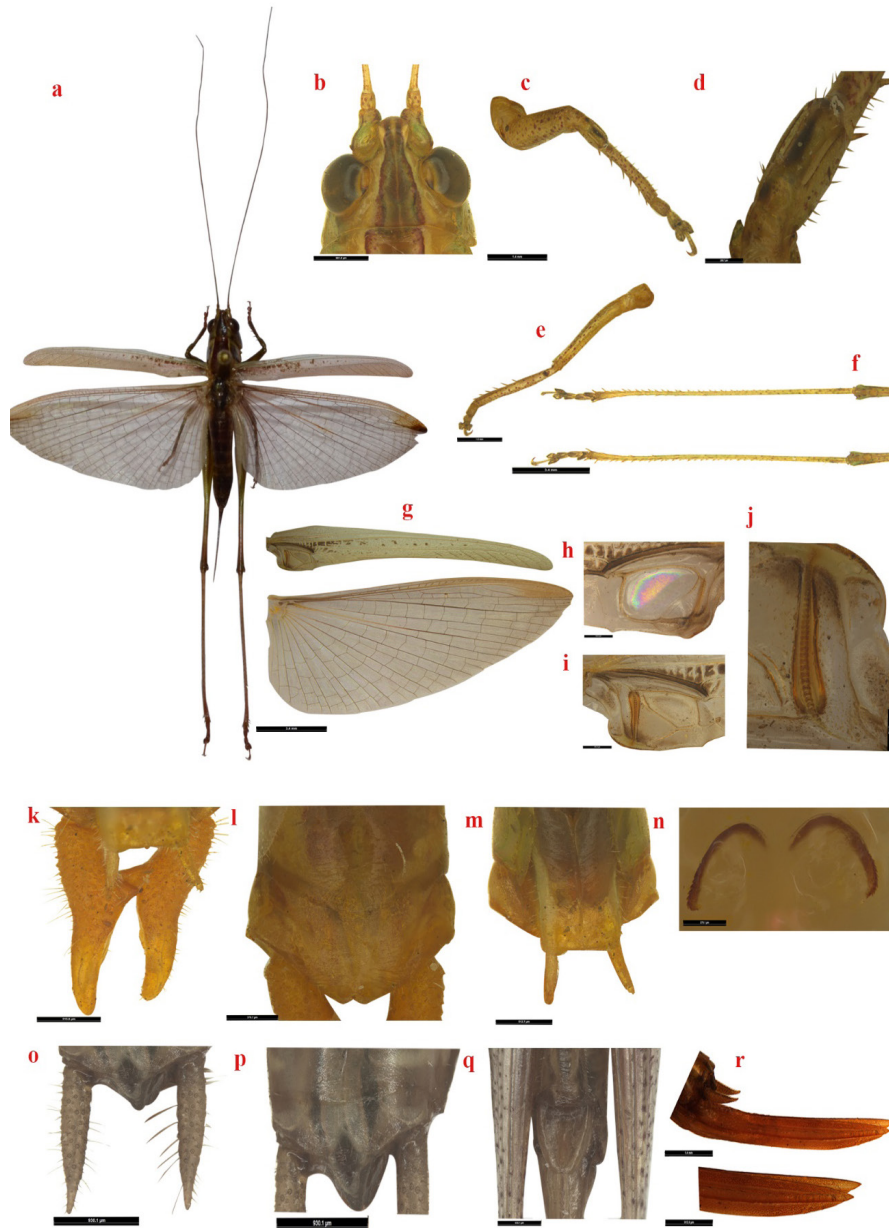
*Xiphidion maculatus*. Le Guillou, 1841: 294; *Conocephalus (Xiphidion) arabicus* Uvarov, 1933: 262; Popov, 1981: 114-148; *Conocephalus bidens* Uvarov,



1957: 363; Popov, 1981: 127; *Xiphidium continuum* Walker, 1869: 271; *Locusta (Xiphidium) lepida* Haan, 1843: 188–189; *Xiphidion neglectum* Bruner, 1920: 123; *Xiphidium sinensis* Walker, 1871: 35; Panhwar et al., 2013: 173; *Xiphidium dimidiatum* Matsumura and Shiraki, 1908: 56, Ito and Ichikawa, 2004: 59.

**Redescription:** ♂ Head brownish yellow and not wider than long. Eyes spherical, protuberant outwards and yellowish rimmed basally. Antenna dull brownish

with minute pubescent hairs throughout the length. Scapus equally long as inter ocular distance and two times wider than inter-ocular distance. Median reddish brownish patch with straight margins and fainted yellowish line in the centre extending from apex of fastigium to hind margin of pronotum. Lateral extremes of the patch covered by dark yellowish streaks. Apical fastigium rounded and projected outwardly over frons. Frons with globe shaped yellowish spot present just beneath apex of fastigium. Epistomal suture distinct



Figs. 2a-r: *Conocephalus maculatus* (Le Guillou): Female: a. full view; Male: b. head; c. fore leg; d. tympanum; e. mid leg; f. hind tibia; g. fore and hind wings; h. right mirror and file; i. left mirror and file; j. left stridulatory file; k. cerci; l. supra anal plate; m. sub genital plate; n. male genitalia; Female: o. cerci; p. supra anal plate; q. sub genital plate; r. ovipositor

and sub-ocular suture not clearly visible. Apical margin of clypeus flat and depressed medially. Labrum wide rounded apically with lateral margins feebly concave. Palpi of maxilla and labium pubescent. Apical segment of both palpi tipped dull brownish. Apex of both palpi slightly bigger than base. Thorax with pronotum with feebly concave upper margin and lower margin extended over mesonotum and sub-obtuse. Lateral margin concave. Median carina distinct but humeral sinus weak. Lateral lobes appear faintly elevated and partially cover secondary tympanum. Secondary tympanum ovoid, a thin cuticular structure and cover half of spiracle of propleuron. Prothoracic spiracle in the lateral lobe of pronotum obovate and partly covered by secondary tympanum. Mesonotum depressed medially with triangular mesonotal lobes. Mesonotal lobes elongated and longer than wide. Mesosternum with median raised ridge yellowish in colour and lobes rounded.

Legs irregularly round darker spots present on tibia and femur. Spots darker in mid tibia. Ventral side of outer coxae unispinose. Femur lack spines both on dorsal and ventral side. Fore femur with a single inner spine and no outer spine on knee lobes. Mid- and hind femur with one apical spine each on both sides. Tympanum appear slit-like, situated basally on fore tibia. Opening present on either side laterally and the tympanum appear to be present within a shallow depression. Fore- and mid-tibia lack dorsal spines. Dorsally, hind tibia armed with minute to small black tipped spines on inner (38 numbers) and outer margins (32 numbers). Fore-, mid- and hind tibia ventrally armed with varying number of spines on both margins. Hind tibia with spines on inner side (7 numbers) and spines on outer side (11 numbers) ventrally. Hind tibia with one pair of apical spur dorsally and two pairs of apical spurs ventrally. The inner pair of spurs shorter than outer pair of spurs. Wings with FW: Yellowish with darker veins. Irregularly spread brown patches present below radial vein; dense in the basal cell but only few in the sub-marginal cell. Mirror square shaped with slightly elevated top margin on right tegmen while left mirror appear broad and rectangular, not well developed. Right stridulatory file plumpier basally and terminate into thin profile towards apex enclosing closely arranged teeth. However, the left file plumpier throughout except thin extremities with evenly placed teeth (50 numbers). Basal anal margin straightened but towards apex feebly curved. HW: Subcostal and marginal cell dull yellowish subapically. A series of 18 to 20 thick transverse veins present in the subcostal cell.

Abdomen with tergites with black patch running medially along the entire abdominal length. Male with tenth abdominal tergite wider than long with visible median carina and weakly bilobed along apical margin. Supra-anal plate widely rounded and concave. Sub genital plate yellowish medially depressed. Apical margin of sub genital plate inwardly bent in the median region weakly. A pair of bilateral stylus curved and yellowish. Cerci single toothed just above mid-internal side and pubescent. Tooth of cercus tipped black and sharp edged. Ti present as pairs, well sclerotized and yellowish brown in colour. Ti. R and distinctly curved inwards but Ti. R is 1.12 times longer than Ti. L. Ti spinulate asymmetrically with no further division apically. Ti. R bears 12 spines and Ti. L bears 13 – 14 spines along the outer margin. Female: Prominent raised ridge present medially on tenth abdominal tergite. Apical margin of supra anal plate with a median incision. Sub genital plate roughly triangular with acute apical margin. Cerci with no internal tooth but pitted and pubescent. Ovipositor brownish yellow with visible depression throughout the length of bottom half of Dv. Dv longer than Vv and terminate into a sharply projecting tip with lower margin slightly elevated and upper margin straight beyond apex of Vv. Inner and outer sides of both valves except the depressed region appear pitted.

**Measurements:** Male: 14.38-14.68 mm long; head: 2.54-2.84 mm long and 2.47-2.77 mm wide; pronotum: 2.93-3.23 mm long and 1.6-1.9 mm wide; hind leg: 25.97-26.27 mm long; fore wing: 16.72-17.02 mm long; stridulatory file: left: 1.29-1.33 mm long; right: 0.91-0.99 mm long; hind wing: 18.86-19.16 mm long; cerci: 1.51-1.81 mm long. Female: 14.9-15.2 mm long; head: 1.97-2.27 mm long and 2.64-2.94 mm wide; pronotum: 2.97-3.27 mm long and 1.76-2.06 mm wide; hind leg: 30.17-30.47 mm long; fore wing: 18.6-18.9 mm long; hind wing: 19.6-19.9 mm long; cerci: 1.23-1.53 mm long; ovipositor: Dv: 7.33-7.41 mm long; Vv: 7.09-7.16 mm long.

**Materials examined:** 5 specimens: Tamil Nadu, Coimbatore (11°00'0"N, 76°55'33"E; 10°59'44"N, 76°54'59"E, 417 masl): 3♂ and 2♀ (10.02.2021; 09.03.2021), 3 specimens: Tamil Nadu, Erode, Bhavanisagar (11°28'40"N, 77°08'32"E; 11°28'59"N, 77°08'22"E; 11°28'51"N, 77°07'43"E, 256 masl): 1♂ and 2♀ (09.04.2021), leg. Dharini S. V.

**Distribution:** India, Pakistan, Singapore, Africa, Australia, China, Indonesia, Java, Malaysia, Nepal, New Guinea and Philippines (Shishodia et al., 2010;

Tan, 2010; Zhou et al., 2010; Panhwar et al., 2013; Kashakuro, 2017; Abrori and Leksono, 2021.)

**Comments:** Based on the feeding habit, *C. maculatus* is carnivorous on lepidopteran eggs and larvae, apple snails, sometimes even dead insects and also phytophagous feeding on seeds, flowers and grains of grass species (Kraker, 1996; Oda and Ishii, 1998; Chitra et al., 2000; Litsinger et al., 2006; Takahashi and Kiritani, 2008; Wason and Pennings, 2008; Chakraborty, et al., 2014). Further, it was suggested to bioindicator of climate change (Senthilkumar and Sanjayan, 2008).

### 3. *Conocephalus rentzi* Farooki and Usmani (Figs. 3a-r)

*Conocephalus rentzi* Farooki and Usmani, 2018: 381-398.

**Redescription:** ♂ Head with compound eyes dark, circular, brownish and rimmed basally. Antenna finely pubescent and greenish throughout. Vertex wide apex blunt and terminate into a laterally compressed fastigium. Vertex with reddish patch bilaterally margined by yellowish streak on both sides. Fastigium narrow and 1.7 times less wide than inter-ocular distance. Frons greenish yellow with dark brown tear drop shaped spot present just beneath fastigium. Frontoclypeal suture distinct. Pre-ocular ridge not clearly visible. Apex of clypeus feebly flat with a median lobe-like extension. Labrum feebly rounded and give flap-like appearance. Maxillary palpi 5 segmented with apex of fifth segment not slanted and tipped brownish. Labial palpi 3 segmented with apex of last segment slanted and tipped dull brown. All segments of palpi with minute pubescent hairy structures. Thorax with upper margin of pronotum straight. Lateral margin concave. Dorsal region with median brownish patch bilaterally covered by irregular thick yellowish streaks. Median carina indistinct with humeral sinus. Spiracle on pronotum covered partially by secondary tympanum. Secondary tympanum elliptical present as a thin cuticular structure but raised slightly near posterior edge of pronotal lobes. Widely spaced hyaline small pair of spurs present on prosternum. Mesosternal interspace hardly present, covered by triangular and widened mesosternal lobes. Metasternal lobes apically slightly excised in the middle and mesosternal interspace indistinct.

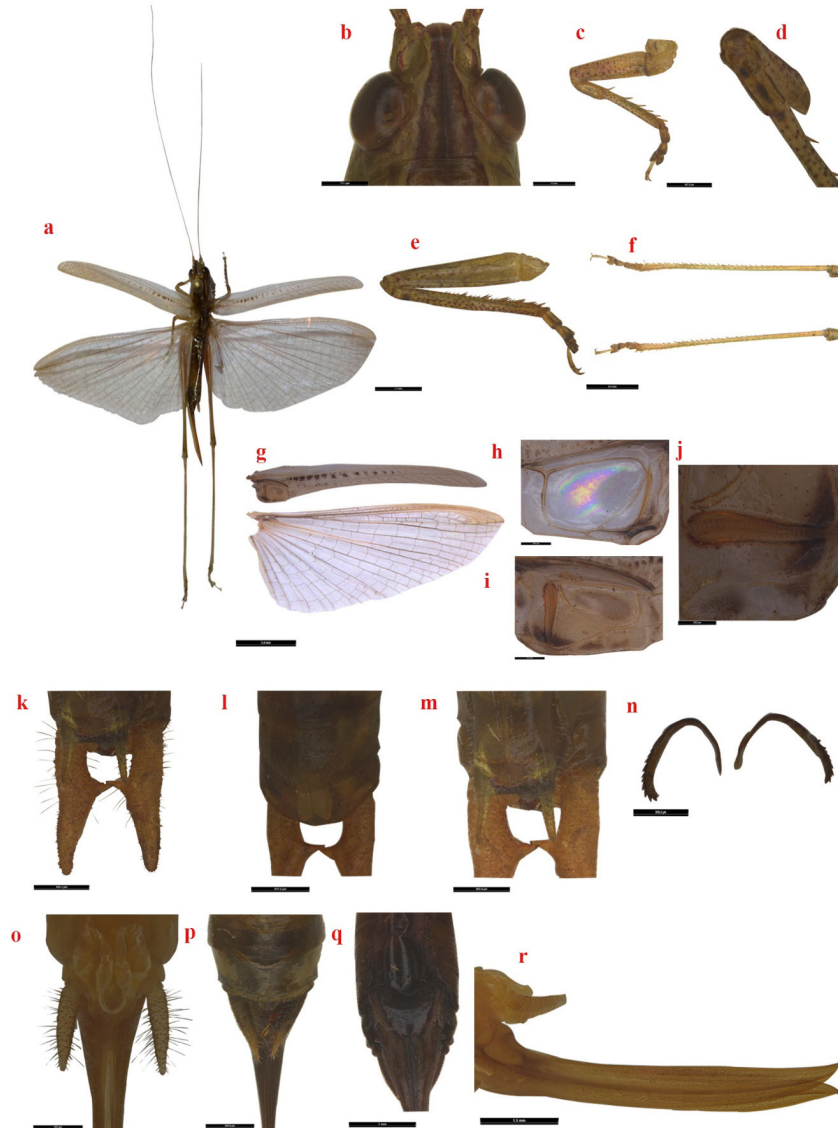
Legs dark pinkish spots of irregular size cover all sides of tibia and femur of all pairs. A yellowish spine present on venter of fore coxae on outer side. Knee lobes of femur roughly round and spinose. Genuiculi lobes of fore femur with one inner spine only and no outer spine,

mid femur with one spine on each side and hind femur with two spines on each side ventrally. Tympanum present on basal first half fore tibia. Tympanum with small pits present on either of the anterior region of fore tibia. Fore- and mid-tibia unarmed dorsally but with six spines each on inner and outer sides of ventrally. Hind tibia with spines along inner (30 numbers) and outer margin (26 numbers) dorsally. Hind tibia with a pair of apical spurs on dorsal side and two pair of apical spurs on ventral side with outer pair longer than inner pair. Tarsus coloured black apically. Basitarsus apical margin nearly straight but not straight in other three tarsomeres. Wings with FW: Yellowish brown with dark veins. Brownish patches (13 to 15 numbers) of irregular size run along radial vein beneath from base to middle remigium. Stridulatory file of left FW with short and evenly spaced teeth (44 numbers). Base of mirror and file in the left FW wider than apex. Right mirror equally wide and long but file not well developed. HW: Wholly hyaline with distal costal and subcostal cell dull brown.

Abdomen having tergites with a middle dull brownish patch across the length throughout. Lateral sides of abdomen appear greenish yellow. Male: Triangular and feebly broadened tenth abdominal tergite with distinct median carina; basal margin of which appear indented. Supra-anal plate broader than long with prominent mid raised ridge and apex not sharp rather weakly flat. Subgenital plate long with visible median carina. Apical lamina subgenitalis with a pair of pubescent stylus bilaterally and a distinct central excision. Cerci pitted with inwardly directed tooth situated just above median region. Tip of the internal tooth coloured black. Paired Ti dark brownish and curved inwardly. Ti. R and Ti. L equally long and spinulate symmetrically. Ti. R feebly bifurcate apically. Both Ti bear 10-11 spines along the outer distal margin. Female: Apex of penultimate tergite rounded with a median excision. Supra-anal plate triangular with a median groove and apical angle obtuse. Sub-genital plate wider than long with feebly triangular excised apex. Ovipositor yellowish basally but slightly become yellowish brown towards apex. Dv longer than ventral valves. Apical Dv more projected into a sharply curved tip beyond apical Vv. Mid to apical region of outer and inner sides of both valves appear pitted and feebly pubescent.

**Measurements:** Male: 13.09-13.39 mm long; head: 18.9-2.19 mm long and 2.53-2.83 mm wide; pronotum: 2.29-2.59 mm long and 2.1-2.4 mm wide; hind leg: 28.97-29.27 mm long; fore wing: 16.66-16.96 mm long; stridulatory file: left: 1.27-1.35 mm long; right: 1.03-1.11 mm long; hind wing: 18.0-18.30 mm long;





Figs. 3a-r: *Conocephalus rentzi* (Farooki and Usmani): Female: a. full view; Male: b. head; c. fore leg; d. tympanum; e. mid leg; f. hind tibia; g. fore and hind wings; h. right mirror and file; i. left mirror and file; j. left stridulatory file; k. cerci; l. supra anal plate; m. sub genital plate; n. male genitalia; Female: o. cerci; p. supra anal plate; q. sub genital plate; r. ovipositor

cerci: 1.48-1.67 mm long. Female: 14.77-15.07 mm long; head: 2.08-2.38 mm long and 2.63-2.93 mm wide; pronotum: 2.11-2.41 mm long and 1.63-1.93 mm wide; hind leg: 28.09-28.39 mm long; fore wing: 16.42-16.72 mm long; hind wing: 18.86-19.16 mm long; cerci: 1.10-1.14 mm long; ovipositor: Dv: 6.86-6.95 mm long; Vv: 6.79-6.84 mm long.

**Materials examined:** 9 specimens: Tamil Nadu, Coimbatore (11°00'09"N, 76°55'33"E; 10°59'44"N, 76°54'59"E, 417 masl): 6♂ (17.02.2021; 04.03.2021; 16.03.2021), 3♀ (29.12.2020; 17.02.2021), 5 specimens: Tamil Nadu, Erode, Bhavanisagar (11°28'40"N 77°08'32"E; 11°28'59"N, 77°08'22"

E; 11°28'51"N, 77°07'43"E, 256 masl): 2♂ and 3♀ (09.04.2021), leg. Dharini S V.

**Distribution:** Uttar Pradesh, India (Farooki and Usmani, 2018).

**Comments:** *C. rentzi* closely resembles *C. maculatus*. This is the first record of this species on rice. However, functional role of this species remains to be studied.

*Conocephalus* spp. have been documented both as predators and pests in rice crop (Pitkin, 1980). Deep insight focusing on functional significance of

*Conocephalus* spp., might pave way for evolving as a potential biocontrol agent on serious rice pests.

#### ACKNOWLEDGEMENTS

The help rendered by labmates of Insect Biosystematics laboratory of TNAU Insect Museum viz. Mr R K Balaji, Mr N Dilipsundar, Ms R Divya and Mr M Arunkumar is acknowledged.

#### FINANCIAL SUPPORT

The research is a part of Master's programme of the first author with no funding from public, commercial, or not-for-profit sectors.

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(Manuscript Received: October, 2021; Revised: March, 2022;

Accepted: March, 2022; Online Published: April, 2022)

Online First in [www.entosocindia.org](http://www.entosocindia.org) and [indianentomology.org](http://indianentomology.org) Ref. No. e21227