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A Review of the Tettigoniidae Krauss, 1902 (Tettigonioidea: Ensifera: Orthoptera) with a New Species from Pakistan

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Abstract: The Tettigoniidae commonly known as katydids or bush crickets (Ensifera: Orthoptera) is reviewed, with five genera and twelve species viz: *Trigonocorypha unicolor* Stal 1873, *T. angustata* Uvarov 1922, *Phaneroptera spinosa* Bei-Beienko 1965, *P. roseata* Walker 1869, *P. bivittata* Be-Bienko 1954, *P. gracilis* Burmeister 1838, *Holochlora japonica* Brunner von Wattenwyl 1878, *H. venosa* Stal 1873, *H. nigrotympana* Ingrisch 1990, *Ducetia japonica* Thunberg 1815, *Letana bulbosa* Ingrisch 1990 including one new species *Holochlora?* Sp. nov. The distribution records of species within various districts of Sindh Pakistan are augmented. Modified taxonomic keys to the various genera and species of Tettigoniidae occurring in Sindh Pakistan are provided. Intraspecific variation within nominal species is discussed.

Key words: Tettigoniidae, Pakistan, new species, *Holochlora*, taxonomic keys.

1. Introduction

Family Tettigoniidae was established by Krauss, 1902, Eades *et al*. [1] reported Tettigoniidae as the largest family of Order Orthoptera that consists of worldwide distributed species. It is well known as katydids or bush crickets mostly are terrestrial, herbivorous, carnivorous, and omnivorous in nature. Varieties of crops and rangeland plants are affected by this. In Australia, Asia, and Africa, meadow katydids of the genus *Conocephalus* can build in numbers and move in large swarms. On a local level, many species cause damage to rice and crops time to time [2]. Rentz [3] reported that there are about 20 subfamilies in Tettigoniodea, which are placed in one family Tettigoniidae while Gorochov [4, 5] suggests that it should be placed in 5 families of Tettigonioidea. He also provides information on the geographic distribution, development, and stridulation of Conocephalinae species. Ingrisch and Shihodia [6] carried out a detailed study on the phylogeny, biogeography, and stridulation behaviour of Oriental Agraeciini. He traced the sister-group relationship of the various tribes of Conocephalinae and Agraeciini, while phylogenies including behavioral characters favor the view of independent evolution of the stridulatory apparatus in Grylloidea and Tettigoniioidea Gwynne [7] and Desutter-Grandcolas [8]. Baily [9] reviewed the tribe Copiphoini and studied their relationship to the Indo-Pacific species classified along with its distribution patterns in detail. Wagan and Kevan [10] studied the 17 genera of Tettigoniodiae of Indo-Pak and Sri-Lanka. They reported two new species i.e. *Potuaaptera*? and *Bolivaritettixnathani*. Wagan and Kevan [10] gave description and re-description of many known species. Ragge [11] did not propose any tribal classification in his review of African Phaneropteranae while Gorochov and Kang [12] studied Chinese genera of Ducetiini and discussed the close relationship of genera to Elimaeni based on the possession of an additional stridulatory area. Nagy [13] reported that species of Phaneropterinae are long-winged Thermophilous bush crickets and able to colonise new sites quickly. They also occupy a wide variety of open habitats from

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Xerothermic to wetland including ruderal habitats but usually it occurs in tall herb or lower shrubby vegetation everywhere. Tilmans [14] studied the Euphilideptera and stated that it is a relatively large genus with 45 currently recognized species.

NIBR [15] and Storozhenko *et al.* [16] reported 47 species from South Korea. Bailey [17] observed sound production in Tettigoniids for sexual communication. Guo *et al.* [18], Kim *et al.* [19] and Heller *et al.* [20] surveyed the taxonomic status of Tettigoniids, classified Tettigoniidae species based on morphological characteristics, and developed a sound pattern used by the male Tettigoniidae for the attraction of females for sexual response. However, the information available so far for this part of the world was insufficient with exception of Riffat *et al.* [21]. It was therefore necessary to revise this family from this region. Further, taxonomic key illustrations, based on morphological characters, are presented. However, bionomics and ecological accounts have also been briefly discussed. In this manuscript, we offered twelve species with addition of one new entry from Pakistan and it assures that this data might be helpful in filling certain gaps in Tettigoniidae fauna of Pakistan and will bring knowledge up to date.

2. Material and Methods

2.1 Killing of Samples

All the specimens were collected from the different agriculture crops of various districts of Sindh. Material was brought to Entomology and Bio-control Research Laboratory (EBCRL), Department of Zoology, University of Sindh, Jamshoro. Method for killing was adapted from Vickery and Kevan [22] and Riffat and Wagan [23] with slight modifications. Specimens were killed by using potassium cyanide or chloroform in standard entomological killing bottles for 5-10 min. Samples were not left too long because the color of the specimen could be changed.

2.2 Pinning and Stretching of Specimens

Pinning of samples was done quickly after killing. Insect's pin was inserted on the pronotum posterior to transverse sulcus slightly to the right of median carina. Head was directed slightly downwards on the stretching board. Left wings were set with the long axis of the body nearly at the right angle to the pin. Posterior legs were bent beneath the body to minimize the possibility of breaking and to occupy the small area. The abdomen was dropped below the wings and not obscured by the hind legs.

2.3 Preservation and Identification

Fully dry insects were preserved in insect cabinet with labels showing collection date, habitat, locality, and collector name. Naphthalene balls ($C_{10}H_8$) were placed in boxes to prevent the attack of ants and other insects. Specimens were identified through bibliographies given by Riffat and Wagan [23] or orthoptera species file (OSF) by Cigliano *et al.* [24] was consulted.

2.4 Line Drawing and Photography

Photographs of the various species were prepared. Line drawing was made with Camera Lucida fitted on microscope and this improved with the help of software Adobe illustrator CC-2015.

2.5 Morphometry of Samples

Measurement of various body parts was calculated in millimeters (mm) through Ocular graph, compass, divider, and the scale.

2.6 Mapping/Geo-Referencing

Species distribution was mapped using the localities provided in the literature and available specimens. Latitude and longitude information for available sites was also complied. Geo-referencing maps for individual species were also provided by using Google Earth Pro (7.3.0.3832-32-bit).

2.7 Depository

Sindh Entomological Museum, Department of Zoology, University of Sindh, Jamshoro, Pakistan.

3. Results

Family Tettigoniidae

Subfamily Phaneropterinae

Tribe Trigonocoryphini

Genus *Trigonocorypha* Stål, 1873

1. *Trigonocorypha unicolor* Stoll, 1787

(Figs. 1-7; Tables 1-4)

Gryllus (*Tettigonia*) *unicolor* Stoll, C. 1787:7818;

Steirodon unicolor Serville, 1838: 1-14;

Trigonocorypha crenulate Brunner von Wattenwyl. 1878: 357;

Trigonocorypha unicolor (Stoll, 1787); Kirby, W. F. 1906: 448.

Diagnosis

Body is large and the color is green. Fastigium inverted below, triangular, and wide posteriorly than antennal pedicel and pointed anteriorly near the frontal apex, upper side had grooves. Eyes broad, oval, and slightly bulging were outward. Pronotum flat and had slightly concave disc, rounded posteriorly, lateral lobes flat and vertical, and form distinct angle with disc, humeral notch slightly deep and sharp. Tegmina densely compact leathered and widened at the middle anteriorly. Wings larger than the tegmina and had transparent veins. All femora almost flat at the lower side and had inconspicuous grooves. Fore-coxae had small spinules, both tympanal openings oval, membranous and outward. Mid-tibiae had spinules on inner margin. Hind femora contained spinules on lower side of both margins. Cerci in male elongated and curved, whereas cerci in female small with tiny hair, ovipositor short, flattened, and fine serration on upper and lower apical margin.

Material examined: SINDH, 6♂s and 27♀s Jamshoro 25.4304° N, 68.2809° E; 4♂s, 18♀s Dadu 26.7341° N, 67.7795° E; 1♂ 7♀s Sehwan 26.4122° N, 67.8629° E; 4♂s, 15♀s Matiari 25.5922° N, 68.4442° E; 3♂, 24♀s Hyderabad 25.3960° N, 68.3578° E; 5♂s, 12♀s Naushahro Feroze 26.8463° N, 68.1253° E.

Phenology

Trigonocorypha unicolor was widely distributed in the field. Hopper appeared in mid-July and became adults in mid-August to October. The peak period was observed from August to October and declination in population was seen in November to December. The useful plants affected by this species are: *Oryza sativa* (rice), *Tritium aestivum* (wheat), *Sacharum officinarium* (sugarcane), *Medicago sativa* (Lucerne) and *Dactyloctenium aegyptium* (common lawn grass).

Global Distribution

India, Sri-Lanka, Pakistan, Afghanistan, Iran.

Discussion

T. unicolor was reported for first time from the different localities of Sindh. It was entirely seen different from other species based on its typical structure of pronotum. It spent a long time of day at thick vegetation of trees and shrub leaves; its favorable time for reproduction and other activities was at nighttime. *T. unicolor* species was fully active at nighttime. Earlier, it was also reported by Riffat *et al.* [25] from Jamshoro. During present investigations we have confirmed its dominant status at locality level.

2. *Trigonocorypha angustata* Uvarov, 1922

(Figs. 1-7; Tables 1-4)

Trigonocorypha angustata Uvarov, 1922:7833

Trigonocorypha angustata Bey-Bienko, 1954: 99

Diagnosis

Its body is green and yellowish green. Fastigium triangular shape and middle sulcus deep and wide and anterior margin slightly sinuate. Pronotum is flat anteriorly and concave posteriorly. Tegmen is much larger than hind knees of hind femora and had pale band at basal part and widened posteriorly, maximum width slightly exceed than pronotal length. Wings are larger than tegmen. Outer margin of fore tibiae had only apical spines and usually spines were adjacent to the tympanal organs. On the contrary, there were several small spines at inner margin on lower side. Male last abdominal tergite had small nick at outer side. Male cerci slightly curved, and is narrow at apical part. It reached the apex of sub-genital plate. Female cerci also bend, conical posteriorly and narrow slightly at inner side.

Material examined: SINDH, 3♂s, 10♀s Jamshoro 25.4304° N, 68.2809° E; 1♂ Dadu 26.7341° N, 67.7795° E; 2♀s Matiari 25.5922° N, 68.4442° E; 2♂s, 5♀s Hyderabad 25.3960° N, 68.3578° E; 3♀s Naushahro Feroze 26.8463° N, 68.1253° E; 1♀ Moro 26.6684° N, 67.9941° E.

Phenology

Hopper emerged in month of July and adult showed their presence from August to September. The abundance in their numbers was seen from August to October and a less number were in November to December. Plants affected by this species were *Sorghum vulgare* (jowar), *Oryza sativa* (rice), *Poa annua* (meadow grass), *Sesbania bispinosa* (sesbania), *Helianthus annus* (sunflower) and *Malus domestica trees* (apple).

Global Distribution

Iraq, India, Pakistan.

Discussion

Trigonocorypha angustata is smaller in size, it was quite possible that our specimens could be the subspecies or species, but at this stage we are confused because we did not see the holotype. Therefore, we could not separate this specie as sub-species or species. This specie was first time described by Uvarov [26] and he found a single female from Persian Gulf, while Bei-Bienko [27] found 2 males and 1 female from Southern Iran. Furthermore, he also described that *T. angustata* had much narrow tegmina along with a slight notch beyond the middle of anterior margin. However, earlier Riffat *et al.* [25] reported less numbers of this species from Jamshoro. Presently we have also reported few samples which confirmed its presence at district levels of Sindh.

Tribe Phaneropterini

Genus *Phaneroptera* Serville, 1831

3. *Phaneroptera spinosa*, Bei-Beienko, 1965

(Figs. 1-7; Tables 1-4)

Phaneroptera gracilis spinosa Stolyarov, 2005: 8125

Phaneroptera spinosa Bey-Bienko. 1954: 8124

Diagnosis

Its body is green yellowish in color with reddish-brown dots; its fastigium is with slightly deep, narrow, and acute groove. Pronotum usually had pale vague lateral band and clear moderate cylindrical convex apical part in the anterior two-third part, but flat in posterior third part. Tegmina ended a short distance before reaching the hind femoral apices. Left tegmina of male had stridulatory organ not exposing out beyond the tegminal margin. Tegmina is brownish and distal margin also brownish yellow without dots. Wings are brownish pink in color and had longitudinal veins. Supra-anal plate in male is small, square, and slightly rounded at the posterior margin and situated between cercal bases. Cerci in female are thin and long as to the length of basal width of ovipositor, whereas cerci in male long and wholly arched, but not flapped. Ovipositor wide, upper margin curved basally.

Material examined: SINDH, 6♂s, 17♀s Jamshoro 25.4304° N, 68.2809° E; 3♂s, 13♀s Dadu 26.7341° N, 67.7795° E; 2♀s Sehwan 26.4122° N, 67.8629° E; 2♂s, 9♀s Matiari 25.5922° N, 68.4442° E; 7♂s, 23♀s Hyderabad 25.3960° N, 68.3578° E; 2♂s, 4♀s Naushahro Feroze 26.8463° N, 68.1253° E; 3♀s Moro 26.6684° N, 67.9941° E.

Phenology

This species was abundantly found in different fields. Their hopper could be seen during the month of July while adults in August to October this period considered its peak period. Decline in numbers was noticed from November to December. Different plants i.e. *Cynadondactylon* (Common lawn grass), *Helianthus annus* (Sunflower), *Oryza sativa* (Rice), *Penicumtergidum* (Grasses), *Echinochloa colonum* (Cultivated field) are affected by this species.

Global Distribution

India and Pakistan.

Discussion

It is large, but closely resembled with *P. roseata.* It is abundantly found in different localities of Sindh. The large number of collection of this species from different sites of Sindh confirmed its dominant status in entire

region. Their favorite host plants are: *Medicago sativa Lucerne* (Grass) and *Dactyloctenium aegyptium.* Previously this species had been reported by Riffat *et al.* [25]. Currently we have captured its fair numbers.

4. *Phaneroptera roseate* Walker, 1869

(Figs. 1-7; Tables 1-4)

Phaneroptera gracilis (Ragge, 1956: 250); Ragge, 1968: 92

Phaneroptera roseate Walker, 1869: 8111

Diagnosis

Its body is green with a few reddish-brown dots and medium sized. Antennae pale is yellow in color. Fastigium is narrow. Pronotum is entirely flat, but usually cylindrical at apical part and rounded posteriorly. Fore-wings had angle along the pronotal apex with rudimentary ridges immediate after the humeral notches. Hind wings were brownish at basal and green at tip and had transparent veins. Tegmina was green and had faint intracellular brownish dots and went beyond the hind femoral apices. Male stridulatory organ had dark base and small apical spots and did not expose out to the posterior tegminal margin. Subgenital plate in male had parallel margins. Female ovipositor curved in shape. Male supra-anal plate was large and quadrangular, it covered the cercal base at anterior, thick, and rectangular notch at posterior, bent upward at lateral margin. Male cerci were much thinner than the second antennal segment that was wide and flattened at outer margin.

Material examined: SINDH, 1♂s, 4♀s Jamshoro 25.4304° N, 68.2809° E, 2♂s, 9♀s Dadu 26.7341° N, 67.7795° E; 3♂s, 18♀s Matiari 25.5922° N, 68.4442° E; 5♂s, 29♀s Hyderabad 25.3960° N, 68.3578° E; 3♂s, 9♀s Naushahro Feroze 26.8463° N, 68.1253° E.

Phenology

Phaneroptera roseata young appeared in July and adults could be seen from August to October. Its increased number was found in from August to September and declination in their number was noticed in November to December. This species affected the following plants: *Cynadon dactylon* (common lawn grass), *Helianthus annus* (sunflower), *Oryza sativa* (rice), *Penicumtergidum* (grasses), *Echinochloa colonum* (cultivated field), *Vitis vinifera* (grapevine), *Medicago sativa* (lucerne) and *Dactyloctenium aegyptium* (common lawn grass).

Global Distribution

India, Pakistan.

Discussion

Presently fair number was collected from different localities of Sindh. These findings suggest that *P. roseate* is the pest of different fruits and vegetation. During the present study, a greater number of plants such as *Cynadondactylon*, *Helianthus annus*, *Oryza sativa* and *Vitis vinifera* were affected. Further, many valuable fruits like berry, herb, shrubs, and fruit orchards were also affected.

***5. Phaneroptera bivittata* Be-Bienko, 1954**

(Figs. 1-7; Tables 1-4)

Phaneroptera bivittate Ragge, 1956: 237

Phaneroptera bivittate Garai, 2002: 431-447

Phaneroptera bivittate Bey-Bienko, 1954: 8209

Diagnosis

Its body was medium, delicate pale in coloration when dried. Head was small with measuring up to 3 mm. Fastigium slightly widened usually, having longitudinal groove reaching the anterior margin. Antennae pale was brown in color; eyes were black. Pronotum is scattered reddish spots, usually small, with pale or without paler longitudinal band, in the two third with moderately convex apex, almost cylindrical in posterior third flat, lateral lobes of equal length and height, joined slightly rounded with apex. Posterior margin arcuately truncate and lower margin distinctly truncate. Distal part of tegmen of same basal width as the height of stridulatory organ, semi-transparent, with irregular venation, distally gradually tapering, transparent not darkened with regular transverse veins. Wings were transparent, with brown major longitudinal veins. Male cerci were thin, strongly arcuate, moderately conical in basal half, cylindrical distally, with slightly flattened apical part

which gradually narrows to straight, flat elongate apical spine which is not quite black at apex.

Material examined: SINDH, 4♀s Jamshoro 25.4304° N, 68.2809° E; 1♂, 6♀s Dadu 26.7341° N, 67.7795° E; 2♀s Matiari 25.5922° N, 68.4442° E; 4♂s, 12♀s Hyderabad 25.3960° N, 68.3578° E; 1♂, 8♀s Naushahro Feroze 26.8463° N, 68.1253 E.

Phenology

During the field survey *Phaneroptera bivittata* has been collected from the *Poa tenella*. However, *Sorghum vulgare*, *Poaannua*, *Malusdomestica*, *Oryza sativa* and *Helianthus annus* were also seen in field.

Global Distribution

Iran, Jordan, Palestine, Iberian Peninsula, East Africa, India, Pakistan.

Discussion

It differs from *Phaneroptera tenicerca* Ramme by the absence of marked apical constriction in the cerci of male. The material at hand differs from Bei-Bienko [27] description in size of pronotum, tegmen, femur and total body length. He reported 7♂s from Araks valley in Southern Armenia and Southern Nakhicheran Autonomous S.S.R, Kopet-Dag, Turkhmenistan. At present, we ensure that its range can be extended to the other localities of Sindh if further surveys are planned.

6. *Phaneroptera gracilis* Burmeister, 1838

(Figs. 1-7; Tables 1-4)

Phaneroptera subnotata Brunner von Wattenwyl. 1878: 216

Anerota gracilis Hebard. 1922: 501785

Phaneroptera (*Phaneroptera*) *gracilis* Shishodia, K. Chandra and S. K. Gupta. 2010: 312

Phaneroptera (*Phaneroptera*) *gracilis gracilis* Kim, T.-W. and Hong Thai Pham. 2014: 74

Phaneroptera gracilis Burmeister, H. 1838: 8101

Diagnosis

Its body was medium, greenish yellow. Dorsal side of pronotum was uneven with a V-Shaped with slightly. Concave from dorsal margin lateral lobes of pronotum longer than high. Tegmina and wings were well developed having almost coriaceous, with slightly prominent secondary veins, marginal area of elytra is equally reticulated and having same color as the other parts of elytra. Fore coxa was armed with many minutes' distinct spine. Supra-anal was plate with round apex. Cerci were thin, longer from basal width of ovipositor. Subgenital plate was elongated, triangular, with rounded apex. Ovipositor sickle-shaped slightly up turned with fine rounded teeth on the entire dorsal margin and apical part of ventral margin. Genicular lobes of all femora were armed by bispinous. All femora were unarmed dorsally. Tympanum on fore tibia opened on both sides.

Material examined: SINDH, 2♂s, 1♀ Jamshoro 25.4304° N, 68.2809° E; 2♀s Dadu 26.7341° N, 67.7795° E; 1♀ Sehwan 26.4122° N, 67.8629° E; 1♂, 5♀s Matiari 25.5922° N, 68.4442° E; 5♂s, 14♀s Hyderabad 25.3960° N, 68.3578° E; 6♂s, 7♀s Naushahro Feroze 26.8463° N, 68.1253° E; 2♂s, 1♀ Moro 26.6684° N, 67.9941° E.

Phenology

Our information based on the material which was collected from *Vinca rosea* locally terms SadaBahar plant which is evergreen shrub that is not only famous as ornamental plant, but it also has medicinal value. It is noteworthy insects vigorously feed on leaves and flowers of this plant. Present study recommends that if more surveys would be conducted in other areas its host plant range could be extended more.

Global Distribution

Africa, India, Palestine, Annam, Australia, Celebes, China, Malaysia, Maldives, Islands, Myanmar, Sri-Lanka, Sumba islands, Pakistan.

Discussion

The illustration in the report shows that this species is very closely related to *P. spinosa* but differs in the shape of subgenital plate and tegmina in the present specimen tegmina having almost coriaceous, with slightly prominent secondary veins, marginal area of elytra is equally reticulated while in *P. spinosa* tegmina terminates a short distance narrowing moderately apically with dense irregular venation.

Kristin *et al.* [28] collected 3 specimens of this species from Romanian regardless of the description of sexes. More recent, Farooqi and Usmani [29] collected fair number of male and female from different states of India and declared this as major pest of flowering plants. Kim and Pham [30] also reported this species from the Vietnam. At the present, we are hopeful in future when survey range would be extended its fair numbers are expected.

Tribe Holochlorini

Genus *Holochlora* Stål, 1873

7. *Holochlora japonica* Brunner Von Wattenwyl, 1878

(Figs. 1-7; Tables 1-4)

Holochlora japonica Brunner von Wattenwyl, 1891: 91

Holochlora japonica Brunner Von Wattenwyl, 1878: 9040

Diagnosis

Its body is green and moderately large. Eyes are broad and oval. Pronotum is thick at anterior, little flat at posterior having extra transverse groove and bending roundly downward at lateral side of disc, pronotum high in length at posterior margin. Antennae is yellowish brown and dark shades at apex. Space between protruding margins of antennal sockets was less than 2nd antennal joint. Sub ocular distance is like the vertical diameter. Female abdominal (tegminal) tergite is large and has slightly deep longitudinal groove at the middle. Ovipositor has dark apex and sharp black serrate lines at lateral side. Female cerci has little tapering to a pointed apex and curved.

Material examined: SINDH, 3♂s, 9♀s Jamshoro 25.4304° N, 68.2809° E; 2♂s, 5♀s Dadu 26.7341° N, 67.7795° E; 1♂s, 2♀s Sehwan 26.4122° N, 67.8629° E; 4♂s, 11♀s Matiari 25.5922° N, 68.4442° E; 3♂s, 21♀s Hyderabad 25.3960° N, 68.3578° E; 1♂, 5♀ Naushahro Feroze 26.8463° N, 68.1253° E; 1♂, 1♀ Moro 26.6684° N, 67.9941° E.

Phenology

Holochlora japonica was found in ample, their young emerged in July and adults appeared from mid-August to October. The large number of this could be seen between August and September and decrease in November to December. The plants affected by this species were *Cynadon dactylon* (Common lawn grass), *Helianthus annus* (Sunflower), *Oryza sativa* (Rice), *Penicumtergidum* (Grasses) and *Echinochloacolonum* (Cultivated field).

Global Distribution

Afghanistan, India, Japan, Pakistan.

Discussion

Our collected material had very close similarities with the description of Bei-Bienko [27] with expectation of its body size this is smaller in size. Present study recommends that when more material is in our hands it will offer some more authentic characters to confirm its siblings or non-siblings' status. Earlier, Zacher [31] and Bei-Bienko [32] reported that *H. japonica* is a sever pest of citrus in Japan and Taiwan, while Tomizawa [33] stated that it also damaged the mulberry cultures. At present we collected specimens from agricultural crops of Sindh which had thick vegetations.

8. *Holochloravenosa* Stal, 1873

(Figs. 1-7; Tables 1-4)

Holochlora venosa Brunner von Wattenwyl. 1878: 178

Holochlora venosa Stål. 1873: 9009

Diagnosis

Its body is medium to large, green, eyes wider, Antennae brownish-rusty of brownish yellow in color. Pronotum slightly thickened in anterior without lateral carina; transverse sulcus "V shaped". Anterior margin was approximately straight, posterior margin obtusely rounded. Lateral lobes of pronotum were higher than long. Femur has ventro internal spinules, middle femur with ventro external spinules, posterior femur with internal and external spines. Tegmina had costal veins sharp, straight edged by line. *H. venosa*lateral view of apex of abdomen was greatly enlarged. Cerci short slightly curved, uneven. Subgenital plate is triangular;

ovipositor robust, wide, lateral surface with transverse convex fold at base, with sharp dark serration.

Material examined: SINDH, 2♂s, 7♀s Jamshoro 25.4304° N, 68.2809° E; 1♂, 12♀s Dadu 26.7341° N, 67.7795° E; 2♂s, 3♀s Sehwan 26.4122° N, 67.8629° E; 6♂s, 18♀s Matiari 25.5922° N, 68.4442° E; 4♂s, 7♀s Hyderabad 25.3960° N, 68.3578° E; 2♂s, 6♀s Naushahro Feroze 26.8463° N, 68.1253° E; 2♀s Moro 26.6684° N, 67.9941° E.

Phenology

Holochloravenosa was collected from the *Sorghum vulgare* crop surrounded by different grasses i-e. *Penicumtergidum*, *Dactyloctenium aegyptium* and *Demostachya bipinnata*. This species is reported as a serious pest of citrus and mulberry in Japan and Taiwan by Bei-Bienko [32]. During the present survey we have found that these species live among shrubs and are attracted towards light in dark.

Global Distribution

Korea, India, China, Japan, Vitenam, Ceylon, Taiwan, Island, Pakistan.

Discussion

Stal (1873) established the genus *Holochlora* based on structure of subgenital plate, male cerci, and wing venation. Earlier, Brunner [34] gave detailed description of male of *H. venosa*from British straits. At present, we have reported a number of specimens of this species from different localities of Sindh. The specimens in our hand are greater in size compared with the measurements of Brunner [34]. He reported body length 19 mm, pronotum 5.8 mm, tegmina 33 mm and femur 24 mm. During present study, we have noted maximum length i.e. 25 mm. Present study recommends that, it might be due to geographical variation and species feeding on energetic host plants.

9. *Holochloranigrotympana* Ingrisch, 1990

(Figs. 1-7; Tables 1-4)

Holochlora semirotunda Xia, K.-L. and X.-W. Liu. 1990: 9028

Holochlora nigrotympana Liu, Chunxiang, X.-W. Liu and L. Kang. 2008: 230

Holochlora nigrotympana (Ingrisch, 1990); 1989: 9027

Diagnosis

The body is green, small to medium in size. Eyes are dark brown. Pronotum is dorsally flattened without conspicuous notch. Tegmina is fully developed, broader in the middle and slenderer near apex, with costa bordered by dark brown line. Radius branched off slightly before middle of tegmina, radius sector base with three more oblique veins, anterior tibiae with inner tympanum and above black tympanum. Cerci short, concealed by 10th abdominal tergum; subgenital plate split into two sheets like lobes from quarter.

Material examined: SINDH, 1♂, 11♀s Jamshoro 25.4304° N, 68.2809° E; 3♀ Dadu 26.7341° N, 67.7795° E; 1♂, 6♀ Sehwan 26.4122° N, 67.8629° E; 2♂s, 7♀s Matiari 25.5922° N, 68.4442° E; 9♂s, 11♀s Hyderabad 25.3960° N, 68.3578° E; 1♂, 3♀s Naushahro Feroze 26.8463° N, 68.1253° E; 1♂ Moro 26.6684° N, 67.9941° E.

Phenology

This species has been sampled from the rice field surrounded with grasses and shrubs. It was observed that insects vigorously feed upon the apical parts of the plants. It may cause severe damage to the cultivated fields if its population increases in numbers.

Global Distribution

Central Thailand, India, China, Bhutan, Pakistan.

Discussion

H. nigrotympana was described by Ingrisch [35] from Central Thailand. The specimens at our hand are differing slightly by the shape of the male tenth abdominal tergite which is gradually sloping to the apex (without step-like declination), the pre apico-ventral projection is stouter and pointing. However, the rest of the characters are similar with description given by Ingrisch [35]. From Thailand Heller *et al.* [36] studied that number of stridulatory pegs present on *H. nigrotympana*. Ingrisch [37] reported 2 males from Bhutan. At present, we have collected a large number of specimens from most cultivated crops of Sindh,

Pakistan. Optimistically, further surveys in this area will fill this deficiency and will offer more authentic characters for better understanding of this taxa.

10. *Holochlora*? Sp. nov.

(Figs. 1-7; Tables 1-4)

Diagnosis

This species is very closely related to *Holocholora japonica.* In this new specimen the fastigium of vertex pointed, is narrow and triangular shaped. Pronotum flat, eyes oval and bulging outside whereas in *H. japonica* pronotum is slightly thicker at the anterior half, lateral side of disc bending roundly downward. In this species cerci long, narrow and pointed whereas *H. japonica*it is slightly curved, uneven, gradually tapering. Tibia is larger than femur and it has small several spines run throughout the surface of tibia. Sharp black spines are present on both sides. Tarsus is yellowish green with black outer margins. Four black spines present between the joint of tibia and tarsus. Ovipositor is large, flattened, and curved. Anterior genital plate is wider and elongated. Ovipositor is long with zigzag lines. The suture makes an ovipositor as a double line structure in shape. Cerci are long, narrow and pointed with small hair line. Projections are throughout the surface. In this species ovipositor is large, flattened and curved while in the *H. japonica ovipositor* with darkened apex, upper valve with sharp black serrate line on the lateral surface.

Description of Female

It is large and graceful. Head is small, fastigium of vertex pointed narrow and triangular. Eyes are oval, pronotum flat and dome-shaped at the lateral side that makes a small cessation between lateral and dorsal side. Tegmen with yellowish green. It has a small number of black spots that are present at lower side of the tegmina. Femur is large, narrow with numerous white spots at the basal anterior part joint between femur and tibia is black with large white spot on this.

Morphometry: ♀ (*n* = 1) LH 0.35 mm, LP 0.5 mm, LT 23 mm, LF 23 mm, LT 24 mm, LT 0.3 mm, TBL 27 mm.

Note: ♂ not found.

Material examined: Sindh: Hyderabad holotype: 1♀ 2020.viii.3 (Surriya and Riffat).

Habitat

This specimen was collected from *Azadirachta indica*, *A. juss* commonly known as Neem near Hyderabad (25.3960° N, 68.3578° E).

Depository

The type-material (TN: 638 SEM) has been deposited in Sindh Entomological Museum, Department of Zoology, University of Sindh, Jamshoro.

Distribution

Pakistan Sindh Hyderabad, its presence in Sindh has been geo-referenced by using Google Earth Pro (7.3.0.3832-32-bit).

Discussion

The pronotum and ovipositor of this species exhibit a unique feature with the rest of the *Holochlora* species. At present we have single female. So, we hesitate to declare whether this is new species or subspecies until the male is described and DNA barcoding of species is done.

Tribe Ducetiini

Genus *Ducetia* Stål, 1874

11. *Ducetia japonica* Thunberg, 1815

(Figs. 1-7; Tables 1-4)

Locusta japonica Thunberg. 1815: 9937

Ducetia japonica Stål. 1874: 9936

Ducetia thymifolia Kirby, W.F., 1906: 398

Phasgonura japonica Furukawa, 1929: 175

Ducetia japonica Thunberg, 1815: 497355

Diagnosis

Body small, grey, brown, antenna has a light color, fastigium of vertex pointed, moving downward and slightly long and slender with pointed ends at the posterior side. Pronotum had brown bands with green sides anteriorly, pronotum had upright median grooves and clearly seen longitudinal carinae that make folds over the lower margin. Tegmina tapered at the apical part, the radial and median part had very

thin cross lines and space between the lines can be seen clearly. Hind wings rusty that have slightly light brown color, its anterior margin is very straight and had no strong arched shape area apically. Small spinules present on fore coxae but, hind femora had strong, fine, and large spinules at the lower margin. Cerci in male longer than female but, in female longer than width of median length of ovipositor, upper margin of ovipositor fully concave, moving inward at the basal half part but retains the strong, upright, and straight serration at the apical half part, it had small folds laterally along a sparse papilla that extruded aslant backside and at the base of ovipositor there was small tubercle. Femur had 11 to 13 short spines whereas, these differ in number on tibia, it had 36 to 38 spinules. Subgenital plate in female small whereas, long, narrow and had two lobes that were adjacent to each other and fully divided into deep lobes. Subgenital plate had deep bent at the upper part. Cerci in male resembled of poleaxe apically. Tegmina slightly tapered up to the apex. Cerci in male wide basally and has hair like spines and pointed at apex. Ovipositor well developed, elongated posteriorly and pointed upward basally and it retained fine serrations at the half length of ovipositor.

Material examined: SINDH, Jamshoro (25.4304° N, 68.2809° E); 1♂ 2020.xi.6 2♀s, Hyderabad (25.3960° N, 68.3578° E) 4♀s 2020.xi.13.

Phenology

The hopper appeared during the month of July, and adults could be seen from August to October. The increase in their number was observed in August to October and decrease in their numbers was noticed in November to December. *Oryza sativa* (rice), *Tritium aestivum* (wheat), *Sorghum vulgare* (sorghum/jowar) were affected by this.

Global Distribution

India, Japan, Pakistan.

Discussion

This species was first time reported from Hyderabad and its adjoining areas of Jamshoro, Sindh. The material that we collected had generally the same description that was given by the Bei-Bienko [27]. The only difference was noticed in their tegmina which was about 2 mm shorter than the species character suggested by Bei-Bienko [27] and he recorded this species from China, Szechwan provinces and Korea whereas this species was also recorded by the Willemse [38] from Philippines, Indo-China, Bengal, Taiwan, and some parts of India. Before our work Garai [39] recorded this species from northern areas of Pakistan. Presently, we have collected few numbers but more material in future will offer further descriptions.

Tribe Letanini

Genus *Letana* Walker, 1869

12. *Letana bulbosa,* Ingrisch, 1990

(Figs. 1-7; Tables 1-4)

Letana bulbosa Ingrischand Shishodia. 2000: 16

Letana bulbosa Ingrisch, 1990: 12242

Diagnosis

Body small to medium size and green in color. Antenna also green and light annulations but, darker at the peak. Pronotum expanded. Stridulatory file small, semi-spherical and slightly curved basally, it has an area of almost 1.5 mm long; it is narrow in width. Tergite not projected out, but 9th tergum pointed and tapering posteriorly. Apex slightly pointed and concave, lateral margins of supranal plate merged with compressed surface downward and its apex slightly truncate. Cerci short in male, slightly straight posteriorly, curved basally and raised black and brown spots basally, at the half basal the internal margins of cerci had small black or brown spots. Subgenital plate had lateral lobes and its apical part slightly wide at apex, elongated, sclerite black color phallus and no shape, tip tapering and free and base bifurcated.

Material examined: SINDH, 1♂, 4♀s Jamshoro 25.4304° N, 68.2809° E; 2♀s Matiari 25.5922° N, 68.4442° E; 3♀s Hyderabad 25.3960° N, 68.3578° E.

Phenology

This species is widely distributed in different areas of Sindh. Hopper emerged during the month of July

and adults appeared from August to October. The abundance in their number was noticed from August to September, and declination occurred in their number from November to December. Plants affected by this species were *Pinnuswallichiana* (Pine trees), *Azadirachta indica* (Neem tree) and *Penicumtergidum* (Grasses).

Global Distribution

India and Pakistan.

Discussion

The holotype of *L. bulbosa* was reported from India by Ingrisch [35] and again Ingrisch & Shishodia [40] reported a female from Punne, India. Our collection includes a few numbers of specimens of *L. bulbosa* that was collected from Jamshoro and its adjacent areas.


1AD (♂)


2AD (♀)


3AD (♂)


1BL (♂)


2BL (♀)


3BL (♂)


4AD (♂)


5AD (♀)


6AD (♂)


4BL (♂)


5BL (♀)


6BL (♂)


7AD (♀)


8AD (♂)


9AD (♀)


7BL (♀)


8BL (♂)


9BL (♀)

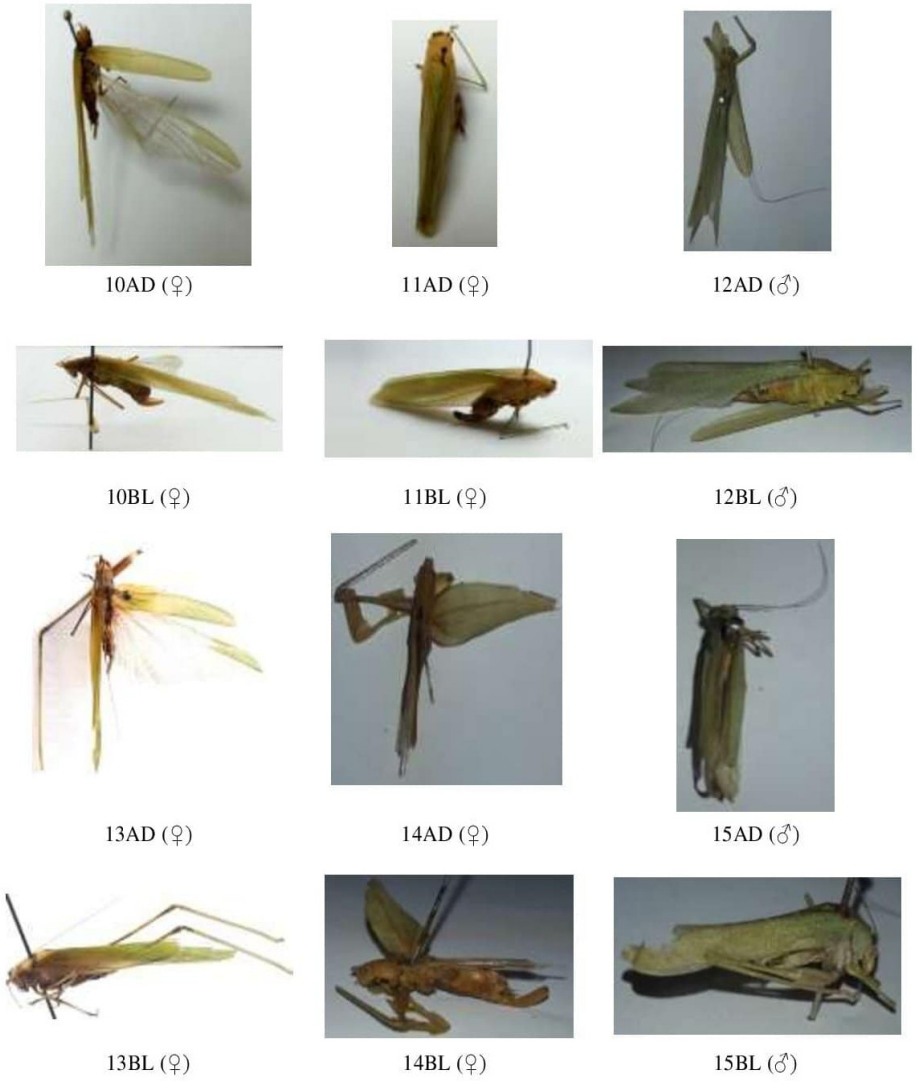

Fig. 1 Male and female dorsal and lateral view of Tettigonioidae species (*D. dorsal*, *L. Lateral*) (Scale = 2 mm). (1), (2) *T. unicolor* ♂♀, (3) *T. angustata* ♂, (4), (5) *P. spinosa* ♂♀, (6), (7) *P. roseate* ♂♀, (8) *P. bivittata* ♂, (9) *P. gracilis* ♀, (10) *H. japonica* ♀, (11) *H. venosa* ♀, (12) *H. nigrotympana* ♂, (13) *H.* sp. nov. ♀, (14) *D. japonica* ♀, (15) *L. bulbosa* ♂.

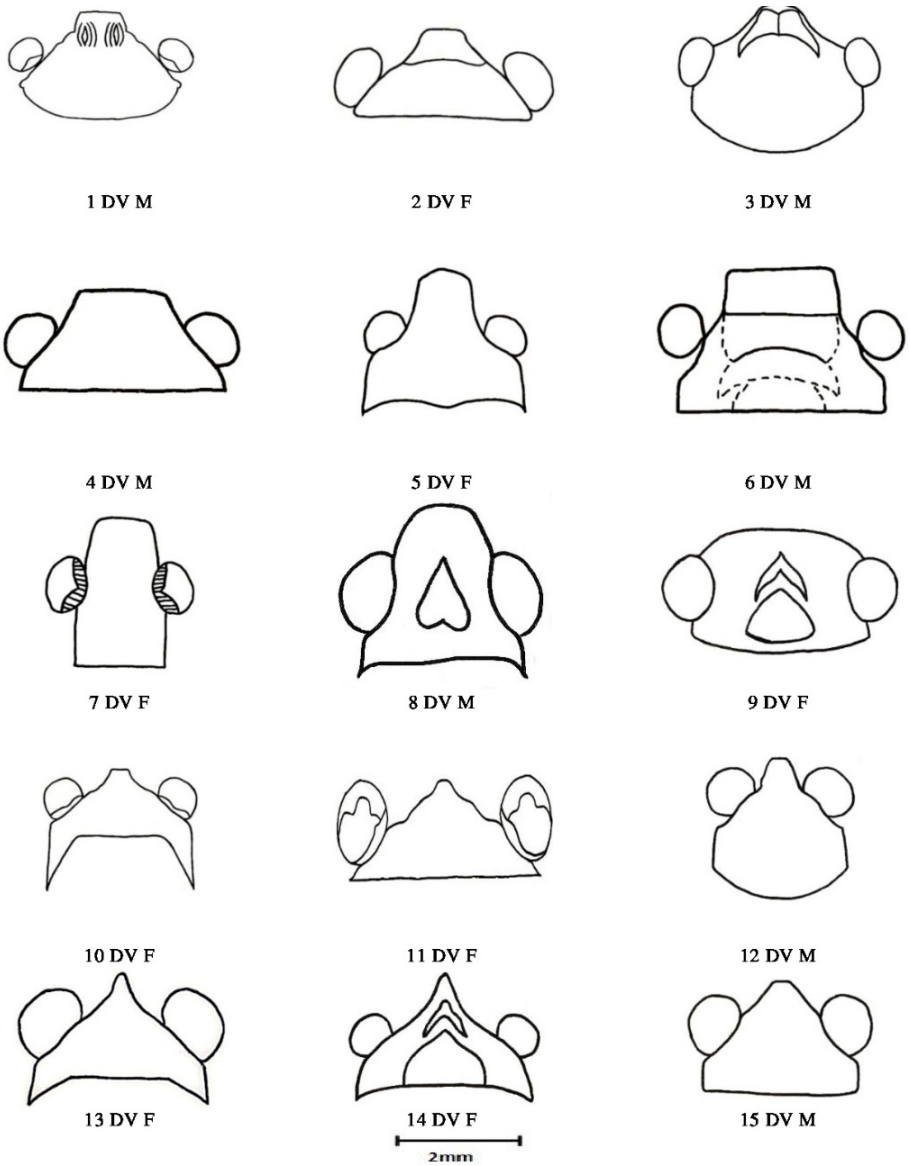

Fig. 2 Male and female head dorsal view of Tettigonioidae species (*D. dorsal*) (Scale = 2 mm). (1), (2) *T. unicolor* ♂♀, (3) *T. angustata* ♂, (4), (5) *P. spinosa* ♂♀, (6), (7) *P. roseate* ♂♀, (8) *P. bittata* ♂, (9) *P. gracilis* ♀, (10) *H. japonica* ♀, (11) *H. venosa* ♀, (12) *H. nigrotympana* ♂, (13) *H.* sp. Nov ♀, (14) *D. japonica* ♀, (15) *L. bulbosa* ♂.

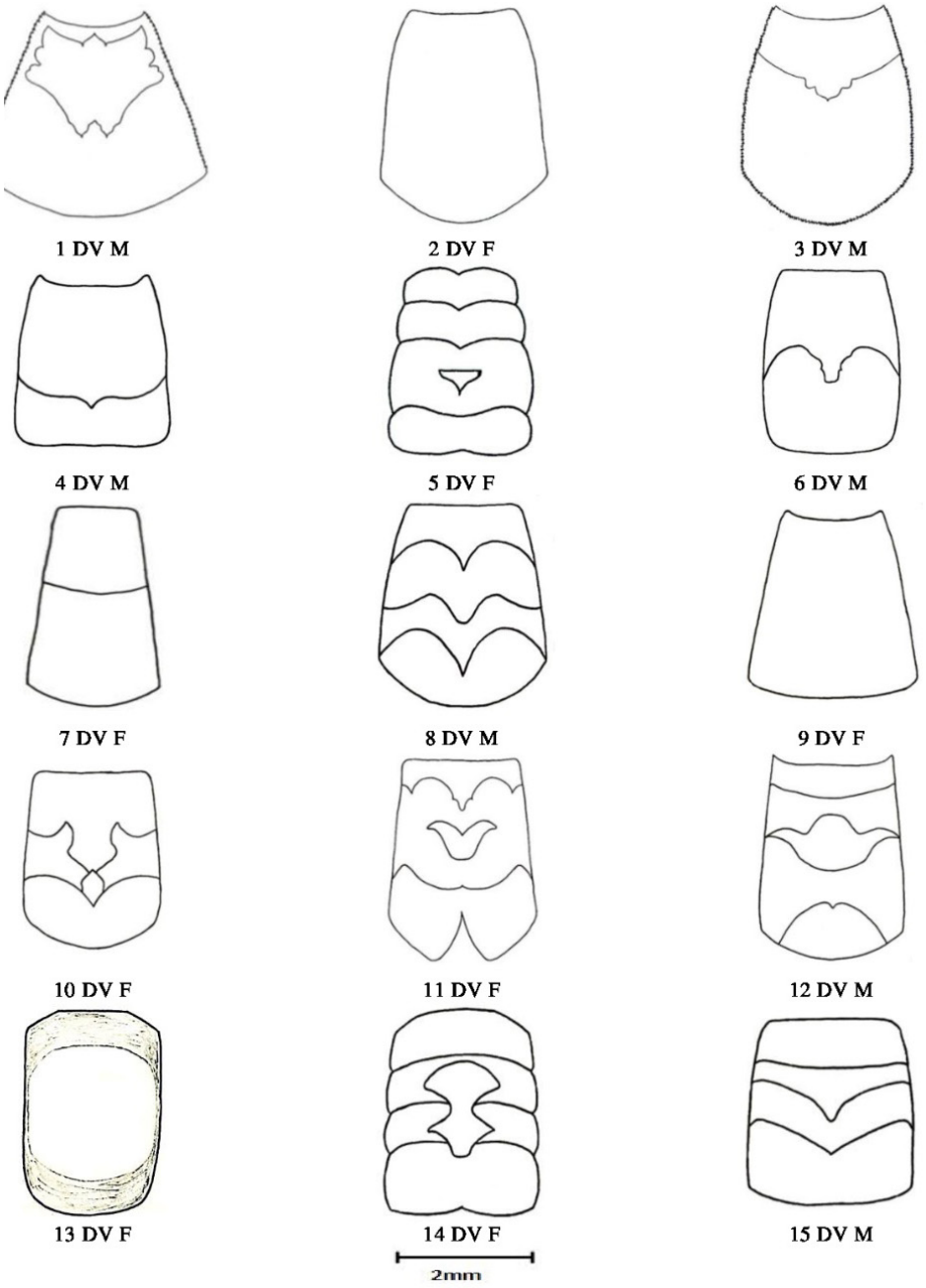

Fig. 3 Male and female pronotum dorsal view of Tettigonioidae species (*D. dorsal*) (Scale = 2 mm). (1), (2) *T. unicolor* ♂♀, (3) *T. angustata* ♂, (4), (5) *P. spinosa* ♂♀, (6), (7) *P. roseate* ♂♀, (8) *P. bivittata* ♂, (9) *P. gracilis* ♀, (10) *H. japonica* ♀, (11) *H. venosa* ♀, (12) *H. nigrotympana* ♂, (13) *H.* sp. nov ♀, (14) *D. japonica* ♀, (15) *L. bulbosa* ♂.

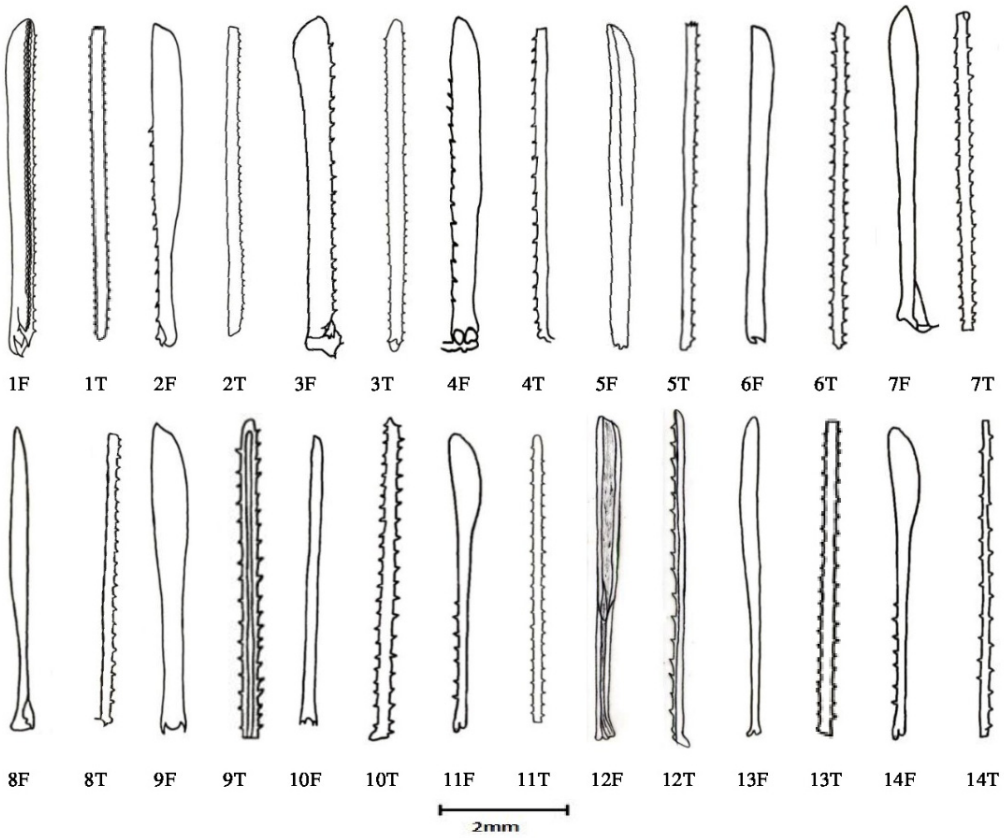

Fig. 4 Femur and tibia dorsal view of Tettigonioidae species (*D. dorsa*) (Scale = 2 mm). (1), (2) *T. unicolor* ♂♀, (3) *T. angustata* ♂, (4) P. spinosa ♂, (5), (6) *P. roseate* ♂♀, (7) *P. bivittata* ♂, (8) *P. gracilis* ♀, (9) *H. japonica* ♀, (10) *H. venosa* ♀, (11) *H. nigrotympana* ♂, (12) *H.* sp. nov ♀, (13) *D. japonica* ♀, (14) *L. bulbosa* ♂.

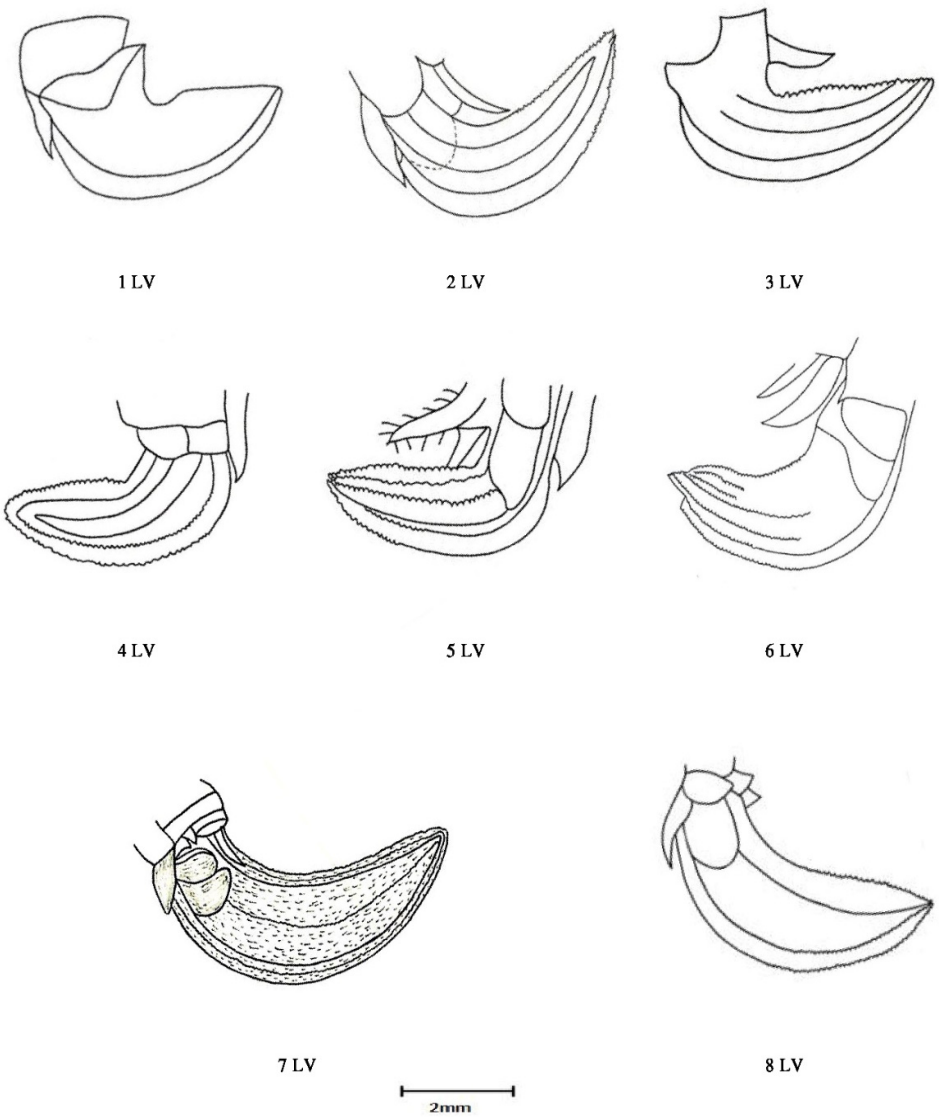

Fig. 5 Ovipositor of Tettigonioidae species (Scale = 2 mm). (1) *T. unicolor* ♀, (2) *P. spinosa* ♀, (3) *P. roseate* ♀, (4) *P. gracilis* ♀, (5) *H. japonica* ♀, (6) *H. venosa* ♀, (7) *H.* sp. nov. ♀, (8) *D. japonica* ♀.

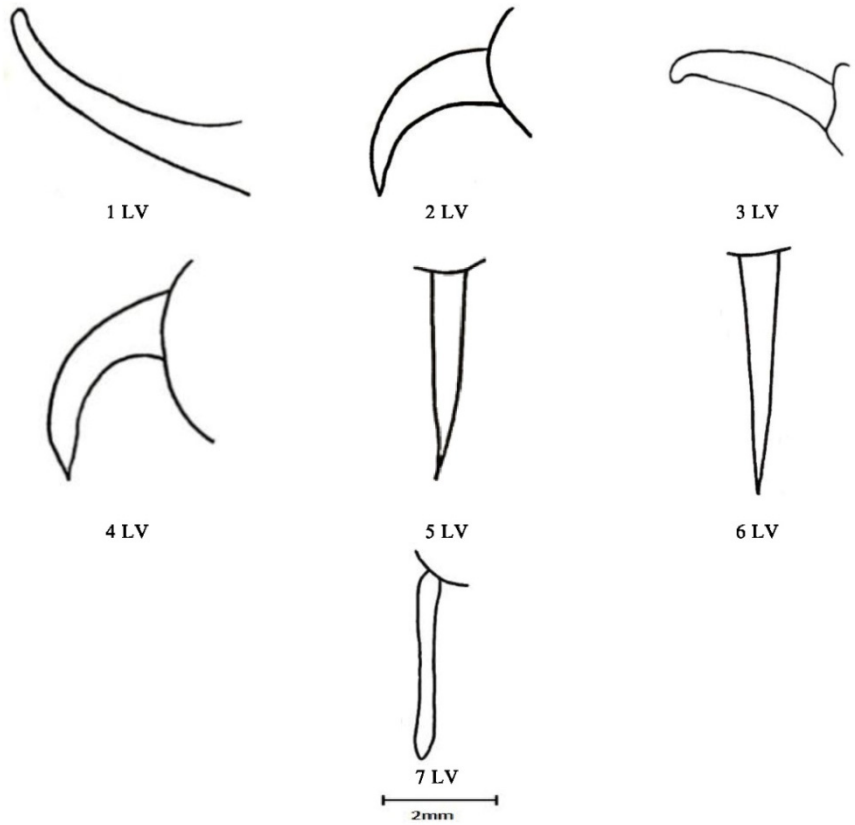

Fig. 6 Cerci of Tettigonioidae species (Scale = 2 mm). (1) *T. unicolor*, (2) *T. angustata*, (3) *P. spinosa*, (4) *P. roseate*, (5) *P. bivittata*, (6) *H. nigrotympana*, (7) *L. bulbosa*.

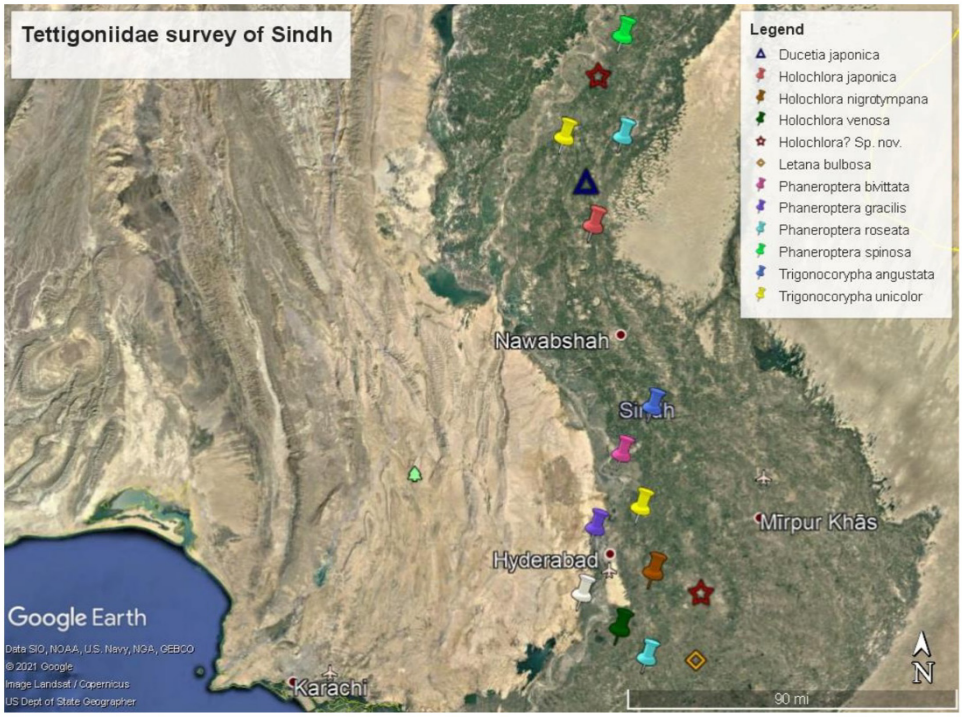

Fig. 7 Tettigoniidae species occurring in different localities of Sindh, Pakistan.

Table 1 Measurements of species of various genera of family Tettigonioidae (in mm).

		Body	Head	Pronotum	Femur	Tibia	Tegmen	Cerci/Ovipositor
Trigonocorypha unicolor Stal, 1873	M	20-29	1.4-2.45	2.45-7.7	8-27	9-30	40-45	----
	F	28-31	1.4-1.75	5.95-7.7	8-28	9-32	44-52	4.2-6.3
T. angustata Uvarov, 1922	M	21-27	1.4-2.1	4.55-07	12-24	13-29	33-44	----
	F	16-32	1.4-2.9	2.4-4.8	7-34	8-33	28-52	2.4-4.1
Phaneroptera spinosa Bei-Bienko, 1965	M	13-20	1.05-1.92	2.8-3.5	6-20	7-21	24-30	-----
	F	17-20	1.4-2.1	3-3.67	24-28	28-30	26-28	3.5-4.2
P. roseate Walker, 1869	M	15-18	1.4-1.75	3.15-3.5	6-21	7-25	17-33	-----
	F	9-32	1.4-2.8	1.4-3.5	6-23	7-27	23-25	2.1-4.2
Phaneroptera bivittata Bei-bienko, 1954	M	15-27	1.4-1.8	3.5-4.2	9-28	10-32	21-25	-----
	F	10-29	1.4-1.10	2.4-5.1	8-33	12-36	18-27	2.2-3.4
Phaneroptera gracilis Burmeister, 1838	M	13-23	1.4-1.8	2.1-2.4	7-19	5-21	14-18	----
	F	19-28	1.4-2.1	3.5-3.9	6-21	8-23	17-25	3.5-4.1
Holochlora japonica Brunner,1878	M	12-14	1.2-1.4	2.2-3.8	4-15	4-16	17-21	----
	F	16-18	1.4-1.75	3.5-4.2	6-20	7-21	23-25	2.1-4.2
Holochloravenosa Stal, 1873	M	27-39	1.4-1.9	1.4-4.2	5-21	8-19	13-44	----
	F	49-58	1.4-2.4	2.1-5.6	8-19	6-20	14-52	2.4-06
Holochlora nigrotympana Ingrisch, 1990	M	14-18	1.2-2.4	3.5-4.2	6-20	7-22	21-32	----
	F	20-23	1.4-2.8	3.5-4.9	8-24	10-28	36-39	2.4-3.5
Holochlora? Sp. nov.	F	27	0.35	0.5	23	24	23	2.3
Ducetia japonica Thunberg, 1815	F	29-31	1.05-2.1	1.4-2.8	07-22	06-24	22-27	3.5-3.6
Letanabulbosa Ingrisch, 1990	M	21-26	1.4-2.2	1.2-2.8	06-17	07-20	17-22	-----

Table 2 List of species collected from different localities of Sindh, Pakistan.

Species	Jamshoro			Dadu			Sehwan			Matiari			Hyderabad			Naushahro			Moro		
		M	F		M	F		M	F		M	F		M	F		M	F		M	F
Trigonocorypha unicolor	33	6	27	22	4	18	8	1	7	19	4	15	27	3	24	17	5	12	--	---	---
Trigonocorypha angustata	13	3	10	1	1	--	--	--	--	2	--	2	7	2	5	3	---	3	1	---	1
Phaneroptera spinosa	23	6	17	16	3	13	2	--	2	11	2	9	30	7	23	6	2	4	3	---	3
Phaneroptera roseate	5	1	4	11	2	9	--	--	--	21	3	18	34	5	29	12	3	9	--	---	---
Phaneroptera bivittata	4	--	4	7	1	6	--	--	--	2	--	2	16	4	12	9	1	8	--	--	--
Phaneroptera gracilis	3	2	1	2	--	2	1	--	1	6	1	5	19	5	14	13	6	7	3	2	1
Holochlora japonica	12	3	9	7	2	5	3	1	2	15	4	11	24	3	21	6	1	5	2	1	1
Holochlorave nosa	9	2	7	13	1	12	5	2	3	24	6	18	11	4	7	8	2	6	2	--	2
Holochloranig rotympana	12	1	11	3	--	3	7	1	6	9	2	7	20	9	11	4	1	3	1	1	--
Holochlora? Sp. Nov.	--	--	--	--	--	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--
Ducetia japonica	2	--	2	--	--	--	--	--	--	--	--	--	5	--	5	--	--	--	--	--	--
Letana bulbosa	5	5	--	--	--	--	--	--	--	2	2	--	3	3	--	--	--	--	--	--	--

Table 3 Key to the various genera of Tettigoniidae of Sindh Pakistan.

1	Male cerci slightly conical curved, Fastigium of vertex narrow completely divided into two by middle sulcus	3
−	Male cerci curved and tapered, fastigium of vertex usually wide and not divided by middle sulcus but with grooves	*Phaneroptera*
2	Ovipositor sickle shaped, wide and short in length, Female abdominal tergite large with slightly deep longitudinal groove at the middle	*Holochlora*
−	Ovipositor flattened, narrow and bent at basal part, Female abdominal tergite small or long, narrow with two lobes	*Ducetia*
3	Pronotum had slightly concave disc and very flat. Pronotum rounded at the posterior margin and lack pointed fringe	*Trigonocorypha*
-	Pronotum large curved at anterior and posterior side, fastigium of vertex narrow at the anterior side	*Letana*

Table 4 Key to the species of Tettigoniidae of Sindh Pakistan.

1	Tegmina densely compact, leathered and widened at the middle anteriorly	*T. unicolor*
−	Tegmen much larger than hind knees of hind femora and pale band at basal part and widened posteriorly	*T. angustata*
2	Pronotum usually moderate cylindrical convex apical part in the anterior two-third part, but flat in posterior third part	*P. spinosa*
_	Pronotum entirely flat, but usually cylindrical at apical part but, rounded posteriorly	*P. roseata*
3	Cerci in male longer and thin as compared to the female, large and extrude from the basal width of ovipositor	*P. gracilis*
−	Cerci in male slightly conical at the basal half, very arched, thin and cylindrical at the distal part, flattened at the anterior part and narrow towards the pointed end at the posterior part	*P. bivittata*
4	Ovipositor had dark apex and sharp black serrate lines at lateral side	2
−	Ovipositor had slight sharp and dark serration, wide, fully developed, and racy, lateral surface had convex fold at base	*H. venosa*
5	Female abdominal (tegminal) tergite large and had slightly deep longitudinal groove at the middle	*H. japonica*
−	Abdominal tergite large but, the 10th abdominal tergum short rather than other dorsally, extended towards the posterior side	*H. nigrotympana*
6	Femur flat and slightly curved anteriorly, it lacks spines, Tegmen large and has several lateral carinae	*Ducetia japonica*
−	Femur flat at basal side but curved at upper side, it has small spines on half lower side, it is curved anteriorly, Tegmen small and has leathered structure	*Letana bulbosa*

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