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Systematic Study of Genus *Hedotettix* of family Tetrigidae (Califera: Orthoptera) with three new records from Sindh, Pakistan

Saiqa Sanam, Riffat Sultana and Surriya Sanam

Department of Zoology, University of Sindh, Jamshoro, Sindh, Pakistan

*Corresponding author's email; saiqasanam12@gmail.com

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Abstract

Tetrigidae are very minute insects, about ~14-20 millimeters long, most identifiable character extended pronotum, which covers the whole abdomen. These pygmy locusts encountered near water embankments viz. ponds, lakes, canals and along the rivers. Infrequently found in dry places, forests and deserts. They prefer to feed on seedlings, fungi, algae and wet meadows and hay fields and it brings about pernicious effects on the valuable crops. In this regard, four species of the genus *Hedotettix* have been described, with three of them being new state records: *Hedotettix costatus* Hancock, 1912, *H. rusticus* Bolivar, 1887, and *H. angustivertex* (Bolivar, 1908).

Keywords: *Wet meadows, pronotum, seedlings, mosses*

Introduction:

These groundhoppers are small, short horns with elongated tapered tectiform pronotum which encircles the abdominal segments and hind wings (Kocarek *et al.*, 2005). Tetrigidae (pygmy grasshoppers, grouse locusts or ground hoppers) can be recognized by their elongated pronotum and the nonappearance of the arolium between the tarsal claws. Because of their immense diversity, Tetrigids are found practically everywhere in tropical lands. (Steinmann 1962, Steinmann 1969-1971). All lengths and widths were computed for Tetrigidae species and measured from the frontal crest to the apical parts of the Subgenital plate (Tumbrinck, 2014). Some species of Tetrigidae appear with developed wings are good fliers but some individuals with reduced wings were not good fliers. The difference in flight patterns is due to the quality of food resources and dietary divergence in Tetrigidae species (Kerpeštam and Forsman 2013). Orthopteran species are in vegetation of Pulau Ubin, a natural wildlife area where orthopteran species refuge, it is a rare urbanized, mainland of Singapore (Tan, 2010). Tetrigidae prefer marshy places, mostly; Tetrigidae terricolous, and some of them are semi-aquatic swimmers and divers (Podgonaya 1983, Paranjape *et al.*, 1987). Tetrigidae ecology and biology are uncertain, however seasonal and daily behaviors like as food biology and signaling behavior have been examined in *Tetrix bolivari*. This species emerges and grows from March to

September, although their daily activities are separated into both positive and negative. positively are reliant on temperature, and negatively on relative humidity. *Tetrix bolivari* mostly consumes mosses and other organic matter, however *Brylum caespiticium* and *B. argentum* are the two mosses that it consumes most frequently. Data about the substrate-borne vibrational signals utilized in communication and vibrational impulses have four basic kinds that have been distinguished by male wing tremulation (Kocarek *et al.*, 2011). Tetrigidae are very tiny insects, due to their size they have been ignored. By keeping this in mind we have studied systematics and ecological distribution, pinpointing of new records on the base of their diagnostic characters, images pencil drawing and morphometry to construct the key in which we compare parallel distinguishing features of each species.

Material and Methods

All Tetrigidae samples were collected from the different sources viz. Rice fields, Sugarcane, Wheat, Algae and from the Houses near the fields. Collected samples were carried out to the laboratory for further analysis at Entomological Biocontrol Research Laboratory, University of Sindh. Euthanasia (mercy killing) method was applied to kill the samples, which was created and proposed by Vickery and Kevan (1983) and Riffat and Wagan (2015).

In normal arthropod, potassium cyanide or chloroform is used for killing and insects are retained in 5-10 minutes. If we place the insects for a longer time it can fade up their colors. Insect pin was placed/ inserted on the dorsum surface, somewhat to the right lateral side of the pronotum. After that insects were placed on stretching board for 24 hours. Then fully dried samples were stored in insect containers after labeling i.e., collectors name, source, encountered date. To keep ants and other insects at bay, naphthalene balls were also put in boxes. Insects were identified with the help of OSF (Orthoptera online species file) and by adapting bibliographies which were created by Riffat and Wagan (2015). Photographs of species were also captured with a Micro lens of Lucida Camera and quality was enhanced through different software's (Adobe Photoshop and Adobe Illustrator). Different body parameters are computed in millimeters. The species diverseness was represented by providing latitude and longitude information for available sites of collection. The material has been stored in (SEMJ), the registration TN: 802 SEM Department of Zoology, University of Sindh, Jamshoro Pakistan.

Results:

Family Tetrigidae

Subfamily Tetriginae

Tribe Tetrigini

Genus *Hedotettix* Bolivar, 1887

Hedotettix costatus Hancock, 1912

Material examined. Pakistan- Sindh Province: 03♀; Saiqa: 23.Oct. 2019, Mirpurkhas, 25.5065°N, 69.0136°E, 02♀; Saiqa: 29. Sep. 2021, Jamshoro, 25.4304°N, 68.2809°E, 01♀; Saiqa: 30. Sep. 2021, Hyderabad, 25.3960°N, 68.3578°E, 03♀; Saiqa: 25. Oct. 2021, Kotri, 25.3494°N, 68.2743°E.

Description. The body is smaller than *Hedotettix gracilis*, with a reddish brown anterior and a faint golden tint running down from the centre of the pronotum to the posterior end of the pronotum. Filiform antennae are present. The head is tiny, with an enate fastigium vertex, that is thinner at the front. Brown eyes that are protruding. The pronotum is lengthy and tapering towards the posterior end. The pronotum has light brown spots on the dorsal surface, and the median carina is compressed and visible on the dorsum. Tegmen are little and oblong. The front and posterior ends of the femur are brownish, whereas the centre is yellowish. Tibia is made up of 7-8 pair of spines.

Ecology. Specimens collected from the mat of moss plants.

Global Distribution. Pakistan, India, Nepal, Bangladesh and Malesia.

Remarks. *Hedotettix costatus* was described by Hancock, 1912. Shishodia et al., 2010 included this

species in the Zoological Survey of India's annotated checklist of Orthoptera (Insecta). Later on, Kumar et al., 2017 examined the taxonomic classification of this species from India later on. For the first time, this species has been documented in Sindh, Pakistan.

Hedotettix rusticus Bolivar, 1887

Material examined. Pakistan- Sindh prov: 02♂; Saiqa: 09. Sep. 2019, Mirpurkhas, 25.5065°E, 69.0136°N, 02♂; Saiqa: 29. Sep. 2021, Jamshoro, 25.4304°N, 68.2809°E, 01♂; Saiqa: 18. Sep. 2021, Hyderabad, 25.3960°N, 68.3578°E, 02♂; Saiqa: 17. Oct. 2019, Kotri, 25.3494°N, 68.2743°E.

Description. The body is tiny and light brownish, with dark uneven brown patterns covering the entire body. The head is short, and the eyes are oval, brown, and protruding. The fastigium of vertex is smaller and bent somewhat outward at the anterior endpoint. Filiform antennae with 13-14 segments. The anterior ends of the pronotum have log tapering and semi-circular dark brown spots. Except for the proximal lateral sides, the pronotum's midsection is golden pale. Brown spots can also be found on the pronotum's dorsal surface. The medial carina is pushed inward and not as conspicuous as in other *Hedotettix* species. The femur is brown in hue with black spots anteriorly. Tibia is made up of 6-7 pair of spines.

Ecology. Most of the specimens were collected from the outer margins of the moist soil.

Global Distribution. Pakistan, Philippines, Ireland.

Remarks. Earlier Bolivar, 1887 identified *Hedotettix rusticus*. Later, Blackith (1992) examined the Tetrigidae of Southeast Asia, producing an annotated list with partly translated keys and bibliography from the Ireland. This species has now been recorded for the first time from several fields holding water flow and its adjacent places in the district of Mirpurkhas, Sindh, Pakistan.

Hedotettix angustivertex (Bolivar, 1908).

Material examined. Pakistan- Sindh prov. 03♀; Saiqa: 11. Oct. 2019, Mirpurkhas, 25.5065°N, 69.0136°E, 02♀; Saiqa: 24. Sep. 2021, Jamshoro, 25.4304°N, 68.2809°E, 03♀; Saiqa: 28. Sep. 2020, Hyderabad, 25.3960°N, 68.3578°E, 03♀; Saiqa: 26. Oct. 2021, Kotri, 25.3494°N, 68.2743°E.

Description. The body is tiny and light brown in hue. Little head pressed inward. Brown eyes that are round and bulge outward horizontally. Filiform antennae, 11-12 segments. The fastigium of vertex is thinner, and the sulcus is noticeable dorsally. Pronotum is elongated, with a median carina that is somewhat constricted across the entire dorsum, and three brown stripes on either side of the pronotum

on the anterior side. Tegmen has an oval form. There are no bands on the femur. Tibia is made up of 10-11 pairs of spines.

Ecology. These specimens were taken from irrigated areas where mosses and grass were abundant on the surfaces.

Global distribution. Pakistan, Ivory Coast, Uganda, Democratic Republic of the Congo, Tanzania.

Remarks. Previously, (Bolivar, 1908) identified *Paratettix angustivertex* from Banana and Leopoldville, Democratic Republic of the Congo, West-Central Tropical Africa Zaire. Gunther, K. 1979 reported this species as *Hedotettix angustivertex* from sub-Saharan Africa. It is now being reported from Sindh, Pakistan.

***Hedotettix granulatus* Bolivar, 1895.**

Material examined. Pakistan- Sindh prov. • 04♀; Saiqa: Oct. 22. 2019, Mirpurkhas, 25.5065°N, 69.0136°E, 01♀; Saiqa: Oct. 29. 2021, Jamshoro, 25.4304°N, 68.2809°E, 03♀; Saiqa: Oct. 26. 2020,

Hyderabad, 25.3960°N, 68.3578°E, 05♀; Saiqa: Oct. 24. 2019, Kotri, 25.3494°N, 68.2743°E.

Description. The body is tiny and dark brownish grey in color. Head is small and constricted. The eyes are light brown and protrude outwardly, and the vertex fastigium is shorter but somewhat arched and broader at the proximal extremity. Filiform antennae 13-14 segmented. The pronotum is robust and tapering towards the posterior end. Some rough ridges on the body's surface. Tegmen is a tiny oval with a slightly bent anterior end. The femur is similarly dark brownish grey, with a more compressed and conspicuous carina than the pronotal carina. Tibia has 8 to 9 pair of spines.

Ecology. The specimens were collected from Sugarcane and Rice fields of the Sukkur and Mirpurkhas.

Global Distribution. Pakistan, Seychelles

Remarks. Earlier *Hedotettix granulatus* Bolivar, 1895. Later Matyot 1998 reported this species from Seychelles. For the first time, it has been recorded from Sindh, Pakistan.

Table 1. Morphometry of different parameters of four species of genus *Hedotettix*

Species	Parameters								
	LH	WH	LP	WP	LF	WP	LT	WT	TBL
<i>H. costatus</i>	0.75 ± 0.13	1.54 ± 0.05	12.6 ± 2.8	2.68 ± 0.36	5.18 ± 0.40	1.74 ± 0.175	4.49 ± 0.56	0.32 ± 0.05	17 ± 1
<i>H. rusticus</i>	0.65 ± 0.12	1.52 ± 0.05	13.6 ± 2.9	2.66 ± 0.35	5.16 ± 0.40	1.72 ± 0.178	4.48 ± 0.56	0.32 ± 0.04	18 ± 1
<i>H. angustivertex</i>	0.75 ± 0.12	1.50 ± 0.04	13.5 ± 2.7	2.67 ± 0.36	5.18 ± 0.40	1.74 ± 0.176	4.49 ± 0.56	0.32 ± 0.05	16 ± 1
<i>H. granulatus</i>	0.75 ± 0.13	1.54 ± 0.05	12.6 ± 2.8	2.55 ± 0.30	5.17 ± 0.41	1.75 ± 0.174	4.47 ± 0.55	0.32 ± 0.04	18 ± 1



Figure 1. *Hedotettix costatus* (♀) (1A, 1B), *H. rusticus* (♂) (2A,2B), *H. angustivertex* (♀) (3A,3B), *H. granulatus* (♀) (4A, 4B) Dorsal and lateral view.

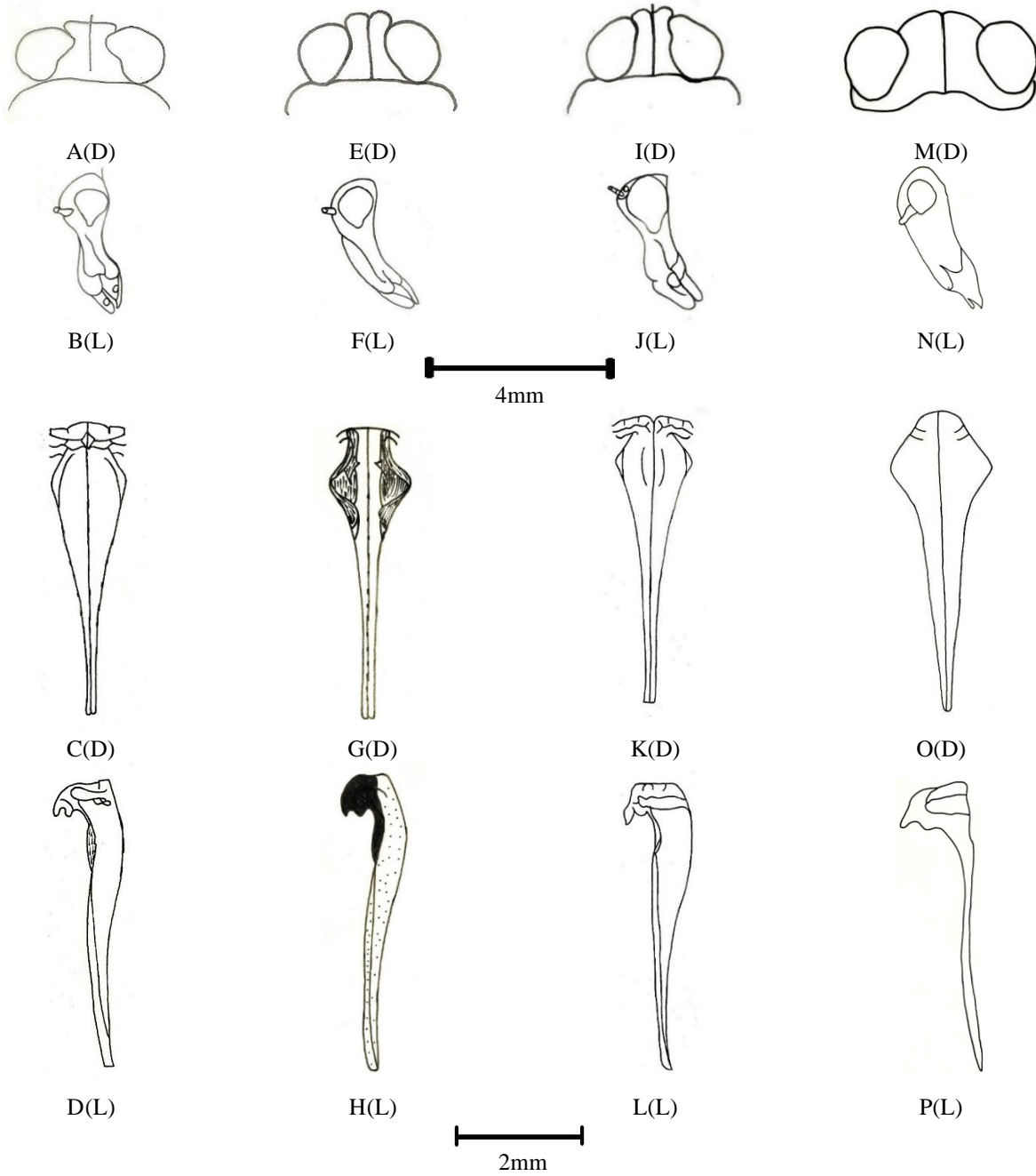


Figure 2. *Hedotettix costatus* (♀) (A,B,C,D) *H. rusticus* (♂) (E,F,G,H), *H. angustivertex* (♀)(I,JK,L), *H. granulatus* (♀) (M,N,O,P), D= dorsal, L= lateral view of head and pronotum.

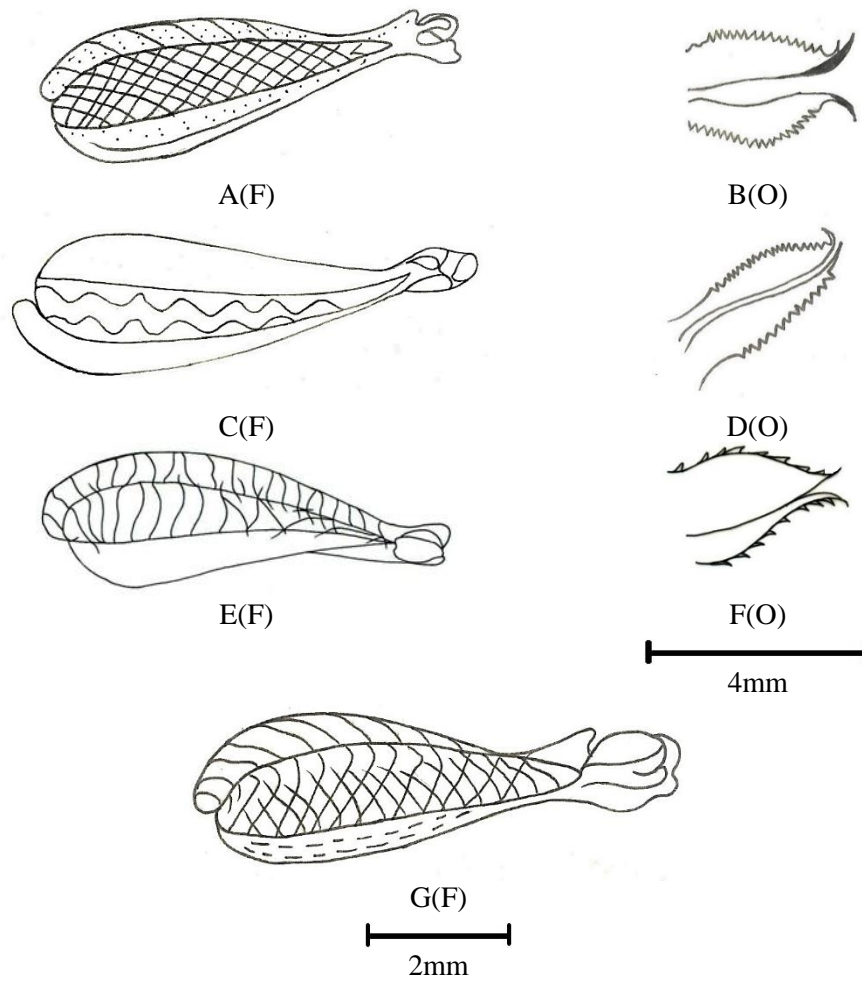


Figure 3. *Hedotettix costatus* (♀) (A,B) *H. angustivertex* (♀) (C,D) *H. granulatus* (♀) (E,F), F= Hind femur, O= Ovipositor, *H. rusticus* (♂) (G) Hind femur.

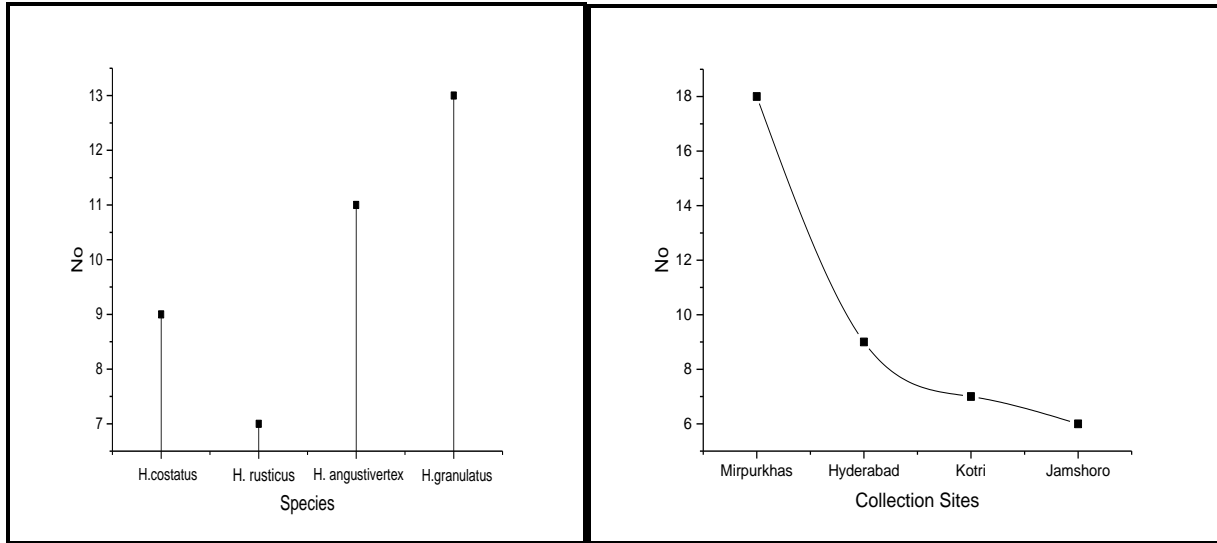
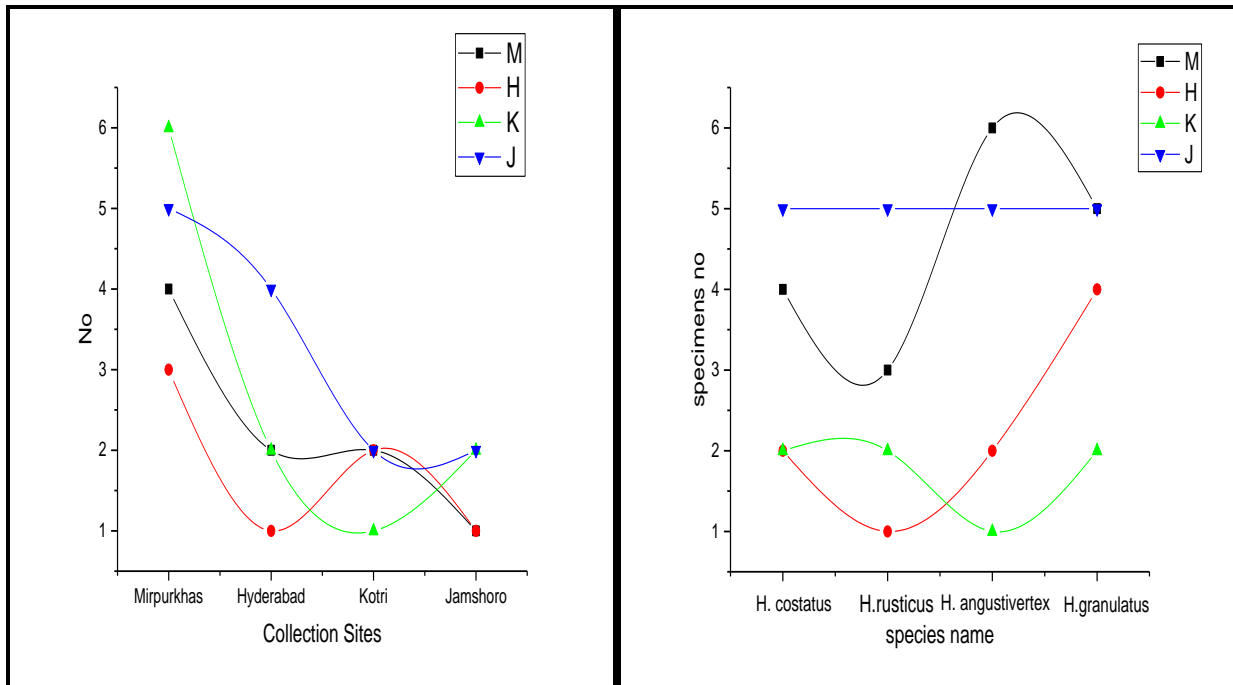


Figure 4. No: of collected specimens of each species from different localities of Sindh.



Note: Black= Mirpurkhas, Blue= Jamshoro, Green= Kotri, Red= Hyderabad.
Figure 5. Collection from different localities of Sindh.

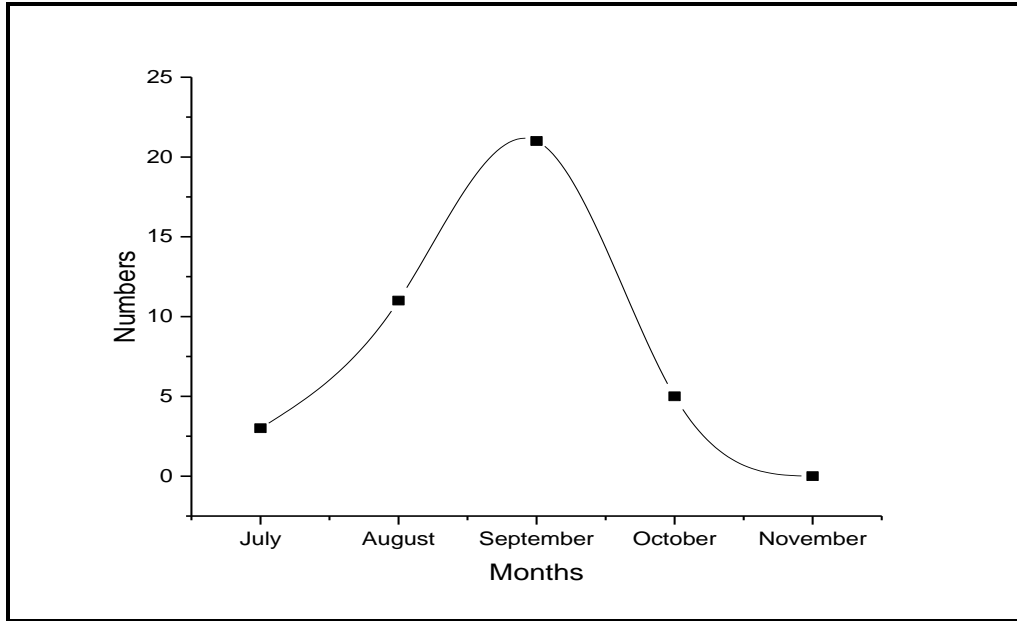


Figure 6. Collection of specimens during the different months of the summer season.

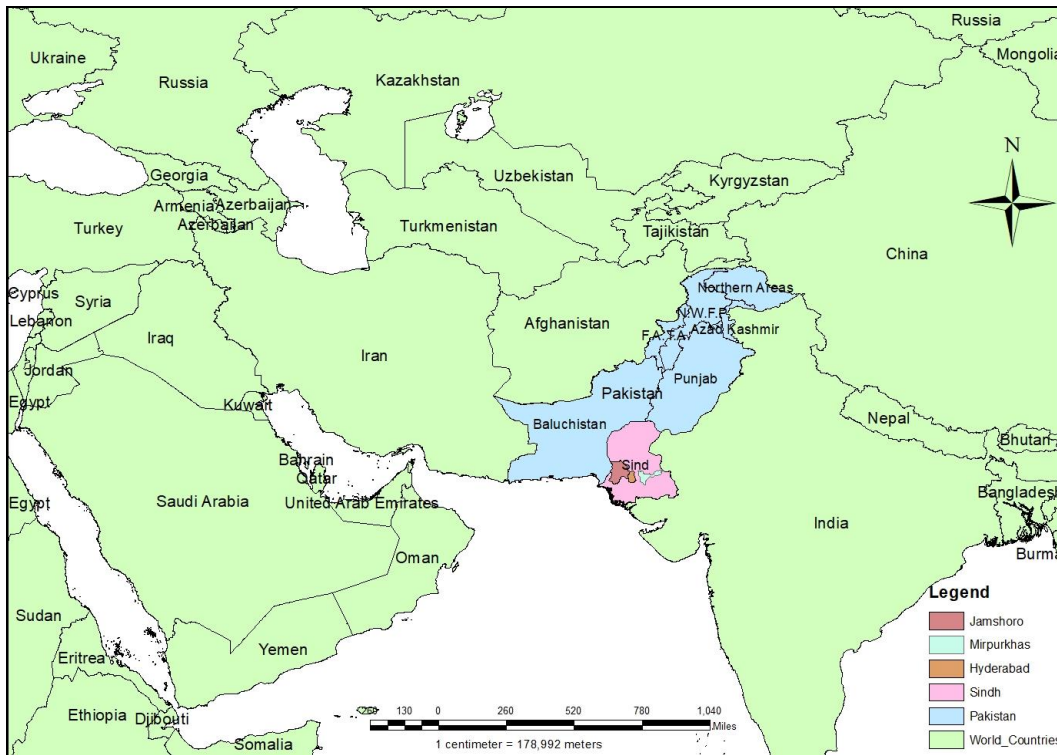


Figure 7. Distribution of Tetrigidae species at the different sites of the Sindh Province Pakistan.

Conclusion

The Sindh agricultural crops are severely harmed by grasshoppers of the Tetrigidae family. They are the main pest of the flora in deserts, as well as wheat, rice, and maize. Pygmy grasshoppers are less than 20 mm

long and may be identified by their lengthy pronotum, which runs the whole length of the abdomen. Pygmy grasshoppers more frequently inhabit near ponds and streams. Sometimes discovered in forests, rice fields, sandy places with lichen, and arid environments. These

grasshoppers especially eat roots of plants, saplings, moss grass, fungi, algae and cause significant loss to cash crops. In this aspect four species of the family Tetrigidae were recorded and three species, namely *Hedotettix costatus* Hancock, 1912, *H. rusticus* Bolivar, 1887, *H. angustivertex* (Bolivar, 1908) are noted as national and state records. In addition, the taxonomic status of numerous Tetrigidae species, synonymy of species, material inspected, diagnosis, measurement of various body characteristics, ecology, and worldwide distribution are discussed. A spline-connected graphical illustration depicts the prevalence of pygmy locusts at the genus level. The large number of moss/grass species consumed by a single Tetrigidae species over a brief period of time demonstrates the maximum hopper movement that took place over a

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- limited area of ground. Our work is unusual for researchers since it draws attention to new breakthroughs and their impact on agricultural crops. This effort will assist crop protection organizations in taking the necessary measures to reduce insect pests in Pakistan and other agricultural countries. Furthermore, the primary goal of this research was to determine the effects of Tetrigidae on mosses, algae, and other vital medicinal plants. The goal of this study was to gather new information/data on the prevalence of Tetrigidae species in Sindh Pakistan. Our effort will address a research vacuum that has existed for several years and will open the way for foreign and new scholars to gain information. The current value research of pygmy grasshoppers will aid in the timing of (IPM) control activities.
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