

# Morphometry and illustration of the immature stages of *Truxalis fitzgeraldi* Eichwald, 1830 (Acrididae) from Sindh Pakistan

Sajjad Ali Larik\*, Riffat Sultana\*, Muhammad Saeed Wagan\* , Imran Khatri\*\*, Samiullah Soomro\*

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

\*\* , Department of Entomology, Sindh Agriculture University Tandojam, Pakistan

**Abstract:** This study has been carried out on the immature stages of phytophagous grasshoppers so the major aim of this study is to support the taxonomists and agriculturists in order to identify the phytophagous immature stages and their nature of damage in crops. The knowledge of diversity, ecology and taxonomy of immature stages of grasshoppers is very poor in Pakistan. On the basis of above facts, we contributed a brick of the knowledge to explore the morphometric study of immature specimens of *Truxalis fitzgeraldi* with their damage, habitat and distribution in Sindh, Pakistan. The adults and nymphs not only reared under laboratory conditions but agricultural fields also were surveyed to explore the immature stages and to capture the specimens respectively. Each stage of instars have been observed during the growing phase of *T. fitzgeraldi* till their adult stage. Moreover, this study also contributed to explore the identification keys, digital images of instars and line drawing along with their ecological distribution.

**Index Term:** Immature, Phytophagous, *Truxalis*, Ecology, Diversity.

## 1. INTRODUCTION

Grasshoppers are known as the most noticeable group of insect pests which found in grassland and deserts abundantly [1]. These cause persistent risk not only to meadowlands but also to various agricultural crops of Pakistan [2]. On the subfamily Truxalinae in Sub-Continent research has been conducted by various scientists [3], [4] [5]. However, [6] [7] [8] [9] [10] [11] [12] explored some species from Pakistan. Subfamily Truxalinae synonymized by [13] as under subfamily Acridinae whereas before this regarded as a separate taxon by all scientists [14].

It has been revealed that species of genus *Truxalis* are causing huge damage to many crops. Predominantly, specimens were observed in cotton, corn field, cultivated land and watermelon [10] [22]. Moreover, [2] in their research that members of *Truxalis* are extensively scattered (adjacent to road sides, water channels, lawns, grasses and

agricultural crops) all over the country due to their phytophilous nature.

Body shape and behavior are one of the fascinating characteristics of species of the genus *Truxalis* Fabricius. Due to their long legs they can move freely on grasses which is the most adopted characteristic of species of *Truxalis*. Species of this genus attack dry and coarse grass with the help of large mandibular. To support the mandibular muscles head capsule is required which is well established. Moreover, due to friction of wings a crackling noise is remarkable characteristic in males during flying [14] [15].

In the past *Truxalis fitzgeraldi* Dirsh was known as *Truxalis grandis fitzgeraldi* and [16] [17] as *Truxalis fitzgeraldi* Dirsh. Asia-Temperate, Western Asia and Iran are known as type locality of *T. fitzgeraldi* whereas the type of *T. fitzgeraldi* is unspecified primary type [18].

In tropical areas due to lack of taxonomic literature study on the biodiversity, taxonomy and ecology of immature stages of grasshoppers is observed as difficult [18]. Molecular study is highly recommended to identify the species during immature stages [19]. No detailed morphometric study has been carried out on the immature stages of these phytophagous grasshoppers so the major aim of this study is to support the taxonomists and agriculturists in order to identify the phytophagous immature stages and their nature of damage in crops. The knowledge of diversity, ecology and taxonomy of immature stages of grasshoppers is very poor in Pakistan. On the basis of above facts we contributed a brick of the knowledge to explore the morphometric study of immature specimens of *T. fitzgeraldi* with their damage, habitat and distribution in Sindh, Pakistan.

## II. MATERIALS & METHODS

### A. Survey and collection area

Survey were carried out in the months of March to September during the years 2013 to 2017. Scientific insect hand net (50 cms length) was the primary method of collection along with hand picking where necessary. The specimens of *T. fitzgeraldi* with different stages of instars were captured from cultivated land crops, edge of fields and water channels i.e. maize, wheat, alfalfa, vegetables, millet, grasses, berseem and sorghum.

#### B. Killing, preservation and rearing

Specimens were brought to EBCR Lab in order to kill and preserve. On the other hand some mature couples of specimens of *T. fitzgeraldi* were reared in scientific cage to take the morphometric measurements of instars. Killing, preservation and rearing methods were followed by slight modification [17] [20] [21].

#### C. Identification and morphometry of hopper

Stereoscopic dissecting binocular microscope (SDBM) was used to identify the hoppers stages. Ocular squire graph (2X) and vernier caliper were used to take the measurement of body parts of 1<sup>st</sup> to 2<sup>nd</sup> instars / hopper and 3<sup>rd</sup> to 5<sup>th</sup> respectively. Moreover, compound microscope was used to count the segments of antennae. Millimeter (mm) scale was used to measure all parts.

#### D. Sorting out of different hopper stages

The stock culture collected from the various field was transferred into EBCR lab and sorted out into different nymphal stages by using magnifying glass.

### III. RESULTS AND DISCUSSION

#### E. *TRUXALIS FITZGERALDI* DIRSH, 1951

##### 1) DESCRIPTION

Medium size body colour is greenish brown. Antennae sword shaped and bigger than head. Anterior part of head fastigium of vertex is thin or narrow and at side it is upwarded and having median carinae on whole portion of pronotum. Dorso-ventrally tegmina greenish in color while at the middle brown line runs completely over anterior and posterior side along with whitish dots like color present on tegmina. At the basal side hind wings are reddish. Cerci conical and hairy. Tip of abdominal portion was upward and erected.

##### 2) COLORATION

Green brownish body in color. Having greenish tegmina brownish bands runs from anterior to posterior portion. At basal side wings were pale reddish while cerci dusty brown.

##### 3) COMPARATIVE NOTE

Wagan [22] studies this species from various districts i.e Sukkur, Larkana and Sanghar while from Dadu it was captured in bulk quantity. The species similar to *Truxalis grandis* Klug with upper wing thin and blurred speculum, which small in size, much circular apex of fastigium of vertex. In Popov [22] in my point of view, this species was distinct because of its short size.

#### 4) DESCRIPTION OF IMMATURE STAGES OF *TRUXALIS FITZGERALDI* DIRSH, 1951

##### 1<sup>st</sup> INSTAR

Antennae ensiform with first 4 segments larger than others, fastigium of vertex consistently produced before eye broad laminate and truncate at the apex. Pronotum parallel possess posterior sulcus and posterior margin bilobed semi-circular. Wing pads were not appeared.

##### 2<sup>nd</sup> INSTAR

Antennae ensiform with 12 segments. First antennal segment was extra-large. Pronotum divergent towards metazona, tactiform, prozona larger than metazona. Posterior margin of pronotum flat, supra-anal plate profuse at basal part and somewhat thinning towards apex.

##### 3<sup>rd</sup> INSTAR

Antennae ensiform with 15 segments. Pronotum divergent towards metazona, tactiform, posterior margin of pronotum obtusely rounded. Wing pads were directed down wards. Supra-anal plate wide at basal part and somewhat thinning towards apex.

##### 4<sup>th</sup> INSTAR

Antennae ensiform with 17 segments. Median carinae of pronotum in cut by posterior sulcus, pronotum disk truncate. Wing pads directed up wards up to middle of 2<sup>nd</sup> abdominal segment. Supra anal plate elongated and leaf like.

##### 5<sup>th</sup> INSTAR

Antennae ensiform with 18 segments. 3<sup>rd</sup> segment is broader in length and width. Fastigium of vertex truncate inwards. Median carinae of pronotum cut by posterior sulcus. Wing pads directed up wards up to margin of 2<sup>nd</sup> abdominal segment.

Note: Occurrence of this species both immatures and mature has been shown in Table 3.



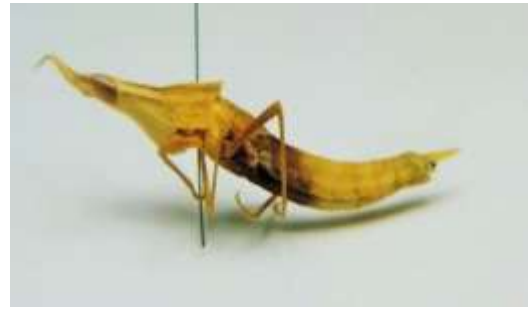
1<sup>ST</sup> instar



2<sup>ND</sup> instar



3<sup>RD</sup> instar



4<sup>TH</sup> instar



5<sup>TH</sup> instar

**Figure 1: Various developmental stages of *T. fitzgeraldi***

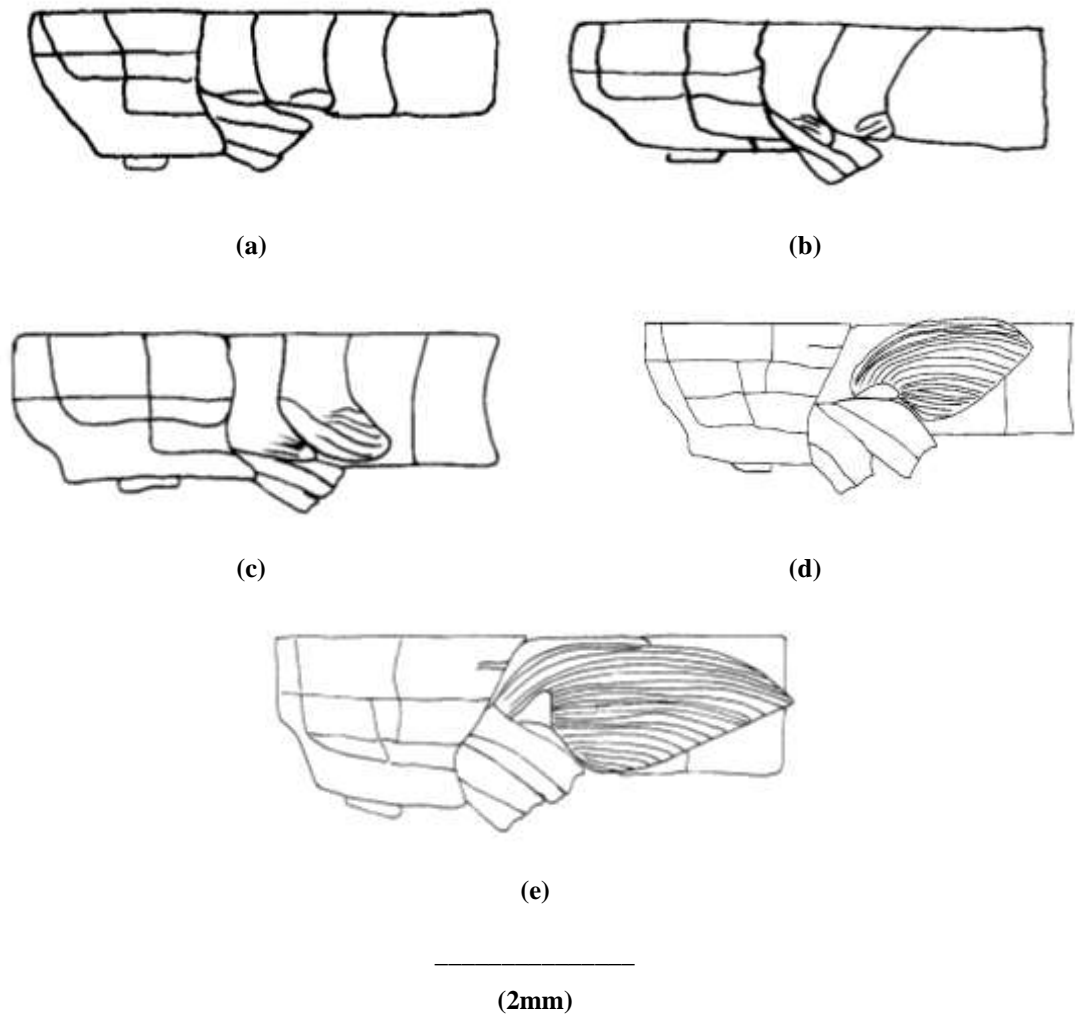


Figure 2: (a-e) Development of wings pads in various instars of *T.fitzgeraldi* (First to fifth instar)

**Table 1. Identification key to the various instars of *T. fitzgeraldi***

1	Pronotum parallel having posterior sulcus and posterior margin bilobed semi-circular. Wing pads not appeared.....	1 <sup>st</sup> instar
–	Pronotum divergent towards metazona, tactiform, prozona larger than metazona. Slight line of wing pad appeared .....	2 <sup>nd</sup> instar
2	Pronotum divergent towards metazona, tactiform, posterior margin of pronotum obtusely rounded. Wing pads sharp thick lines appear and directed down wards ..	3 <sup>rd</sup> instar
-	Not as above .....	3
3	Antennae ensiform with 17 segments. Wing pads directed up wards up to middle of 2nd abdominal segment .....	4 <sup>th</sup> instar
-	Antennae ensiform with 18 segments. Wing pads directed up wards up to margin of 2nd abdominal segment.....	5 <sup>th</sup> instar

Table 2: Measurements of various body parts of *T. fitzgeraldi*

Body parameters (mm)	Developmental stages (n=10)				
	1 <sup>st</sup> Instar Mean±SD (n=10)	2 <sup>nd</sup> Instar Mean±SD (n=10)	3 <sup>rd</sup> Instar Mean±SD (n=10)	4 <sup>th</sup> Instar Mean±SD (n=10)	5 <sup>th</sup> Instar Mean±SD (n=10)
Antennal segments	11.0±0.3	14.2±0.32	16.0±0.32	19.4±1.02	20.6±0.8
Antennal length	2.9±0.3	5.99±0.30	7.32±0.14	9.95±0.62	12.06±0.82
Length of pronotum	1.62±0.7	3.42±0.16	7.52±0.62	10.82±0.62	13.05±0.62
Length of femur	10.8±0.62	11±0.62	11.98±0.72	12.73±0.62	13.87±0.7
Length of tibia	9.58±0.92	10.23±0.8	11.23±0.3	12.3±1.23	13.05±0.52
Length of supra-anal plate	2.0±0.30	2.3±0.2	2.53±0.13	3.2±0.3	4.20±0.2
Total body length	14.2±0.72	15.9±2.32	17.62±2.32	19.03±0.32	21. ±0.32

**Table 3: Different stages of *T.fitzgeraldi* collected from field during various months of the year 2013-2017**

Months	Developmental stages							
	I	II	III	IV	V	Adults	Total	Percentage
January	-	3	7	5	9	7	31	5.1%
February	-	-	4	7	12	15	38	6.2%
March	2	5	6	9	13	8	43	7.1%
April	4	8	11	7	10	15	55	9.1%
May	3	5	8	13	14	23	66	10.6%
June	5	3	8	11	21	28	76	12.6 %
July	4	6	8	12	15	23	68	11.2 %
August	5	3	5	11	17	15	56	9.2 %
September	3	5	8	10	12	17	55	9.1 %
October	1	2	5	7	14	20	49	8.1 %
November	-	1	4	5	11	15	36	7.1 %
December	-	-	2	3	8	13	26	4.3 %

#### IV. MATERIAL EXAMINED

Sindh: Khairpur; kingri 28.i.2013 17♂♂ 14♀♀ (Larik.S. A), Shikarpur; Mahmooda Bagh 16.ii.2014. 18♂♂ 20♀♀ (Larik.S. A and Soomro.S), Khairpur; piryalo 9.iii.2015. 17♂♂ 26♀♀ (Larik.S. A and Soomro.S), Sanghar, Khadero and Shahpur Chakar 21.iv.2015. 20♂♂ 35♀♀ (Larik. S.A), Hyderabad; Qasimabad 7.v.2016 30♂♂ 36♀♀ (Riffat.S and Larik.S. A), Dadu: khairpur Nathan shah.20.vi. 2016. 26♂♂ 50♀♀ (Riffat.S and Soomro.S. A), Jamshoro; kotri 28.vii.2016. 28♂♂ 40♀♀ (Riffat.S and Larik.S. A), the same but 28. viii.2016. 10♂♂ 19♀♀ (Riffat.S and

Larik.S. A), Shaheed Banizir abad, Qazi Ahmed 5.ix.2016. 23♂♂ 32♀♀ (Soomro. S and Larik.S), the same but 6. x.2016. 9♂♂ 16♀♀ (Riffat.S and Larik.S. A), Khairpur; Rani Pur. 20. Viii.2017. 5♂♂ 19♀♀ (Riffat. S and Soomro.S), same but 16. ix.2017. 9♂♂ 17♀♀ (Riffat.S and Soomro.S. A), Jamshoro; Thanoo Boola khan. 5. x. 2017 11♂♂ 13♀♀ (Riffat.S and Larik.S. A), Sanghar; Tando Adam 11. xi. 2017 16♂♂ 20♀♀ (Riffat.S and Wagan M.S) same but. 23. Xii. 2017 5♂♂ 21♀♀.

## V. ECOLOGICAL ACCOUNT

*T. fitzgeraldi* is one of the most common species found all over the Sindh province. The emergence of instars of this species commonly occurs in (March to May) and late summer (September to November) so they are having biannual life. Sometimes due to diapause condition their hatching occurs very late, so they were found throughout the year upto December. Immatures of this species occur on vegetative fields as well as deserts and semi deserts fields. Due to their color with soft body and small size they were very difficult to capture or collect in the fields. Early hoppers feed on small grasses. After feeding they prefer to go under the shady places to avoid extreme temperature and protected from their natural enemies. As hoppers of this species feed about all types of crops so it is said to be the pest of all crops and cause huge damage.

## VI. CONCLUSION

Immature stages of *T. fitzgeraldi* species are the phytophagous so it was immense need of time to know properly about their various instars stages along with their harmful nature and distribution. This study also contributed to explore the identification keys, digital images of instars and line drawing along with various instars. Moreover, keeping in mind the above fact about *T. fitzgeraldi* this research was conducted to study the immature stages along with their distribution, morphometry and ecology.

## ACKNOWLEDGMENT

The authors are highly thankful to Mr. Raja Sohail Ahmed Larik PhD Scholar, Nanjing University of Science and Technology, 210094, P.R China for his constructive comments and English corrections.

## REFERENCES

- [1] Lomer CJ, Bateman RP, Johnson DL, Langewald J, Thomas M .2001. Biological control of locusts and grasshoppers. Annual Review of Entomology 46: 667–701. <https://doi.org/10.1146/annurev.ento.46.1.667>
- [2] Samiullah Soomro and Riffat Sultana. 2020. "Diversity with position of habitat of Pyrgomorphidae Brunner von Wattenwyl, 1874 (Orthoptera: Caelifera) from Khairpur, Sindh", International Journal of Current Research, 12, (07), 12647-12650. DOI: <https://doi.org/10.24941/ijcr.39171.07.2020>
- [3] Kirby, W.F., 1914. The Fauna of British India Including Ceylon and Burma-Orthoptera (Acrididae). Taylor and Francis, London, Pages: 276.
- [4] Bei-Bienko, G.Y. and L.L. Mishchenko, 1951. Locusts and Grasshoppers of USSR and Adjacent Countries. Monston Publishers, Jerusalem, Israel, pp: 400.
- [5] Dirsh, V.M., 1965. The African Genera of Acridoidea. Cambridge Univ. Press, London, Pages: 579.
- [6] Ahmad, M.M., 1958. The acrididae of Lyallpur. M.Sc. Thesis, Punjab University, Lahore, Pakistan.
- [7] Hollis, D., 1970. A revision of the genus *Tristria* (Orthoptera: Acridoidea). J. Natural Hist., 4: 457-480.
- [8] Moeed, A., 1971. Key to the identification of grasshoppers belonging to family Tetrigidae and subfamilies Acridinae and Oedipodinae of Hyderabad and adjoining areas. Sindh Univ. Res., J., 5: 79-92.
- [9] Perwin, R., H. Ahmed and M. Ahmed, 1983. Seasonal incidence of grasshoppers in Karachi (Pakistan) on general vegetables. Bull. Zool., 1: 67-77.
- [10] Samiullah Soomro, Riffat Sultana, Ahmed Ali Samejo, Mohan Lal. 2020. Past Outlook and Current Taxonomic Scenario of Genus *Chrotogonus* (Pyrgomorphidae: Orthoptera): A Review. International Journal of Zoology and Applied Biosciences. Volume 5, Issue 5, pp: 249-254. Link: <https://www.ijzab.com/article/320>
- [11] Wagan, M.S., 1990. Grasshoppers (Acrididae) of Sindh. Pakistan Science, Foundation., Islamabad, Pakistan, pp: 110.
- [12] Mazhar, N., A. Suhail and M. Yousuf, 1993. Check list of the acrididae of the Punjab province. Pak. Entomol., 15: 9-12.
- [13] Jago, N.D., 1996. Song, sex and synonymy: The palaearctic genus *Acrida* Linnaeus (Orthoptera, Acrididae, Acridinae) and synonymy of the subfamily Truxalinae under the subfamily Acridinae. J. Orthoptera Res., 5: 125-129.
- [14] Suhail A, Khan H.A, Naeem-Ullah U and Arif M.J.2000. Taxonomic Studies of the Subfamilies Tropidopolinae and Truxalinae (Acrididae: Orthoptera) from Pakistan. Pakistan Journal of Biological Sciences 3 (6): 1069-1072.
- [15] Anjum S., N. M. Malik, and M. Yousf .1994. Taxonomic studies on Acridinae (Acrididae: Orthoptera) of the Punjab, Pakistan. Pakistan Entomologist 16 (1/2), 55-58.
- [16] Riffat, S., & Wagan, M. S. 2012. Review of the genus *Hieroglyphus* Krauss 1877 (Hemiacridinae: Acrididae: Orthoptera) with description of one new species from Pakistan. Pakistan Journal of Zoology, 44(1), 43-51.
- [17] Larik S.A, Sultana R, Wagan M.S, Khatri I.2022. Study on the immature stages of *Truxalis eximia eximia* Eichwald, 1830 (Acrididae) from Sindh Pakistan. Journal of Xi'an Shiyou University (Natural Science Edition), vol. 18, issue 3, pp. 326-333.
- [18] Riffat Sultana, Samiullah Soomro and Chuan Ma. 2022. Molecular Identification of *Chrotogonus* spp. (Pyrgomorphidae: Caelifera: Orthoptera). Pakistan J. Zool., vol. 54(4), pp 1931-1934, DOI: <https://dx.doi.org/10.17582/journal.pjz/20190826170812>
- [19] Key, K., 1930. Preliminary ecological notes on the Acridiinae of the Cape Peninsula. South Afr. J. Sci., 27: 406-413.



- [20] Vickery V. R., Kevan D. K. McE. 1983. A monograph of the orthopteroid insects of Canada and adjacent regions. Lyman Entomological Museum and Research Laboratory Memoir No.13, 1-1462
- [21] Riffat, S., & Wagan, M. S. 2012. Review of the genus *Hieroglyphus* Krauss 1877 (Hemiacridinae: Acrididae: Orthoptera) with description of one new species from Pakistan. Pakistan Journal of Zoology, 44(1), 43-51.

- [22] Wagan, M., & Riffat, S. 2013. Biodiversity and distribution of the orthoptern insects of Pakistan. Paper presented at the Proceedings of Pakistan Congress of Zoology, 24, 57-58

**Correspondence Author** – Dr. Sajjad Ali Larik,  
Department of Zoology, University of Sindh,  
Jamshoro. Email: [sajjadsaleh@hotmail.com](mailto:sajjadsaleh@hotmail.com)