

Study on the immature stages of *Truxalis eximia eximia* Eichwald, 1830 (Acrididae) from Sindh Pakistan

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

*. Department of Zoology, University of Sindh Jamshoro Pakistan

** Department of Entomology, Sindh Agriculture University Tandojam Pakistan

Abstract-Grasshoppers are considered to become the most important group of Class Insecta for their contribution to variety and abundance. Many crops, including sugarcane, sandal, Pinus, tomato, gram, groundnut, maize, jowar, millet, pearl, and rice, are considered severely pest by *Truxalis eximia eximia* Eichwald, 1830. Present study was carried out during the March to September 2013-2017. The adults and nymphs were captured from agricultural fields and reared under laboratory conditions. It was observed that *Truxalis eximia eximia* passes upto 5 instars to become adult. Addition to this, description of species, line drawing of instars, digital images of instars, identification key of instars along with ecological distribution are provided. Hopefully, this study will be beneficial for the future researchers dealing with the *Truxalis* fauna.

Index Terms-Acrididae, Instars, agricultural crops, Ecological distribution, identification key.

I. INTRODUCTION

Grasshoppers are known to be the most important group of Phylum Arthropoda for their contribution to diversity and abundance. They are an important component of agricultural fields and grasslands, and their global pest status has been reviewed in detailed [1]. Acridid grasshoppers feed on a wide variety of plants, although the normal diets of most species are strictly limited to only a few species. Information on host plants is available for many acridids [2]. *Truxalis eximia* Eichwald, 1830 is regarded as severe pest of many crops such as sugarcane, sandal, Pinus, tomato, gram, groundnut, maize, jowar, millet, pearl, and rice. The species belonging to genus *Truxalis* are found in various habitats which are associated with one another. These species were found in habitats with grasses that quickly grow upto 2 to 3 feet height in spaces [3]. The type of *Acrida gigantea* (Herbst, 1786) according Herbst is from Europe, southern Europe, as it is unspecified primary type. Two subspecies of *Truxalis eximia* Eichwald, 1830 are known; *cypria* Dirsh, 1950 and *eximia* Eichwald, 1830, later one is recorded here from Tandojam. From Pakistan *Truxalis eximia eximia* Eichwald, 1830, was previously recorded by [4] [5]. *Truxalis fitzgeraldi* Dirsh, previously [4] recorded as *Truxalis grandis fitzgeraldi* and [6] as *Truxalis fitzgeraldi* Dirsh. The type of *T. fitzgeraldi* is unspecified primary type and the Type locality is from Asia-Temperate, Western Asia, Iran. Acridinae consists of 12 species recorded by [4] from various localities of Pakistan, including *Acrida gigantea* (Herbst). *A. turrita* (Linnaeus), *A. lugubris* Burr. *A. exaltata* (Walker). *Gonista rotundata* Uvarov. *Phlaeoba infumata* Brunner, *P. panteli* I. Bolivar, *Ceracris deflorata* (Brunner), *C. nigricornis nigricornis* Walker, *C. nigricornis laeta* (I. Bolivar), *Duroniella gracilis* Uvarov and *D. laticornis* (Krauss) have been recorded from various localities of Pakistan. The goal of present study was to study on morphometrics of immature stages of *Truxalis eximia eximia* species.

II. MATERIALS & METHODS

A. Investigation Area

Various stages of *Truxalis eximia eximia* were collected from agricultural fields i.e. maize, millet, sorghum, wheat, berseem, alfalfa, vegetables and grasses around the periphery of field and as well as from water channels with the help of traditional insect hand net (8.89 cms in diameter and 50.8 cms in length) and same by hand picking. Collection was made in the months of March to September 2013-2017.

B. Killing and preservation of samples

For the killing and preservation of specimens' method described by Vickery & Kevan (1983) [7] and Riffat & Wagan (2012) [6] was adopted.

C. Sorting out of different hopper stages

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

D. Identification and measurement of hopper

Identification of hopper was carried out under the stereoscopic dissecting binocular microscope. The body parts of the hoppers were measured with vernier caliper except first and second instars. The first and second instars / hopper were measured by ocular squire graph at 2x and segments of antennae were counted under microscope. All the measurements are given in millimeter (mm).

III. RESULTS & DISCUSSION

E. *Truxalis eximia eximia* Eichwald (1830)

1) Description of adult male

Moderately extended body structure and sword like antennae or ensiform with 16 segments brown in color to some extent longer than pronotum and head. Conical and elongated head thin fastigium of vertex towards front portion conical and elongated. Anterior margin of fastigim vertex narrow with circular apex. Metazona angular and tectiform in shape, tegmina strip like and narrow with brownish dots upon the apex. Wings are semitransparent and greenish sylendrical. Hind femur extended with carinal lines on upper knee lobes

with three conical spines. Hind tibia brownish extended thin with 23 to 24 black tipped spines on both lateral sides. Supra-anal plate with sub-acute apices and oblong cerci compacts at bottom having sub-acute apices. Small ovipositor having ventral and dorsal valve with circular and acute apices, round ventral valve at bottom and their size is small.

2) Description of adult female

Large and resembling with male, apex with blackish spots and with thin band on tegmina and wings are semitransparent and greenish swordlike or cylindrical. Similarly, femur contains carinae and it is elongated in size. Wings shape blackish colored. Extended femur with carinae.

3) Coloration

Their body is greenish and dusty. Brown reddish eyes and antennae. Similarly, hind femur with angular apex and dusty brown with black tipped spines present at both sides.

4) Comparative note

Earlier its morphological characteristics were reported by Wagan (1990) [8] but there were some minor differences in information regarding colors. Species were mostly found in vegetative areas, grassy lands trenches and track sides. Wagan (1990) [8] collected specimens of this species from Khairpur, Larkana, Hyderabad, Dadu and Thatta regions of Sindh. Similarly, Yousuf (1996) [9] collected this species from Hyderabad, Badin, Faisalabad and Rawalpindi areas of Sindh and Punjab.

5) Description of immature stages of *Truxalis eximia eximia* Eichwald, 1830

Figure. 1, 2; Table. 1, 2

1ST INSTAR

Body light green in colour. Antennae ensiform with 9-10 segments. Wing-pads slightly appears. Fastigium of vertex

having outer margin raised and curved. Pronotum and femur with black spot towards centre at the outer side. Supra-anal plate elongated leaf shaped.

2ND INSTAR

Antennae ensiform with 11-12 segments. Wing-pads slightly appears with rounded margin directed down wards. Fastigium of vertex having outer margin raised and curved, pronotum possess median and lateral carinae. Femur with black spots towards centre. Supra-anal plate elongated leaf shaped and hairy.

3RD INSTAR

Body green in colour. Antennae ensiform with 13-14 segments. Fastigium of vertex having outer margin raised and curved. Pronotum with mediana carinae and lateral side. Wing-pads slightly moves upwards. Femur having black spots towards centre of outer side. Tibia with 21 outer and 22 inner spines.

4TH INSTAR

Antennae ensiform with 15-16 segments. Wing-pads reaches up to half of the 1st abdominal segment. Fastigium of vertex having outer margin raised and curved inwards. Pronotum shorter than head, Femur having black spot. Tibia with 23 spines outer and 24 inner spines.

5TH INSTAR

Antennae ensiform with 17-18 segments. Wing-pads reaches up to 2nd abdominal segment. Fastigium of vertex having outer margin raised and curved inwards. Pronotum with median and lateral carinae distinct. Tibia possess 25 outer and 26 inner spines.



1ST INSTAR



2nd INSTAR



3RD INSTAR



4TH INSTAR



5TH INSTAR

Figure 1. Various developmental stages of *Truxalis eximia eximia*

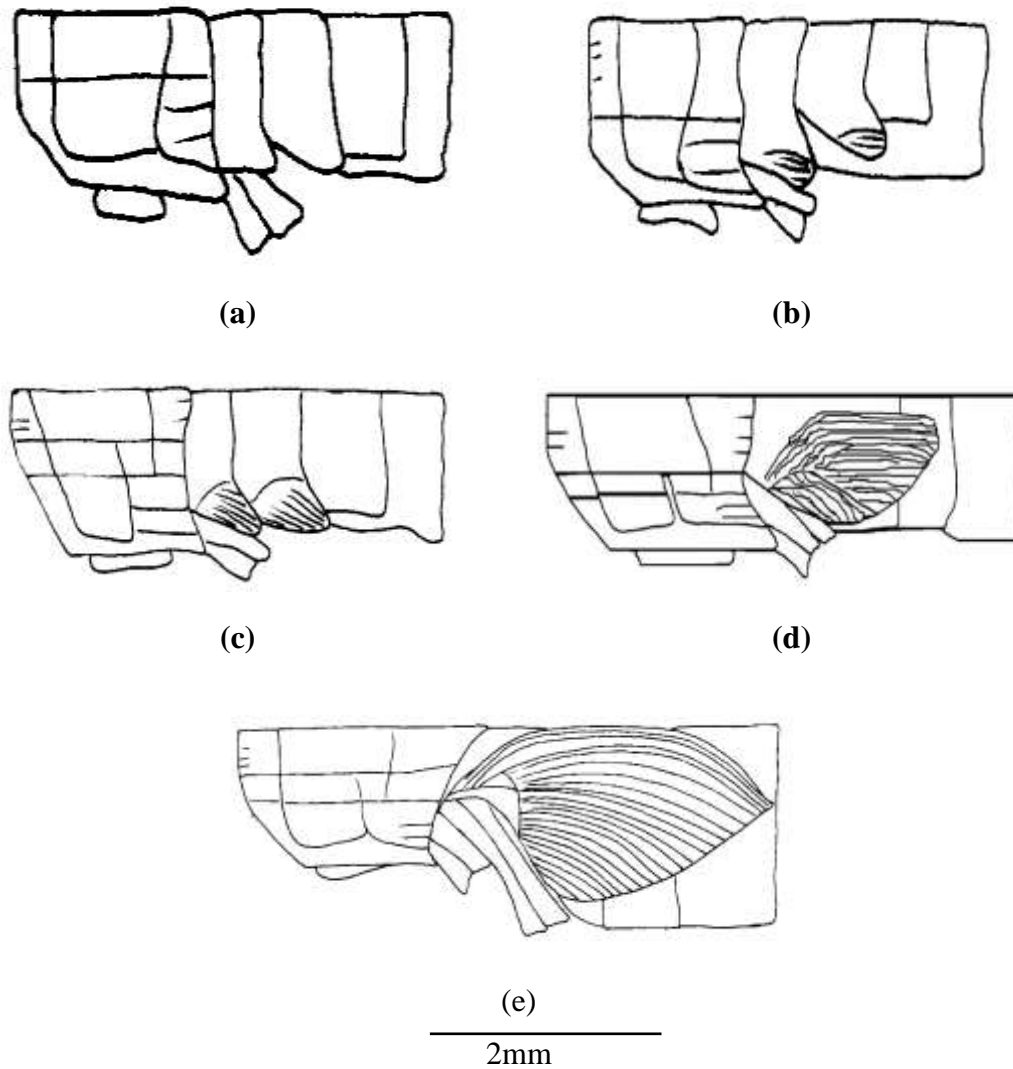


Figure 2 (a-e) Development of wings pads in various instars of *Truxalis eximia eximia* (First to fifth instar)

Table 1 Identification key to the various instars of *Truxalis eximia eximia*

1	Frontal edge of pronotum somewhat obtusely protruding posterior angle of apex of pronotum rounded upper valvula of female ovipositor thin and extended 3.5 times as long as wide.....	1 st Instar
-	Frontal edge of pronotum truncate apex of posterior angle of lateral lobe of pronotum completely angular or very short truncate upper valvula of female ovipositor expended and small 2.5 times as long as wide	2 nd Instar
2	Body green in colour Antennae ensiform with 13-14 segments. Fastigium of vertex having outer margin raised and curved. Pronotum with median carinae and lateral side. Wing-pads slightly moves upwards. Femur having black spots towards centre of outer side. Tibia with 21 outer and 22 inner spines.....	3 rd Instar
-	Not as above.....	3
3	Antennae ensiform with 15-16 segments. Wing-pads reaches up to half of the 1st abdominal segment. Fastigium of vertex having outer margin raised and curved in wards pronotum shorter than head. Femur having black spot. Tibia with 23 spines outer and 24 inner spines	4 th Instar
-	Antennae ensiform with 17-18 segments. Wing-pads reaches up to 2nd abdominal segment. Fastigium of vertex having outer margin raised and curved inwards. Pronotum with median and lateral carinae distinct. Tibia possess 25 outer and 26 inner spines.....	5 th Instar

Table 2 Morphometric characteristics of various body parts of *Truxalis eximia eximia*

Body parameters (mm)	Developmental stages (n=10)				
	1 st Instars Mean±SD (n=10)	2 nd Instars Mean±SD (n=10)	3 rd Instar Mean±SD (n=10)	4 th Instar Mean±SD (n=10)	5 th Instar Mean±SD (n=10)
Antennal segments	10.5±0.23	15.32±1.02	17.4±0.32	19.3±1.03	21.23±0.6
Antennal length	3.52±0.12	3.9±0.12	5.5±0.12	8.5±0.25	10.8±0.23
Length of pronotum	1.82±0.12	2.8±0.12	3.0±0.12	4.9±0.034	5.0±0.012
Length of femur	8.9±0.23	9.8±1.62	9.62±0.4	11.25±0.76	13.2±0.5
Length of tibia	7.6±0.21	8.23±1.23	10.52±0.32	10.82±0.5	11.5±0.4
Length of supra-anal plate	1.5±0.30	1.62±0.12	2.30±0.02	2.43±0.10	3.0±0.1
Total body length	14.8±0.32	16.32±0.32	17.42±0.13	19.32±0.42	20.0±3.0

Table 3. Different stages of *Truxalis eximia eximia* 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	8	10	33	3.5%
February	1	-	-	7	12	18	38	4.0 %
March	4	7	3	5	9	24	52	5.5%
April	6	4	9	12	16	28	75	7.9%
May	2	5	11	21	28	40	107	11.2%
June	5	8	16	18	33	56	136	14.2%
July	3	5	19	22	30	41	120	12.6%
August	4	8	10	14	16	13	65	6.9%
September	2	5	12	19	35	44	117	12.2 %
October	7	9	15	22	29	53	135	14.2%
November	-	3	5	10	11	18	47	5.0 %
December	-	1	3	6	8	10	28	3.0 %

IV. MATERIAL EXAMINED

Sindh: Khairpur; Kingri 28.i.2013, 14♂♂, 19♀♀ (Larik. S. A), Shikarpur 16.ii.2014 16♂♂, 22♀♀ (Larik.S. A and Soomro.A), Khairpur; piryaloi 9.iii.2015 23♂♂ 29♀♀ (Larik.S. A and Kumar.S), Sanghar, Khadero and Shahpur Chakar 21.iv.2015 34♂♂41♀♀ (Larik. S.A), Hyderabad; Qasimabad 7. v.2016. 48 ♂♂59♀♀ (Riffat.S and Larik.S. A), Dadu: Khairpur Nathan shah.20.vi.2016. 65♂♂71♀♀ (Larik.S. A Panhwar.W. A), Jamshoro; Kotri 28.vii.2016. 57♂♂ 63♀♀ (Riffat.S and Larik.S. A), the same but 28.viii.2016 28♂♂ 37♀♀ (Riffat. S and Larik. S. A) Shaheed Banizir abad, Qazi Ahmed 5.ix.2016. 54♂♂ 63♀♀ (Riffat. S and Larik.S), the same but 6. x.2017. 64♂♂ 71♀♀ (Riffat.S and Larik.S. A), Khairpur; Rani Pur. 20. Xi.2017 19♂♂

28♀♀ (Riffat. S and Wagan M.S), Jamshoro; Thano Boola khan. 5. Xii. 2017 11♂♂ 17♀♀. (Riffat. S and Larik. S.A).

Ecological Distribution (Table. 3)

Truxalis eximia eximia is one of foremost and broadly dispersed species in Sindh. Hoppers generally hatch out in field during April. They are found in fields of mixed grasses and agricultural fields. Mostly on *Desmostachya bipinnata*. *Truxalis eximia eximia* is quite abundant in such fields where green grasses are present. Hoppers of this species shows color variations so generally it is found in two colors, light green, and creamy color. Early, instars mostly found in open grounds and on the sides of vegetative fields in the

morning time which is ideal time for their feeding and temperature also looks good but when temperature increases so they stop feeding and hide themselves under shady places. Again, in the evening time they come out for feeding in the field it was noted that the early hoppers feed more than adults because they lack functional wings. Earlier 3 instars prefer to feed on lawn grasses i-e *Penicum tergidum* (Boora) *Digitaria* sp. and other grasses. During feeding if they feel any different fields of maize, jowar, and paddy. Generally immature endure to be associated with crops but some of them were also captured from the short distance sides of crop fields. During any danger they hide themselves in grasses and shady places from their natural enemies as well. Threat rapidly, they stop feeding and hide under the shades of grasses. They are widely dispersed through

I. CONCLUSION

Present study concludes the study on immature stages of *Truxalis examia examia* for the first time. Besides, it was noted that *Truxalis examia examia* is one of foremost and broadly dispersed species in Sindh. Hoppers generally hatch out in field during April. So their breeding season starts from April to July.

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Correspondence Author – Dr. Sajjad Ali,
Department of Zoology University of Sindh
Jamshoro. Email address.sajjadsaleh@hotmail.com