TAXONOMIC STUDIES OF THE GRASSHOPPERS OF THE SUBFAMILY TROPIDOPOLINAE (ACRIDIDAE: ORTHOPTERA) IN LARGEST INDIAN STATE, UTTAR PRADESH

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ABSTRACT: Family Acrididae is widely distributed in India and members are called typical grasshoppers. Grasshoppers are the most abundant aboveground insect found especially in dry habitat and also distributed in crop fields. Plant feeding by grasshoppers can deplete plant biomass and damage crops. In extreme cases herbivory can cause ecosystem damage. This can occurs directly from disruption of habitat by loss of vegetation or indirectly through induced erosion of soil. Members of the subfamily Tropidopolinae are purely raminivorous but also feed on crops and cause defoliation. Two species of grasshoppers *Tristria pulvinata* (Uvarov, 1921) and *Tropidopola longicornis* (Fieber, 1853) of the subfamily Tropidopolinae recorded from Uttar Pradesh, India.

KEY WORDS: Taxonomy, Tropidopolinae, Acrididae, grasshoppers, Uttar Pradesh.

Subfamily Tropidopolinae was erected by Jacobson in 1905 to include *Tropidopola* as its type genus. Subfamily has been studied by Dirsh (1961), Uvarov (1966), Hazra et al. (1995) and Day & Hazra (2003). This is represented by two genus *viz*. *Tristia* and *Tropidopola* from India. Genus *Tristria* was originally erected by Stal (1873) to include a new species *lacerta* described from China. Uvarov (1921) erected the genus *Tapinophyma* to include a new Indian species *pulvinata*. Later on Uvarov (1923) synonymized the genus *Metapula* (erected by Giglio-Tos, 1907) and *Tapinophyma* with *Tristria*. Genus *Tropidopola* was erected by Stal (1873) to include *cylidrica* as a type species. Taxonomy of this species has been done by Bei-Beinko & Mishchenko (1951), Harz (1975) and Usmani (2008) respectively.

Recently taxonomy of these species have been done by Chandra et al. (2007) from Madhya Pradesh and Chattisgarh, Shishodia et al. (2010) from India, Usmani & Khan (2010) from Northestern states, Usmani & Nayeem (2012) from Bihar, Nayeem & Usmani from Jharkhand (2012), Kumar & Usmani (2013) from Rajasthan, Nayeem et al. (2013) from Bihar and Kumar & Usmani (2013) from Punjab respectively. There is no consolidated study of the grasshoppers belonging to this subfamily in Uttar Pradesh except Usmai et al. (2010) who reported only *Tropidopola longicornis* from Western Uttar Pradesh, thus authors tried to study the taxonomy and distribution of these species of grasshoppers in order to make the record up to date.

Largest Indian state in terms of population is Uttar Pradesh, located at 26.8500° N, 80.9100° E has a humid temperate climate, demarcated into three distinct regions. Himalayan region in the north, Gangetic plains in the centre and Vindhya Hills & Plateau to the south. The state is bordered by Rajasthan to the west, Haryana and Delhi to the northwest, Uttarakhand and the country of Nepal to the north, Bihar to the east, Jharkhand to the southeast, and Madhya Pradesh to the southwest. The climate varies from moderately temperate in the Himalayan region to tropical monsoon in the central plains and southern upland regions. In the plains, the average temperatures vary from 12.5°C to 17.5°C in January and

27.5°C to 32.5°C in May and June. Rainfall in the state ranges from 40-80 inches in the east to 24-40 inches in the west. It is the second largest state of India by economy, the leading sector is agriculture and majority of the population depends upon farming.

Orthoptera constitutes 26,330 valid species found throughout the world (http://Orthoptera.SpeciesFile.org>. dated 20.3.2014) and out of that 1033 species, 400 genera and 21 families are known from India (Shishodia et al., 2010). The Order is divided into two suborders *i.e.* Caelifera called short horned grasshoppers and Ensifera called long horned grasshoppers (Ander, 1939). Suborder Ensifera have antennae longer than the body length thus called long horned grasshoppers. The auditory organs located on the fore legs and they stridulate through the base of their forewings. The females usually have long ovipositors extended from the end of their abdomen. Suborder Caelifera includes the short-horned grasshoppers have antennae shorter than the body length. The auditory organs are found on the first abdominal segment and they stridulate by lateral part of their forewings. Females normally larger than males with short ovipositor.

Acrididae is the family under the Caelifera called grasshoppers and locust, comprising 8,000 species around the world and out of that136 species and 28 genera are endemic (Chandra & Gupta, 2013). Members of this family usually have their wings well developed and sometimes brightly coloured. Most of them have an annual life cycle. Some species, under some conditions, will migrate in a dense swarms form, known as locusts. Grasshoppers are the small creature of nature, small to large sized insect found everywhere and well known for their jumping behavior. They cause considerable damage to agricultural crops, pastures and forests (Joshi et al., 1999). The primary diet for grasshoppers is grasses and forbs (Behmer & Joern, 1993). It is primarily graminivorous, feeding on several common grasses and sedges (Mulkern, 1967).

MATERIAL AND METHODS

I. Collection, killing and identification

Authors surveyed paddy fields of Uttar Pradesh to collect the grasshopper *Tristria pulvinata* and *Tropidopola longicornis* during the period of 2010-2012. They were caught by the ordinary aerial insect net and through hand picking as well. The collected specimens were killed in bottles having soaked cotton with ethyl acetate. Dry mounts were prepared for better understanding the certain characters like size, colour, texture etc. For this purpose, the specimens were first relaxed, stretched, later pinned and labeled. Specimen identifies the with the help of binocular stereoscopic microscope (Nikon SMZ 1500) upto species level on the basis of characters like size, colour and texture, running with available literature and keys.

II. Morphometry and preservation

Measurement in mm of four important differentiating parts of body (Body length, pronotum, tegmina and hind femur) has been done with the help of Vernier Calliper. Mean value, Standard Deviation of male and female are calculated to show the differentiation and intraspecific variation. Permanent collections of pinned specimens were kept in store boxes and cabinets with complete records indicating the reference number, locality, date of collection and name of host plants. To prevent decomposition of the specimens, naphthalene balls were kept in boxes and for wet preservation specimens are stored in plastic vials using 70 % ethyl alcohol.

RESULTS

Two species of grasshoppers *Tristria pulvinata* and *Tropidopola longicornis* of the subfamily Tropidopolinae recorded from Uttar Pradesh, India during the survey of the duration 2010-2012.

SUBFAMILY TROPIDOPOLINAE JACOBSON, 1905

Tropidopolini Jacobson, 1905. Orthopteroid and Pseudoneuropteroid Insects of Russian Empire and adjacent countries, 73, 306.

Type-genus: *Tropidopola* Stal, 1873. Recencio Orthopterorum. Revue critique des Orthopteres decrits par Linne, De Geer et Thunberg, 1: 43, 86.

Diagnostic characters: Body strongly elongate, narrow; head cylindrical in profile; frons usually oblique; fastigium of vertex short, dorsum of pronotum of variable shape, crossed by three transverse sulci, median and lateral carinae present or absent; dorsum of pronotum of variable shape; prosternal process present; mesosternal interspace closed; tegmina or wings fully developed or shortened; tympanum present; hind femur never robust, lower basal lobe shorter than upper one; external apical spine of hind tibia present; arolium medium to large sized.

Two genera of this subfamily have been reported from the region and a key for their separation is given below.

KEY TO INDIAN GENERA OF TROPIDOPOLINAE JACOBSON, 1905

1. Pronotum flattened, lateral carinae present, posterior margin truncated; lower genicular lobe of hind knee short and round; frontal ridge flat.....*Tristria* Stal, 1873
- Pronotum cylindrical, lateral carinae lacking, posterior margin rounded; frontal ridge shallowly sulcate; lower genicular lobe of hind femora acute angular..*Tropidopola* Stal, 1873

Genus *Tristria* Stal, 1873

Tristria Stal, 1873. Recencio Orthopterorum. Revue critique des Orthopteres decrits par Linne, De Geer et Thunberg, 1: 40, 80.

Type-species: *Tristria lacerta* Stal, 1873 (= *pisciforme*). Revue critique des Orthopteres decrits par Linne, De Geer et Thunberg, 1: 80.

Metapula Giglio-Tos, 1907. Boll. Musei Zool. Anat. Comp. R. Univ. Torino, 22 (554): 10. Syn. by Otte, 1995. Orthoptera Species File, 4: 99.

Type-species: *Metapula olivacea* Giglio-Tos, 1907 (= *Tristria discoidalis*). Boll. Musei Zool. Anat. Comp. R. Univ. Torino, 22 (554): 11.

Tapinophyma Uvarov, 1921. Ann. Mag. nat. Hist., 9-7: 496. Syn. by Otte, 1995. Orthoptera Species File, 4: 99.

Type-species: *Tapinophyma pulvinata* Uvarov, 1921. Ann. Mag. nat. Hist., 9-7: 497.

Diagnostic characters: Body small to medium size; antennae thick, filiform, in basal half compressed, shorter than head and pronotum together; fastigium of vertex convex, much shorter than longest diameter of eye, with median carinula; frons slightly oblique; frontal ridge flat; dorsum of pronotum flattened, crossed by three transverse sulci, median and lateral carinae distinct, almost straighjt; metazona much shorter than prozona, posterior margin truncate; porsternal process compressed antero-posteriorly, reaching anterior margin of mesosternum, apex rectangular; mesosternal interspace contiguous for short distance; tegmina and wings fully developed; hind femur slender, knee lobe short and rounded; external apical spine of hind tibia present, arolium medium sized.

The genus is represented by single species from the region.

Tristria pulvinata (Uvarov, 1921) (Fig. 1)

Tapinophyma pulvinata Uvarov, 1921. Ann. Mag. nat. Hist., 9 (7): 497.
Tristria pulvinata (Uvarov); Nayeem & Usmani, 2012. Munis Entomology & Zoology, 7 (1): 399.

Diagnostic characters: Body medium sized; antennae considerably shorter than head and pronotum together; head conical with apex rounded, frons strongly oblique; fastigium of vertex obtusely parabolic, convex, elevated, median carinula of fastigium of vertex present; pronotum elongated, tectiform, with flattened dorsum, median carina and lateral carinae weak, crossed by three transverse sulci, lateral carinae diverging posteriorly; prosternal process curved backwards, strongly flattened antero-posteriorly; mesosternal interspace closed, lobes rounded, inner margin angulated and coinciding medially; metasternal pits very closely set; tegmina fully developed extending up to hind knee but shorter than abdomen; wings hyaline, wingspan short; hind femora slender; hind tibiae straight with fourteen dorso-external and eleven dorso-internal spines; dorso-external apical spine of hind tibiae present; spurs not specialized, tarsal region weakly flattened; arolium medium sized.
Distribution: India: Andhra Pradesh, Assam, Bihar, Delhi, Haryana, Karnataka, Kerala, Maharashtra, Meghalaya, Orissa, Punjab, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. **Elsewhere:** Sri Lanka.
Material Examined: India: Uttar Pradesh: Allahabad, 3♂,3♀, 06-X-2010, On paddy & grasses; Ghazipur, 4♂,3♀, 09-X-2010, On paddy & grasses; Deoria, 2♂,4♀, 12-X-2010, On paddy & grasses; Faizabad, 5♂,4♀, 24-X-2010, On paddy & grasses; Sultanpur, 4♂,2♀, 25-X-2010, On paddy & grasses; Hamirpur, 4♂,6♀, 04-IX-2011, On paddy & grasses; Fatehpur, 4♂,4♀, 11-IX-2011, On paddy & grasses; Farrukhabad, 5♂,3♀, 06-VIII-2012, On paddy & grasses; Meerut, 8♂,7♀, 21-VIII-2012, On paddy & grasses; Muzaffarnagar, 7♂,4♀, 22-VIII-2012, On paddy & grasses; Saharanpur, 6♂,5♀, 23-VIII-2012, On paddy & grasses.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	28.32-30.14	30.23-32.68	28.93± 0.57	32.80±1.17
Pronotum	4.35-5.31	6.51-7.62	4.99±0.30	7.10±0.40
Tegmina	14.45-16.19	19.23-20.52	15.17± 0.63	19.76±0.48
Hind Femur	12.54-14.19	17.53-18.84	13.33±0.64	18.12±0.47

Standard deviation of 0.30 in case of male pronotum, 0.63 in case of tegimna, 0.64 in case of hind femur and 0.57 in case of body length indicates that size of pronotum, hind femur, tegmina and body length are not of much variable and may varies with little fractions among individuals of the species. Standard deviation of 0.40 in case of female pronotum, 0.48 in case of tegimna and 0.47 in case of hind femur indicates that size of pronotum, tegmina and hind femur are not of much variable whereas body length may varies with little fractions among individuals of the species.

Genus *Tropidopola* Stal, 1873

Tropidopola Stal, 1873. Recencio Orthopterorum. Revue critique des Orthopteres decrits par Linne, De Geer et Thunberg, 1: 43, 86.
Type-species: *Gryllus cylindricus* Marschall, 1836 (= *Tropidopola cylindrical cylindrica*). Ann. Naturhist. Mus. Wien, 1 (2): 210.

Opomala Fischer, 1853. Orthoptera Europaea, 296, 305. Syn. by Otte, 1995. Orthoptera Species File, 4: 102.

Type-species: Not available.

Opsomala Fieber, 1853. Lotos, 3: 90-104. Syn. by Otte, 1995. Orthoptera Species File, 4: 102.
Type-species: Not available.

Diagnostic characters: Body slender and of medium size; antennae thick, filiform, shorter than head and pronotum together; head acutely conical, not longer than length of pronotum; fastigium of vertex angular, not longer than longest diameter of eye, with median carinula; fastigial foveolae present; frontal ridge shallowly sulcate; dorsum of pronotum cylindrical, crossed by three transverse sulci, median and lateral carinae absent; metazona shorter than prozona, posterior margin rounded; prosternal process inflated in apical part, with wide, slightly convex, flat apical surface; tegmina narrow, reaching the tip of abdomen; hind femur slender; hind tibia with external apical spine, arolium medium sized.

The genus is represented by single species from the region.

***Tropidopola longicornis* (Fieber, 1853)** (Fig. 2)

Opsomala longicornis Fieber, 1853. Lotos, 3: 98.
Opsomala syrica Walker, 1871. Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum Supplement: 51. Syn. by Mishchenko, 1965. Fauna of Russia Orthopt., 190 [164].
Opomala cylindrica Giglio-Tos, 1893. Boll. Musei Zool. Anat. Comp. R. Univ. Torino, 8 (164): 11. Syn. by Massa & Fontana, 1998. Boll. Mus. civ. St. nat. Verona, 22: 76.
Tropidopola nigerica indica Uvarov, 1937. Ann. Mag. nat. Hist., 10 (19): 519. Syn. by Mishchenko, 1965. Fauna of Russia Orthopt., 190 [164].
Tropidopola longicornis (Fieber); Massa, 2009. Jour. Orth. Res., 18 (1): 81.

Diagnostic characters: Body medium sized; antennae filiform, slightly shorter than head and pronotum together; head conical; fastigium of vertex flattened, median and lateral carinulae sharp, median carinula extending up to vertex; frontal ridge shallowly sulcate, gradually narrowing upwards with sharp carinulae; fastigial foveolae present; pronotum finely rugose and shiny, nearly of uniform width, dorsum cylindrical, with three transverse sulci, median carina obtusely present, lateral carinae lacking; prosternal process moderate in size; tegmina fully developed, reaching abdomen; wings hyaline, wingspan narrow; hind femora slender; lower lobe of hind-knee angular; hind tibiae straight, hairy, flattened distally with two rows of black spines, eleven dorso-external while thirteen dorso-internal; spurs not specialized; arolium of large size.
Distribution: India: Bihar, Maharashtra, Punjab and Uttar Pradesh. **Elsewhere:** Africa, Egypt, Europe and Pakistan.
Material Examined: India: Uttar Pradesh: Azamgarh, 2♂,2♀, 08-X-2010, On grasses; Ghazipur, 1♂,2♀, 09-X-2010, On grasses; Sultanpur, 2♂,2♀, 25-X-2010, On paddy & grasses; Hamirpur, 3♂,2♀, 04-IX-2011, On grasses.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	32.56-34.51	38.41-42.56	33.32± 0.73	39.95±1.63
Pronotum	5.62-6.88	6.68-7.79	6.10± 0.43	7.10±0.45
Tegmina	21.85-23.04	22.28-23.34	22.42± 0.38	22.66±0.31
Hind Femur	13.37-14.71	14.54-16.15	13.90±0.53	15.33±0.64

Standard deviation of 0.43 in case of male pronotum, 0.38 in case of tegimna, 0.53 in case of hind femur and 0.73 in case of body length indicates that size of

pronotum, hind femur, tegmina and body length are not of much variable and may varies with little fractions among individuals of the species. Standard deviation of 0.45 in case of female pronotum, 0.31 in case of tegimna and 0.64 in case of hind femur indicates that size of pronotum, tegmina and hind femur are not of much variable whereas body length may varies with little fractions among individuals of the species.

DISCUSSION

Grasshoppers of the subfamily are purely graminivorous, also occurs in forest and barren areas. Adults are found from June to October. These are the economically important reported in many parts of the country by numerous authors from grasses and rarely from crops. These are defoliators feeds on whole leaves except the mid rib, resulting arrested growth and size of plants. Hoppers are vigorous feeders at particular place because of lack of wings, thus more dangerous than adults and on moulting wings developed then moves towards the periphery for feeding on another host of choice. Population of grasshoppers relatively becomes low with decreasing temperature from the month of November and appears healthy with increasing temperature and on first shower of monsoon in the month of June/July. Population also crashed due to extreme drought that results in exploitation of vegetations i.e., lack of food which bounces back on return vegetation.

In the present study distribution and taxonomy of these grasshoppers has been discussed for the first time. Taxonomy is the backbone of science without identification no one can conclude the result. Study reveals that the host plant of these grasshoppers and extensively found in grasses than crops that clearly indicate grasses are the most preferred food of this grasshopper thus may be concluded that these grasshoppers are major pest of paddy. On the absence of grasses feeds upon crops, thus cultivation techniques should be modified in such a way that grasses which support population of grasshoppers may be grown around the crop field to prevent feeding to crops thus damage may be prevented.

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Figure 1. *Tristia pulvinata*.

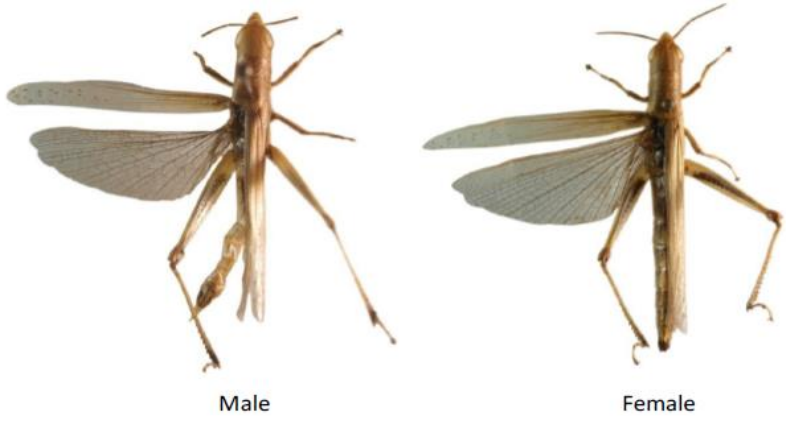

Figure 2. *Tropidopola longicornis*.