



## Female genitalia as a taxonomic tool in the classification of Indian Acridoidea (Orthoptera)

Mohammad Kamil Usmani<sup>1</sup> & Hirdesh Kumar<sup>2</sup>

<sup>1,2</sup> Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh 202002, India  
Email: <sup>1</sup>usmanikamil94@gmail.com (corresponding author), <sup>2</sup>entomologist1985@gmail.com

**Abstract:** A comparative study on female genitalia was carried out in Indian species of the superfamily Acridoidea. An attempt has been made to describe and illustrate the different structures viz., spermatheca, ovipositor, sub genital plate, supra-anal plate and cerci of female in Acridids with an aim to discover their significance in order to make the identification of genera and species, together with other generic characters more perfect and convenient. Genitalic structures particularly female subgenital plate, ovipositor and spermatheca makes it possible to put forward some suggestions regarding interrelations of families and subfamilies of Acridoidea more clearly than the external characters.

**Keywords:** Acridoidea, female genitalia, Indian species, Orthoptera, significance.

All the economically important species belonging to the superfamily Acridoidea are commonly known as locusts and grasshoppers. Sometimes they are called Short-horned Grasshoppers in contrast to Ensifera (Tettigonoidea and Grylloidea) or Long-horned Grasshoppers which constitute one of the other

suborders of Orthoptera. Locusts and grasshoppers constitute an economically important group of orthopterous pests that infest a number of cultivated and noncultivated crops. They cause considerable damage to agricultural crops, pastures and forests and are well reputed for their destructiveness all over the world. Locusts and grasshoppers have invaded green crops from the earliest days to the present time. Locusts are the main pests in countries bordering deserts. The devastations caused by migratory swarms of locusts are well known. Swarms of the Desert Locusts *Schistocerca gregaria* have plagued agriculture from ancient recorded times.

The accurate identification of the pest is the essential basis for all investigations. Correct identification and knowledge on the biology is very essential for evaluation of the damage caused by the pests and also for developing suitable control measures. Knowledge of the biology, behaviour of a pest is fundamental to an understanding of its ecology and population dynamics and to developing efficient control methods. Knowledge of the nature and causes of pest damage is also essential in order to suggest the appropriate amount of research and control efforts required. Experience has shown that control of agricultural pests is made easier when their taxonomy and biological observations have been placed on a sound basis.

The genitalic structures particularly epiphallus, aedeagus and spermatheca are less affected than the external characters by environmental conditions. A comparative study of these characters may therefore help to trace the interrelationship of the groups more clearly than the external characters.

The genitalia of many animals, particularly arthropods, not only show a great deal of structural detail but are also highly species-specific. Genitalic structures are most useful among the arthropods. In many group of insects genitalic structures are more important for species diagnosis than any other

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character.

It has been suggested that a lock and key relationship exists as regards the copulatory structures of the males and females of those species with sclerotised genitalia. Such appears the case in certain group of insects. In general, genitalic structures must be evaluated just like other characters. In groups where their significance has been proved they are usually very useful, because genitalic structures appear to be among the first to change in the course of speciation. Recently in 2009 Usmani studied the male and female genitalia in some Libyan species of Acrididae.

The present study is based on the conventional as well as genitalic characters, for a better understanding of the significance of morphological structures. Comparative study has been done on genitalia with reference to subgenital plate (Fig. 1a), ovipositor (Fig. 1b), spermatheca (Fig. 1c) and supra-anal plate & cerci (Fig. 1d), of females.

## Methods

**Preparation for genitalic studies:** For a detailed study of the various components of genitalia, the apical part of female bodies was cut off and boiled in 10% potassium hydroxide for a variable period till the material became transparent (usually about 10 minutes) to remove unsclerotized and non-chitinous tissues. They were then thoroughly washed in tap water for complete removal of KOH and examined in 70 percent ethyl alcohol on a cavity slide. Later, every specimen was dissected under a binocular microscope with the help of fine needles to separate various components viz., supra-anal plate and cerci, subgenital plate, ovipositor and spermatheca. The normal process of dehydration was adopted and clearing was done in clove oil. The genitalic structures were mounted separately on cavity slides in Canada balsam. A 22mm square cover-glass over the cavity of the slide was normally used when examining the supra-anal plate and subgenital plate. This was made to prevent them from curling upwards and inwards at the edges. The ovipositor was mounted in Canada balsam on another cavity slide oriented to the required position without cover glass. The slides were kept in a slide drier at a temperature of approximately 40°C for about one week to get them completely dry.

The permanent slides were examined under the microscope in order to make a detailed study of the

genitalic structures.

Drawings were initially made with the help of a camera lucida. Details were filled in by conventional microscope examination.

## Observations and Results

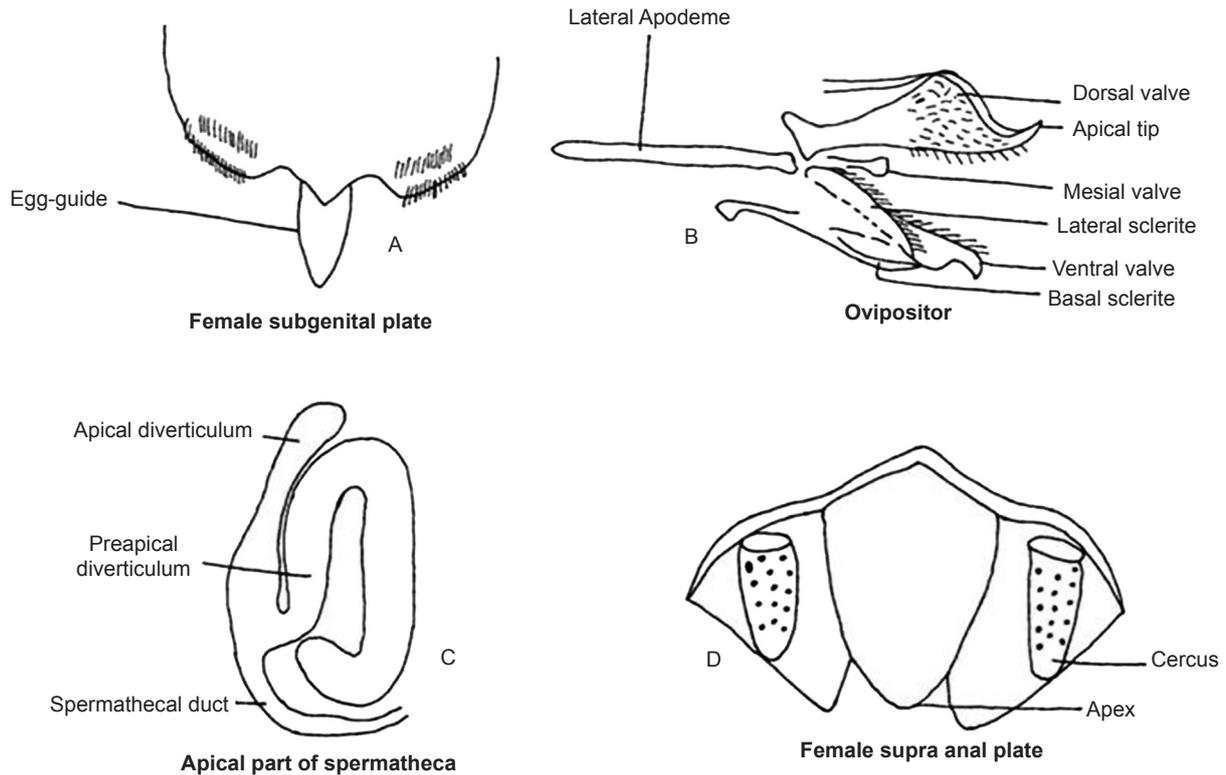
For a better understanding of the significance of genitalic structures, comparative study has been done on genitalia with reference to subgenital plate, supra-anal plate & cerci, ovipositor and spermatheca of females.

### Female Genitalic Structures

**Subgenital plate (VIII sternite) (Fig. 1a):** The subgenital plate of the female is the VIII sternite and therefore not homologous with that of the male. In the middle the surface has a finger-like process, the egg-guide which extends beyond the posterior margin of the plate between the bases of the lower ovipositor valves is often concealed by them. On each side of the egg-guide there are sometimes found brown sclerotised patches discovered by Jannone (1939) who regarded them as sensory.

Rudimentary or well developed condition of the egg-guide is taken as stable characters for separating various families. The presence or absence of Jannone's organs and setae on the posterior margin of the female subgenital plate are taken as subfamilial characters. Posterior margin is entirely setose in the subfamilies Acridinae, Truxalinae and Oedipodinae; setae confined to posterior lateral margins in the subfamilies Catantopinae, Coptacridinae, Cyrtacanthacridinae, Eypreponemidinae and Calliptaminae; posterior margin without setae in Oxyinae and Gomphocerinae, sometimes present in the latter subfamily. Shape of the posterior margin of subgenital plate is suggested as a generic character. Length and shape of the egg-guide of the female subgenital plate is considered as characters of specific significance. Flat or concave, smooth or dentate condition of the ventral surface of the plate is used for separating various species of the genus *Oxya*.

**Ovipositor (Fig. 1b):** It consists of three pairs of valves, two of them large and conspicuous and the third (inner) concealed between them. The ventral valve is articulated with the subgenital plate and ends in a strongly sclerotised hook. The dorsal valve is also strongly sclerotised and with a hook-like tip. The



**Figure 1. Female genital structures in Acridoidea**

inner valve is a small, moderately sclerotised lobe. Basally, the valves are articulated with a pair of long, parallel sclerotised apodemes, extending well into the body cavity, to which are attached the main muscles of the ovipositor.

Long and slender or short and broad condition of the ovipositor valves are taken as stable characters for separating various subfamilies. Length of the lateral apodeme in relation with the dorsal valve is regarded as a generic character. The shape of valves and apical tips are regarded as specific characters.

**Spermatheca (Fig. 1c):** The spermatheca is also known as recepticulum seminis. It is an essential part of the female reproductive system in which the spermatozoa are stored, and they can be ejected upon eggs as the latter are passed from the oviduct.

The spermatheca of Pamphagidae has a single apical diverticulum although the same type occurs in other families (Pyrgomorphidae); while Acrididae as a family is characterised by a spermatheca with two diverticula. Tubular or sac-like condition of pre-apical diverticula of spermatheca is taken as stable characters for separating various families. The long or short and slender or broad condition of apical, tubular or sac-

like condition of pre-apical diverticula of spermatheca are suggested as valid characters for grouping the subfamilies. Apical and preapical diverticula of spermatheca tubular in the subfamilies Oxyinae, Hemiacridinae, Coptacridinae, Eypreocnemidinae, Tropidopolinae and Calliptaminae; apical diverticulum very long and slender, preapical diverticulum tubular in Cyrtacanthacridinae, Catantopinae and Romaleinae; apical diverticulum short or rudimentary, preapical diverticulum sac-like in the subfamilies Acridinae, Truxalinae, Gomphocerinae and Oedipodinae.

The size of apical and preapical diverticula and the presence or absence of protuberance on preapical diverticulum is taken as specific characters.

**Female supra-plate and cerci (Fig. 1d):** The X tergite, the epiproct and the cercus in females are always of simple structure, even in the species where these parts are highly specialised in the male sex but in some groups there may be considerable variation in its shape and size. The shape of the female supra-anal plate is suggested as a useful generic character. The shape and length of the female cerci are considered as characters of specific significance.

## Discussion

Earlier studies on the systematics of Indian Acridoidea are exclusively based on conventional external visible characters, namely shape, size, colouration, texture, number of antennal segments etc. A revolution in Acridoid systematics was brought about by genitalic characters which has resulted in a profound change in the systematic concept of this group. The genitalic structures are less affected than the external characters by environmental conditions. A comparative study of these structures makes it possible to put forward some suggestions regarding interrelations of families and subfamilies of Acridoidea more clearly than the external characters.

Subfamilies Oxyinae, Hieroglyphinae, Catantopinae, Coptacridinae, Cyrtacanthacridinae, Eyprepocnemidinae, Tropidopolinae, Calliptaminae and Eremogryllinae are so closely related that earlier and recent workers have put all of them in one group. In all the subfamilies apical and preapical diverticula of spermatheca are tubular. The grouping is justified not only by the common character of spermatheca but also by the fact that all the subfamilies (of Catantopidae) possess prosternal process. The subfamilies Cyrtacanthacridinae, Calliptaminae and Catantopinae are closely related in having spermatheca with long and slender apical diverticulum, whereas in the subfamilies Eyprepocnemidinae and Tropidopolinae,

spermatheca with apical diverticulum moderately long and slender.

The spermatheca is with a single diverticulum in Pamphagidae while in Pyrgomorphidae it is of variable forms, mostly with a single diverticulum, sometimes with a small or large preapical diverticulum. In the family Acrididae, apical diverticulum is short, rudimentary or sometimes absent and pre-apical diverticulum is sac-like.

The sac-like condition of pre-apical diverticulum of spermatheca is regarded as advanced characters. These occur in the subfamilies Acridinae, Oedipodinae, Truxalinae and Gomphocerinae. The grouping of these subfamilies into the family Acrididae is justified by the absence of prosternal process. Gomphocerinae is regarded as the most advanced subfamily among the group (Uvarov 1966).

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