

STUDIES ON THE MALE GENITAL MUSCULATURE OF GRASSHOPPER *ACRIDA EXALTATA* (WALK.) (ORTHOPTERA: ACRIDIDAE)

Robina Naseer¹ and *Mohammad Amir²

¹Department of Zoology, A.S.M. Degree College, Tejpur, Jawan, Aligarh

²Department of Zoology, A.M.U., Aligarh (U.P.)

*Author for Correspondence

ABSTRACT

The male genital musculature of grasshopper *Acrida exaltata* (Walk.) (Orthoptera: Acrididae) is described and origin and insertion of each muscle discussed. The male genital musculature consists of mainly twenty one muscles with different origin and insertion in ninth, tenth and eleventh abdominal segments. These muscle includes internal dorsal muscle (260), retractor of phallus (261), ventral muscle (265), retractor of the aedeagus (266), protractor of the aedeagus (267), internal lateral muscles (268, 269), external lateral muscle (270), epiphallic muscle of aedeagus or retractor of cingulum (278), lateral muscle of the aedeagus (279), muscle of the ventral lobe of aedeagus (280), lateral dilator of the endophallus (281), dorsal dilator of endophallus (282), compressor of the endophallus (283), compressor of the ejaculatory duct (284), muscles of ejaculatory duct (285), depressor of the cercus (287), median levator of the cercus (288), lateral levator of the cercus (289), ventral muscle of the paraproct (291), adductor of the cercus (293) and adductor of the paraproct (294).

Keywords: Grasshopper, *Acrida Exaltata*, Genital Musculature, Male, Abdomen

INTRODUCTION

Insects are the chief rivals of human being because of the fact that both men and majority of insects constantly compete with each other for food and shelter. India is predominantly an agricultural land with nearly 70% of its total working population engaged in Agriculture. A large number of insects cause injury to economic plants by feeding on them externally and chewing their leaves or other parts, by sucking cell sap with the help of piercing mouth parts. Grasshopper cause significant damage to tree seedlings and agricultural crops (Joshi *et al.*, 1999), hence considered as oligophagous and according to host preferences classified as graminivorous, forbivorous and ambivorous or mixed feeders (Mulkern, 1967). *Acrida exaltata* (Walk.) is found in Sri Lanka, some parts of U.P., Darjeeling and Meghalaya. It is of green colour, the head and pronotum of about equal length, tegmina obtusely pointed, scarcely longer than the hind femora; wings yellowish hyaline, the cells in the posterior part cloudy in the middle.

The genital musculature of male *A. exaltata* is described in the present study. It belongs to the family Acrididae of order Orthoptera. The muscles external to the cingulum in Acrididae show sufficient similarity to those of Acrididae in all the homologies. The body muscles are well developed in the abdomen of grasshopper. The comparative myology of the abdomen is better known in the Orthoptera than in any other of the larger order of the insects. The musculature of the VIIIth segment in the male is like that of preceding segments. Special muscles of the phallic complex are found in IXth and following segment (Uvarov, 1966).

MATERIALS AND METHODS

Adults and nymphs of *A. exaltata* were collected in and around campus of Aligarh Muslim University, Aligarh. Nymphs were reared in Jars measuring 15x10 cm at 32±2°C and 65±5 % R.H. in B.O.D. cabinet. Adults male were reared in cage under normal laboratory conditions. For the study of genitalic musculature, apical part of abdomen of male insects was cut off. It was dissected under a binocular microscope in 70% alcohol by giving lateral cuts. After that muscles were traced with fine forceps and

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needles and stained with Borax carmine (alcoholic) for two minutes. Diagram of various muscles of genitalia were drawn with the help of binocular microscope.

RESULTS AND DISCUSSION (Figures 1-5)

The organs specifically concerned with sexual mating are collectively known as external genitalia (Snodgrass, 1935). The external genitalia of male Orthoptera are mostly phallic organs which are concerned with the accumulation of sperm and their transmission to the female genital chamber.

The male external genitalia of *A. exaltata* is formed of mainly four parts *i.e.* sub-genital plate, supra anal plate, epiphallus and endophallus. The sub-genital plate is formed by the Xth sternite and is a plate like structure. Tergite XI represents the supra anal plate which covers the anus from above. It is sub triangular in shape. The epiphallus is an independent sclerite located below the anterior portion of the phallus and supra anal plate. It is made up of three sclerites lophi, ancorae and lateral lobes. The endophallus is the internal component of phallic organ and consist of aedeagus, ejaculatory duct and spermatophore sac.

Male Genital Musculature of Ninth Abdominal Segment

The muscles of ninth segment include the muscles of epiphallus, endophallus, aedeagus, ejaculatory duct and ejaculatory sac.

Internal Dorsal Muscle (No. 260)

This muscle is paired, small and slender in *A. exaltata* and originates from ninth tergum (IXT) and inserted on tenth tergum (XT). This finding is in agreement with *Dissosteira carolina* (Snodgrass, 1935), *Poecilocus pictus* (Anwar, 1965), *Chrotogonus trachypterus* (Singh and Chauhan, 1975) and *Oxya velox* (Kabir and Begum, 1987).

Retractor of Phallus (No. 261)

The retractor of the phallus is paired, broad, fan shaped muscle with broad base in *A. exaltata*. They originate from a broad base on the ventral part of ninth tergum (IXT) and inserted on lateral sclerites lateral to epiphallus. This finding agrees with Snodgrass (1935), Anwar (1965) and Eades and Kevan (1974) in *D. carolina*, *P. pictus* and *Atractomorpha sinensis sinensis* respectively, although Anwar (1965) numbered this muscle as muscle no. 258 in *P. pictus*. However, Wasti and Akbar (1969) labelled it as muscle no. 4 in *P. pictus* and reported it as short compact band of muscles having origin from cingulum in the region of rami and attachment to the sternum. Similarly, Singh and Chauhan (1975) numbered it as muscle no. 188 in *C. trachypterus* where it arises from ventral margin of the ninth tergum, runs posteriorly and inserted on the ventral sclerite, lateral to epiphallus.

Ventral Muscle (No. 265)

These muscles are paired, strap like, long but very delicate and divides into two branches (265a&b) in *A. exaltata*. They arise laterally on the ninth sternum (IXS) and inserted on the membrane of the tenth segment on the tergal side just before the base of paraproct. This study is in agreement with Snodgrass (1935), Anwar (1965), Singh and Chauhan (1975) and Kabir and Begum (1987) in *D. Carolina*, *P. pictus*, *C. trachypterus* and *O. velox* respectively.

Retractor of the Aedeagus (No. 266)

This muscle is paired, broad and contains thin fibres which arises from a median ridge of ninth sternum (IXS) and attached dorsally to the wall of the genital chamber lateral to the base of aedeagus. These findings are in agreement with Snodgrass (1935), Anwar (1965) and Eades and Kevan (1974) in reported similar findings in *D. carolina*, *P. pictus* and *A. s. sinensis* respectively. Similarly, Singh and Chauhan (1975) and Kabir and Begum (1987) reported similar findings in *C. trachypterus* and *O. velox*.

Protractor of the Aedeagus (No. 267)

The protractor of aedeagus is paired, long and curved muscle, arising on the median ridge of the ninth sternum (IXS) lateral to retractor of aedeagus (266), converging dorsally and anteriorly on the lateral lobe of epiphallus. Snodgrass (1935) reported similar findings in *D. carolina*. However, Anwar (1965) and Singh and Chauhan (1975) numbered it as muscle no. 263 and 191 in *P. pictus* and *C. trachypterus* with findings similar to that of *A. exaltata*.

Internal Lateral Muscles (No. 268, 269)

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Internal dorsal muscles (268, 269) are paired and large oblique muscles on each side in *A. exaltata*. They arise externally close to retractor of phallus (261) from the ninth tergum (IXT). The muscle (268) is inserted ventrally on the lateral margin of the ninth sternum while muscle (269) is inserted on the distal part of IX sternite. These findings are in agreement with those of Snodgrass (1935) in *D. carolina*, Anwar (1965) in *P. pictus*, Singh and Chauhan (1975) in *C. trachypterus* and Kabir and Begum (1987) in *O. velox*, with some variation in the attachment of muscles.

External Lateral Muscles (No. 270)

External lateral muscles are paired and small which arise on the anterior lateral area of ninth tergum (IXT) and inserted on the outer face of the apodeme of ninth sternum. Snodgrass (1935) in *D. carolina*, Anwar (1965) in *P. pictus*, Kabir and Begum (1978) in *O. velox* made similar observations as those in the present study.

Epiphallic Muscle of Aedeagus or Retractor of Cingulum (No. 278)

Epiphallic muscle of aedeagus muscle in present study is paired, long, twisted and lying dorsally in the basal fold of phallus, and inserted on the lateral lobe of the epiphallus on the zygoma of aedeagal apodemes. This muscle is homologous to retractor of cingulum of *Atractomorpha crenulata* (Snodgrass, 1935). Present findings of *A. exaltata* are in agreement with *A. s. sinensis* (Eades and Kevan, 1974). However, Singh and Chauhan (1975) labelled this muscle as 196 in *C. trachypterus* but Kabir and Begum (1987) retained the same no. (278) in *O. velox* with findings similar to that of *A. exaltata*.

Lateral Muscle of the Aedeagus (No. 279)

The lateral muscle of aedeagus in *A. exaltata* is paired, small and arising latero-ventrally at the base of aedeagus and inserted dorsally on the lower edge of the lateral plate of the aedeagus. Snodgrass (1935) described similar arrangement of muscles in *D. carolina* with that of *A. exaltata*. However, Singh and Chauhan (1975) and Kabir and Begum (1978) described slightly different arrangement of muscles in *C. trachypterus* and *O. velox*. While in *C. trachypterus*, these muscles (197) are short, running transversely between sclerotized sub-ventral plate and the base of dorsal valve but in *O. velox*, these muscles (279) are transversally arranged originating from the base of sub-ventral plate and inserted on the base of dorsal valve just in front of zygoma. But Wasti and Akbar (1969) and Eades and Kevan (1974) could not find this muscle in *P. pictus* and *A. s. sinensis* respectively.

Muscle of the Ventral Lobe of the Aedeagus (No. 280)

This muscle of the ventral lobe of aedeagus is paired and delicate, arising within the base of aedeagus and inserted near the apex of the ventral lobe of the aedeagus. Anwar (1965) and Singh and Chauhan (1975) named it as muscle of sub ventral lobe of aedeagus in *P. pictus* and *C. trachypterus*, which was long, arising from the base of ventral valve of aedeagus and inserted on the distal end of sub ventral lobe. The finding of Kabir and Begum (1987) on this muscle in *O. velox* is in agreement with the present study. But Wasti and Akbar (1969) and Eades and Kevan (1974) did not record it in *P. pictus* and *A. s. sinensis*.

Lateral Dilator of the Endophallus (No. 281)

These muscles are paired, broad, and thick and more or less fan shaped which arises dorsally on the aedeagal apodeme and inserted on the endophallic apodeme. Present findings are in conformity with Snodgrass (1935), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. carolina*, *C. trachypterus* and *O. velox* respectively, where the origin and insertion is almost similar. Anwar (1965) labelled it as muscle no. 277 in *P. pictus* and reported it as a very small muscle which arises from the tenth tergum and inserted on the outer wall of rectum. Similarly, Wasti and Akbar (1969) described these as broad band of muscles in *P. pictus* which are attached to the inner lateral aspect of the endophallic apodeme and connects the two endophallic plates internally.

Dorsal Dilator of the Endophallus (No. 282)

The dorsal dilator of the endophallus is paired, broad, flat and obliquely arranged which originates from the aedeagal apodeme and inserted mesally on the dorsal edge of the endophallic plate. Snodgrass (1935), Anwar (1965), Singh and Chauhan (1975) and Kabir and Begum (1987) pointed similar origin and insertion of this muscle in *D. carolina*, *P. pictus*, *C. trachypterus* and *O. velox* with some variation due to structure of aedeagal apodeme.

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This muscle is not recorded in *P. pictus* (Wasti and Akbar, 1969) and *A. s. sinensis* (Eades and Kevan, 1974) and its absence is correlated with complete or virtual loss of apodeme of cingulum (origin) and of lateral plate of endophallic sclerite (insertion).

Compressor of the Endophallus (283)

Compressor of the endophallus is broad but thin sheet of unpaired transverse muscle which unites the endophallic apodeme. These findings are in agreement with Snodgrass (1935), Anwar (1965), Eades and Kevan (1974), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. Carolina*, *P. pictus*, *A. s. sinensis*, *C. trachypterus* and *O. velox* respectively.

Compressor of the Ejaculatory Sac (284)

Compressor of the ejaculatory sac is paired and broad which arises next to lateral dilator of endophallus (281) on the endophallic plate and gets inserted on the lateral wall of ejaculatory sac. Kabir and Begum (1987) did not record this muscle in *O. velox*. Present findings are similar to those of Snodgrass (1935), Anwar (1965) and Singh and Chauhan (1975) in *D. carolina*, *P. pictus*, and *C. trachypterus* respectively.

Muscles of the Ejaculatory Duct (No. 285)

This muscle is unpaired and forms a thick circular band around the anterior side of ejaculatory duct in *A. exaltata*. This finding show similarity with those of Snodgrass (1935), Eades and Kevan (1974), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. carolina*, *A. s. sinensis*, *C. trachypterus* and *O. velox*. However, Anwar (1965) did not record this muscle in *P. pictus*.

Male Genital Musculature of Tenth Abdominal Segment

The genital musculature of tenth abdominal segments has no evident relation to the muscles of preceding segments which include muscles of cerci, epiproct and paraproct.

Depressor of the Cercus (287)

This muscle is paired and narrow which arises anteriorly on the median part of tenth tergum (XT) and inserted posteriorly on the posterior margin of the basal lobe of the cercus. These findings are in agreement with the Snodgrass (1935), Anwar (1965), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. carolina*, *P. pictus*, *C. trachypterus* and *O. velox* respectively, where the origin and insertion show similarity with the present study with some variation in the size of muscle.

Median Levator of the Cercus (288)

This muscle is paired, small, slightly conical or fan shaped and longitudinally arranged. It originates from the tenth tergum (XT) lateral to the preceding muscle (287) and inserted posteriorly on the small sclerite between the tenth tergum and basal lobe of the cercus. Present finding is in confirmity with those of Snodgrass (1935), Anwar (1965), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. carolina*, *P. pictus*, *C. trachypterus* and *O. velox*.

Lateral Levator of the Cercus (289)

This muscle is paired, thin, small and longitudinally arranged, arising from the tenth tergite (XT) lateral to the median levator of the cercus (288) and inserted near the angle of base of the cercus. This finding matches with those of Snodgrass (1935), Anwar (1965), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. carolina*, *P. pictus*, *C. trachypterus* and *O. velox* with some variation in the size and orientation of the muscle.

Ventral Muscle of the Paraproct (291)

In *A. exaltata*, this muscle is paired and broad at the base and narrow at tip. It originates from anterior margin of the tenth tergum (XT) and inserted on the base of paraproct (Papt) internally. Similar findings are reported by Snodgrass (1935), Anwar (1965), Singh and Chauhan (1975) and Kabir and Begum (1987) on *D. carolina*, *P. pictus*, *C. trachypterus* and *O. velox*, where the origin and insertion are almost similar to those of present study, with some difference in the length and thickness of muscle.

Genital Musculature of Eleventh Abdominal Segment

The genital musculatures of eleventh abdominal segment include muscles associated with cerci and paraproct.

Adductor of the Cercus (293)

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Adductor of cercus of *A. exaltata* is paired, long and thin muscle which arises from anterior part of epiproct (Eppt) and inserted on the inner extremity of basal lobe of the cercus. These findings are similar to those of Snodgrass (1935), Anwar (1965) and Singh and Chauhan (1975) *D. carolina*, *P. pictus*, and *C. trachypterus* having similar origin and orientation to those of the present study, with some difference in the size and length of the muscle. These differences could be attributed to the variable size of the insect. However, Kabir and Begum (1987) could not record this muscle in *O. velox*.

Adductor of the Paraproct (294)

This muscle is paired and thin in *A. exaltata* but slightly longer than the adductor of cercus (293) arising close to the median levator of the cercus (288) on the epiproct (Eppt) and inserted on the upper part of the paraproct (Papt). Similar findings are reported by Snodgrass (1935), Anwar (1965) and Singh and Chauhan (1975) in *D. carolina*, *P. pictus*, and *C. trachypterus* respectively, having similar origin and insertion to that of present study. However, Kabir and Begum (1987) could not find this muscle in *O. velox*.

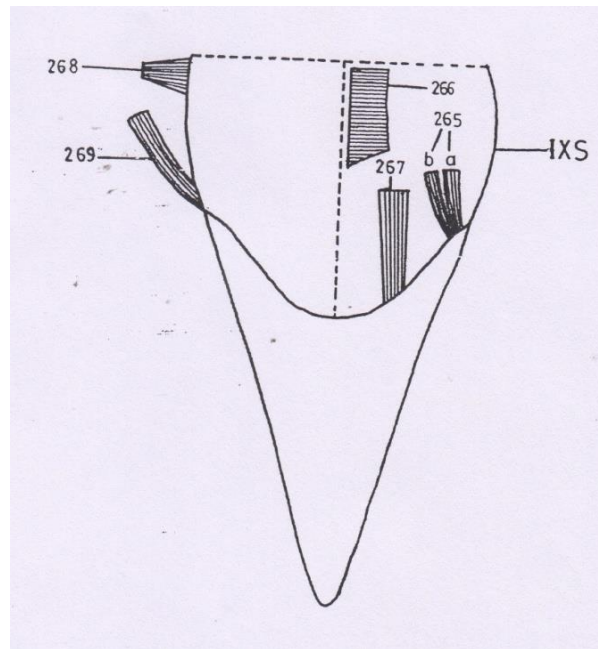


Figure 1

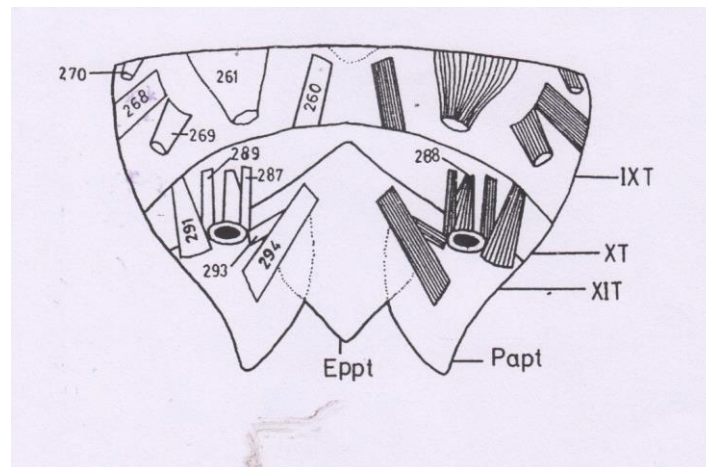


Figure 2

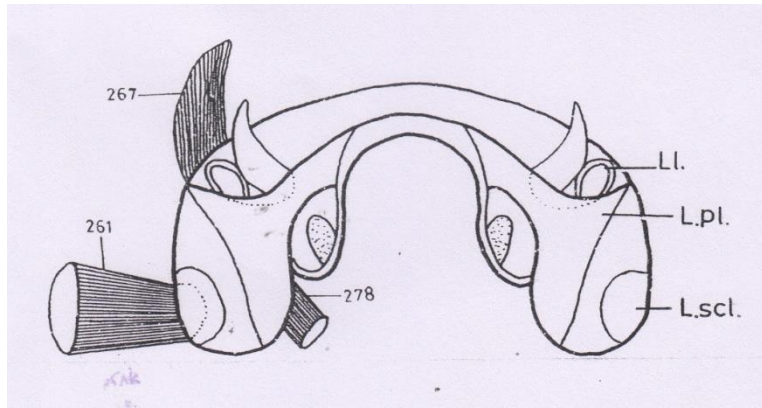


Figure 3

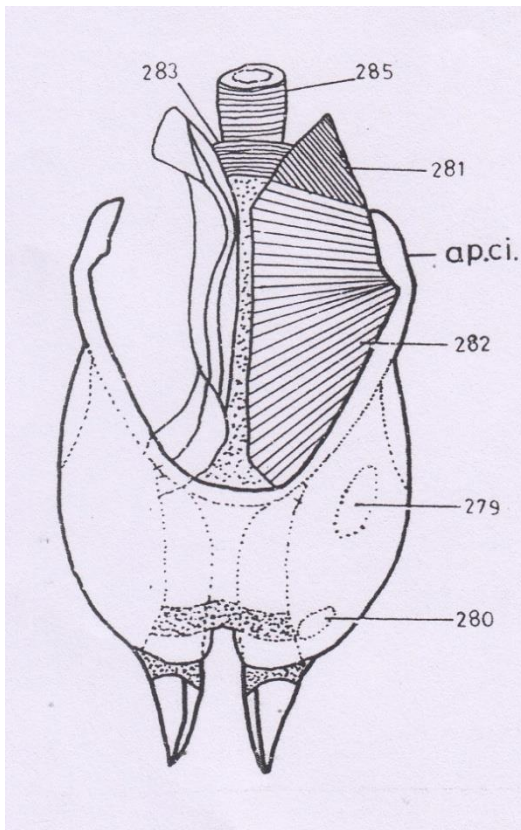


Figure 4

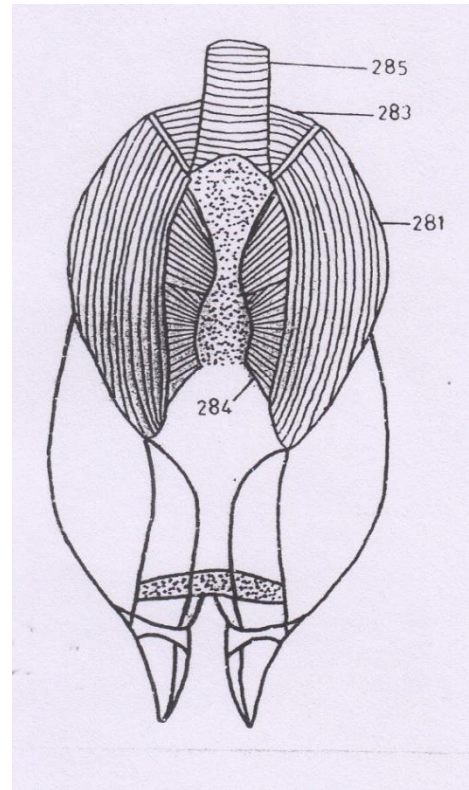


Figure 5

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