International Journal of Entomology Research
ISSN: 2455-4758; Impact Factor: RJIF 5.24
www.entomologyjournals.com
Volume 1; Issue 7; November 2016; Page No. 20-31

Taxonomic significance of aedeagus in the classification of Indian Acrididae (Orthoptera: Acridoidea)

Shahnila USMANI, Mohd. Kamil Usmani, Mohammad AMIR

Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Abstract
Comparative study of aedeagus is made in one hundred and two species of grasshoppers representing fifty-nine genera belonging to the family Acrididae. Its taxonomic significance is shown. Divided, undivided or flexured conditions of aedeagus is taken as familial character. Apical valve of aedeagus longer or shorter than basal valve is considered as generic character. Shape of apical and basal valves is suggested as specific character.

Keywords:

1. Introduction
The aedeagus is a main intromittent organ consisting of a pair of basal and apical valves. The basal valves are lying above the spermatophore sac and connected by the flexure with the long curved apical valves which are normally concealed under the membranous pallium. During the course of copulation it is inserted between ventral ovipositor valves of the female into vagina and its tip reaches the spermathecal duct. Dirsh & Uvarov (1953) [2] studied apical valves of penis in three species of *Anacridium*. Dirsh (1956) [1] has shown the taxonomic importance of phallic complex including aedeagus (penis) in classifying and grouping various families of Acridoidea and described five main types of penis in different families. Uvarov (1966) [7] considered apical valves of taxonomic value particularly in identification of species. Hollis (1968) [3] and Jago (1977) [4] described and illustrated aedeagal valves in differentiating various species of the genera Aiolopus and Ochrilidia respectively. Kevan *et al.* (1975) [5] studied the concealed copulatory structures including aedeagus and showed its significance in different tribes of the family Pyrgomorphidae. Usmani & Ajaili have shown taxonomic significance of aedeagus in Libyan Acridoidea.
Keeping in view the taxonomic importance of aedeagus in the classification of Acridoidea, the present writers made an attempt to make a comparative study of aedaegus in one hundred and two Indian species representing fifty-nine genera of the superfamily Acrididae. The characters i.e. divided or undivided condition of aedaegus, presence or absence of flexure, apical valves longer or shorter than basal valves, narrow or broad condition of apical and basal valves are suggested as characters of taxonomic significance.

2. Materials and Methods
Adult specimens of grasshoppers were collected from various localities in India. For the study of aedeagus, apical part of male body was cut off and boiled in a test tube containing 10% KOH solution till the material became transparent. This was later washed thoroughly in water for complete removal of KOH. It was then dissected under binocular microscope with help of fine needles in order to take out aedeagus. After this, normal process of dehydration was adopted and clearing was done in clove oil. The aedeagus was mounted in Canada balsam on a cavity slide under 22mm square cover glass. Drawings were made with the help of Camera lucida.

3. Description of Aedeagus
Subfamily Acridinae
1. *Truxalis eximia* Eichwald, 1830 (Fig. 1 A)
Aedeagus flexured, apical valve long and narrow, slightly curved, apex obtusely pointed, slightly narrower and shorter than basal valve, connected with basal valve with flexure; basal valve slightly broad, almost of uniform width and truncated basally, gonopore process long and broad with truncated apex.

2. *Truxalis nasuta* (Linnaeus, 1758) (Fig, 1 B)
Aedeagus flexured, apical valve narrow, slightly curved, apex acutely pointed, slightly narrower and shorter than basal valve, connected with basal valve with flexure; basal valve slightly broad, almost of uniform width and truncated basally, gonopore process broad with truncated apex.

3. *Neophlaeoba walayarensis* Usmani & Shafee, 1983 (Fig. 1C)
Aedeagus flexured, apical valve narrow, curved, sharply pointed, shorter and narrower than basal valve, connected with basal valve with flexure; basal valve broad, almost of uniform width and broadly rounded basally, gonopore process broad with obtuse apex.

4. *Acrida exaltata* (Walker, 1859) (Fig. 1 D)
Aedeagus flexured, apical valve strongly curved upward, apex pointed, slightly shorter and narrower than basal valve, connected with basal valve with flexure; basal valve of uniform width and rounded basally, gonopore process narrowing and truncated towards its acute apex.

5. *Acrida gigantea* (Herbst, 1786) (Fig. 1 E)
Aedeagus flexured, apical valve curved upward, apex acute, slightly narrower and shorter than basal valve, connected with basal valve with flexure; basal valve narrow of uniform width with obtusely rounded basally, gonopore process narrowing and acutely pointed at apex.

6. ***Acrida turrita*** **(Linnaeus, 1758)** (Fig. 1 F)
Aedeagus flexure, apical valve strongly upcurved, narrower and slightly shorter than basal valve, apex blunt; basal valve much broad and truncated basally, gonopore process short with obtuse apex.

7. ***Phlaeoba infumata*** **Brunner von Wattenwyl, 1893** (Fig. 1 G)
Aedeagus flexured, apical valve slightly curved, narrower and much shorter than the basal valve, apex pointed, connected with basal valve with flexure; basal valve broad and dilated and narrowing basally; gonopore process long and narrow with acute apex.

8. ***Phlaeoba tenebrosa*** **(Walker, 1871)** (Fig. 1 H)
Aedeagus flexured, apical valve slightly curved, narrower and shorter than the basal valve, apex obtuse, connected with basal valve with flexure; basal valve much broader and slightly dilated and narrowing basally; gonopore process broad with truncated apex.

9. ***Phlaeoba panteli*** **Bolivar, 1902** (Fig. 1 I)
Aedeagus flexured, apical valve uniformly broad, curved, narrowing apically and shorter than basal valve, apex acute, basal valve slightly broad and strongly truncated basally; gonopore process short, narrow with acute apex.

10. ***Phlaeoba angustidorsis*** **Bolivar, 1902** (Fig. 1 J)
Aedeagus flexured, apical valve elongate, uniformly narrow, curved medially, pointed apically and shorter than basal valve, basal valve slightly broad and truncated basally; gonopore process narrow with acute apex.

11. ***Phlaeoba antennata antennata*** **Brunner, 1893** (Fig. 1 K)
Aedeagus flexured, apical valve narrow, slightly curved, narrower and shorter than the basal valve, apex pointed, connected with basal valve with flexure; basal valve broad, slightly dilated and narrowing basally; gonopore process short with truncated apex.

12. ***Orthochtha indica*** **Uvarov, 1942** (Fig. 1 L)
Aedeagus flexured, apical valve narrow, slightly upcurved, apex sharply pointed, narrower and slightly longer than basal valve, connected with basal valve with flexure; basal valve broad and narrowing basally with protuberance, gonopore process short, broad and slightly truncated with obtuse apex.

13. ***Orthochtha ramchandrae*** **Popov, 1981** (Fig. 1 M)
Aedeagus flexured, apical valve narrow and slightly upcurved, apex acutely pointed, narrower and as long as basal valve, connected with basal valve with flexure; basal valve much broad and strongly dilated basally; gonopore process short, broad with acute apex.

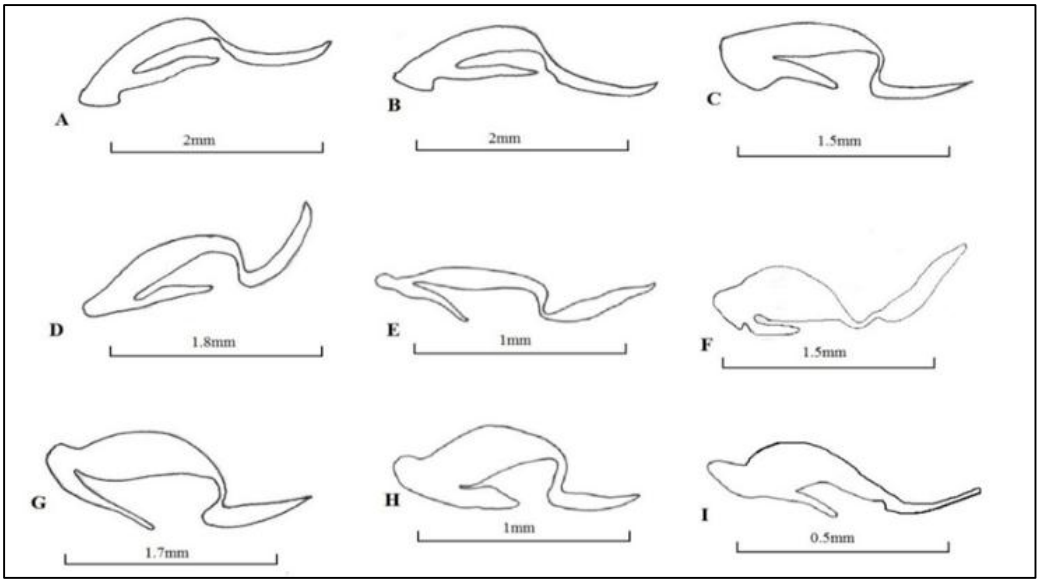
14. ***Orthochtha schmidti*** **Popov & Fishpool, 1992** (Fig. 1 N)
Aedeagus flexured, apical valve long, of uniform width and strongly upcurved, apex obtuse, narrower and longer than basal valve, connected with basal valve with flexure; basal valve much broad and obtusely rounded basally; gonopore process long, broad with obtusely rounded apex.

15. ***Odontomelus manipurensis*** **Meinodas & Shafee, 1990** (Fig. 1 O)
Aedeagus flexured with apical valve uniformly narrow, curved upward and pointed apically, basal valve much broader and longer than apical valve, truncated basally; gonopore process uniformly broad with rounded apex.

Subfamily Calliptaminae

16. ***Acorypha glaucopsis*** **(Walker, 1870)**(Fig. 1 P)
Aedeagus flexured, apical valve short, narrow, curved medially, apex obtusely rounded, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowing and dilated basally; gonopore process short, narrow with acute apex.

17. ***Acorypha insignis*** **(Walker, 1870)** (Fig. 1 Q)
Aedeagus flexured, apical valve short, narrow, apex acute, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowing and dilated basally; gonopore process long, narrow with obtuse apex.



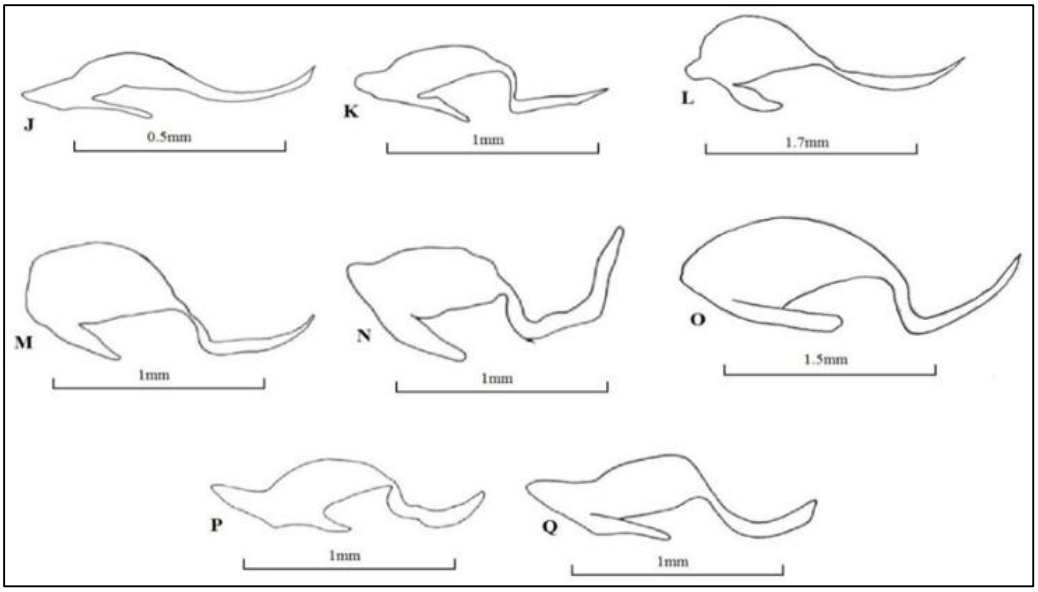


Fig 1: A-Q Aedeagus (Male); A. *Truxalis exemia*, B. *Truxalis nasuta*, C. *Neophlaeoba walayarensis* D. *Acrida exaltata*, E. *Acrida gigantea*, F. *Acrida turrita*, G. *Phlaoeba infumata*, H. *Phlaeoba tenebrosa*, I. *Phlaeoba panteli*, J. *Phlaeoba angustidorsis*, K. *Phlaeoba antennata antennata*, L. *Orthochtha indica*, M. *Orthochtha ramchandrae*, N. *Orthochtha schmidti*, O. *Odontomelus manipurensis*, P. *Acorypha glaucopsis*, Q. *Acorypha insignis*

Subfamily Gomphocerine

18. *Aulacobothrus strictus* Bolívar, 1902 (Fig. 2 A)
Aedeagus flexured, apical valve short and narrow, slightly curved medially, apex acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, dilated basally; gonopore process short with obtusely truncated apex.

19. *Aulacobothrus socius* Bolívar, 1902 (Fig. 2 B)
Aedeagus flexured, apical valve short and narrow, slightly curved medially, apex acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, rounded basally; gonopore process short with obtusely rounded apex.

20. *Aulacobothrus luteipes luteipes* (Walker, 1871) (Fig. 2 C)
Aedeagus flexured, apical valve short and narrow, slightly curved apically, apex acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, broadly rounded basally; gonopore process short with acutely pointed apex.

21. *Aulacobothrus luteipes infernus* Bolivar, 1902 (Fig. 2 D)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowing basally; gonopore process short with acute apex.

22. *Aulacobothrus taeniatus* Bolivar, 1902 (Fig. 2 E)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex obtuse, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowing basally; gonopore process short with rounded apex.

23. *Crucinotacris decisa* (Walker, 1817) (Fig. 2 F)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acute, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, of uniform width, dilated basally with protuberance; gonopore process short and narrow with obtuse apex.

24. *Dociostaurus (Dociostaurus) apicalis* (Walker, 1871) (Fig. 2 G)
Aedeagus flexured, apical valve uniformly broad, downcurved, narrower and shorter than basal valve, connected with basal valve with flexure dilated towards its pointed apex, basal valve broad, dilated basally, gonopore process narrowing towards its obtuse apex.

25. *Leva indica* (Boliver, 1902) (Fig. 2 H)
Aedeagus flexured, apical valve elongated, narrow, curved, narrower and slightly shorter than basal valve, connected with basal valve with flexure; apex pointed; basal valve moderately broad and rounded basally, gonopore process elongated, uniformly broad, with acute apex.

26. *Leva cruciata* Bolívar, 1914 (Fig. 2 I)
Aedeagus flexured, apical valve short and narrow, strongly upcurved, apex acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, of uniform width, narrowing basally; gonopore process short, narrow with pointed apex.

27. *Leva soluta* Bolivar, 1914 (Fig. 2 J)
Aedeagus flexured, apical valve short and narrow, upcurved, apex acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad basally, narrowing towards its obtuse apex; gonopore process short with pointed apex.

28. *Stenohippus mundus* (Walker, 1871) (Fig. 2 K)
Aedeagus flexured, apical valve short and narrow, upcurved, apex acutely pointed, narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve

broad, of uniform width, dilated basally; gonopore process short with rounded apex.

29. *Ochrilidia geniculata* (Bolívar, 1913) (Fig. 2 L)
Aedeagus flexure, apical valve strongly curved upward, much narrower and shorter than basal valve, apex sharply pointed, connected with basal valve with flexure; basal valve broad and rounded basally; gonopore process narrow with obtuse apex.

30. *Ochrilidia gracilis gracilis* (Krauss, 1902) (Fig. 2 M)
Aedeagus flexured, apical valve short, narrow, slightly curved upward, much narrower and shorter than the basal valve, apex obtusely rounded, connected with basal valve with flexure; basal valve broad and dilated basally; gonopore process short and broad with truncated apex.

31. *Leionotacris bolivari* (Uvarov, 1921) (Fig. 2 N)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acute, narrower and slightly shorter than basal valve, connected with basal valve with flexure; basal valve broad, of uniform width, rounded basally; gonopore process short with truncated apex.

32. *Dhimbana dawsoni* Henry, 1940 (Fig. 2 O)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve moderately broad, narrowing basally with obtuse apex; gonopore process short with obtuse apex.

33. *Chorthippus* (*Chorthippus*) *indus* Uvarov, 1942 (Fig. 2 P)
Aedeagus flexure, apical valve short, narrow, curved upward, apex blunt, much shorter than basal valve, basal valve elongate, uniformly broad, twice as long as apical valve, rounded basally; gonopore process short, narrow with acute apex.

Subfamily Spathosterninae

34. *Spathosternum prasiniferum* (Walker, 1870) (Fig. 2 Q)
Aedeagus flexured, apical valve narrow, slightly curved, apex rounded, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve moderately broad, of uniform width, rounded basally; gonopore process narrow with rounded apex.

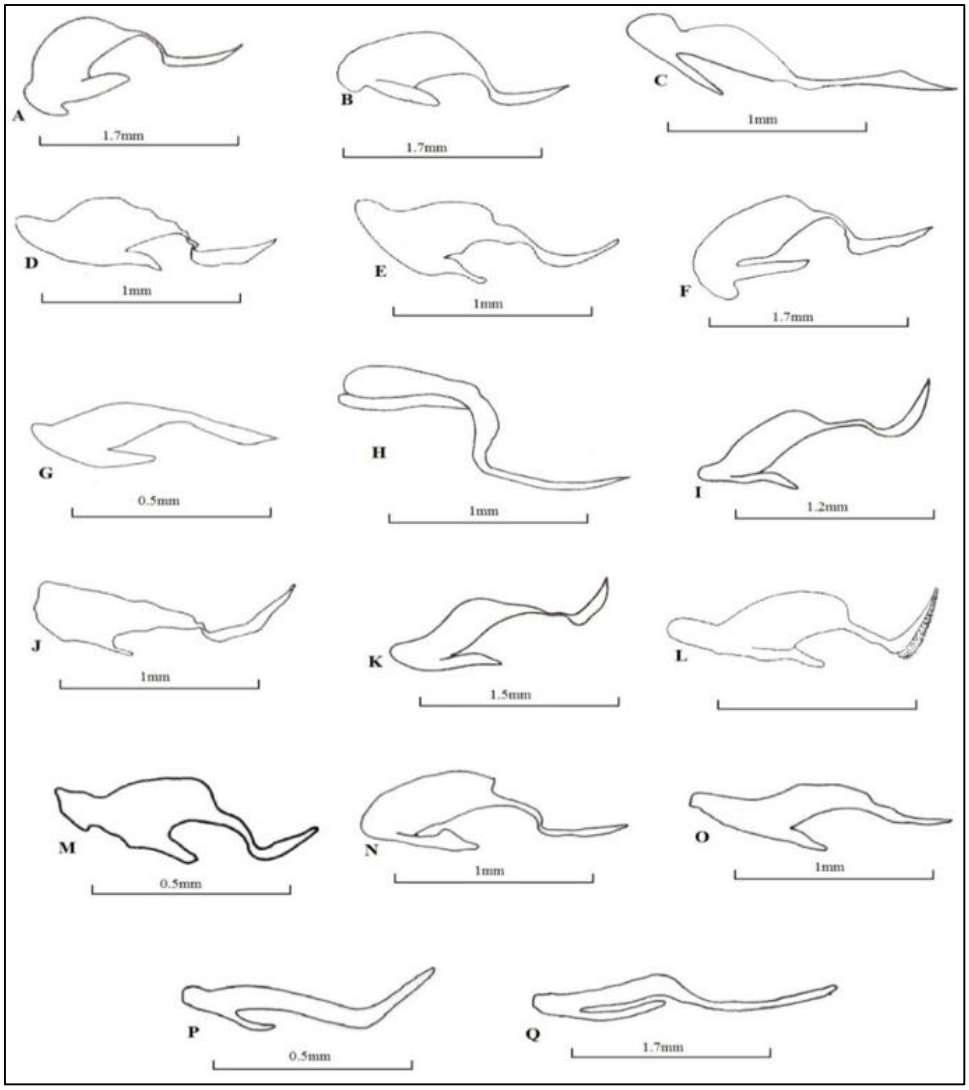


Fig 2: A-Q Aedeagus (Male); A. *Aulacobhothrus* strictus, B. *Aulacobhothrus socius*, C. *Aulacobhothrus luteipes*, D. *Aulacobothrus luteipes infernus*, E. *Aulacobothrus taeniatus*, F. *Crucinotacris decisa*, G. *Dociostaurus (Dociostaurus) apicalis*, H. *Leva indica*, I. *Leva cruciata*, J. *Leva soluta*, K. *Stenohippus mundus*, L. *Ochrilidia geniculata*, M. *Ochrilidia gracilis gracilis*, N. *Leionotacris bolivari*, O. *Dhimbana dawsoni*, P. *Chorthippus* (*Chorthippus*) *indus*, Q. *Spathosternum prasiniferum*

Subfamily Oxyinae

35. *Oxya fuscovittata* (Marschall, 1836) (Fig. 3 A)
Aedeagus flexured, apical valve narrow, slightly curved, apex rounded, narrower and slightly shorter than basal valve; connected with basal valve with flexured, basal valve slightly broad, of uniform width, elongated and rounded basally; gonopore process narrow with obtuse apex.

36. *Oxya japonica* (Thunberg, 1815) (Fig. 3 B)
Aedeagus flexured, apical valve long, slender and upcurved, shorter than basal valve, connected with basal valve with flexured, apex rounded; basal valve slightly broad of uniform width, rounded basally; gonopore process long and narrow with obtuse apex.

37. *Oxya hyla hyla* Serville, 1831 (Fig. 3 C)
Aedeagus flexured, apical valve broad, short and stubby, apex rounded, slightly shorter than basal valve; connected with basal valve with flexured, basal valve slightly broad, of uniform width, curved and rounded basally; gonopore process narrow with rounded apex.

38. *Oxya chinensis* (Thunberg, 1815) (Fig. 3 D)
Aedeagus flexured, apical valve long, broad medially, narrow apically, slightly shorter than basal valve and slightly curved upward with obtuse apex, basal valve broad, dilated basally; gonopore process long, broad at apex.

39. *Oxya nitidula* (Walker, 1870) (Fig. 3 E)
Aedeagus flexured, apical valve narrow, short and stubby, apex rounded, slightly shorter than basal valve; connected with basal valve with flexure, basal valve slightly broad, of uniform width; truncated basally; gonopore process uniformly broad with rounded apex.

40. *Oxya velox* (Fabricius, 1787) (Fig. 3 F)
Aedeagus flexuredd, apical valve long, slender and upcurved, apex pointed, narrower and slightly shorter than basal valve; connected with basal valve with flexured, basal valve slightly broad, of uniform width, narrowing and dilated basally; gonopore process narrow with truncated apex.

41. *Gesonula punctifrons* (Stål, 1861) (Fig. 3 G)
Aedeagus flexured, apical valve narrow, slightly curved, apex acute, narrower and shorter than basal valve; connected with basal valve with flexured, basal valve slightly broad, of uniform width, truncated basally; gonopore process narrow with obtuse apex.

42. *Pseudoxya diminuta* (Walker, 1871) (Fig. 3 H)
Aedeagus flexured, apical valve long and narrow, incurved, slightly longer than basal valve with acute apex, basal valve narrow, broad and truncated basally, gonopore process broad and truncated at apex.

43. *Lemba motinagar* Ingrisch *et al*., 2004 (Fig. 3 I)
Aedeagus apical valve very long and narrow, downcurved and incurved, slightly shorter than basal valve, apex blunt, basal valve long and narrow with.protuberance and hooked basally; gonopore process long, broad, truncated apically.

Subfamily Hemiacridinae

44. *Hieroglyphus banian* (Fabricius, 1798) (Fig. 3 J)
Aedeagus flexured, apical valve narrow, curved medially, apex obtuse and upcurved, narrower and shorter than basal valve, connected with basal valve with flexure, basal valve broad and rounded basally; gonopore process long, narrow, obtuse at its apex.

45. *Hieroglyphus nigrorepletus* Bolívar, 1912 (Fig. 3 K)
Aedeagus flexured, apical valve narrow, curved, apex pointed and upcurved, narrower and shorter than basal valve, connected with basal valve with flexure, basal valve broad and broadly rounded basally, gonopore process narrowing towards its truncated apex.

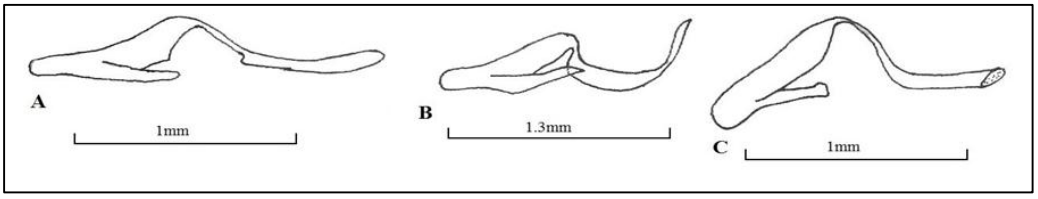
46. *Hieroglyphus oryzivorous* Carl, 1916 (Fig. 3 L)
Aedeagus flexured, apical valve narrow, curved upward, apex pointed and upcurved, narrower and much shorter than basal valve, connected with basal valve with flexure, basal valve uniformly broad, dilated basally, gonopore process large, elongate, narrowing towards its acute apex.

47. *Hieroglyphus perpolita* (Uvarov, 1933) (Fig. 3 M)
Aedeagus flexured, apical valve narrow, curved, apex subacute, narrower and shorter than basal valve, connected with basal valve with flexure, basal valve broad and narrowing basally with obtuse apex, gonopore process elongate, narrowing towards its truncate apex.

Subfamily Tropidopolinae

48. *Tristria pulvinata* (Uvarov, 1921) (Fig. 3 N)
Aedeagus flexured, apical valve narrow, curved, apex acute, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve moderately broad, of uniform width, dilated basally; gonopore process narrow with obtuse apex.

49. *Tropidopola longicornis longicornis* (Fieber, 1853) (Fig. 3 O)
Aedeagus flexured, apical valve narrow, apex acutely pointed, narrower but slightly longer than basal valve, connected with basal valve with flexure; basal valve slightly broad, almost of uniform width, narrowing and obtusely rounded basally; gonopore process narrow with obtuse apex.



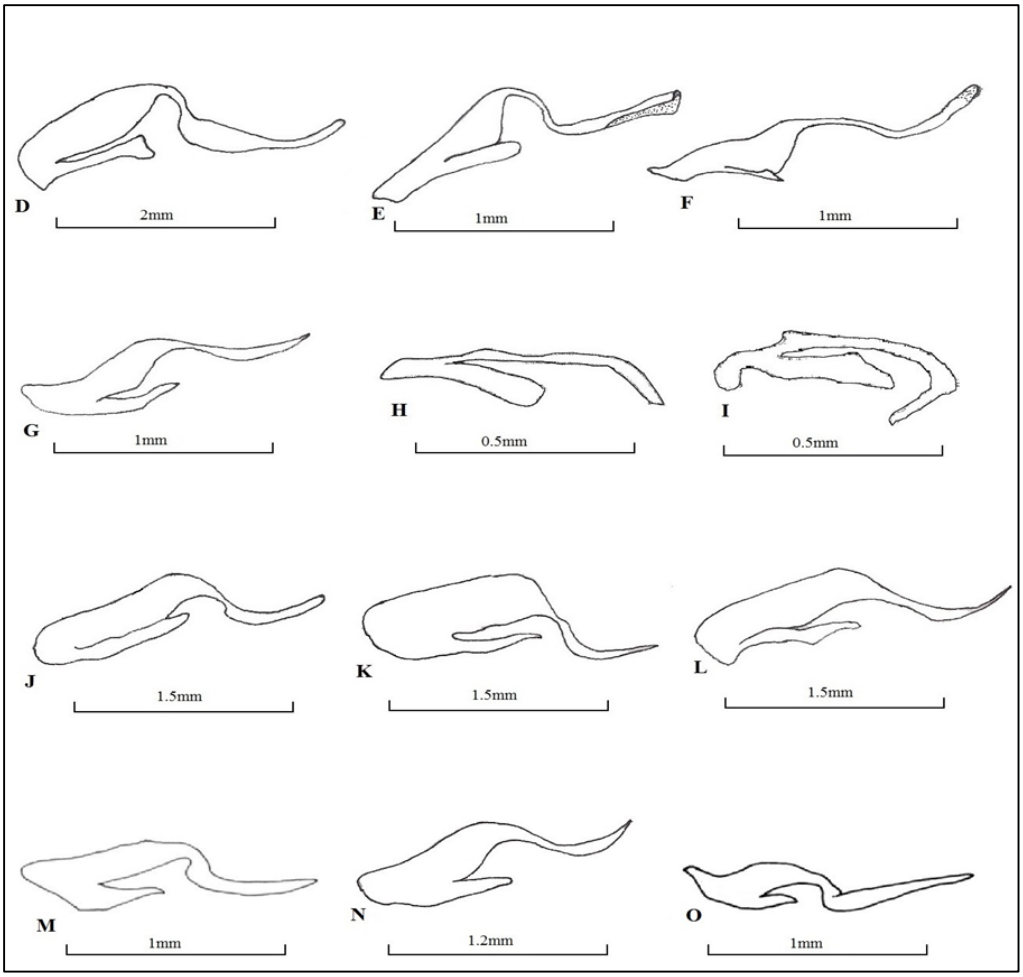


Fig 3: A-O Aedeagus (Male); A. *Oxya fuscovittata*, B. *Oxya japonica*, C. *Oxya hyla hyla*, D. *Oxya chinensis*, E. *Oxya nitidula*, F. *Oxya velox*, G. *Gesonula punctifrons*, H. *Pseudoxya diminuta*, I. *Lemba motinagar*, J. *Heiroglyphus banian*, K. *Heiroglyphus nigrorepletus*, L. *Heiroglyphus oryzivorous*, M. *Hieroglyphus perpolita*, N. *Tristria pulvinata*, O. *Tropidopola longicornis longicornis*

Subfamily Oedipodinae

50. *Oedaleus abruptus* (Thunberg, 1815) (Fig. 4 A)

Aedeagus flexured, apical valve short and narrow, curved upward, apex dilated, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowing basally; gonopore process short with acutely conical apex.

51. *Oedaleus senegalensis* (Krauss, 1877) (Fig. 4 B)

Aedeagus flexured, apical valve short and narrow, curved upward, apex truncated, narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve broad, broadening basally; gonopore process short with acutely conical apex.

52. *Aiolopus simulatrix simulatrix* (Walker, 1870) (Fig. 4 C)

Aedeagus flexured, apical valve moderately broad, curved, apex blunt, much narrower and shorter than basal valve, connected with basal valve by flexure; basal valve much broader and narrowing basally; gonopore process long with acute apex.

53. *Aiolopus thalassinus thalassinus* (Fabricius, 1781) (Fig. 4 D)

Aedeagus flexured, apical valve short and narrow, slightly upcurved, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad basally, narrowing and slightly dilated basally; gonopore process short with blunt apex.

54. *Aiolopus thalassinus tamulus* (Fabricius, 1798) (Fig. 4 E)

Aedeagus flexured, apical valve short and narrow, slightly upcurved, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowing and strongly dilated basally; gonopore process short with blunt apex.

55. *Sphingonotus rubescens rubescens* (Walker, 1870) (Fig. 4 F)

Aedeagus flexured, apical valve short and narrow, slightly upcurved, apex truncated and acutely pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, dilated basally; gonopore process short with obtuse apex.

56. *Sphingonotus savignyi* Saussure, 1884 (Fig. 4 G)

Aedeagus flexured, apical valve short and narrow, slightly upcurved, apex dilated and acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve moderately broad, strongly upcurved and broadly rounded basally; gonopore process short with rounded apex.

57. *Heteropternis respondens* (Walker, 1859) (Fig. 4 H)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex truncated, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, broadly rounded basally; gonopore process short with obtuse apex.

58. *Dittopternis venusta* (Walker, 1870) (Fig. 4 I)
Aedeagus flexured, apical valve short and narrowing apically, slightly curved, apex pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, narrowly rounded basally; gonopore process short with acute apex.

59. *Acrotylus humbertianus* Saussure, 1884 (Fig. 4 J)
Aedeagus flexured, apical valve short and narrow, curved, apex truncated, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, broadly narrowing basally; gonopore process short with obtuse apex.

60. *Acrotylus insubricus* (Scopoli, 1786) (Fig. 4 K)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, obtusely narrowing basally; gonopore process short with truncated apex.

61. *Locusta migratoria* (Linnaeus, 1758) (Fig. 4 L)
Aedeagus flexured, apical valve long and narrow, curved upward, apex acutely pointed, narrower and much longer than basal valve, connected with basal valve with flexure; basal valve broad and narrowing basally; gonopore process long with rounded apex.

62. *Gastrimargus africanus* (Thunberg, 1815) (Fig. 4 M)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex obtuse, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve slightly broad, truncated basally; gonopore process long with truncated apex.

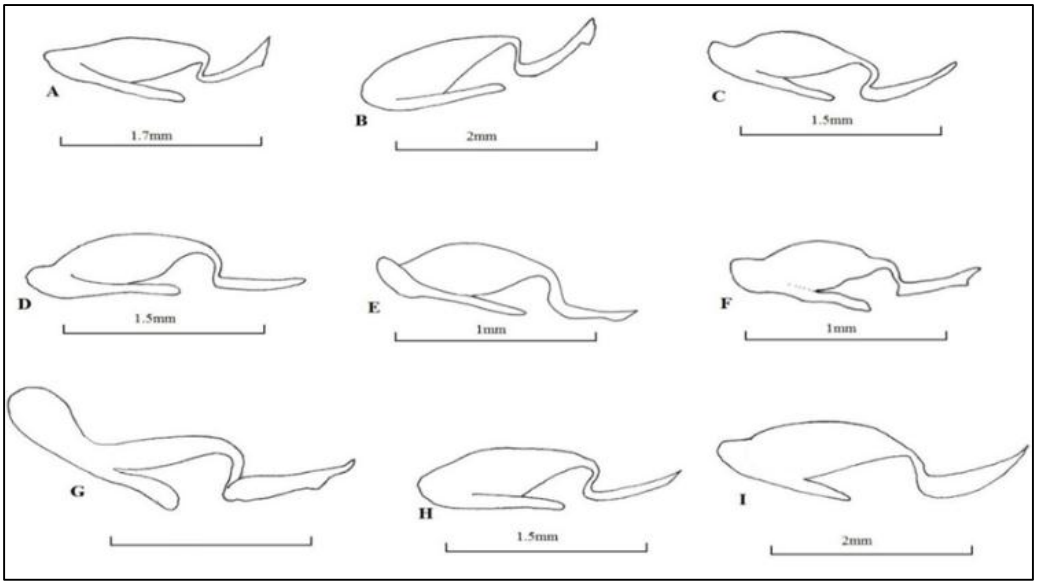
63. *Gastrimargus africanus sulphureus* Bey-Bienko, 1951 (Fig. 4 N)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acute, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve slightly broad, broadly rounded basally; gonopore process long with truncated apex.

64. *Pternoscirta caliginosa* (Haan, 1842) (Fig. 4 O)
Aedeagus flexured, apical valve short and narrow, curved upward, apex pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, broadening towards its base; gonopore process long with truncated apex.

65. *Scintharista notabilis* (Walker, 1870) (Fig. 4 P)
Aedeagus flexured, apical valve short and narrow, upcurved, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve uniformly broad, rounded at its base; gonopore process short with pointed apex.

66. *Ceracris nigricornis* Walker, 1870 (Fig. 4 Q)
Aedeagus flexured, apical valve short and narrow, upcurved, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, with short protuberance at its base; gonopore process long, uniformly broad with obtuse apex.

67. *Ceracris deflorata* (Brunner, 1893) (Fig. 4 R)
Aedeagus flexured, apical valve elongate,-narrow, curved medially with pointed apex, narrower and longer than basal valve, basal valve uniformly broad, rounded basally; gonopore process short, narrow with pointed apex.



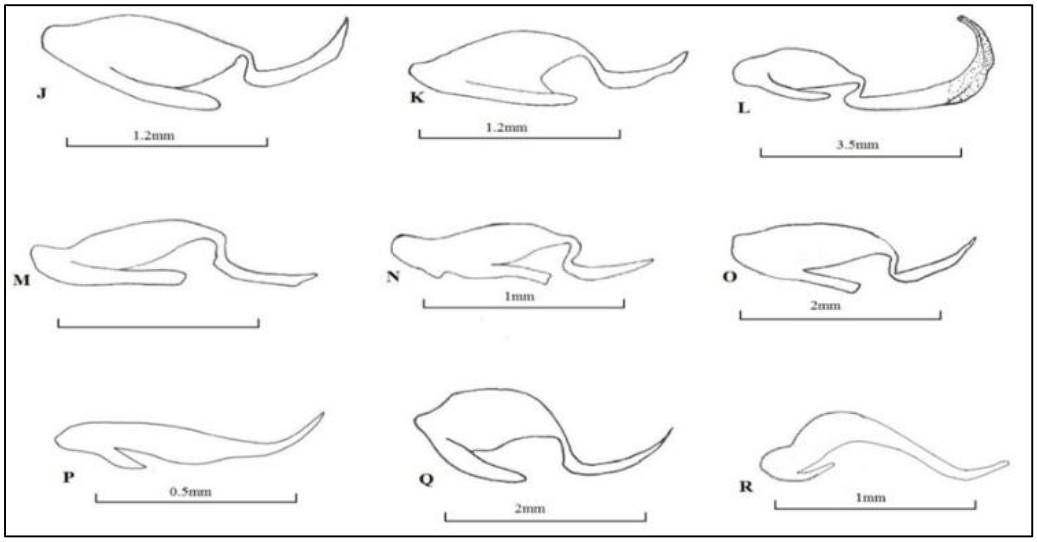


Fig 4: A-R Aedeagus (Male); A. *Oedaleus abruptus*, B. *Oedaleus senegalensis*, C. *Aiolopus simulatrix*, D. *Aiolopus thalassinus*, E. *Aiolopus thalassinus tamulus*, F. *Sphingonotus rubescens rubescens*, G. *Sphingonotus savignyi*, H. *Heteropternis respondens*, I. *Dittopternis venusta*, J. *Acrotylus humbertianus*, K. *Acrotylus insubricus*, L. *Locusta migratoria*, M. *Gastrimargus africanus*, N. *Gastrimargus africanus sulphureus*, O. *Pternoscirta caliginosa*, P. *Scintharista notabilis*, Q. *Ceracris nigricornis*, R. *Ceracris deflorata*

68. *Bryodema luctuosa inda* Saussure, 1884 (Fig. 5 A)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, rounded and broadening basally; gonopore process short with truncate apex.

69. *Oedipoda miniata miniata* (Pallas, 1771) (Fig. 5 B)
Aedeagus flexured, apical valve short and narrow, upcurved, apex acute, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, elongated and narrowing basally; gonopore process short with acute apex.

70. *Chloebora grossa* Saussure, 1884 (Fig. 5 C)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex truncated, narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve broad, truncated and narrowing basally; gonopore process short with bifurcated apex.

71. *Chloebora marschalli* (Henry, 1933) (Fig. 5 D)
Aedeagus flexured, apical valve long and narrow, slightly curved medially, apex truncated, narrower and slightly shorter than basal valve, connected with basal valve with flexure; basal valve broad, obtusely rounded basally; gonopore process short with obtuse apex.

72. *Chloebora crassa* (Walker, 1870) (Fig. 5 E)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex truncated, narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve broad broadly rounded basally; gonopore process short with slightly bifurcate apex.

73. *Morphacris fasciata* (Thunberg, 1815) (Fig. 5 F)
Aedeagus flexured, apical valve narrow, straight, apex truncated, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad medially, truncated and narrowing basally; gonopore process long with acute apex.

74. *Trilophidia annulata* (Thunberg, 1815) (Fig. 5 G)
Aedeagus flexured, apical valve narrow, straight, apex pointed, much narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve broad and broadly truncated basally; gonopore process long with acute apex.

75. *Trilophidia repleta* (Walker, 1870) (Fig. 5 H)
Aedeagus flexured, apical valve narrow, straight, apex truncated, much narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve broad medially and truncated basally; gonopore process long with truncated apex.

Subfamily Cyrtacanthacridinae

76. *Anacridium flavescens* (Fabricius, 1793) (Fig. 5 I)
Aedeagus flexured, apical valve upcurved, narrower and shorter than basal valve, apex obliquely truncated and branched with thread-like structures, basal valve broad, broadly rounded basally; gonopore process short, narrow with obtuse apex.

77. *Anacridium aegyptium* (Linnaeus, 1764) (Fig. 5 J)
Aedeagus flexured, apical valve curved medially, narrower and shorter than basal valve, apex obliquely truncated and branched with thread-like structures, basal valve broad, broadly rounded basally; gonopore process short, narrow with obtuse apex.

78. *Cyrtacanthacris tatarica* (Linnaeus, 1758) (Fig. 5 K)
Aedeagus flexured, apical valve narrow and strongly upcurved, apex acutely pointed, narrower and longer than basal valve, connected with basal valve with flexure, basal valve broad, almost of uniform width, rounded basally; gonopore process narrow with truncated apex.

79. *Schistocerca gregaria* (Forskål, 1775) (Fig. 5 L)
Aedeagus flexured, apical valve narrow, curved, apex acutely pointed, narrower and longer than basal valve, connected with basal valve with flexure, basal valve broad, almost of uniform width, broadly rounded basally; gonopore process narrow with truncated apex.

Subfamily Eyprepocneminae
80. *Eyprepocnemis alacris* (Serville, 1838) (Fig. 5 M)
Aedeagus flexured, apical valve narrow, curved, apex rounded, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve slightly broad, truncated basally with small and acute protuberance; gonopore process short and broad with rounded apex.

81. *Tylotropidius varicornis* (Walker, 1870) (Fig. 5 N)
Aedeagus flexured, apical valve narrow, curved, apex pointed, narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve broad, truncated and flat basally; gonopore process broad with obtuse apex.

82. *Heteracris nobilis* (Brancsik, 1893) (Fig. 5 O)
Aedeagus flexured, apical valve narrow and upcurved, apex rounded, narrower but shorter than basal valve, connected with basal valve with flexure; basal valve moderately broad, broadly rounded basally; gonopore process short and broad with obtuse apex.

83. *Heteracris littoralis* (Rambur, 1838) (Fig. 5 P)
Aedeagus flexured, apical valve narrow and curved, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, flat and much broad basally with small protuberance; gonopore process short and broad with obtuse apex.

84. *Heteracris pulcher* (Bolivar, 1902) (Fig. 5 Q)
Aedeagus flexured, apical valve narrow and upcurved, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, flat and broad basally with obtusely rounded protuberance; gonopore process short and broad with obtuse apex.

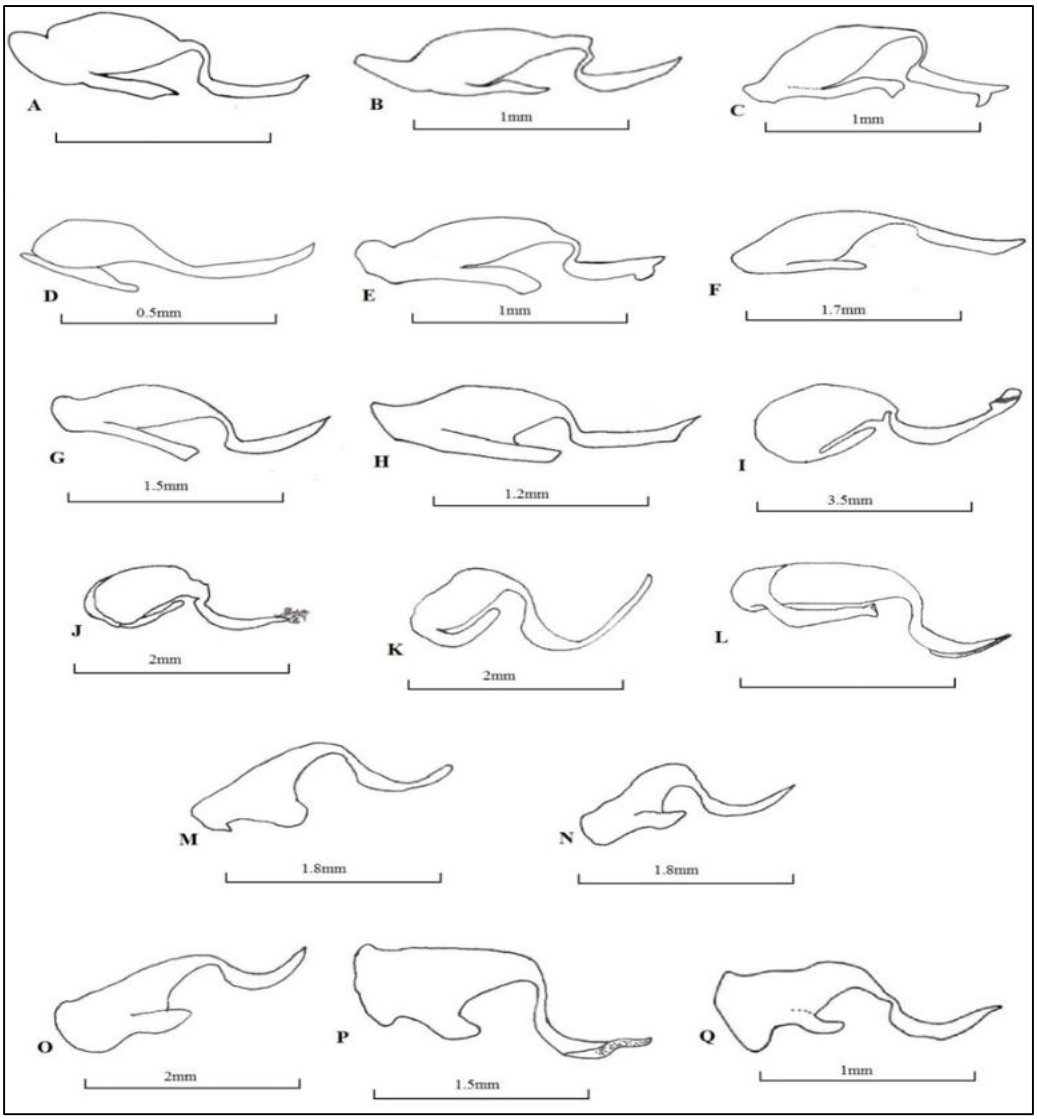


Fig 5: A-Q Aedeagus (Male); A. *Bryodema luctuosa inda*, B. *Oedipoda miniata miniata*, C. *Chloebora grossa*, D. *Chloebora marschalli* E. *Chloebora crassa*, F. *Morphacris fasciata*, G. *Trilophidia annulata*, H. *Trilophidia repleta*, I. *Anacridium flavescens*, J. *Anacridium aegyptium*, K. *Cyrtacanthacris tatarica*, L. *Schistocerca gregaria*, M. *Eyprepocnemis alacris*, N. *Tylotropidius varicornis*, O. *Heteracris nobilis*, P. *Heteracris litttoralis*, Q. *Heteracris pulcher*

Subfamily Catantopinae

85. *Pachyacris violascens* (Walker, 1870) (Fig. 6 A)
Aedeagus flexured, apical valve long, narrow, downcurved, apex pointed and hooked, narrower and much longer than basal valve, connected with basal valve with flexure; basal valve slightly broad, narrowing basally; gonopore process long and narrow with obtuse apex.

86. *Eupreponotus inflatus* Uvarov, 1921 (Fig. 6 B)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex truncated, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, of uniform width, obtusely rounded basally; gonopore process short, broad with obtuse apex.

87. *Apalniacris shillong* Ingrisch, Willemse & Shishodia, 2004 (Fig. 6 C)
Aedeagus flexured, with aedeagal valves small; apical valve longer and narrower than basal valve, slightly curved medially, with acute apex, basal valve broad and flat basally; gonopore process, broad medially with obtuse aapex.

88. *Choroedocus illustris* (Walker, 1870) (Fig. 6 D)
Aedeagus flexured, apical valve long and narrow, upcurved, apex acutely pointed, narrower but longer than basal valve, connected with basal valve with flexure; basal valve broad and truncated basally; gonopore process short with obtuse apex.

89. *Choroedocus robustus* (Serville, 1838) (Fig. 6 E)
Aedeagus flexured, apical valve elongate narrow, longer than basal valve, apex pointed, basal valve short and broad basally, hammer-like with short pointed protuberance, gonopore process much narrow, obtuse at apex.

90. *Catantops erubescens* (Walker, 1870) (Fig. 6 F)
Aedeagus flexured, apical valve short and narrow, upcurved, apex acutely pointed, narrower and slightly shorter than basal valve, connected with basal valve with flexure; basal valve broad and truncated basally; gonopore process short with obtuse apex.

91. *Stenocatantops splendens* (Thunberg, 1815) (Fig. 6 G)
Aedeagus flexured, apical valve short and narrow, upcurved, apex rounded, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad and truncated basally; gonopore process short with truncated apex.

92. *Diabolocatantops innotabilis* (Walker, 1870) (Fig. 6 H)
Aedeagus flexured, apical valve short and narrow, upcurved, apex pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad and truncated basally; gonopore process short with truncated apex.

93. *Diabolocatantops pinguis* (Stål, 1861) (Fig. 6 I)
Aedeagus flexured, apical valve short and narrow, upcurved, apex rounded, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve slightly broad, obtusely rounded basally; gonopore process long with truncated apex.

94. *Xenocatantops karnyi* (Kirby, 1910) (Fig. 6 J)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve uniformly broad, truncated basally; gonopore process long, broad with obtuse apex.

95. *Xenocatantops brachycerus* (Willemse, 1932) (Fig. 6 K)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, of uniform width, rounded basally; gonopore process short with truncated apex.

96. *Xenocatantops humilis* (Serville, 1838) (Fig. 6 L)
Aedeagus flexured, apical valve short and narrow, slightly curved, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, of uniform width, obtusely rounded basally; gonopore process long, narrow with acute apex.

97. *Navasia insularis* Kirby, 1914 (Fig. 6 M)
Aedeagus flexured, apical valve short and narrow, strongly curved upward, apex pointed, much narrower and much shorter than basal valve, connected with basal valve with flexure; basal valve of uniform width, broad basally with truncated protuberance; gonopore process short, hammer-like, broadly rounded at apex

98. *Oxyrrhepes obtusa* (Haan, 1842) (Fig. 6 N)
Aedeagus flexured, apical valve long and broad, curved upward, apex truncate, almost as long as basal valve, connected with basal valve with flexure; basal valve slightly broad of uniform width, truncated basally; gonopore process short with obtuse apex.

Subfamily Coptacridinae

99. *Eucoptacra binghami* Uvarov, 1921 (Fig. 6 O)
Aedeagus flexured, apical valve narrow, apex acutely pointed, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, almost of uniform width; truncated basally; gonopore process short with acute apex.

100. *Eucoptacra praemorsa* (Stal, 1860) (Fig. 6 P)
Aedeagus flexured, apical valve narrow, apex obtuse, narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, almost of uniform width, obtusely narrowing basally; gonopore process long, broad with truncated apex.

101. *Epistaurus abberans* Brunner, 1859 (Fig. 6 Q)
Aedeagus flexured, apical valve short, narrow, curved medially, shorter than basal valve, apex pointed, basal valve narrow, rounded and broad basally; gonopore process long of uniform width with obtuse apex..

102. *Coptacra punctoria* (Walker, 1870) (Fig. 6 R)
Aedeagus flexured, apical valve narrow, apex pointed, much narrower and shorter than basal valve, connected with basal valve with flexure; basal valve broad, obtusely rounded basally; gonopore process short, narrow with rounded apex.

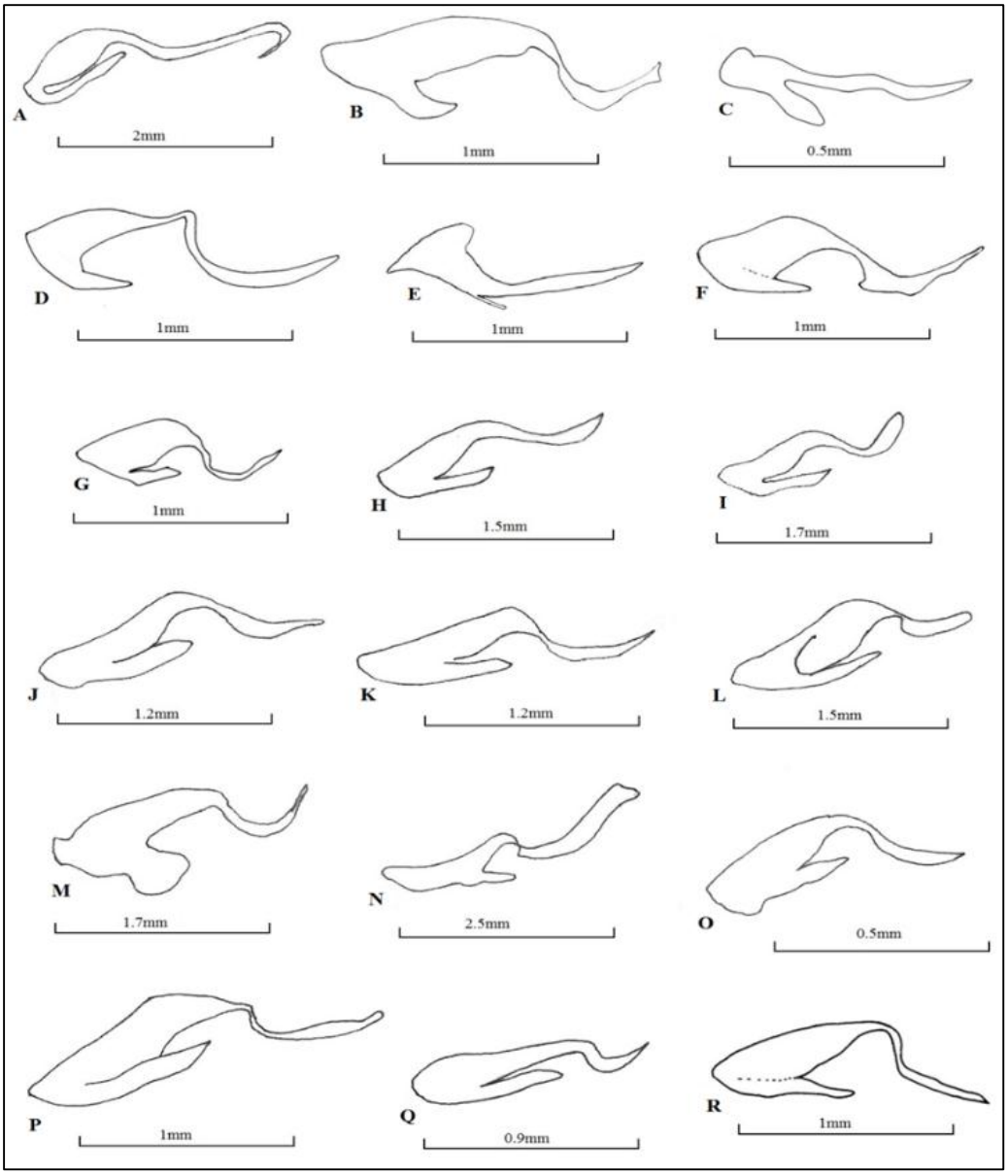


Fig 6: A-R Aedeagus (Male); A. *Pachyacris violascens*, B. *Eupreponotus inflatus*, C. *Apalniacris shilling*, D. *Choroedocus illustris*, E. *Choroedocus robustus*, F. *Catantops* erubescens, G. *Stenocatantops splendens* H. *Diabolocatantops innotabilis*, I. *Diabolocatantops pinguis*, J. *Xenocatantops karnyi* K. *Xenocatantops brachycerus*, L. *Xenocatantops humilis*, M. *Navasia insularis*, N. *Oxyrrhepes obtusa*, O. *Eucoptacra binghamii*, P. *Eucoptacra praemorsa*, Q. *Epistaurus abberans*, R. *Coptacra punctoria*

4. Discussion

A comparative study of aedeagus in one hundred and two species of Indian grasshoppers representing fifty-nine genera belonging to the family Acrididae has shown that there are certain characters, i.e. divided or undivided condition aedeagus, presence or absence of flexure, apical valves longer or shorter than basal valves, narrow or wide, upcurved or downcurved conditions of apical valves and shape of apical and basal valves have significant value in separating various families, genera and species of Acrididae.

Flexured condition of aedeagus is a constant character in the family Acrididae. Upcurved or downcurved condition of apical valves and length of apical and basal valves are suggested as generic characters. Apical valves slightly curved, much shorter and much narrower than basal valves in *Neophlaeoba*, *Phlaeoba*, *Acorypha*, *Dociostaurus*, *Leionotacris*, *Dhimban*a, *Aulacobothrus and Crucinotacris*; apical valves slightly curved and slightly shorter than basal valves in *Anacridium*; apical valves strongly curved, narrower and much shorter than basal valves in *Schistocerca*, *Eyprepocnemis*, *Tylotropidius*, *Heteracris*, *Hieroglyphus*, *Tristria*, *Leva* and *Chorthippus*; apical valves curved upward, narrower and shorter than basal valves in *Oedaleus*, *Aiolopus*, *Sphingonotus*, *Heteropternis*, *Dittopternis*, *Acrotylus*, *Gastrimargus*, *Pternoscirta*, *Scintharista and Ceracris*; apical valves curved upward, narrower and much longer than basal valves in *Locusta*; apical valves curved upward, much narrower and much shorter than basal valves in *Stenohippus*, *Ochrilidia*; apical valves deeply curved upward, slightly narrower and shorter than basal valves in *Acrida*; apical valves slightly curved, slightly narrower and shorter than basal valves in *Truxalis*; apical valve curved, narrower and as long as or slightly longer than basal valve in *Orthochtha*; together with other conventional characters have made the identification of genera more perfect and convenient. Shape of apical and basal valves is suggested as specific character in separating various species within the genera

Acrida, Phlaeoba, Orthochtha, Acorypha, Aulacobothrus, Leva Ochrilidia, Oedaleus, Sphingonotus, Acrotylus, Aiolopus, Gastrimargus, Ceracris, Chloebora, Trilophidia, Oxya, Hieroglyphus, Anacridium, Heteracris, Choroedocus, Dibolocatantops, Xenocatantops and Eucoptacra.

5. Acknowledgements
The authors are thankful to the Chairman, Department of Zoology, Aligarh Muslim University, Aligarh for providing necessary facilities. The first author is also obliged to University Grants Commission for Non-Net UGC Fellowship.

6. References
1. Dirsch VM. The phallic complex in Acridoidea (Orthoptera) in relation to taxonomy. Trans. R. Ent. Soc. Lond. 1956; 108:223-365.
2. Dirsch VM, Uvarov BP. Tree locusts of the genus Anacridium (Orthoptera, Acridoidea). Eos, Madr. 1953; 29:7-69.
3. Hollis D. A revision of the genus Aiolopus Fieber (Orthoptera: Acridoidea). Bull. Br. Mus. nat. Hist. (Ent.), 1968; 22(7):307-355.
4. Jago ND. Revision of the genus Ochrilidia Stal, 1873 with comments on the genera Sporobolius Uvarov, 1941 and Platypternodes I. Boliver, 1908 (Orthoptera, Acrididae, Gomphocerinae). Acrida. 1977; 6(1977):163-217.
5. Kevan DK McE, Akbar SS, CHANG YC. The concealed copulatory structures of the pyrgomorphidae (Orth. Acridoidea): Part VI (Conclusion). Tribes Pyrgomorphini and Chrotogonini. Eos, Madr. 1975; 49:131-218.
6. Usmani MK, Ajaili AA. Taxonomic significance of Aedeagus in some Libyan grasshoppers (Orthoptera: Acrididae). Indian J Syst Ent. 1993; 9(2):1-8.
7. Uvarov BP. Grasshoppers and Locusts. I. Cambridge, 1966, 481.