

## SIGNIFICANCE OF EPIPHALLUS IN SOME INDIAN SPECIES OF ACRIDIDAE (ORTHOPTERA: ACRIDOIDEA)

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**ABSTRACT:** A comparative study of epiphallus is made in sixty Indian species of grasshoppers, representing forty one genera belonging to the family Acrididae. Its significance in the classification of Acrididae is shown. The study revealed that there are certain characters i.e. presence or absence of dorso-lateral appendages; broad or narrow condition of bridge; presence or absence of ancorae; single, bi- or trilobite condition of lophi and shape of ancorae and lophi have significant value in separating various families, genera and species of Acridoidea. Absence of dorso-lateral appendages in the family Acrididae is taken as familial character which is present in all genera of the family Pyrgomorphidae. Presence or absence of ancorae and single, bi- or trilobite condition of lophi are considered as generic characters. Bridge without ancorae, lophi large lobiform in *Anacridium*, *Cyrtacanthacris* and *Schistocerca*; bridge with ancorae, lophi large lobiform in *Heteracris* and *Navasia*; bridge with ancorae, lophi small in *Oxyrrhypes* and *Tristria*; bridge with ancorae, lophi finger shaped in *Tristria* and *Xenocatantops*; bridge with ancorae, lophi bilobate in *Dnopherula*, *Acrotylus*, *Neohelithera*, *Locusta* and *Truxalis*; bridge with ancorae, lophi lobiform in *Aiolopus*, bridge with ancorae, lophi trilobite in *Ochrilidia*. Broad or narrow condition of bridge, Shape of ancorae and lophi is suggested as specific character in separating various species within the genera *Anacridium*, *Catantops*, *Heteracris*, *Oxya*, *Dnopherula*, *Hieroglyphus*, *Eucoptacra*, *Truxalis*, *Trilopidia*, *Oedaleus*, *Acrotylus*, *Aiolopus*, *Catantops* and *Xenocatantops*.

**KEY WORDS:** Significance, epiphallus, Indian species, Acrididae

The epiphallus is a strongly sclerotized structure located on dorsal side of the phallic organ. It serves to grasp the edge of female subgenital plate to fix the phallus firmly during copulation. Its taxonomic significance in various families and sub families of Acridoidea is already known. Dirsh (1956) has shown the taxonomic importance of phallic complex particularly the epiphallus in the classification of Acridoidea. Uvarov (1966) considered epiphallus as very reliable taxonomic character at the family and subfamily level and as a good specific character within the genera for locusts and grasshoppers. Jago (1977) and Mishchenko (1986) gave illustrations of epiphallus in differentiating various species of the genus *Ochrilidia*. Ajaili & Usmani (1990) have shown taxonomic significance in some Libyan species of Acridoidea.

Keeping in view the taxonomic importance of epiphallus, the present study is an attempt to make a comparative study of epiphallus in fifty nine Indian species representing forty genera of the family Acrididae. The characters i.e. broad or narrow condition of bridge; presence or absence of ancorae; single, bi- or trilobite condition of lophi and shape of ancorae and lophi are suggested as characters of taxonomic significance.

### MATERIALS AND METHODS

Adult specimens were collected from various agricultural localities in India. For the study of epiphallus, the apical part of male body was cut off and boiled in

test tube containing 10% KOH solution till the material become transparent. Then, washed thoroughly in water for complete removal of KOH. It was then dissected by aid of stereoscopic microscope and with the help of fine needles epiphallus was taken out. The normal process of dehydration was adapted and cleaning was done in clove oil. The epiphallus was mounted in Canada balsam on a cavity slide. Drawings were made with the help of Camera lucida.

## DESCRIPTION OF EPIPHALLI

### Subfamily Acridinae

#### 1. *Truxalis eximia* (PL. 1 Fig. A)

Epiphallus, bridge curved, moderately broad and undivided; ancorae broad, pointed, anterior projection small with obtuse apex, posterior projection narrow with acute apex; lophi bilobate, lobes distinctly separate.

#### 2. *Truxalis nasuta* (PL. 1 Fig. B)

Epiphallus, bridge narrow and undivided; ancorae moderate, blunt and incurved, anterior projection small with obtuse apex, posterior projection narrow with acute apex; lophi bilobate, lobes close to each other.

#### 3. *Acrida exaltata* (PL. 1 Fig. C)

Epiphallus, moderately broad median bridge; peglike ancorae, anterior projection small with obtusely rounded apex, posterior projection moderate with acute apex; lophi bilobed, nodulated and blunt.

#### 4. *Neophaeoba walayarensis* (PL. 1 Fig. D)

Epiphallus, bridge curved, narrow and undivided; ancorae broad, blunt, anterior projection broad, distinct, posterior projection narrow with pointed apex; lophi elongate, narrow.

#### 5. *Phlaeoba infumata* (PL. 1 Fig. E)

Epiphallus, bridge narrow; ancorae moderate, with incurved pointed apices, anterior projection short with obtuse apex, posterior projection small with acute apex; lophi small, single lobe.

#### 6. *Orthochtha indica* (PL. 1 Fig. F)

Epiphallus, bridge narrow and undivided; ancorae large, acute and incurved, anterior projection moderate and rounded, posterior projection narrow and long with rounded apex; lophi large and lobiform.

#### 7. *Neohilethera maculatipennis* (PL. 1 Fig. G)

Epiphallus, narrow bridge; ancorae long and slender, anterior projection pointed, posterior projection flat, posterior projection broadly expanded; lophi bilobate.

#### 8. *Odontomellus manipurensis* (PL. 1 Fig. H)

Epiphallus, narrow with rounded bridge; ancorae short, anterior projection broad and rounded, posterior projection narrow and blunt, apex acute; lophi lobiform, broad and large.

### Subfamily Gomphocerinae

#### 9. *Dnopherula strictus* (PL. 1 Fig. I)

Epiphallus, bridge undivided medially; ancorae small and robust with pointed apices, anterior projection broad, circular, posterior projection rounded; lophi bilobate, anterior lobe rounded and slightly larger than posterior lobe.

#### 10. *Dnopherula decisis* (PL. 1 Fig. J)

Epiphallus, bridge moderate; ancorae small, pointed and incurved, anterior projection broad with rounded apex, posterior projection narrow with acute apex; lophi bilobate, anterior lobe of lophi smaller than posterior lobe.

**11. *Aulacobothrus luteips*** (PL. 1 Fig. K)

Epiphallus, bridge narrow and undivided medially; ancorae small and incurved with pointed apices, anterior projection small with rounded apex, posterior projection small with acutely conical apex; lophi elongate and lobiform.

**12. *Ochridia geniculata*** (PL. 1 Fig. L)

Epiphallus, bridge narrow and undivided; ancorae moderate, acute anterior projection broad rounded, posterior projection rectangular; lophi trilobite.

**13. *Leva indica*** (PL. 1 Fig. M)

Epiphallus, bridge narrow and undivided medially; ancorae short with pointed apices, anterior projection rounded; lophi small and single lobed.

**Subfamily Oedipodinae****14. *Ceracris nigricornis*** (PL. 1 Fig. O)

Epiphallus, bridge narrow and undivided medially; ancorae moderate and narrow with pointed apices, anterior projection broad and rounded, posterior projection narrow; lophi small.

**15. *Pternoscirta caliginosa*** (PL. 2 Fig. A)

Epiphallus, narrow bridge and undivided; ancorae small with pointed apices, posterior projection rectangular; lophi large, lobiform.

**16. *Morphacris fasciata*** (PL. 2 Fig. B)

Epiphallus, narrow bridge, ancorae narrow, posterior projection flattened, expanded, apices pointed, anterior projection broad, apices pointed; lophi large and lobiform.

**17. *Trilophidia annulata*** (PL. 2 Fig. C)

Epiphallus, bridge narrow and undivided medially; ancorae short and incurved with acutely pointed apices; anterior projection short with rounded apex; posterior projection small with acutely conical apex; lophi large and bilobed and posterior lobes with a shallow excavation.

**18. *Trilophidia repleta*** (PL. 2 Fig. D)

Epiphallus, bridge narrow and undivided medially, ancorae long and narrow, anterior projection broadly rounded, posterior projection flattened; lophi large, broad basally and narrowing apically.

**19. *Oedaleus abruptus*** (PL. 2 Fig. E)

Epiphallus, bridge moderately broad, undivided, straight medially; ancorae moderately curved and obtuse at apex, anterior projections well developed with obtusely conical apex, posterior projections small with angularly rounded apex; lophi large, lobiform, bilobate.

**20. *Oedaleus senegalensis*** (PL. 2 Fig. F)

Epiphallus, bridge narrow, undivided, curved medially; ancorae moderate, anterior projection narrow and pointed posterior projection broad; lophi large and bilobate.

**21. *Aiolopus simulatrix*** (PL. 2 Fig. G)

Epiphallus, bridge moderately narrow and undivided medially, anterior margin slightly incurved in the middle; ancorae moderately broad, curved and pointed at tips, anterior projection small with obtusely rounded apex, posterior projection small with obtuse apex; lophi large and lobiform.

**22. *Aiolopus thalassinus*** (PL. 2 Fig. H)

Epiphallus, bridge moderately narrow and undivided medially; ancorae broad, curved with acute tips, anterior projection small with obtuse apex, posterior projection small with obtuse apex; lophi large and lobiform.

**23. *Sphingonotous savignyi*** (PL. 2 Fig. I)

Epiphallus, bridge narrow; ancorae large, anterior projection pointed, posterior projection narrow, acute; lophi narrow elongate, bilobate.

**24. *Heteropternis respondens*** (PL. 2 Fig. J)

Epiphallus, bridge short and narrow, undivided medially, anterior margin slightly incurved in the middle; ancorae small and incurved with acute apex, anterior and posterior projection broad with rounded apex; lophi large, bilobate and lobiform.

**25. *Dittopternis venusta*** (PL. 2 Fig. K)

Epiphallus, bridge short and undivided; ancorae moderately large, anterior projection broad with obtuse apex, posterior projection narrow with acute apex; lophi large and bilobate.

**26. *Acrotylus humbertianus*** (PL. 2 Fig. L)

Epiphallus, bridge moderately wide and undivided medially, anterior margin incurved in the middle; ancorae short, narrow with incurved and pointed tips, anterior projection small with rounded apex; posterior projection small with obtuse apex; lophi bibobate, finely sculptured.

**27. *Acrotylus insubricus*** (PL. 2 Fig. M)

Epiphallus, bridge moderately wide and undivided medially, anterior margin incurved in the middle; ancorae elongate, narrow with incurved and pointed tips, anterior projection small with obtuse apex, posterior projection small with obtuse apex; lophi bibobate, finely sculptured.

**28. *Locusta migratoria*** (PL. 2 Fig. N)

Epiphallus, bridge moderately narrow and undivided medially; ancorae comparatively large and incurved with pointed tips, anterior projection small with rounded apex, posterior projection small with obtuse apex; lophi large and bilobate with strongly separated lobe.

**29. *Gastrimargus africanus*** (PL. 2 Fig. O)

Epiphallus, bridge narrow and undivided medially, anterior margin incurved in the middle; ancorae small and incurved with acute apex; anterior projection small and incurved with acute apex; posterior projection small with obtuse apex; lophi large, bilobate and lobiform.

### Subfamily Oxyinae

**30. *Oxya hyla hyla*** (PL. 3 Fig. A)

Epiphallus, bridge moderately broad and divided medially; ancorae absent, anterior projection broad, rounded, posterior projection narrow with acute apex; lophi large hook like.

**31. *Oxya hyla intricata*** (PL. 3 Fig. B)

Epiphallus, bridge rounded and divided medially with high projections in the middle, anterior projection flattened, posterior projection small, with acute apex; lophi broad, flattened and tooth like inner lophi.

**32. *Oxya fuscovittata*** (PL. 3 Fig. C)

Epiphallus, bridge narrow and divided medially; ancorae absent, anterior projection short with rounded apex, posterior projection short with acute apex and with boat shaped outer lophi and tooth like inner lophi, of the later the left lophus is always less developed than the right.

**33. *Oxya nitidula*** (PL. 3 Fig. D)

Epiphallus, bridge broad, divided medially, anterior projection small, hook like, curved inward, posterior projection small, rounded; lophi small, streak like.

**34. *Oxya japonica japonica*** (PL. 3 Fig. E)

Epiphallus, bridge broad, undivided medially, anterior projection narrow, elongate, hook like, posterior projection not distinct; lophi elongate hook like and tooth like inner lophi.

**35. *Oxya velox*** (PL. 3 Fig. F)

Epiphallus, moderately broad divided medially, anterior projection small, hook like, posterior projection indistinct; lophi small with acute apex.

**36. *Gesonula punctifrons*** (PL. 4 Fig. G)

Epiphallus, bridge narrow small and undivided medially; ancorae elongate and slender with pointed apices, anterior projection well developed with rounded apex, posterior projection indistinct; lophi small lobiform, bilobate.

**Subfamily Spathosterninae****37. *Spathosternum prasiniferum*** (PL. 3 Fig. H)

Epiphallus, bridge wide and undivided; ancorae small with bluntly rounded and incurved apices, anterior projection long with obtuse and incurved apices, posterior projection short with obtuse apex; lophi small and rounded.

**Subfamily Hemiacruidinae****38. *Hieroglyphus oryzivorus*** (PL. 3 Fig. I)

Epiphallus bridge undivided; ancorae small, incurved with acute apices, anterior projection long, apex obtuse, posterior projection small with rounded apex; lophi large.

**39. *Hieroglyphus banian*** (PL. 3 Fig. J)

Epiphallus, bridge narrow and undivided with central protrusion at base; ancorae small, turned inwards with acute apices, anterior projection small with obtuse apex, posterior projection weakly developed; lophi robust and large with two inner lobes and sinuate outer edges.

**40. *Hieroglyphus nigrorepletus*** (PL. 3 Fig. K)

Epiphallus, bridge narrow and undivided, concave; ancorae small, turned inwards with acute apices, anterior projection small, apex obtuse and incurved, posterior projection small with rounded apex; lophi robust and large.

**Subfamily Catantopinae****41. *Pachyacris violascens*** (PL. 4 Fig. A)

Epiphallus, bridge undivided; ancorae small, rounded, anterior projection small, blunt, posterior projection broad, bluntly rounded; lophi lobiform.

**42. *Catantops innotabilis*** (PL. 4 Fig. B)

Epiphallus, bridge broad and undivided medially, claw shaped ancorae, anterior projection broad rounded, posterior projection elongate with obtuse apex; lophi broad and lobiform.

**43. *Catantops pinguis*** (PL. 4 Fig. C)

Epiphallus, bridge undivided medially, narrow triangular ancorae, anterior projection basically rounded, posterior projection elongate obtuse; lophi narrow and lobiform.

**44. *Catantops karnyi*** (PL. 4 Fig. D)

Epiphallus, bridge narrow and undivided medially; ancorae small and incurved with acutely pointed apex, anterior projection small with truncated apex, posterior projection small with obtuse apex; lophi large and lobiform.

**45. *Xenocatantops humilis brachycerus*** (PL. 4 Fig. E)

Epiphallus, bridge narrow, undivided medially; ancorae small, incurved, with apices pointed, anterior projection broadly rounded, posterior projection with blunt apices; lophi elongate narrow.

**46. *Xenocatantops humilis humilis*** (PL. 4 Fig. F)

Epiphallus, bridge broad and undivided medially; ancorae large and incurved with acutely pointed apex, anterior projection large with blunt apex, posterior projection small with obtuse apex; lophi large and lobiform.

**47. *Navasia insularis*** (PL. 4, fig. G)

Epiphallus, bridge narrow, undivided medially; ancorae long, narrowing apically with pointed apices, anterior projection long, blunt, posterior projection small, narrow, blunt; lophi lobiform.

**48. *Oxyrrhepes obtuse*** (PL. 4, fig. H)

Epiphallus, bridge narrow and undivided medially, anterior margin incurved in the middle; ancorae moderately large and incurved with blunt apex, anterior projection large with rounded apex, posterior projection small with obtuse apex; lophi small, finger shaped and incurved.

**Subfamily Coptacidinae****49. *Eucoptacra binghamii*** (PL. 4 Fig. I)

Epiphallus, bridge narrow and divided medially; ancorae moderately broad with pointed apex, tooth shaped and incurved, anterior projection broadly rounded with obtuse apex, posterior projection less developed, bluntly rounded; lophi large, curved.

**50. *Eucoptacra praemorsa*** (PL. 4 Fig. J)

Epiphallus, bridge narrow and divided medially; ancorae large, tooth shaped and incurved, anterior projection broad with obtuse apex, posterior projection broad with rounded apex; lophi large and lobiform.

**51. *Epistaurus aberrans*** (PL. 4 Fig. K)

Epiphallus, bridge divided medially; ancorae moderate with pointed apex, anterior and posterior projections broadly rounded; lophi bilobed.

**Subfamily Cyrtacanthacridinae****52. *Anacridium flavescens*** (PL. 4 Fig. L)

Epiphallus, bridge broad, undivided medially; ancorae absent; lophi large with pointed apices, anterior and posterior projections absent.

**53. *Anacridium aegyptium*** (PL. 4 Fig. M)

Epiphallus, bridge narrow, undivided medially; ancorae absent; lophi large lobe-shaped, anterior and posterior projections absent.

**54. *Cyrtacanthacris tatarica*** (PL. 4 Fig. N)

Epiphallus, bridge narrow and undivided; ancorae absent, anterior projection small and rounded, posterior projection absent; lophi elongate, lobiform.

**55. *Schistocerca gregaria*** (PL. 4 Fig. O)

Epiphallus, bridge broad and undivided; ancorae absent; lophi large, angular and lobiform, lateral plates and their projections prominent.

**Subfamily Eupreopcnemidinae****56. *Heteacris nobilis*** (PL. 5 Fig. A)

Epiphallus, bridge broad and divided medially; ancorae small, pointed and incurved, anterior projection small with excurved obtuse apex, posterior projection short with atuse apex; lophi large and lobiform.

**57. *Heteracris littoralis*** (PL. 5 Fig. B)

Epiphallus, bridge broad and divided medially; ancorae small, pointed and incurved, anterior projection small with incurved acute apex, posterior projection short with obtuse apex; lophi large and lobiform.

**58. *Tylotropidius varicornis*** (PL. 5 Fig. C)

Epiphallus, bridge narrow and undivided; ancorae small, obtuse and incurved, anterior projection small and obtuse, posterior projection short with obtuse apex; lophi small, lobiform.

**59. *Eyprepocnemis alacris*** (PL. 5 Fig. D)

Epiphallus, bridge narrow and undivided, convex medially; ancorae moderately large, obtuse and incurved, anterior and posterior projection absent; lophi lobiform.

### Subfamily Tropidopolinae

**60. *Tristria pulvinata*** (PL. 5 Fig. E)

Epiphallus, narrow and undivided bridge; ancorae small with obtusely rounded apices and incurved, anterior projection excurved, small, narrow with rounded apex, posterior projection weakly developed; lophi small and narrow.

## DISCUSSION

Comparative study of epiphallus in sixty species of the family Acrididae revealed that there are certain characters i.e. presence or absence of ancorae, mono-, bi- or trilobite condition of lophi and shape of ancorae and lophi have significant value in separating various families, genera and species of Acridoidea. Presence of dorso-lateral appendages in the family Pyrgomorphidae which is absent in all genera belonging to the family Acrididae.

Presence or absence of ancorae and single, bi- or trilobite condition of lophi are considered as generic characters. Bridge without ancorae, lophi large lobiform in *Anacridium*, *Cyrtacanthacris* and *Schistocerca*; bridge with ancorae, lophi large lobiform in *Heteracris* and *Navasia*; bridge with ancorae, lophi small in *Oxyrrhepes* and *Tristria*; bridge with ancorae, lophi finger shaped in *Tristria* and *Xenocatantops*; bridge with ancorae, lophi bilobate in *Dnopherula*, *Acrotylus*, *Neohelithera*, *Locusta* and *Truxalis*; bridge narrow, lophi lobiform in *Aiolopus*, bridge with ancorae, lophi trilobite in *Ochrilidia* together with other generic characters have made the identification of the genera more perfect and convenient. Broad or narrow condition of bridge; shape of ancorae and lophi are suggested as specific character in separating various species within the genera *Anacridium*, *Catantops*, *Heteracris*, *Oxya*, *Dnopherula*, *Hieroglyphus*, *Eucoptacra*, *Truxalis*, *Trilopidia*, *Oedaleus*, *Acrotylus*, *Aiolopus*, *Catantops* and *Xenocatantops*.

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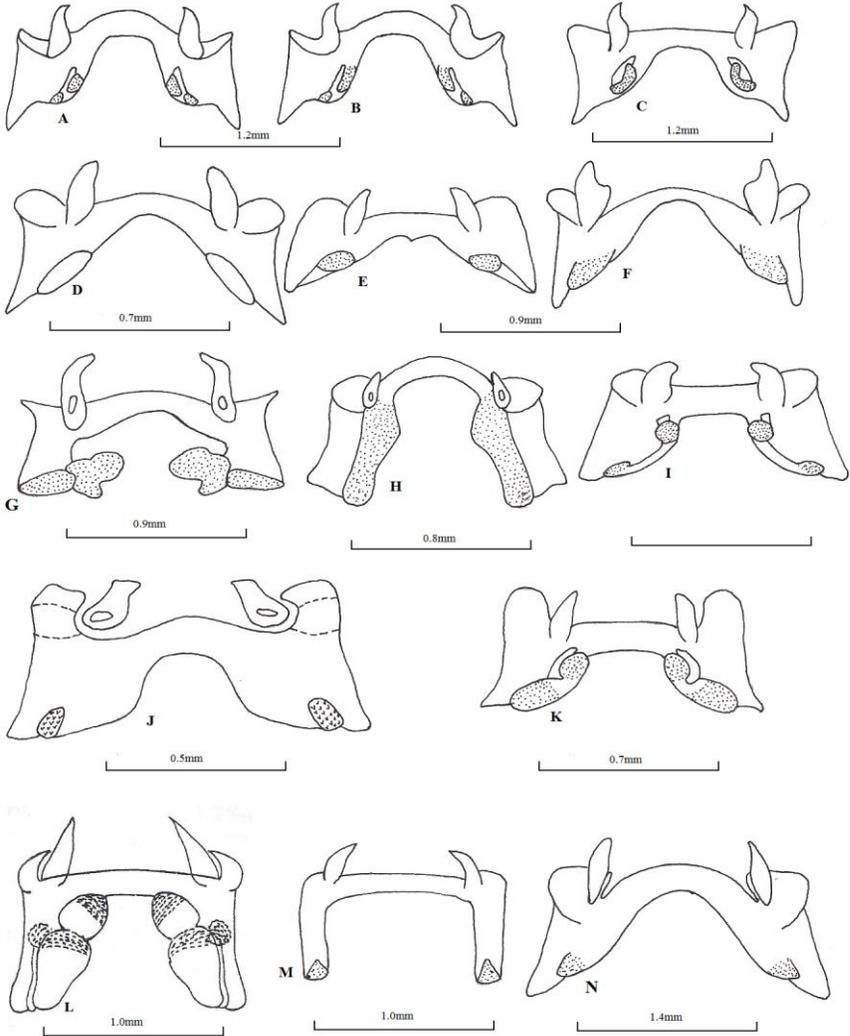


Plate 1. A-N Epiphallus A. *Truxalis eximia*, B. *Truxalis nasuta*, C. *Acrida exaltata*, D. *Neophlaeoba walayarensis*, E. *Phlaeoba infumata*, F. *Orthochtha indica*, G. *Neohilethera maculatipennis*, H. *Odontomellus manipurensis*, I. *Dnopherula strictus*, J. *Aulacobothrus luteips*, K. *Dnopherula decisis*, L. *Ochrilidia geniculata*, M. *Leva indica*, N. *Ceracris nigricornis*.

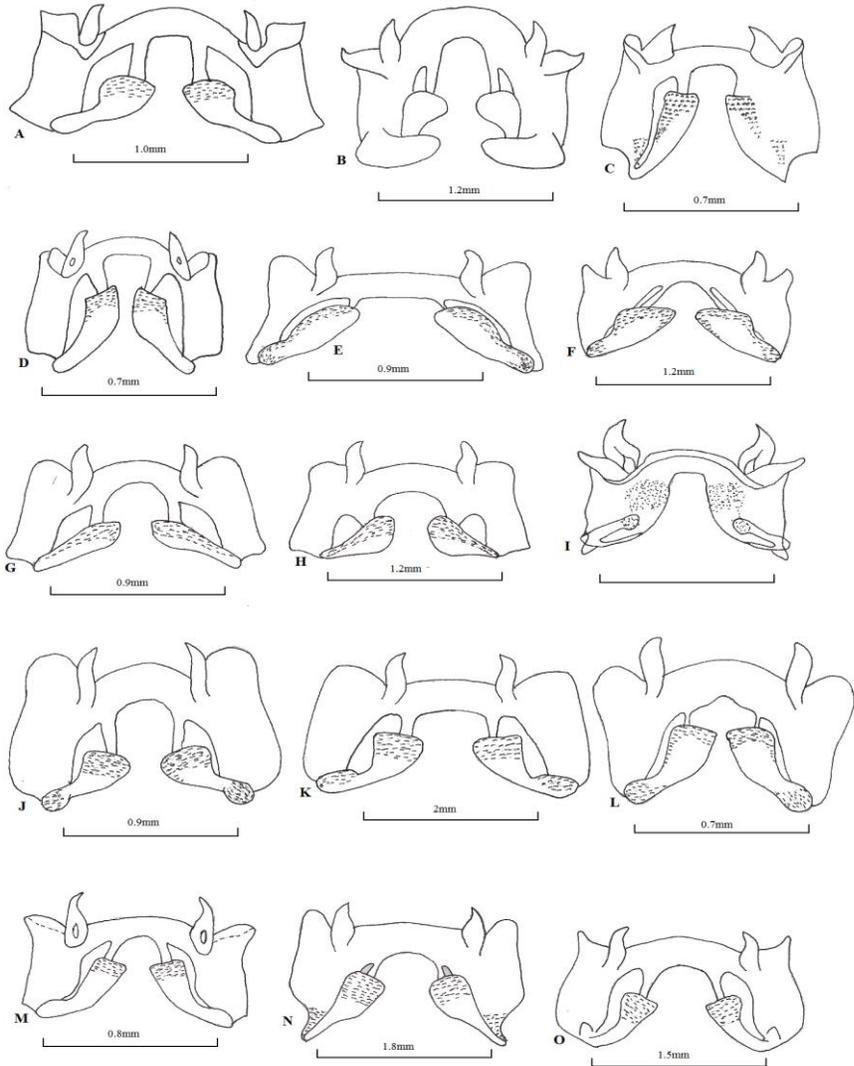


Plate 2. A-O Epiphallus; A. *Pternoscirta caliginosa*, B. *Morphacris fasciata*, C. *Trilophidia annulata*, D. *Trilophidia repleta*, E. *Oedaleus abruptus*, F. *Oedaleus senegalensis*, G. *Aiolopus simulatrix*, H. *Aiolopus thalassinus*, I. *Sphingonotous savignyi*, J. *Heteropternis respondens*, K. *Dittopternis venusta*, L. *Acrotylus humbergianus*, M. *Acrotylus insubricus*, N. *Locusta migratoria*, O. *Gastrimargus africanus*.

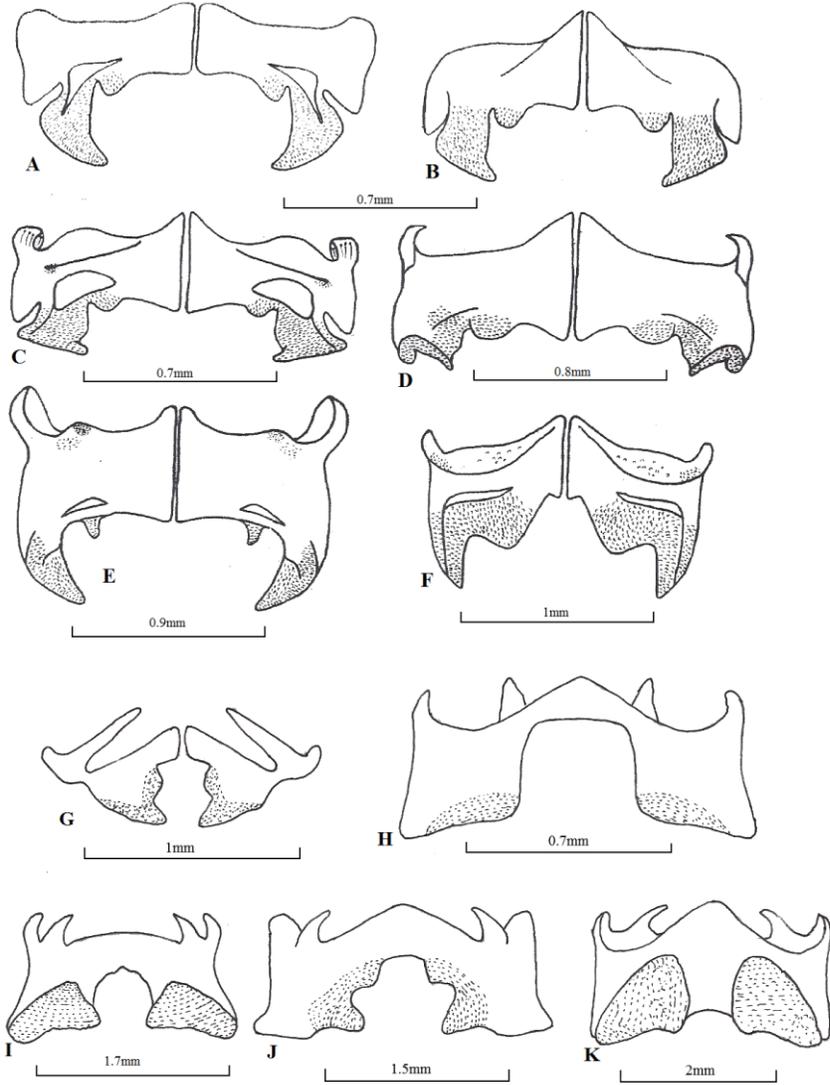


Plate 3. A-K. Epiphallus; A. *Oxya hyla hyla*, B. *Oxya hyla intricata*, C. *Oxya fuscovittata*, D. *Oxya nitidula*, E. *Oxya japonica japonica*, F. *Oxya velox*, G. *Gesonula punctifrons*, H. *Spathosternum prasiniferum*, I. *Hieroglyphus oryzivorus*, J. *Hieroglyphus banian*, K. *Hieroglyphus nigrorepletus*.

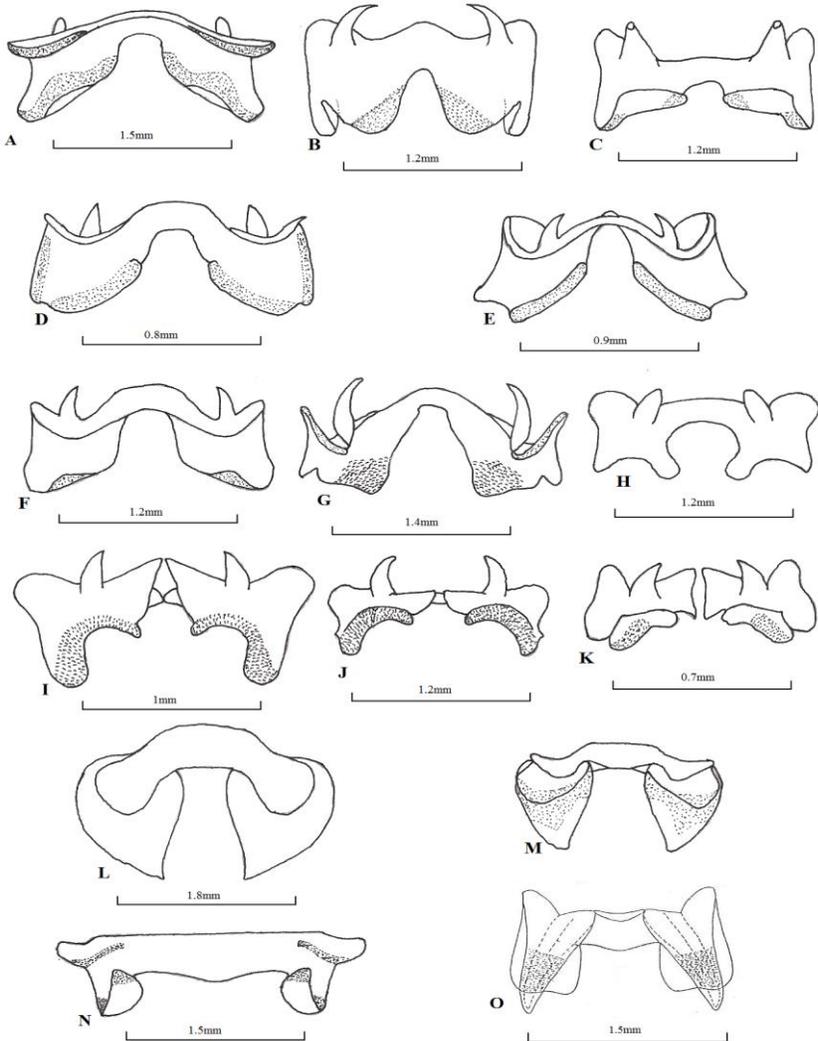


Plate 4. A-O Epiphallus; A. *Pachyacris voilascens*, B. *Catantops innotabilis*, C. *Catantops pinguis*, D. *Catantops karnyi*, E. *Xenocatantops humilis brachycerus*, F. *Xenocatantops humilis humilis*, G. *Navasia insularis*, H. *Oxyrrhopes obtusa*, I. *Eucoptacra binghamii*, J. *Eucoptacra praemorsa*, K. *Epistaurus aberrans*, L. *Anacridium flavescens*, M. *Anacridium aegyptium*, N. *Cyrtacanthacris tatarica*, O. *Schistocerca gregaria*.

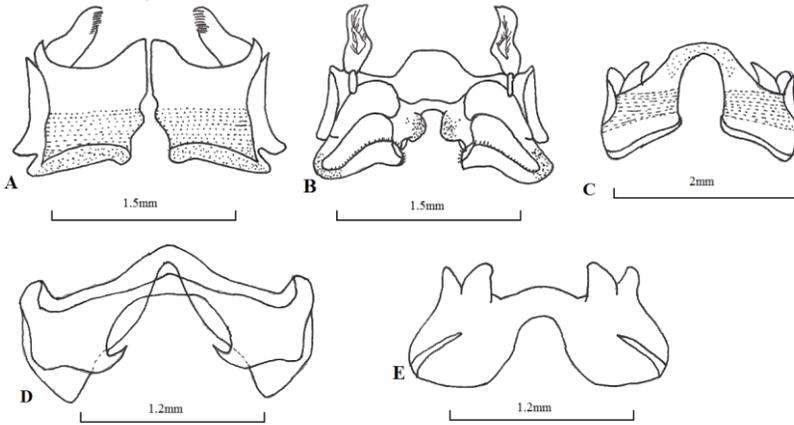


Plate 5. A-E Epiphallus; A. *Heteacris nobili*, B. *Heteracris littorali*, C. *Tylotropidius varicornis*, D. *Eypreocnemis alacris*, E. *Tristria pulvinata*.