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RESEARCH ARTICLE

STUDIES ON MALE GENITALIA OF SOME SPECIES OF FAMILY LIBELLULIDAE (ANISOPTERA: ODONATA) FROM NORTH-WEST INDIA

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Abstract

The secondary male genitalic attributes of five species i.e. *Sympetrum haematoneura* Fraser, *Urothemis signata signata* (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Zygonyx torrid isis* Fraser and *Libellula quadrimaculata* Linnaeus have been studied and illustrated in this manuscript. The significance of various genitalic attributes of all the species has also been highlighted.

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INTRODUCTION

Whenever taxonomic studies are undertaken on any animal group, it becomes customary to get acquainted with a set of stable taxonomic characters particularly related to that group. It may be further added that for different animal groups, a set of reliable and stable taxonomic attributes are always different i.e. these may be stable and of immense taxonomic value for one group but of no relevance in another group. Keeping in the view, an effort has been made to discuss certain stable and reliable taxonomic features on the basis of male genitalia employed in the family Libellulidae. The significance of external genitalia in the Odonate taxonomy has been realized for quite some time now by eminent Indian workers such as Prasad and Srivastava (1960), Khan (1969, 1972, 1973, 1974, 1976), Lahiri (1987), Prasad (1988) and Andrew and Tembhare (1993). But as far as Indian species are concerned, very little has been done, so far. However, Miller (1981, 1982, 1984, 1988, 1990, 1991a, 1991b, 1995), Kirti & Singh (2004) have done some good work on this aspect.

In the present manuscript, five species i.e. *Sympetrum haematoneura* Fraser, *Urothemis signata signata* (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Zygonyx torrid isis* Fraser and *Libellula quadrimaculata* Linnaeus belonging to family Libellulidae have been examined and studied in considerable details. The importance of genitalic characters such as lamina, hamule, genital lobe and penis has been highlighted and it can be inferred that these are highly species specific.

Material and Methods:

The adult dragonflies were collected with the help of insect collecting net from different localities of North-Western states of India in different seasons from August 1997 to October 2000. The adult representatives of dragonflies were killed with ethyl acetate vapours in the killing bottle, and in case of teneral specimens were put alive into triangular paper packets and starved to death. The dead specimens were then bristled, pinned, stretched, dried and preserved. To examine the male genitalic structures, the first three abdominal segments were cut off either from the fresh

specimens or dried ones. However, in latter case, the dragonflies were relaxed in insect relaxing box for 12 hours before detaching the abdomen. The separated abdomen segments were treated with 10% KOH to dissolve the muscles and to soften the chitin. The potashed material was washed in distilled water containing few drops of acetic acid. The dissection of abdomen was done in 50 % alcohol to have a clear view of different genitalic attributes. After proper dehydration, the material was preserved in vials containing a mixture of ethyl alcohol and glycerine in the ratio of 4:1. The sketches of the genitalia were made with the help of a graph eye piece under binocular at different magnifications.

The terminology given by Chao (1953) and Miller (1991) was followed for the names of the different parts of genitalia.

Results:

***Sympetrum haematoneura* Fraser**

Fraser. 1934. *Mem. Dept. Agric. India (Ent.)*, **8**: 70-71.

(Figs. 1-7)

Lamina highly sclerotized, broadly and deeply arched, besotted with setae along apical margin; hamules with anterior hook robust and short, apex bent inwards, posterior base truncated, equal in length to hook; genital lobe long with rounded and thickened apex; penis deeply sclerotized, vesicular spermalis swollen, flask shaped and naked; distal segment of penis short and broad, nearly as long as middle segment, dorsal hood extending distally into a pair of process, latter broad at base, becoming narrow towards apex, latter upturned; lateral lobes almost transparent, long, flattened structures, hiding inner lobes; cornua long and strongly curved; inner lobes broad and long, capable of inflation, highly spinose; apical lobe large, inflatable, broad at base, narrowing down towards apex, latter rounded and extending well beyond lateral lobes, spinose on inner surface.

***Urothemis signata signata* (Rambur)**

Burmeister. 1839. *Handb. Ent.*, **2**: 858.

(Figs. 8-15)

Lamina hood shaped, deeply emarginated, furnished with numerous long and slender setae along free margin, latter reaching upto horizontal bar of framework; hamules without distinct base, anterior hook very large and prominent in profile, projecting markedly; genital lobes small and broad, rounded at apex bearing numerous very short, spine like setae towards outer apical margin and long slender ones towards anterior and posterior margin; vesicular spermalis flask shaped, besotted with setae on either side of middorsum; distal segment of penis with very heavily sclerotized, well developed dorsal hood; lateral lobes heavily sclerotized, foot shaped with apex rounded in lateral view, completely hiding medial process and apical lobe, former modified to form a pair of inner lobes, latter broad at base, constricted towards subterminal proximity and ending at globular apex, latter bearing widely spaced broad scales, serrated at margins, directed proximally, inner lobes mediolaterally a pair of cornua with rounded apex; apical lobe broad, large and highly inflatable structure, bearing overlapping cells with serrated margins.

***Libellula quadrimaculata* Linnaeus**

Linnaeus. 1758. *Syst. Nat.*, **10**: 5433.

(Figs. 16-22)

Small and inconspicuous, coated with setae; lamina coated with numerous small spines and short slender setae over dorsum and comparatively longer ones along free margin, latter slightly notched in middle; hamule deeply sclerotized with long and curved anterior hook, its apex curving inwards and outwards, separated by a deep cleft from inconspicuous and small base, latter besotted with numerous small setae distally; genital lobes short and broad wavy margin bearing short and stiff setae; vesicular spermalis short and globular bearing several long setae on dorsum; penis with distal segment short, broad and highly sclerotized; lateral lobes not well developed more or less fused with apical lobe; a pair of deeply sclerotized cornua present, appearing like horns from dorsal view; medial process forming a lobate and extensively inflatable structure bearing many, long bristles; apical lobe spinose and inflatable.

***Palpopleura sexmaculata sexmaculata* (Fabricius)**

Fabricius. 1787. *Mant. Ins.*, **1**: 338.

(Figs. 23-29)

Lamina depressed, broadly and deeply arched, besotted with numerous long and slender setae along posterior free margin; hamule with well developed anterior hook, separated by a deep and broad cleft from truncated posterior base; genital lobes broadly rounded bearing setae along apical margin; vesicular spermalis small and broad, furnished with tuft of stiff and small setae on either lateral side distally and few longer ones scattered over dorsum; distal segment of penis with lateral lobes more sclerotized along upper half, apices rounded, inner surface bristles;

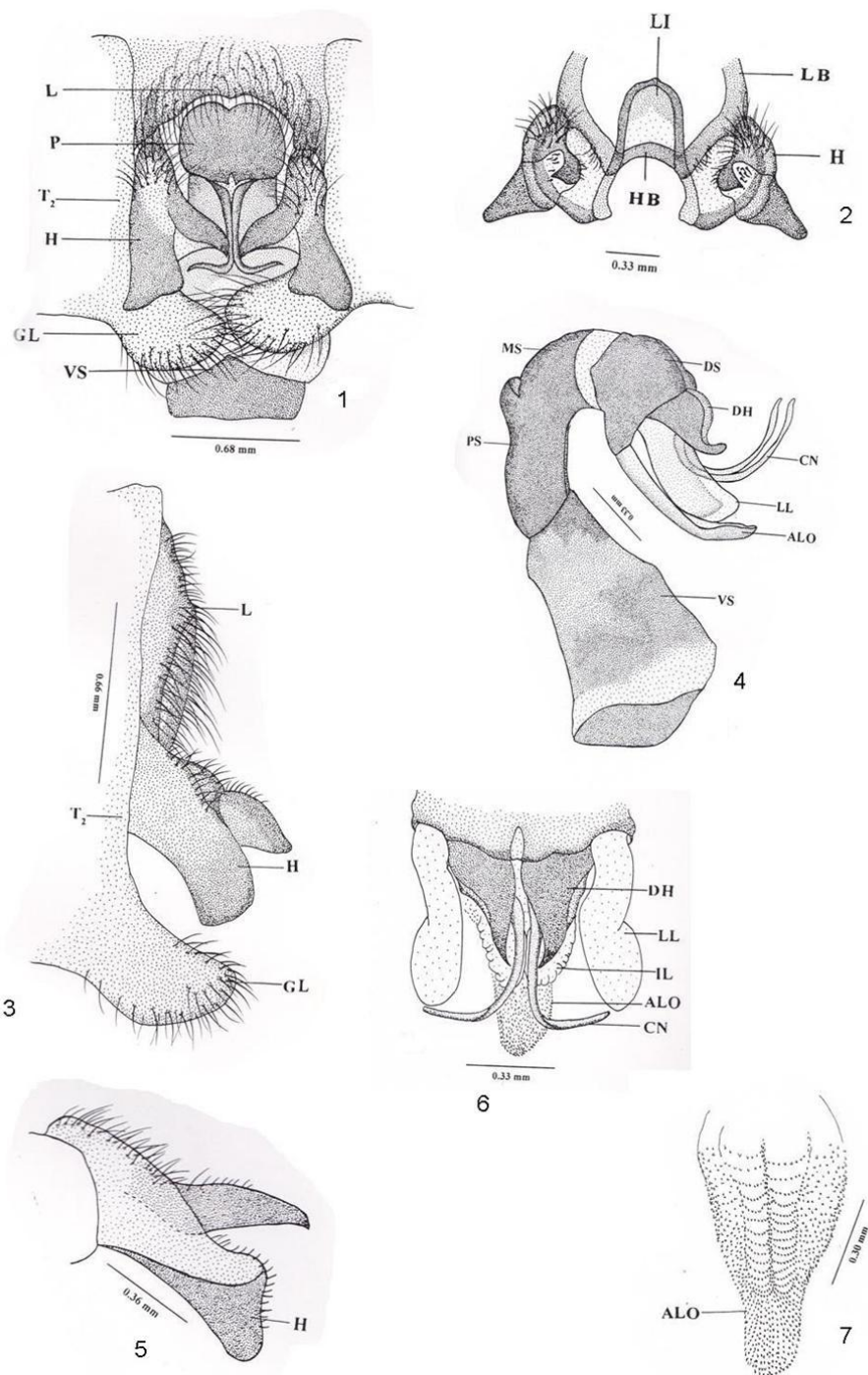
medial process forming a bristled inflatable lobe bearing a pair of cornua on either lateral side, central plate highly sclerotized with apex acutely pointed and curled downwards and backwards like a sickle.

Zygonyx torrid isis Fraser

Fraser. 1924. *Rec. Ind. Mus.*, **26**: 426, 440, 441.

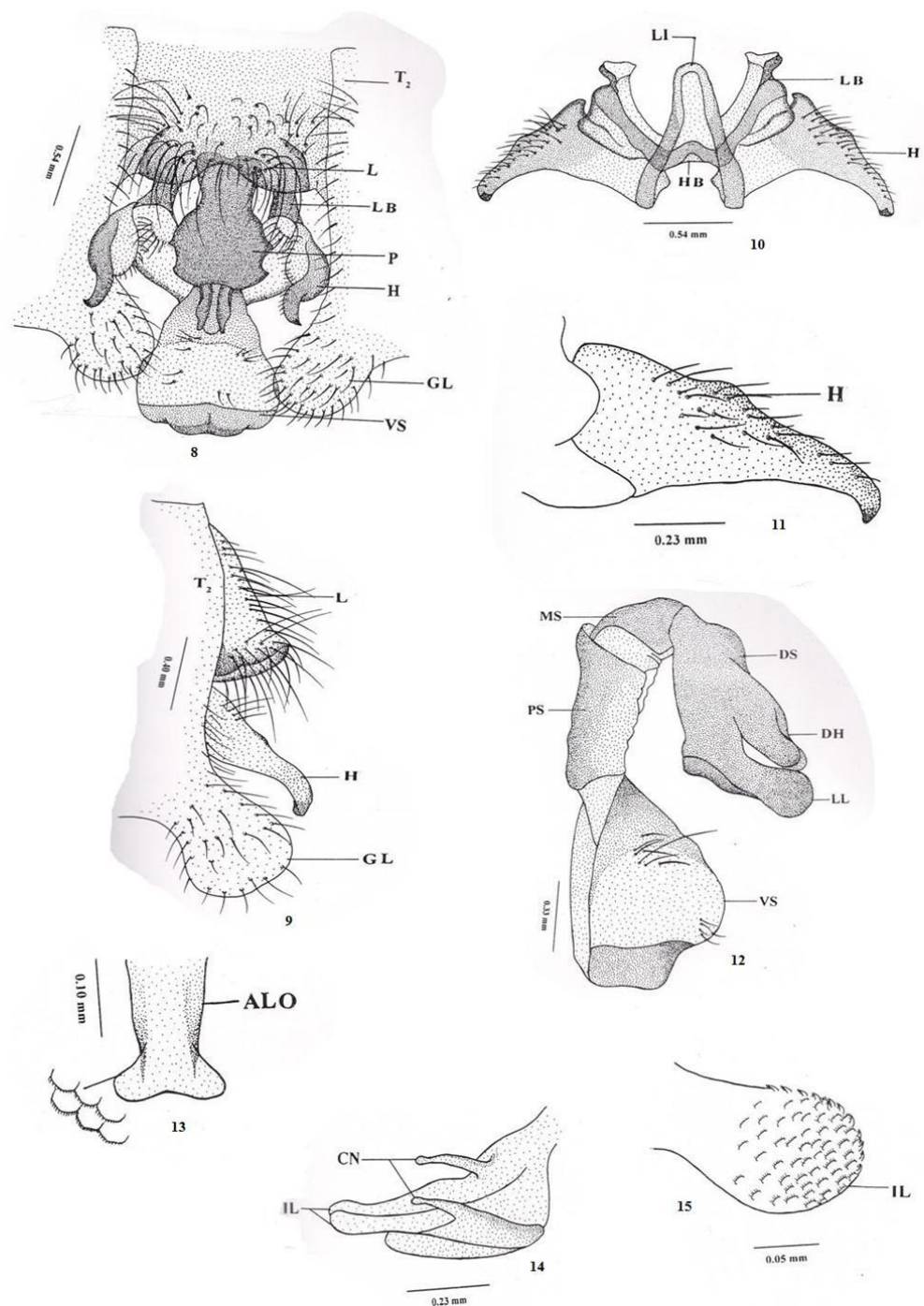
(Figs. 30-37)

Lamina projecting in lateral profile, studded with numerous black denticles and small setae, posterior free margin crenulate; hamules with distinct anterior base, all furnished with numerous small and slender setae; genital lobes black, becoming yellow at apices, short and broadly constricted at base, apical margin slightly truncated, bearing small and slender setae; vesicular spermalis small and globular, sparsely setosed with very slender small setae on dorsum; pennies with distal segment as long as middle and proximal segments taken together; lateral lobes broad, flattened structures, more or less fused with apical lobe; medial process bearing a pair of long, conical, inner lobes below, latter bearing numerous proximally directed spines, a terminal highly bristled lobe in middle and a pair of medial lobes above, latter bearing small spines along anteroapical border; apical lobe large, highly inflatable structure, very spinose, equipped with a dorsally evaginating lobe in middle.



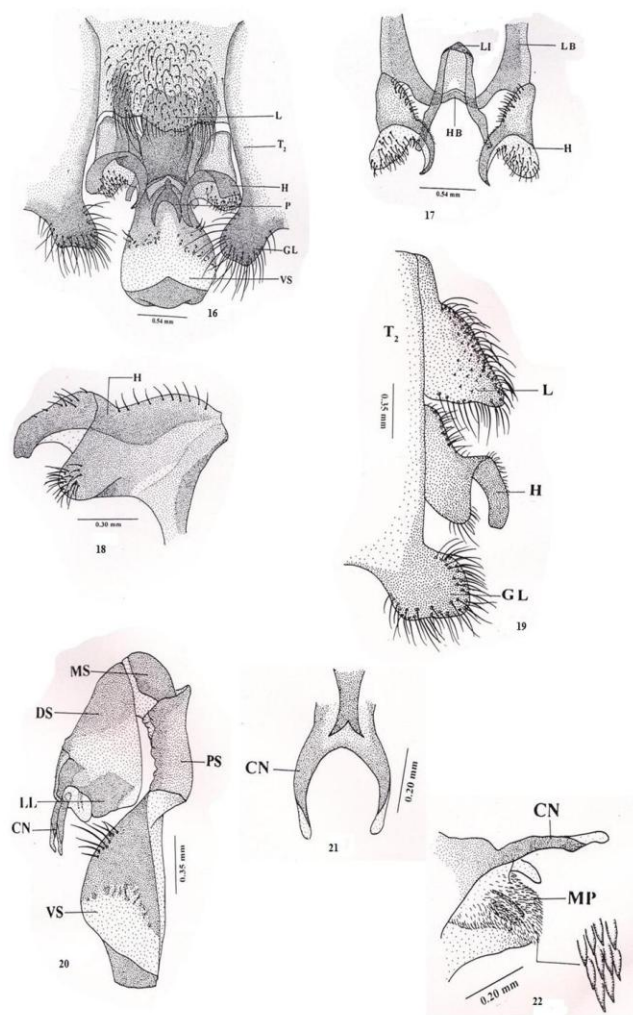
Figs. 1-7. *Sympetrum haematoneura* Fraser

1. Male genitalia (Dorsal view), 2. Hamule + supporting framework, 3. Male genitalia (Lateral view), 4. Penis (Lateral view), 5. Hamule (Lateral view), 6. Distal segment of penis (Dorsal view), 7. Apical lobe (Dorsal view)



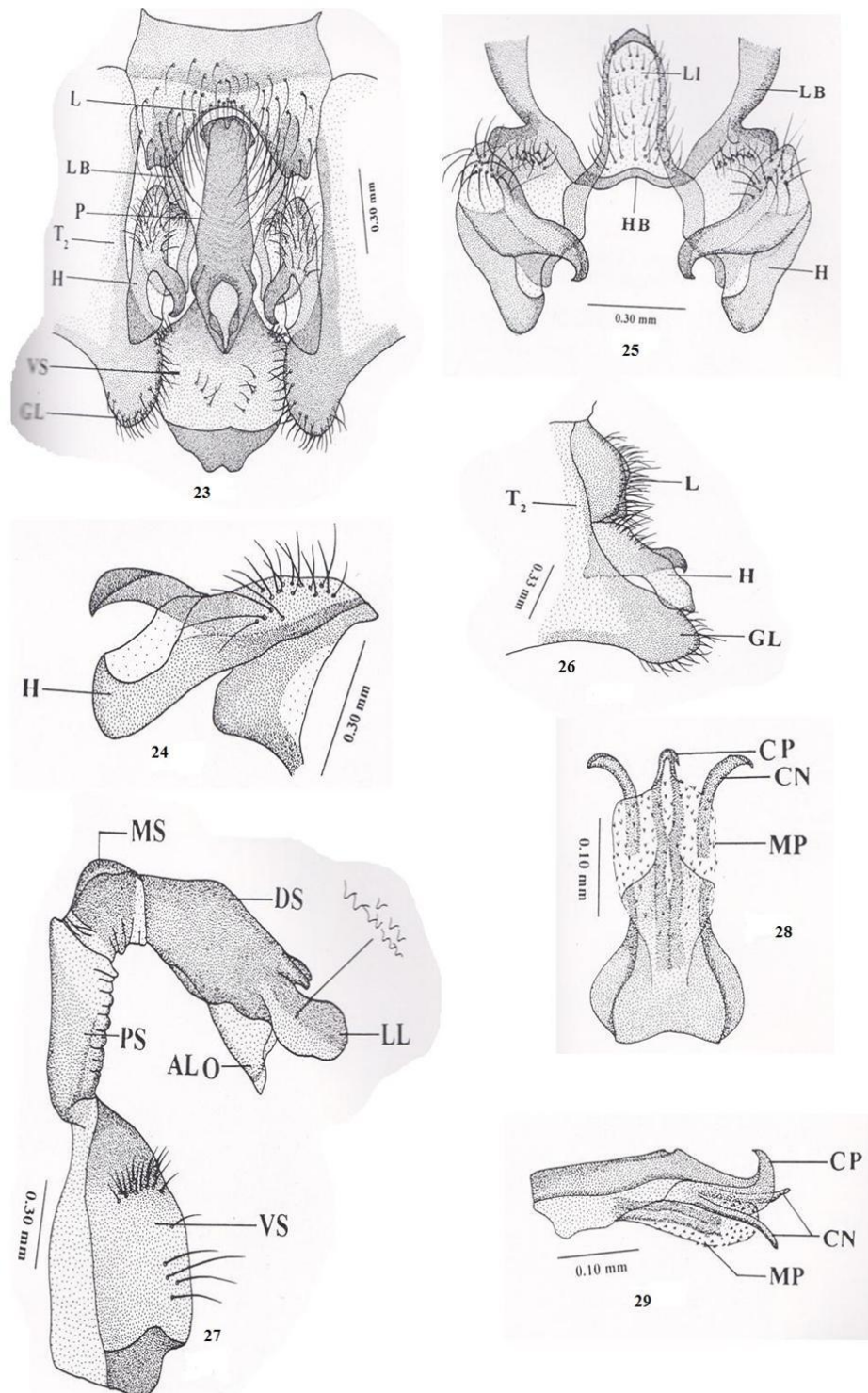
Figs. 8-15. *Urothemis signata signata* (Rambur)

8. Male genitalia (Dorsal view), 9. Male genitalia (Lateral view), 10. Hamule + supporting framework, 11. Hamule (Lateral view), 12. Penis (Lateral view), 13. Apical lobe (Dorsal view), 14. Medial process (Lateral view), 15. Apex of inner lobe.



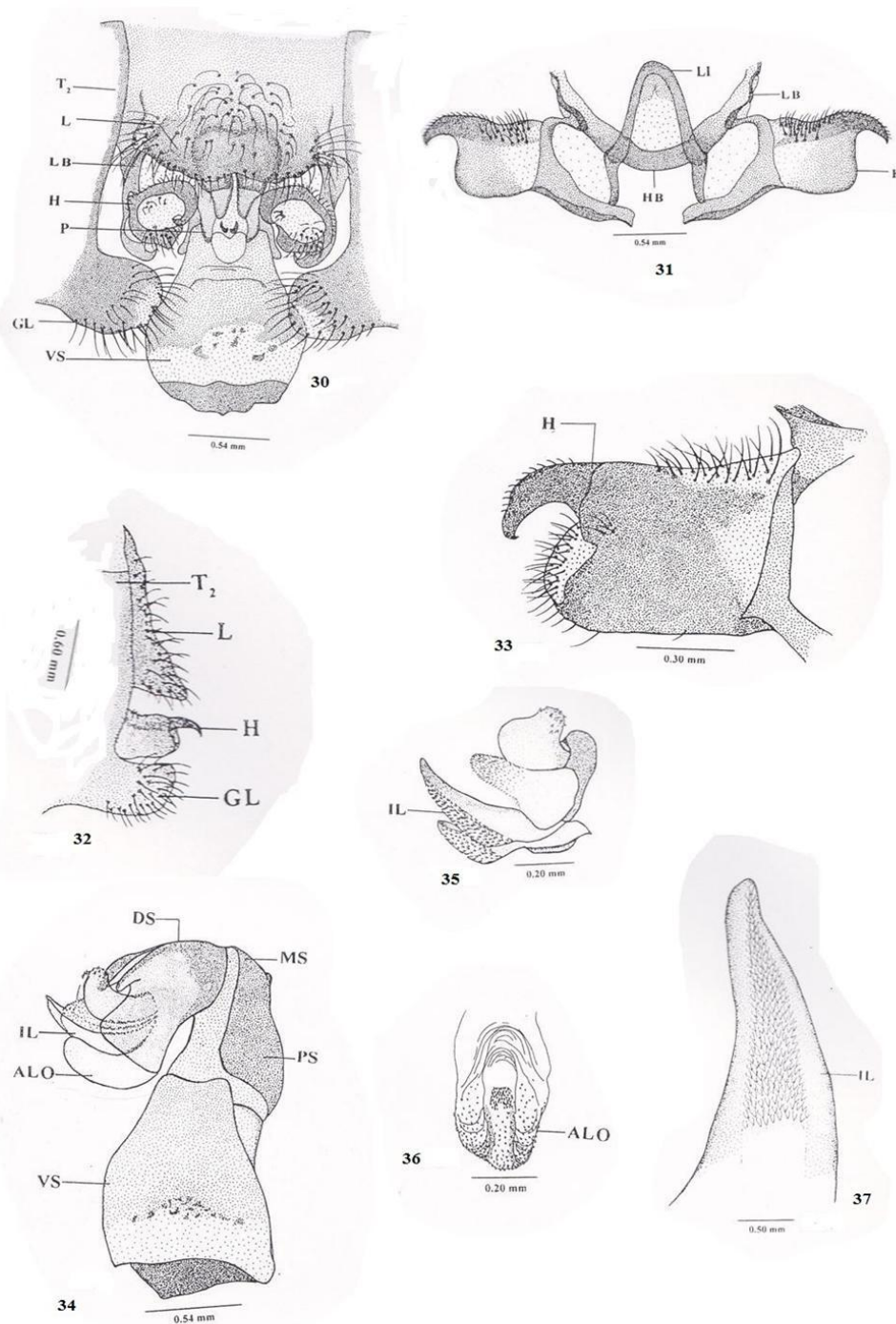
Figs. 16-22 *Libellula quadrimaculata* Linnaeus

16. Male genitalia (Dorsal view), 17. Hamule+ supporting framework, 18. Hamule (Lateral view), 19. Male genitalia (Lateral view), 20. Penis (Lateral view), 21. Cornua (Dorsal view), 22. Medial process (Lateral view)



Figs. 23-29. *Palpopleura sexmaculata sexmaculata* (Fabricius)

23. Male genitalia (Dorsal view), 24. Hamule (Lateral view), 25. Hamule + supporting framework, 26. Male genitalia (Lateral view), 27. Penis (Lateral view), Medial process (Dorsal view), Medial process (Lateral view)



Figs. 30-37. *Zygonyx torrid isis* Fraser

30. Male genitalia (Dorsal view), 31. Hamule + supporting framework, 32. Male genitalia (Lateral view), 33. Hamule (Lateral view), 34. Penis (Lateral view), 35. Medial process (Lateral view), 36. Apical lobe (Dorsal view), 37. Inner lobe (Ventral view).

Discussion:

An illustrated account of the morphology of the secondary male genitalia in the five species studied here is given together with a more detailed descriptive treatment of the components of distal segment of the penis. It can be inferred that all these structures associated with secondary copulation in male dragonflies and show considerable variation in shape and structure. For instance, hamule show considerable variations in shape at generic level in this family. It lacks a distinct base and is roughly conical with its anterior hook short and markedly curled at apices in *Urothemis signata signata* (Rambur) whereas hamular hook is well developed and robust in *Libellula quadrimaculata*. Hamules is highly developed, anterior hook and posterior base separated by a broad and deep cleft in *Palpopleura sexmaculata sexmaculata* (Fabricius) and *Sympetrum haematoneura* Fraser, in which truncated posterior base is equal in length to hook. However, a small and deep cleft is found in *Zygonyx torrid isis* Fraser.

There is remarkable diversity in the form of penis structure at specific level. It is divided into four segments viz., vesicular spermalis, proximal segment, middle segment and distal segment. The distal segment is a highly variable structure and offers several characters of taxonomic value that can be used at generic level. The distal segment bears at its apex an assortment of lobes, which are modified in different species. The lateral lobes are large, broad, flattened plate like structure in *Urothemis signata signata* (Rambur) and *Sympetrum haematoneura* Fraser. However, these are elongated and slender in *Palpopleura sexmaculata sexmaculata* (Fabricius). The apical lobe is occasionally equipped with an additional lobe which evaginates dorsally in *Zygonyx torrid isis* Fraser. The lateral lobes not well developed and more or less fused with apical lobe having a pair of deeply sclerotized cornua and medial process forming a lobate and extensively inflatable structure bearing many long bristles are in *Libellula quadrimaculata* Linnaeus.

All this important male genitalic attributes can be incorporated into detail diagnosis of various species in order to update their status.

Abbreviations:

AL- anterior lamina; ALO- apical lobe; DS- distal segment; F- flagellum; GL- genital lobe; H- hamule, HB- horizontal bar; L- lamina; LB- lateral bar; LL- lateral lobe; LI- ligula; ML- medial lobe; MS- middle segment; P- penis; PS- proximal segment; T₂- second abdominal tergite; VS- vesicula spermalis.

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