

**SOME ASPECTS OF THE MORPHOLOGY OF *CATACANTHUS INCARNATUS*
(DRURY) (PENTATOMIDAE: PENTATOMINAE) WITH
PHYLOGENETIC CONSIDERATIONS**

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Abstract. The external morphology of the metathoracic scent gland ostioles, male and female genitalia, the alimentary, male and female reproductive organs and the scent and salivary apparatus in *Catacanthus incarnatus* (Drury) are studied. The results are compared with those in other pentatomines reported in the literature to-date and the systematic position of the taxon is briefly discussed. The resurrection of the tribe Catacanthini Stål within the subfamily Pentatominae Amyot et Serville is supported.

INTRODUCTION

Catacanthus Spinola of the Division Catacantharia Stal was separated by Atkinson [1] from the members of *Nezaria* Stal on the basis of coloration and the lateral margins of pronotum being reflexed in the former and never or very rarely so in the latter. Distant [2] with some hesitation placing *Catacanthus* in *Nezaria* suggested that careful study might require it to be placed in a separate group.

Present studies on aspects of external morphology, including metathoracic scent gland ostioles, male and female genitalia, and internal anatomy of alimentary and male and female reproductive organs, and the scent and salivary apparatus of *C. incarnatus* (Drury) have clearly shown the group to be isolated in the tribe Pentatomini Stål and have necessitated the resurrection of Catacanthini Stål.

MATERIAL AND METHODS

Adult specimens of *Catacanthus incarnatus* (Drury) were collected on Kathal (jack fruit) in Karachi University Campus, Pakistan and Dacca in Bangladesh and kept in the laboratory on Kathal leaves and studied alive under a Leitz binocular microscope for the description of coloration. The external and internal structures were also studied in a series of specimens mounted dry in the old Pusa collection of the National Museum of the Central Department of Plant Protection, Karachi, including one male and four females from different regions of south east Asia, examined and determined by Distant

and Samuel.

Dissections were made after killing the specimen with ethyl acetate and embedding in wax in a dish under tap-water. For the examination of internal structures in the dry specimens, the abdomen of each specimen was detached, perforated laterally along the connexiva and immersed in 2% solution of sodium metaphosphate in a 100 cc beaker for 24 hr. It was then washed with warm tap-water and the internal soft structures, specially of the reproductive organs, were studied and drawn to the given scales after removing the thoracic and abdominal tergites. The dissected abdomen was then treated for three minutes in 10% boiling solution of KOH for the examination of spermatheca and common oviduct. After the illustrations of these structures were completed, the thoracic and abdominal tergites were carefully glued, and each abdomen was reattached with the specimen. The external male and female genitalia were studied after keeping the pygophore and female terminalia for 3 hr in a concentrated solution of KOH under a 60 W bulb kept at a distance of 1 ft. All diagrams were made on graph paper using an ocular grid to the given scales.

Tribe Catacanthini Stal

Stal: [3] 62; Atkinson [1]: 70

Legs, antennae and labium black, membrane of hemelytra, brassy-black, body above predominantly pale sanguineous, clypeus slightly longer than paraclypei, antenniferous tubercles visible from above, 1st antennal segments reaching beyond apex of head and lateral

margins of pronotum reflexed.

Metathoracic scent gland ostioles with anterior ostiolar peritreme, ostiolar groove and estiolar spout; male pygophore with sclerotized stripe on dorsomedian posterior margin with a small tooth on each lateral limit, ventro-median surface with a highly sclerotized hexagonal plate? theca with well developed paired ventrolateral, lateral and unpaired ventromedian thecal appendages.

The tribe Catacanthini includes at the moment the only genus *Catacanthus* Spinola with species represented in Oriental and Australian regions. It is closely related to Pentatomini Stal but can easily be separated from the latter for having lateral pronotal margins reflexed and other characters noted in the introduction and description.

Catacanthus incarnatus (Drury)

Figs. 1 - 12

Coloration. Body above, except metallic bluish-black head excluding eyes and ocelli, red; anterior and anterolateral margins of pronotum bluish-black; basal bluish-black spots on scutellum not meeting in middle; a large transverse bluish-black spot on posterior 2/3 of each

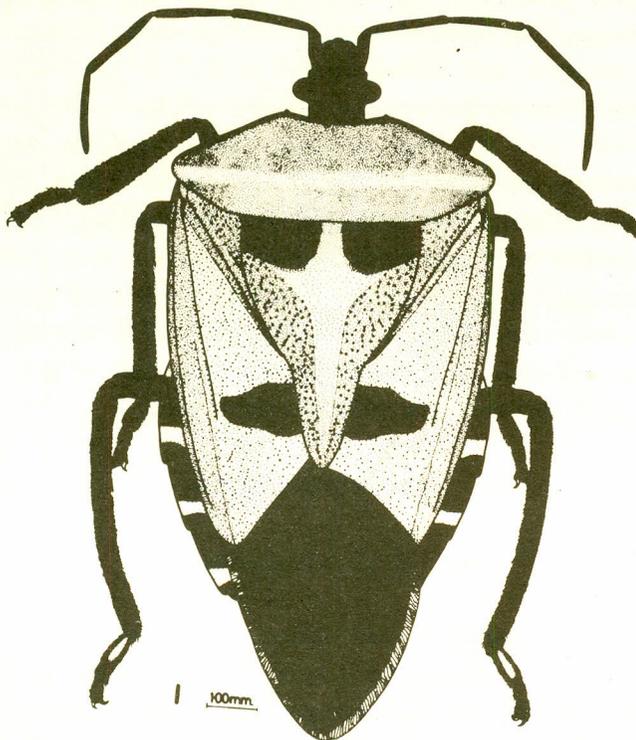
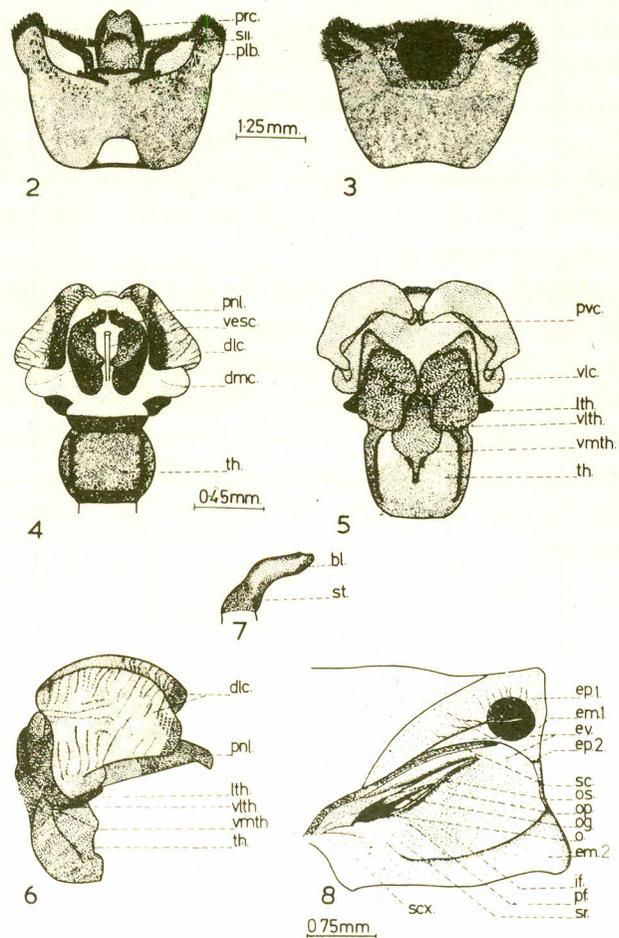


Fig. 1. *Catacanthus incarnatus*, dorsal view.

corium, latter not reaching outer margin; membrane brassy black; anterior and posterior margins of each segment of connexiva indigo-blue, separated by shining white region; antennae and legs, excluding basitarsus of hind legs, piceous; calvus and corium pale sanguineous with dense minute punctures; scutellum with large punctures on sides; pronotum devoid of punctures except a few minute scattered ones on posterior margin; body beneath, except piceous labium, bluish black; basal abdominal segment and series of bluish-black lateral abdominal spots, yellowish.

Head. Broader than long, length 2.8-3.2 mm, width including eyes 3.8-4.2mm; paraclypei with lateral margins reflexed, smooth and angulate in front of eyes; a shallow depression on anterior 1/2 not extending anteriorly and laterally, posterior 1/2 with transverse



Figs. 2-8. *Catacanthus incarnatus*: 2,3, pygophore, q, dorsal view, 3, ventral view; 4-6, aedeagus, 4, dorsal view, 5, ventral view, 6, lateral view; 7, paramere, outer view; 8, metathoracic gland ostioles, ventral view.

striations; clypeus slightly longer than paraclypei; length of anterior portion of head excluding eyes 1.3-1.5mm; length of posterior portion of heading including eyes 1.5-1.7mm; interocular distance 1.8mm; interocellar distance 1.0-1.1mm; antennae with antenniferous tubercles visible from above, 1st segment reaching beyond apex of head, length of segments, I 1.1 mm, II 2.5-2.8mm, III 2.6-3.1mm, IV 2.8-4.5mm, V 2.5mm, antennal Formula $1 < 5 < 3 < 4 < 2$; labium reaching slightly beyond bucculae and equal in length to 4th segment, 3rd segment slightly longer than 2nd, length of segments I 1.5 1.8 mm, II 2.2 mm, III 2.30 - 2.70 mm, IV 1.65 - 1.90 mm, labial formula $1 < 4 < 2 < 3$.

Thorax and Abdomen. Pronotum $3\frac{1}{2}$ times as wide as long, length 3.1-4.9mm, width 11.00-11.3mm, laterally reflexed, anterior margin concave in middle and as broad as head including eyes, anterior angles slightly toothed, humeral angles rounded, posterior margin straight along base of scutellum, latter convex laterally, at anterior $\frac{2}{3}$ somewhat bulging, length 9.3-10.4mm, width 6.6-8.0mm, apical lobe less than $\frac{1}{2}$ as broad as base of scutellum. Metathoracic scent gland ostioles (Fig.8) with pear-shaped aperture peritreme remarkably developed and distinguishable into anterior ostiolar peritreme (op), ostiolar groove (og) and ostiolar spout (os), latter extending antero-laterally and ending near middle of spiracular cleft (sc), evaporatoria (ev) highly developed including nearly inner $\frac{2}{3}$ of metepisternum (epi) entire mesepimeron (em₁) and posterior $\frac{1}{2}$ of mesepisternum (eps) (bluish-black lateral mesosternal spots also included in evaporative region), metasternal portion of evaporatoria typical of pentatomid type, consisting of a smooth region (sr) along posterior margin of peritreme followed by a region of parallel furrows (pf), in turn followed by a larger region of irregular furrows (if) forming most of metasternal evaporatoria, mesosternal part of evaporatoria uniformly rough-textured, both supracoxal lobe (scx) and metepimeron (cm₁) finely punctate and not receiving any extension of evaporatoria. Membranes of hemelytra distinctly exceeding apex of abdomen, with longitudinal veins (Fig. 1), connexiva exposed at repose with apices toothed; anteroventral abdominal process reaching close to apex of labium but not touching it; distance base scutellum apex clavus 13.60-14.10mm, apex clavus-apex scutellum 5.10-8.0mm, apex scutellum-apex abdomen including membrane 10.9-11.1mm. Total

length (0 slightly shorter) 26.1-29.9mm.

Male Genitalia (Figs.2-7). Pygophore broader than long, dorsomedian surface medially slightly concave and bordered by a thin sclerotized stripe (Fig.2), posterolateral lobes (plb) remarkably prominent, truncate and pointing outwardly, small stout spines on dorsolateral portion of posterior $\frac{1}{2}$ of pygophore, ventromedian surface (Fig. 3) with a highly sclerotized hexagonal plate surrounded by a less sclerotized area, postero-lateral lobes bordered ventrally on inner $\frac{1}{2}$ of posterior margin by a prominent sclerotized stripe, outer ventrolateral areas of lateral lobes and entire posteroventral margins beset with long bristles; paramere (Fig. 7) stout, sickle-shaped with a long stem and very short blade; theca (Figs. 4,5 and 6 th) strongly sclerotized and box-shaped bearing many appendages, dorsally a transverse sclerotized band forming posterior margin of theca, ventrally a pair of trilobed ventrolateral thecal appendages (Fig. 5 vlth), a rounded median

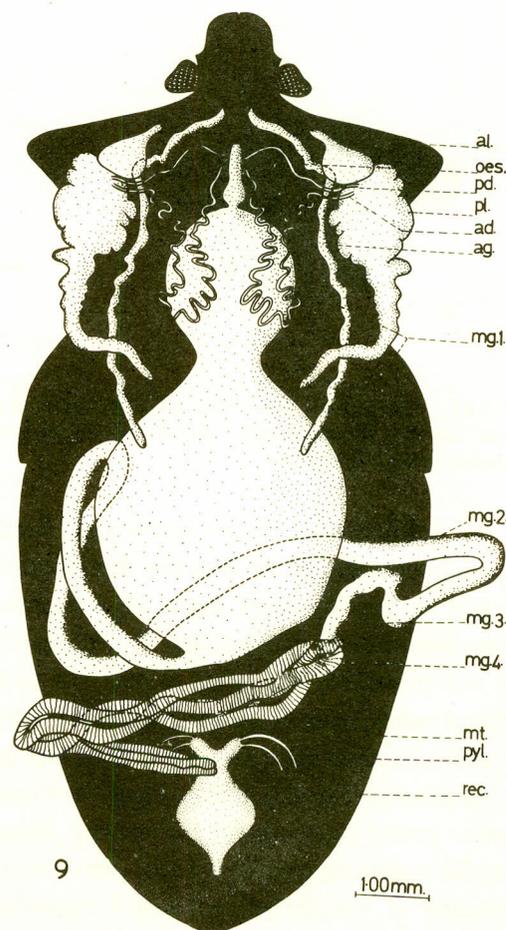
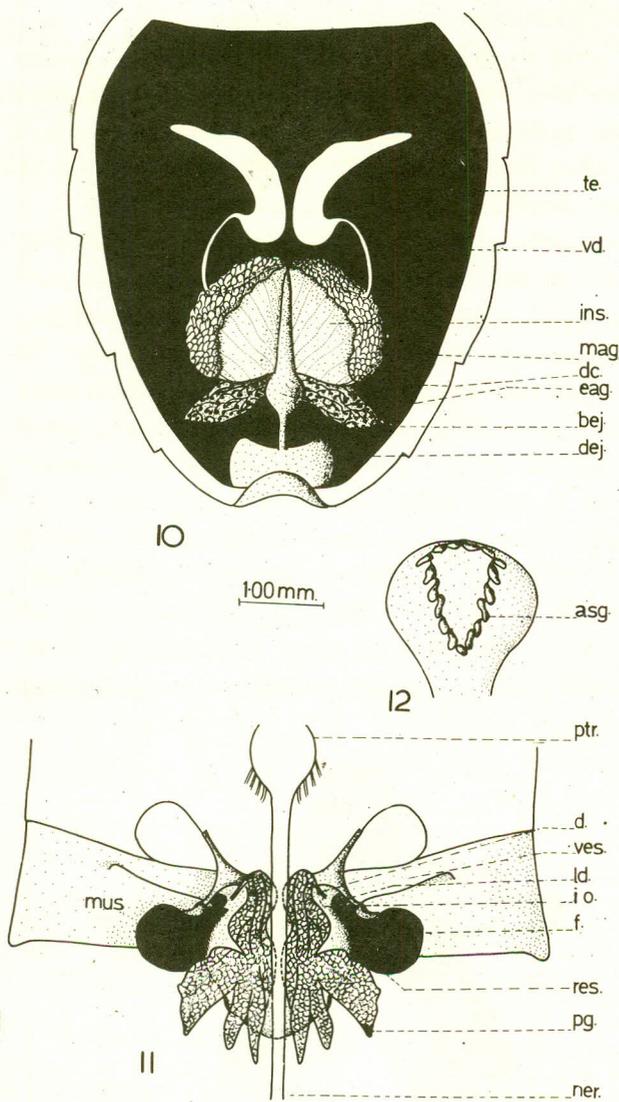
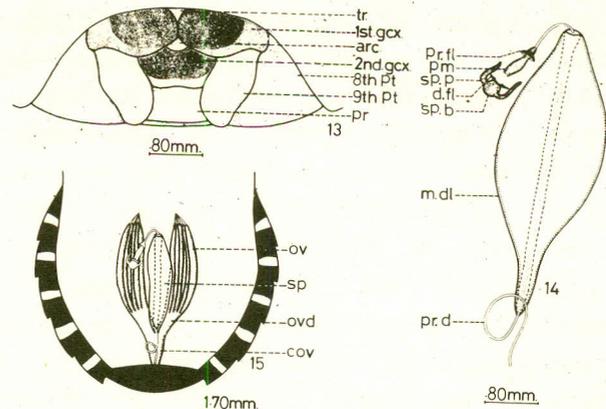


Fig. 9. *Catacanthus incarnatus*: Alimentary organs, dorsal view.



Figs. 10-12. *Catacanthus incarnatus*: 10, male reproductive organs, dorsal view; 11, scent apparatus, dorsal view, 12, reservoir, showing accessory gland, ventral view.

extension of ventromedian thecal appendages (vmth), lateral thecal appendages (lth) lobe-like and appearing on either side of posteriolateral angles of ventrolateral thecal appendages, penial lobes (Figs. 4, pnl) entirely sclerotized and posteriorly narrowed, dentate and turned upward; dorsal membranous conjunctival appendage (dmc) uniformly semi-sclerotized and with anterolateral lobe like extension, dorsolateral appendage (dic) highly developed, dorsal margin strongly sclerotized and turning inward, ventral margins remaining semi-sclerotized, posteroventral inward extension of dorsolateral conjunctival appendages touching a pair of very small elongated posteroventral



Figs. 13-15. *Catacanthus incarnatus*: 13, female terminalia, ventral view; 14, spermatheca, dorsal view; 15, female reproductive organs, dorsal view.

membranous conjunctival appendages (Fig. 5 pvc), anterior inward extension on either side bearing small ventrolateral conjunctival appendages (vlc) on ventral side of anterolateral lobe-like extension of dorsal membranous conjunctival appendage; vesica (Fig. 4 vesc) curves, sclerotized, reaching anterior 3/4th of penial lobes.

Female Genitalia: (Figs. 13,14). Posterior margin of 7th abdominal sternum (7th) concave; 8th paratergites (8th pt.) triangular; visible parts of 1st gonocoxae (1st gcx) broader than long with inner apices in close contact with each other; visible parts of 2nd gonocoxae (2nd gc) medially fused, dorsal surface beset with stout bristles; 9th paratergites (9th pt.) rectangular with rounded apices, slightly extending beyond 8th paratergites; arcus and triangulin only slightly visible; spermatheca described under female reproductive organs (Fig. 14).

Alimentary Organs (Fig.9). Oesophagus (Oes) moderately long with prominent terminal bulbous portion; midgut (mg_1) with smaller spherical anterior portion constricted from posterior larger, suboval sac, midgut₂ (mg_2) tabular and very long, distally slightly constricted, opening into moderately long midgut₃, latter continuing with midgut₄ (mg_4) bearing 4 rows of caeca and terminating in an anterior neck-like region of small sac-like rectum (rec) and bifurcating into two anterolateral tubular branches, from distal ends of each anterolateral branch of pylorus paired malpighian tubules (mt) originating, pylorus far removed from midgut and not connected with it; rectum dilated in middle, broadly then abruptly tapering.

Salivary Glands (Fig. 9). Each principal salivary gland

two-lobed, corresponding with anterior (al) and posterior lobes (pl); anterior lobe broad at base, distally extending as a long finger-like projection; posterior lobe large and expanded prominently, posteriorly tapering in form of a tail, ending bluntly, several large and small swellings and projections appearing all over surface of posterior lobe; principal ducts (pd) thin and slightly convoluted, accessory ducts (ad) highly convoluted, first running posteriorly above anterior midgut, then turning forward having loose convolutions anteriorly after passing beyond limit of anterior midgut, thence anteriorly beneath oesophagus, reaching base of each eye thence turning again posteriorly connecting with accessory glands (eg) of their own side near neck region, latter long, tubular and convoluted, reaching posteriorly on to anterior 1/3 of posterior midgut.

Male Organs. (Fig. 10). Testes (te) elongated, with 6 follicles, covered with shining red pigmentation; seminal vesicles indistinct; vas deferens (vd) thin, running backward and then forward and inward, opening at apex of investing sac (ins); mesadenes (mesg) elongated and recemose, closely pressed against lateral and anterior sides of investing sac but remaining separate in front, opening posteroventrally into bulbos through a common duct (duc) on either side, latter with an elongated anterior extension tapering distally and reaching to apex of investing sac; ectadenes (ec) with thin coiled tubes forming a compact mass on either side of dilated portion of bulbos ejaculatorius and opening into latter through a common duct on either side; ductus ejaculatorius (dej) straight and nearly as long as dilated portion of bulbos ejaculatorius.

Female Organs. (Figs. 14,15). Female reproductive organs were studied only in dry specimens following the procedure already described. Except spermatheca (Figs. 15, sp) all other organs including ovaries (ov), oviducts (ovd) and common oviduct (cov) were greatly shrunken, therefore, the over all morphological details could not be relied upon. However, fortunately all ovarioles in each ovary were intact and their number was recorded as seven.

Spermathecal bulb (Fig. 14, spb) small and with a pair of long finger-like processes (spp), distal (df) and proximal (prfl) flanges prominent, pump region (pm) semi-sclerotized, median dilation large spindle-shaped (mdl), proximal duct (prd) narrow, curved, and shorter than median dilation.

Scent Apparatus (Figs. 11,12). Typical of Pentatomidae, consisting of paired principal (Fig. 11, Pg) and an unpaired accessory (Fig. 12, asq) gland, reservoir (Fig. 11 res), valvular apparatus, vestibules (ves) and external scent gland areas, with each principal gland large, lobulated, larger than reservoir, and opening into lateral duct of latter through a minute duct (d); reservoir heart-shaped sac, completely filling metathoracic cavity beneath ventral nerve cord (ner) and extending into abdomen, anteriorly, giving off a lateral duct (ld) on either side, latter opening into internal orifice (io) formed beneath each metafurca, internal orifice leading into a large barrel-shaped vestibule, opening through ostiole, internal orifice remaining closed with a chitinous disc formed by ventral wall of lateral duct adjacent to base of metafurca, this chitinous disc being attached to opener muscle (mus) having its origin on dorso-lateral angle of 3rd phragma, the functioning of the valvular apparatus similar to that described by Ahmad and Afzal in *Coridius janus* (Fabr.); on ventral surface of reservoir attached a multi-lobulated ring-shaped accessory gland (Fig. 12, asq).

DISCUSSION

Male genitalia of several pentatomines have been studied by Pruthi [5], Baker [6], Bidal [7], Lindberg [8], Leston [9], Wagner [10], Stichel [11], Orian [12] and Day [13]. Pruthi [5] described and illustrated the male genitalia of *C. incarnatus* but he did not recognize several conjunctival and thecal appendages. He also found that the conjunctiva remains permanently exposed in *C. incarnatus*, but did not attempt to inflate the conjunctiva of any other pentatomine studied. The main differences are listed under tribal description.

Schaefer [14] described the homologies of the female genitalia of Pentatomoidea illustrating a pentatomine *Euschistus tristigmatus* Say and discussed the findings of Dupuis [15, 16], Scudder [17], Kumar [18], McDonald [19], and Tay [20]. The confused tribal classification of Pentatominae resulting in the formation of heterogeneous groups (Gross [21], Ahmed and Afzal [22],) makes it difficult, at the moment, to evaluate the importance of these characters at tribal level.

Alimentary organs and/or salivary glands of various pentatomines have been described by Bugnion and Popoff [23, 24], Ancona [25], Malouf [26], Hamner [27], Harris [28], Miyamoto [25] and Ahmad and Khan [30].

The alimentary canal of *C. incarnatus* differs from those of all pentatomines known to the present authors in that midgut₃ is tubular and the pylorus, originating at the anterior end of the spindle-shaped rectum, is distinctly bifurcated with a pair of malpighian tubules arising from each arm; the pylorus does not connect with the posterior part of midgut₁ as shown by Ahmad and Khan [30], in *Nezara Amyot et Serville, Acrosternum Fieber and Piezodorus Fieber*. The posterior lobe of the bilobed principal salivary gland has several finger-like lobules, a condition which has never been described or illustrated by any previous worker in any Pentatomine they studied (Hammer [27], Miyamoto [29], Ahmad and Khan [30]).

The testis follicle number in *C. incarnatus* is 6, which is the same as reported by Malouf [26], Woodward [31], and Pendergrast [32,33] in Pentatomini they studied. Male reproductive organs of pentatomines have been described by Malouf [26], Qadri [34], Woodward [31] and Pendergrast [32,33]; those of *C. incarnatus* differ in that the bulbous ejaculatorius has an elongated anterior extension which tapers anteriorly ending at the apex of the investing sac, mesadenes are elongated, recemose and closely attached to the anterolateral sides of the investing sac, and the ectadenes are thin coiled tubes forming a compact mass.

Female reproductive organs of pentatomini have been studied by Malouf [26], Woodward [31], Pendergrast [32,33], Miyamoto [35], Kumar [36] and Balduf [37]. These authors have shown seven ovarioles in the species they examined. McDonald [19] found in ten species placed by him under the tribe pentatomin, spermathecal bulb with hollow tubular processes of unknown function. Similar processes were shown by Pendergrast [33] and Tay [20] in the Pentatomine species they examined.

The scent apparatus of *C. incarnatus* shows a higher degree of development than those of several Pentatomines described and illustrated by Malouf [26], Gilby and Waterhouse [38] and Ahmad and Khan [30] owing to the principal glands being lobulated (nine lobules) and larger than the reservoir and the accessory gland being greatly convoluted and ring-shaped, a condition which has never been reported in any Pentatomine to date.

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REFERENCES

1. E.T. Atkinson, *J. Asiat. Soc. Beng.* 2, 66(1988).
2. W.L. Distant, *The Fauna of British India including Ceylon and Burma. Rhynchota.*
3. C. Stal, *K. Svensk vetensk. Akad. Handl* 9, 1(1976).
4. I. Ahmad and M. Afzal, *Islamabad J. Sci.* (in press).
5. H.S. Pruthi, *Trans. R. Entomol. Lond.* 78, 187(1925).
6. A.D. Baker, *Can. J. Res.* 4, 148 (1931).
7. J. Vidal, *Mem. Soc. Sci. Nat. Phys. Maroc. Zool.* 48, 1 (1949).
8. H. Lindberg, *Comment. Biol. Helsingfors.* 14(1) (1953).
9. D. Leston, *J. Soc. Br. Ent.* 5(3), 101(1955).
10. E. Wagner, *Bull. Soc. ent. Egypte* 43, 413(1959).
11. W. Stichel, *Illustrierte Bestimmungstabellen der Wanzen, 11 Europa (Hemiptera, Heteroptera).* Europe Berlin. Heft., 17-2, 513 (1960-62).
12. A.J.E. Orian, *Proc. R. ent. Soc. Lond. (B)*, 34, 25 (1965).
13. S.M. Day, *Ann. Mag. Nat. Hist.* (13) 7, 559 (1965).
14. C.W. Schaefer, *J.N.Y. ent. Soc.* 76(2), 87 (1968).
15. C. Dupuis, *Mem. Hist. Nat. Paris.* (A) 6, 4, 183 (1955).
16. C. Dupuis, *naturelles Mus. Hist. Nat. Paris*, 2, 1
17. G.G.E. Scudder, *Trans. R. ent. Soc. Lond.* 111, 405 (1959).
18. R. Kumar, *Zoologica Poloniae.* 12, 3 (1962a).
19. F.J.D. McDonald, *Quaest. Ent.* 2, 7 (1966).
20. E.B. Tay, *Univ. Qd. Publ.* 2, 75 (1966).
21. G.R. Gross, *Plant feeding and other bugs (Hemiptera) of South Australia: Heteroptera*, Part I and II. (Government Printer, South Australia).
22. I. Ahmad and M. Afzal, *Acta. Soc. ent. Cechoslov.* (in press)..
23. E. Bugnion and Popoff, *Arch. Anat. Microsc.* 10, 227 (1908).
24. E. Bugnion and Popoff, *Ibid.* 11, 435 (1910).
25. L. Ancona, *An. Inst. Biol. Univ. Nac. Auton. Mex.* 3, 149 (1932).
26. N.S.R. Malouf, *Bull. Soc. Entomol. Egypte*, 17, 96 (1933).

27. A.L. Hamner, Ohio. J.Sci. **36**, 157 (1936).
28. C.S.Harris, Ohio. J. Sci. **38**, 316 (1936).
29. S. Miyamoto, Sieboldia Acta. Biol. **2**, 197 (1961).
30. I. Ahmad and S.A.Khan, Bull. Inst. R. Sci. Nat. Belg. Entomol, **49**(9), 1 (1973).
31. T.E. Woodward, Entomol. Mon.Mag. **86**, 82 (1950).
32. J.G. Pendergrast, Trans. R. Soc. N.Z. **84**, 139 (1956).
33. J.G. Pendergrast, Trans. R. Entomol.Soc.Lond. **109** (10), 1 (1957).
34. M.A.H. Qadri, J. Zool. Soc.India, **1**, 129(1949).
35. S. Miyamoto, Sieboldia. **2**, 69 (1957).
36. R. Kumar, Ent. Tidskr **83**, 44 (1962b).
37. W.V. Balduf, Proc. Entomol. Soc. Washington **66** (1), 2 (1964).
38. A.R. Gilby, and D.F. Waterhouse, Nature Lond. **216**, 90 (1967)