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New Record of Leafhopper *Hishimonus viraktamathi* on Blackgram in Coastal Andhra Pradesh

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***Abstract*:** Eighteen species of leafhoppers belonging to the family Cicadellidae were associated with blackgram ecosystems, of which one species *viz*., *Hishimonus viraktamathi* Knight, 1973 is identified first time in Andhra Pradesh during 2022-2024 constituting a new distributional record. This species was identified based on the shape and length of the head, length of the pronotum, serrations and number of micro and macro setae on the subgenital plates of the male genitalia structures. Adequate description of the species was provided along with illustrations for quick identification. In addition, a diagnostic key with illustrations is presented for the identification of the remaining species associated with blackgram.

***Keywords*:** Cicadellidae leafhopper, *Hishimonas viraktamathi* Knight, Subgenital plates, Male genitalia.

Leafhoppers (Hemiptera: Cicadellidae) are an economically important group belonging to suborder Auchenorrhyncha. The family Cicadellidae is one of the largest groups of exopterygote insects, comprising about 2,445 described genera and 22,637 species worldwide and about 340 genera and 1,350 species in India (Viraktamath 2006). They are widely distributed and many are serious pests of many economic crops. Few groups of leafhopper genera act as vectors and transmit phytopathogenic organisms that cause diseases and eventual death of plants, a well know example is the *Hishimonus phycitis* (Distant) transmitting little leaf of brinjal. *Empoasca kerri* is a major sucking pest of blackgram, with populations appearing from the seedling stage and continuing up to pod formation. Peak infestation is typically observed around the 37th standard meteorological week, with an average of 7-8 jassids per leaf. Its incidence is strongly influenced by climatic factors, showing positive correlations with minimum temperature, relative humidity, and vapor pressure, and negative correlations with evapotranspiration, rainfall, and wind speed. Due to its persistent presence and impact on plant health, *E. kerri* is considered a key pest in blackgram cultivation in India.

Literature on the occurrence of leafhoppers in a particular crop ecosystem and their identification "keys" are very meager. Viraktamath (1983) emphasized illustrations of economic species of leafhoppers and preservation of voucher specimens in recognized institutions. Jacob et al. (2000) reported forty species belong to 20 genera associated with oilseed crops from Andhra Pradesh and provided illustrated key for their identification. Jacob et al. (2002) reported 41 species of leafhoppers including twelve new records associated with pulse crop *viz.,* greengram, blackgram, pigeonpea, chickpea, soybean, horse gram, and cowpea ecosystems in Andhra Pradesh. Giridhar et al. (2008) studied leafhopper fauna associated with sugarcane ecosystems of South India and reported 22 leafhopper species. Nagesh et al. (2018) reported fifteen leafhopper species associated with maize and sorghum crop ecosystems of Rayalaseema region of Andhra Pradesh and provided illustrated key for their identification. A detailed identification of 14 leafhopper species under two tribes *viz*., Empoascini and Erythronuerini of the subfamily Typhlocybinae collected from different agricultural and horticultural crop systems was reported by Sangeetha et al. (2020).

In the present investigation, 18 leafhopper species were recorded on blackgram, of which detailed description of the species is available in the literature for 17 species in Andhra Pradesh except for *Hishimonus viraktamathi* Knight, which is reported for the first time in Andhra Pradesh. The objective of the present study is to document the diversity of leafhoppers associated with blackgram in Coastal Andhra Pradesh and to report *H. viraktamathi* as a new record for the state, providing diagnostic features and identification keys for associated species for the use of both economic entomologists and extension field workers. Accurate identification of leafhopper species is crucial for developing appropriate pest management strategies. Various workers in India and abroad have done revisionary works in many genera of leafhoppers (Cicadellidae: Hemiptera) but the literature pertaining to studies and identification techniques of leafhoppers encountered in the specific crop Agro-ecosystems are limited in India. The present investigation was conducted on leafhopper fauna associated with blackgram (*Vigna mungo*) in Coastal districts of Andhra Pradesh *viz*., Srikakulam,

Visakhapatnam, Anakapalli, Kakinada, Konaseema, East Godavari, West Godavari, Eluru, Vizianagaram, Krishna, NTR, Guntur, Palnadu, Bapatla, Prakasam and Nellore during 2022-2024.

MATERIAL AND METHODS

Collection, drying and preservation of the specimens: The leafhopper collections were made intensively on blackgram with about 15-20 to and fro insect net sweepings each time. The leafhoppers were aspirated from the net, killed with ethyl acetate swabs and transferred to small glass vials with cork or plastic stoppers, labelled, brought to the laboratory and dried in an hot air oven at 45 - 50^{0}C for about 2-3 hours. Dried specimens were preserved in the homeopathic vials. The vials were properly labelled with collection details, *viz*., name of the collector, collection date, location of collection and host.

Processing of leafhopper for study: For mounting and preparation of genitalia the procedure advocated by Knight (1965) was adopted. The collected leafhoppers were taken to the lab, where they underwent processing, were mounted on thick card triangle mounts and were labelled with the information about the collection, including the host, location, date, and name of the collector.

Preparation of male genitalia: The specimen was carefully placed on a China clay block on its back. Then, using minutons (sharp micro needles) the abdomen was separated from the thorax under a Stereoscopic Zoom Binocular Microscope (CSM2, LABOMED) by applying pressure at the point where the thorax and abdomen met. To aid in the digestion of soft tissues, the abdomen was then placed into a cavity block with a few milliliters of 10% KOH and kept for 10 hours at room temperature. Following 2-3 washes in distilled water, the abdomen was placed on a glass cavity slide with a drop of glycerine for further dissection (separation of the genital organs from the genital capsule) under stereoscopic microscope. The line diagrams of male genitalia were drawn after dissection using Olympus Research Microscope with camera lucida attachment. Whole insect specimens were photographed using Leica S-9 Optical Stereo Zoom Microscope attached with digital analyzer at 10X magnification and micro photographs of genital structures were taken with Olympus Trinocular Research Microscope fitted with photographic attachments and digital analyzer at 40X magnification. Conformation of the species was done by comparing the observed male genitalia parts with keys and literature.

RESULTS AND DISCUSSION

In the present study, 18 species of leafhoppers belonging to 13 genera were collected and identified as; (1) *Aconurella neosolana* (Ramasubbarao and Ramakrishnan); (2) *Austroagallia bifurcata* Sawai Singh and Gill; (3) *Balclutha incisa* (Matsumura); (4) *Balclutha pararubrostriata* Ramasubbarao and Ramakrishnan; (5) *Balclutha saltuella* (Kirschbaum); (6) *Batracomorphus angustatus* (Osborn); (7) *Cicadulina bipunctata* (Melichar); (8) *Empoasca* (*Distantasca*) *terminalis* Distant ; (9) *Empoasca* (*Empoasca*) *kerri* Pruthi; (10) *Empoascanara maculifrons* (Motschulsky); (11) *Exitianus indicus* (Distant); (12) *Hecalus porrectus* (Walker); (13) *Hishimonus phycitis* (Distant); (14) *Hishimonus viraktamathi* Knight; (15) *Maiestas acuminatus*

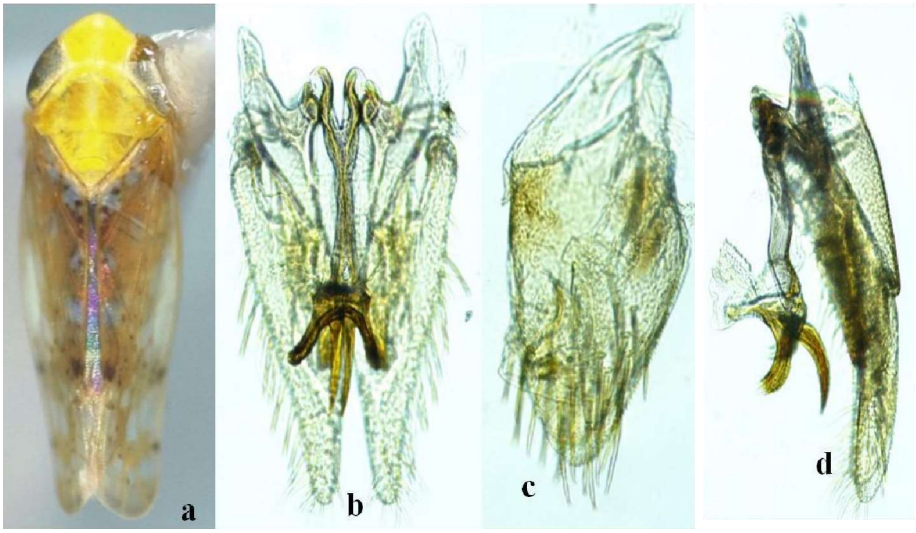


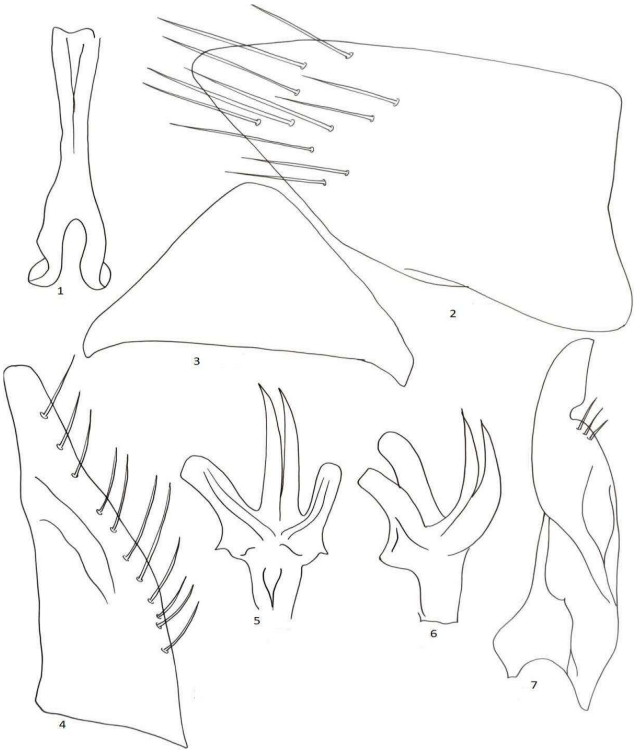
Plate 1. *Hishimonus viraktamathi* Knight a. Adult dorsal view; b. Male genitalia; c. Pygofer lateral view; d. Aedeagus lateral view

(Dash and Viraktamath); (16) *Maiestas dorsalis* (Motschulsky); (17) *Scaphoideus harlani* Kitbamroong and Freytag; and (18) *Yamatotettix sexnotatus* (Izzard).

A perusal of literature indicated that one of the leafhopper species *Hishimonus viraktamathi* Knight was recorded for the first time on blackgram in Andhra Pradesh.

Description of *Hishimonus viraktamathi* Knight : Head is light orange to creamy white; pronotum, scutellum and scutum are yellow. The forewings are hyaline with light and dark brown mottling, the veins are reddish brown, and the ventral side of the thorax is pale and sometimes speckled with dark brown marks. Abdomen is dark brown with golden lateral margins. legs light yellowish, stramineous in appearance. Head equal to or greater than pronotum in width. Subacute vertex, widely rounded at the face. Ocelli situated between the eyes on the anterior edge of vertex. Clypellus elongated with small expansion near the tip. Genal margins bend downward below the eyes. Pronotum is twice as long as the vertex. Tegmina with four apical and three anteapical cells.

The pygofer, in lateral view appears longer than its height, with widely rounded posterior edge and limited macrosetae on posterior half. Valve triangular, posterior angle more widely rounded and is more than 1.5 times longer at the base than it is medially. Subgenital plates are elongate, triangular with marginal and uniseriate setae in addition to short, hair-like setae. Style broad at base, subapical lobe well-developed, apophysis bifid, ventrally oriented. Connective 'Y' shaped, stem is roughly equal to the arms. Aedeagus with short cylindrical shafts that curve slightly dorsal, surface with many tiny denticles; gonopores apical. A pair of long, narrow processes arise between the bases of the shafts, closely opposed, about twice the length of aedeagal shaft. They extend posteriorly and curves slightly dorsally, and it has a row of small teeth along the distal half of the lateral surface.



Hishimonus viraktamathi Knight: 1. Connective, 2. Pygofer lateral view, 3. Valve, 4. Subgenital plate, 5. Aedeagus dorsal view, 6. Aedeagus in lateral view, 7. Style

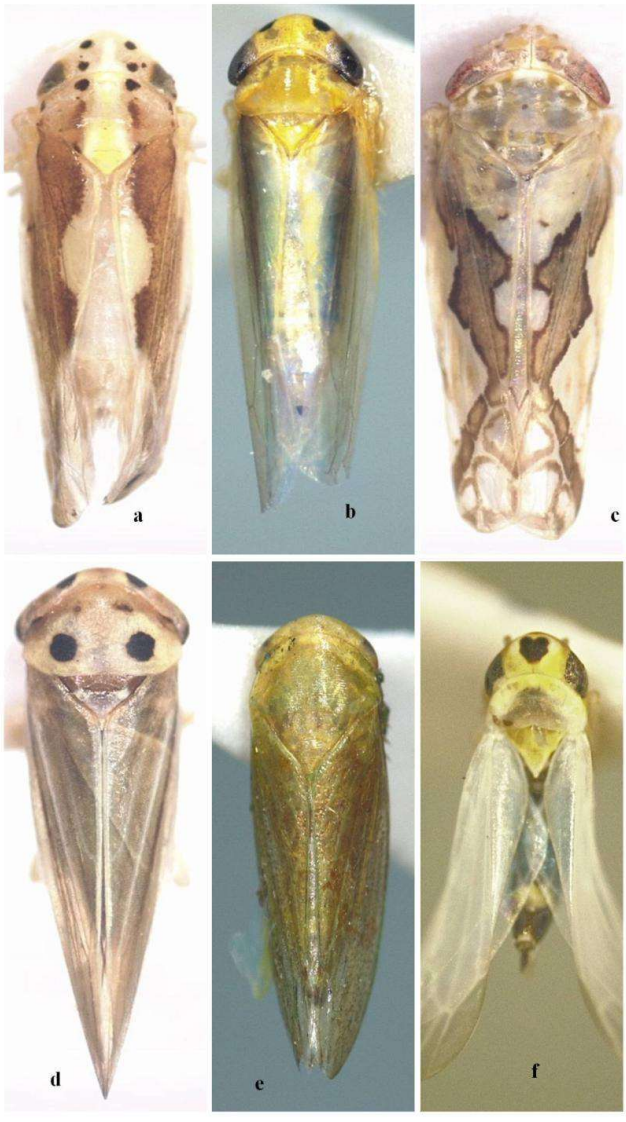


Plate 2. a. *Yamatotettix sexnotatus* (Izzard): Adult dorsal view; b. *Cicadulina bipunctata* (Melichar): Adult dorsal view; c. *Maiestas dorsalis* (Motschulsky): Adult dorsal view, d. *Austroagallia bifurcata* Sawai singh and Gill: Adult dorsal view; e. *Batracomorphus angustatus* (Osborn): Adult dorsal view; f. *Empoascanara maculifrons* (Motschulsky): Adult dorsal view

Measurements

Total length including forewings 1.80 mm, width of the body 0.49 mm. length of the head 0.18 mm, width across the compound eyes 0.31 mm. Length of the pronotum 0.26 mm, length of the scutellum 0.21 mm, length of the wing 1.53 mm and width of the wing 0.286 mm. Length of the male genitalia (including subgenital plates) 0.47 mm and length of the aedeagus 0.13 mm.

Keys for Identification of Leafhopper Fauna Associated with Blackgram Crop Ecosystems

1. Forewings with anteapical cells……2

-Forewings without anteapical cells (Fig. 8)...……..…16

2. Forewings with two anteapical cells (Fig. 10)…..……3

-Forewings with three anteapical cells (Fig. 9)…...…8

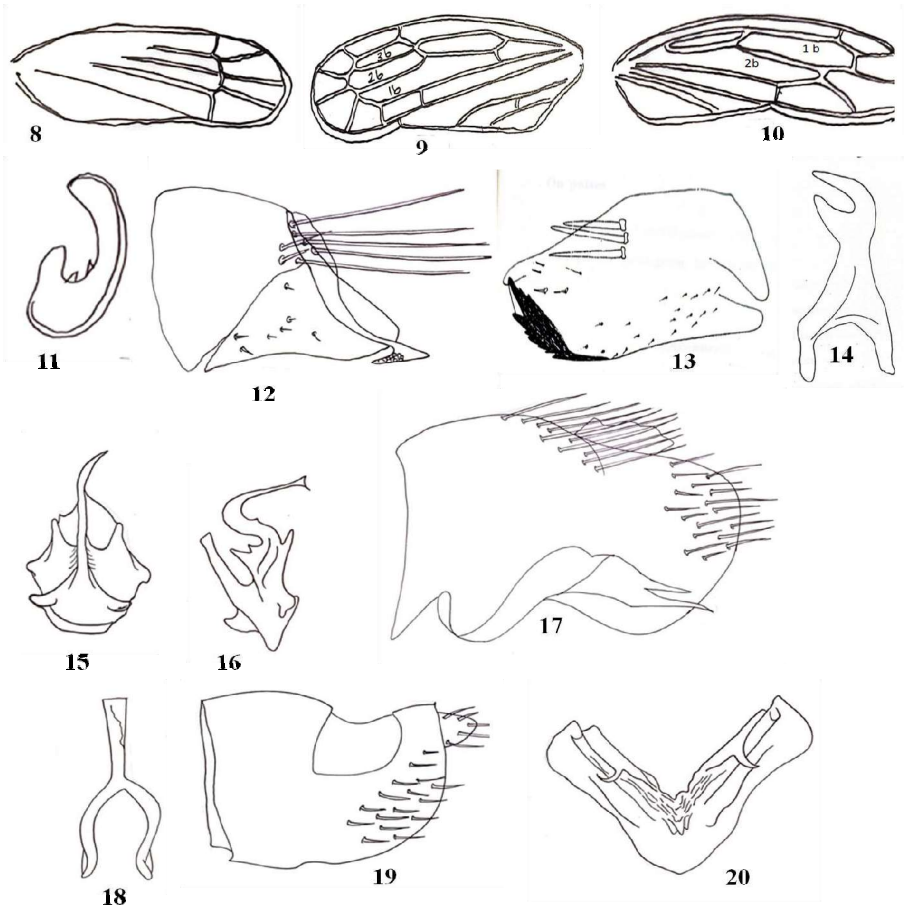
3. Pale brown coloured with a longitudinal pale cream coloured band in the middle from anterior margin of vertex to the apex of tegmina; vertex and pronotum with three pairs of black spots; dorsum of tegmina with a golden stripe running longitudinally that is noticeably wider on the forewing clavus (Plate 2a)……...***Yamatotettix sexnotatus*** **(Izzard)**

-Insects yellowish orange or yellowish green; tegmina with or without distinct colouration, vertex and pronotum without any spots or with a maximum of two spots ……..……4

4. Yellowish orange coloured insects; dorsal side of the abdomen black in colour. Vertex with a pair of round black spots; pygofer with a curved, bifid process and a robust subapical spine; aedeagus shafts cylindrical, short and 'C' shaped (Figs.11-12 and Plate 2b)…… ……..…***Cicadulina bipunctata*** **(Melichar)**

-Vertex without such round black spots and pygofer process and aedeagus not as above……...……5

5. Vertex subacute; styles with apophyses claw like; pygofer



Figs. 8. Fore wing without anteapical cells; 9. Fore wing with three anteapical cells; 10. Fore wing with two anteapical cells; 11-12: *Cicadulina bipunctata* (Melichar) Pygofer lateral view and Aedeagus in lateral view; 13-14 *Aconurella neosolana* (Ramasubbarao and Ramakrishnan) Pygofer lateral view and Style; 1516 *Balclutha incisa* (Matsumura) Aedeagus dorsal view and Aedeagus in lateral view; 17. *Balclutha pararubrostriata* Ramasubbarao and Ramakrishnan Pygofer lateral view; 18-19: *Balclutha saltuella* (Kirschbaum) Connective and Pygofer lateral view, 20 *Hishimonus phycitis* (Distant) Aedeagus

with a distinct serrated comb like structure on posteroventral margin; subgenital plates triangular, shorter than pygofer (Figs. 13-14)…… ***Aconurella neosolana*** **Rao and Ramakrishnan**

–Vertex more or less rounded, styles and pygofer not as above……..……..…6

6. Aedeagus with 3 pairs of basal processes or projections (Figs.15-16). …..***Balclutha incisa*** **(Matsumura)**

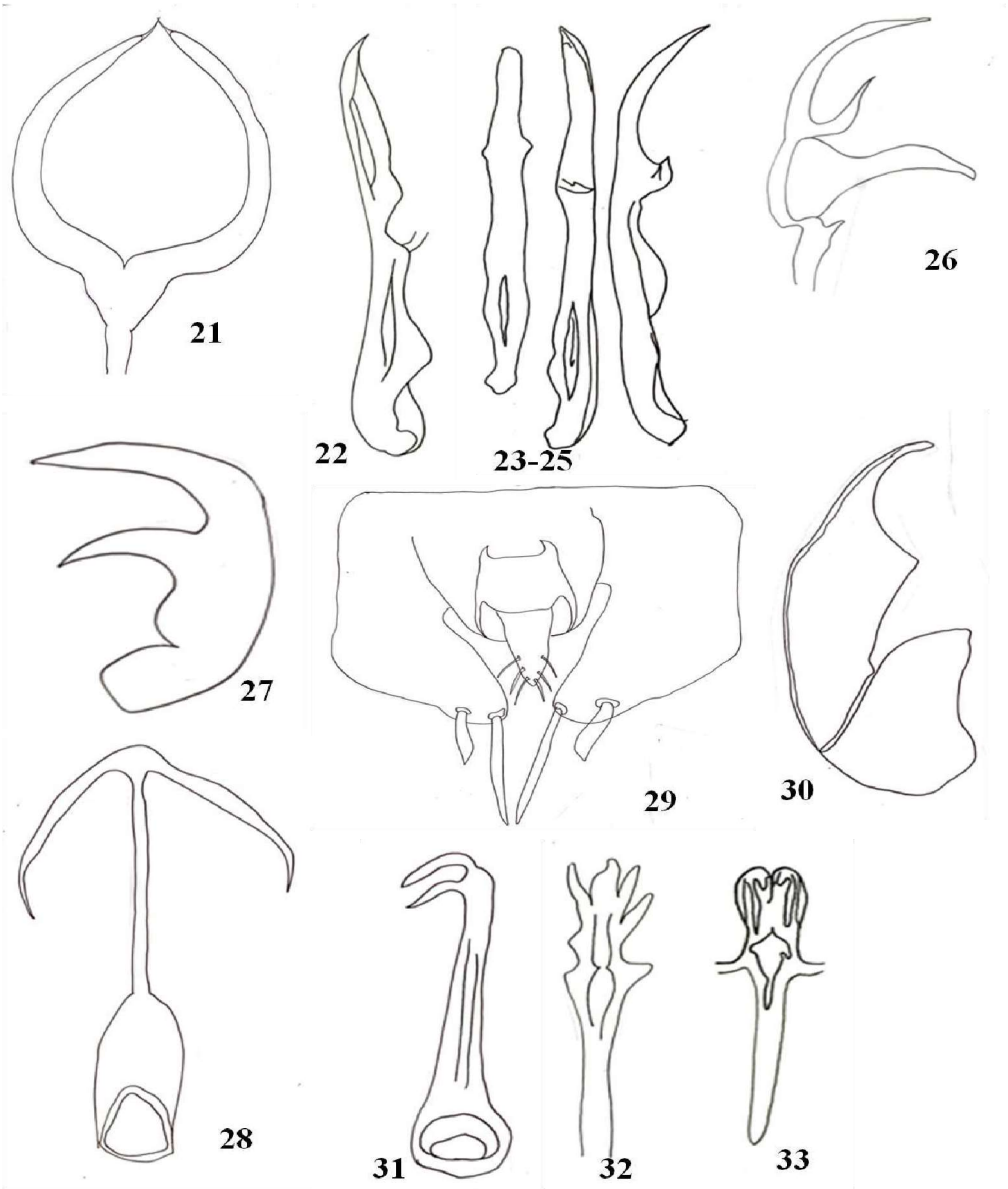
-Aedeagus without such processes……..…7

7. Pygofer process bifurcated, branches hooked; dorsal branch of the process is smaller, hooked, and directed ventrad while the ventral one longer, recurved, hooked and directed dorsal; connective stem longer than arms; forewings with reddish stripes (Fig. 17)…….....***Balclutha pararubrostriata*** **Rao and Ramakrishnan**

-Pygofer without such processes; Connective stem approximately as long as the arms (Figs. 18-19)…..……***Balclutha saltuella*** **(Kirschbaum**)

8. Aedeagus with two shafts…….....…….9

- Aedeagus with single shaft…….....10



Figs. 21. *Scaphoideus harlani* Kitbamroong and Freytag Aedeagus; 22. *Maiestas dorsalis* (Motschulsky) Aedeagus in lateral view; 23-25. *Maiestas acuminatus* (Dash and Viraktamath) Connective and aedeagus dorsal view, lateral view; 26. *Austroagallia bifurcata* Sawai Singh and Gill Aedeagus lateral view; 27. *Batracomorphus angustatus* (Osborn) Aedeagus in lateral view; 28. *Hecalus porrectus* (Walker) Aedeagus; 29-30: *Exitianus indicus* (Distant) Pygofer dorsal view and Aedeagus; 31. *Empoascanara maculifrons* (Motschulsky) Aedeagus; 32. *Empoasca* (*Distantasca*) *terminalis* Distant Aedeagus; 33. *Empoasca* (*Empoasca*) *kerri* Pruthi Aedeagus

9. Aedeagus shafts broad, apex with lateral mesal margins curved anteriorly, apex acutely rounded in posterior view, with curved processes from lateral margins and turned ventrally (Figs. 20).....***Hishimonus phycitis*** **(Distant)**

Aedeagus shafts cylindrical, dorsally curved; a pair of long narrow closely opposed processes arise between bases of shafts, approximately twice length of shafts, extending posteriorly and curving slightly dorsally, with row of small, teeth along distal half of lateral surface (Figs. 1-7; Plate 1. a-d)……***Hishimonus viraktamathi Knight***

10. Connective fused or united with parameres of the aedeagus; aedeagus with shaft cone-shaped, convex near the base, base rectangular in ventral view, gonopore subapical (Figs.)…….…***Scaphoideus harlani*** **Kitbamroong and Freytag**

–Connective not fused with parameres, parameres absent ……..11

11.***Aedeagus fused with*** connective (Fig 22)……. 12

-Aedeagus not fused with connective (Fig 20) ……..…13

12. Aedeagus fused with connective; tegmina pale yellowish brown with distinct reddish-brown zigzag markings; aedeagal shaft wider basally, tapering gradually with acute apex and gonopore subapical (Figs 22; Plate 2c)……***Maiestas dorsalis*** **(Motschulsky)**

–Zig zag markings absent on the tegmina; insect orange yellow, vertex with light median fuscous markings; aedeagal shaft strongly curved, wider at base, progressively narrowed to an acutely pointed spine, gonopore dorsoapical (Figs. 23-24)……***Maiestas acuminatus*** **(Dash and Viraktamath)**

13. Vertex very much narrower, its length is shorter by two or two and half times or even more the length of pronotum…..14

–Vertex not much narrower in its length than pronotum…15

14. Vertex round, slender, with two prominent black spots; aedeagus split into two unequal branches, with a well developed aedeagal apodemes; connective broad, extremely short, without clear distinction of stem and arms (Fig.26; Plate 2d).....***Austroagallia bifurcata*** **Sawai Singh and Gill** -Vertex short, transversely rugose with a broadly rounded anterior border in the dorsal aspect; aedeagus is clefted with two finger like extensions at its tip that are widely separated (Fig. 27; Plate 2d) .....……***Batracomorphus angustatus*** **(Osborn)**

15. Aedeagus long, narrow with a pair of leaf like terminal processes; the apical one third of the forewings brown with white dots in the apical and anteapical cells in the male, these spots are absent in the female (Fig.28)…….***Hecalus porrectus*** **(Walker)**

-Aedeagus without leaf like terminal processes, vertex with a conspicuous black band between compound eyes; pygofer with two prominent dark brown or black spines extending to the apical margin, the upper spine is broader and longer than the lower; aedeagus is simple, curved having an articulation between the base and the shaft (Figs. 29-30)..... .....***Exitianus indicus*** **(Distant)**

16. Aedeagus with one pair of asymmetrical apical processes, but not leaf like, longer one arising from the shaft and the shorter one deriving from the base of the longer one rather than from the shaft; vertex with large black spot on the margin of vertex and face (Fig.31) …….***Empoascanara maculifrons*** **(Motschulsky)**

-Aedeagus without any processes, if present they are short……15

17. Aedeagal shaft narrowed at base, broad at the apex and produced into two pairs of processes near the gonopore; pygofer process elongated, slightly curved and pointed at apex (Fig. 32)…..…..***Empoasca*** **(*Distantasca*)** ***terminalis*** **Distant**

-Aedeagus without any processes, tubular, notched apically, broader apically with middle extensions on both sides and gradually narrowed towards the proximal end; pygofer process elongated, inner surface serrated apically (Fig. 33)……..…..***Empoasca*** **(*Empoasca*)** ***kerri*** **Pruthi**

CONCLUSION

The present study documented 18 species of leafhoppers associated with blackgram ecosystems in Coastal Andhra Pradesh. Among these, *Hishimonus viraktamathi* Knight is reported for the first time from the state, constituting a new distributional record. Detailed description of this species, along with diagnostic features and illustrations, has been provided to facilitate accurate identification. An illustrated key for all recorded species is also presented to support entomologists and field workers in species recognition, which is essential for effective pest surveillance and management in blackgram cultivation.

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