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# New Record of Predator and Parasitoid on Carpenter Bee *Xylocopa fenestrata* F.

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**Abstract:** *Xylocopa fenestrata* F. is a significant buzz pollinator, playing a vital role in the pollination of various field crops and contributing to the stability and productivity of agroecosystems. In the present study, conducted at the Agricultural Research Station, Vijayarai, Andhra Pradesh, during 2023-2025, detailed observations were made on the nesting biology, nesting preferences, and foraging activity of *X. fenestrata*. The artificial nesting substrates made from bamboo nodes were deployed to monitor and document the nesting behavior of this species. The study also identified two natural enemies associated with *X. fenestrata* nests: a predator belonging to the genus *Horia* (Coleoptera: Meloidae), and a parasitoid, *Coelopencyrtus krishnamurtii* (Hymenoptera: Encyrtidae). Out of the 400 nests installed, 60 (15%) were infested with predator/parasitoid. These findings highlight previously ecological interactions and potential threats faced by this important pollinator and have significant implications for its conservation and management.

**Keywords:** *Xylocopa fenestrata*, Pre-pupae, Grub, *Horia* sp., *Coelopencyrtus krishnamurtii*

Pollination is the transfer of pollen from anther to stigma, enabling fertilization and seed or fruit development. It occurs via wind, water, birds, or insects. Insects such as bees form mutualistic relationships with plants, gaining nectar or pollen while transferring pollen between flowers. Some bees perform buzz pollination vibrating their flight muscles to release pollen from tubular or poricidal anthers using higher-frequency vibrations that enhance pollen discharge (Boucher et al., 2025). Floral traits such as shape, tube length, color, and nectar properties determine which pollinators can access rewards, acting as selective filters. Studies show that different pollinators exert distinct selective pressures, shaping floral morphology as in *Stellera chamaejasme* (Zhang et al., 2022) and *Rhododendron* species influenced by both pollinators and climate (Basnett et al., 2024). The floral syndromes describe trait sets linked to specific pollinators, they often exist along a continuum, especially when multiple pollinators or shifts in pollination modes occur (Li et al., 2022).

Although some carpenter bee species, such as *Xylocopa nasalis*, exhibit social behavior where one female builds and forages while others guard the nest, *Xylocopa fenestrata* is generally regarded as solitary. Foraging behavior in *X. fenestrata* is influenced by environmental factors like temperature, humidity, and light, and has been shown to increase significantly with the addition of brood hormones (Pankiw 1998). The genus *Xylocopa* includes large-bodied bees that excavate nests in hardwood. For over 200 years, the circumtropical genus *Horia* (Coleoptera: Meloidae) has been associated with *Xylocopa* spp. and is known to parasitize their nests (Guilding 1824, Cros 1924, 1938). This indicates an antagonistic relationship. The tribe Horiini, primarily tropical, includes three species across two genera in the Palaearctic: *Horia* Fabricius, with two species, and *Synhoria* Kolbe, with one. None have been previously recorded in Israel (Bologna and Pinto 2002, Bologna and Turko 2007, Ricciieri et al., 2023). However, *Horia fabriciana* is known from parts of the Afrotropical region and the southern Palaearctic, including Egypt, Saudi Arabia, the UAE, and Yemen (Löbl and Smetana 2008).

The large parasitoid wasp family Encyrtidae includes approximately 455 genera and 3,710 species. Most are primary parasitoids, particularly of Hemiptera, but some target larvae, eggs, or even ticks. They are globally distributed and play a significant role in biological control. However, their impact can be ecologically significant, as seen with the endangered butterfly *Papilio homerus*, whose egg mortality rate from parasitism reaches up to 77% (Segoli et al., 2010). Among Encyrtidae, *Coelopencyrtus* species are recognized by their relatively narrow female antennal segments, a thorax that is elevated, and a non-exserted ovipositor. In contrast, *Nesencyrtus* has broader antennal segments, an enlarged mouth opening to accommodate large mandibles, a depressed thorax, and a slightly exserted ovipositor. Males differ in antennal structure and head morphology (Burks 1958). Despite extensive research on *Xylocopa* pollination ecology, there are no documented natural enemies of *X. fenestrata* from India or elsewhere. The present study reports, for the first time, a predator (*Horia* sp.) and a parasitoid (*Coelopencyrtus krishnamurtii*) associated with its brood.

## MATERIAL AND METHODS

The present study was conducted at the Agricultural Research Station, Vijayarai, Andhra Pradesh, India, during the period 2023–2025. The research site is located at latitude 16.81210° N and longitude 81.03270° E. To study the nesting biology and behavior of *X. fenestrata*, bamboo nodes with diameters ranging from 1.0 to 1.8 cm and lengths of 3 to 4 feet were used as artificial nesting substrates. These bamboo nests were installed within a pollinator shed established at three different locations within the research station premises to encourage nesting activity under semi-natural conditions. Regular observations were made to document the nesting preferences, nest construction, and other biological behaviors of *X. fenestrata*. Detailed records were maintained on nest establishment, structure, occupancy, and developmental stages. During the course of the study, two natural enemies a predator and a parasitoid were also observed interacting with the nests of *X. fenestrata*. The total number of nests installed and observed was 400, with 60 nests infested by predators/parasites (15%). Adults were preserved in 70% ethanol and sent to ZSI, Kolkata for expert identification.

## RESULTS AND DISCUSSION

*X. fenestrata* preferred nest of diameter of 1.5 cm and 1.6 cm in 2023-24 and 2024-25 respectively. The females of *X. fenestrata* collected pollen and nectar from various crops such as Sunhemp (*Crotolaria juncea*), Diancha (*Sesbania bispinosa*), Redgram (*Cajanaus cajan*), Sesame (*Sesamum indicum*) and Niger (*Guizotia abyssinica*).

The female *X. fenestrata* excavated the bamboo node wood with its mandibles, creating circular discs of wood shavings and laid eggs in a mass provision of pollen and nectar placed between two such excavated wooden discs. The female mass provisioned pollen and nectar within the space. The egg, larval and pupal period was for 3, 16 and 26 days respectively. The bamboo nodes were cut longitudinally to observe various stages of grubs of *X. fenestrata*. (Fig. 1. A

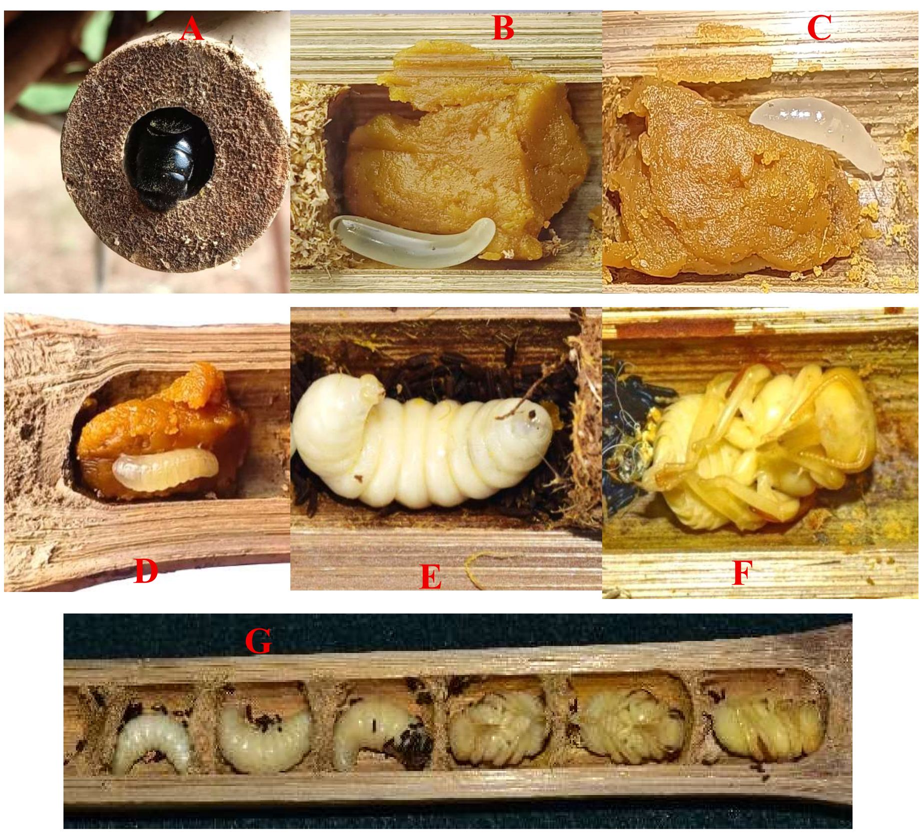


**Fig 1.** Developmental stages of *X. fenestrata* in bamboo node at, ARS, Vijayarai at 2023-24. (A to H) A: *Xylocopa fenestrata nesting* in 1.5 cm bamboo node. B: Egg laid in provisioned food (pollen+ nectar), C: Hatched egg, D: Grub, E: Pre-pupa F: Pupa, G: Different grub stages of *X. fenestrata*

– G) *X. fenestrata* preferred bamboo as nesting material. The nests were built in an angled position in the shadow which might be due to convenience and protection from rain. Despite a range of bamboo node diameters (1.0−2.70 cm) being provided, *X. fenestrata* showed a preference for nodes with diameters of 1.5, 1.6, and 1.7 cm for nest construction. The highest mean acceptance rate was observed in 1.5 cm nodes (41.75%), followed by 1.6cm (35.36%), with the lowest acceptance in 1.7cm nodes (22.87%)

During our observation, the grub of *Horia* sp. was found predating upon the grubs of *X. fenestrata*. The grub of *Horia* sp. closely resembled the *X. fenestrata* grub, likely facilitating concealment within brood cells. But upon close observation, the larvae of *Horia* sp. could be clearly identified by three pairs of prolegs on the thorax often called as triungulin larvae, which is the first instar larvae of the family Meloidae, whereas in the larval stages of *X. fenestrata,* the grubs were immobile and did not have either prolegs or abdominal legs with reduced head and poorly developed sense organs. It was observed that the campodeiform larvae of *Horia* sp. is characterized by well developed head, strong mandibles, clear segmentation of the body and was actively mobile and predating upon the grubs of *X. fenestrata*. The adult beetle laid its egg in the nectar and pollen provisioning in the second cell from the nodal septum. The grub of *Horia* sp. consumed both pollen-nectar mass provision and the grubs of *X. fenestrata*. It had strong mandibles by which it bored through the wooden circular discs/septum and predated upon the grub of *X. fenestrata*. The grub of the predator voraciously predated upon each grub within one day. The time of laying of egg by adult predator was not traceable. The grub changed its colour from white to pale yellow in colour in pupal stage. The adult was collected and sent to Zoological Survey of India, Kolkata for authentic identification. The adult was identified as *Horia* sp. (Fig. 2. A – G).

Another parasitoid belonging to the family Encyrtidae named *Coelopencyrtus krishnamurtii* (Mahdihassan) was recorded in the late grub stage of *X. fenestrata* in one of the trap nests having a diameter of 1.5 cm (Bamboo node) (Fig. 2). The grub which was located in the end of bamboo node near to nodal septum and was the only grub that is infested by *C. krishnamurtii*. The adult wasp of parasitoid laid thousands of eggs in the pre-pupal body of *X. fenestrata*. The larvae fed upon the entire body contents of *X. fenestrata* and the pre-pupa of *X. fenestrata* appeared sac-like and the entire larval body of *X. fenestrata* was occupied with pre-pupae of *C. krishnamurtii*. The infested grub was kept in a glass vial enclosed with cotton plug to record the emergence of adult wasp parasitoids (Fig. 2). The pre-pupae/ late stage grub of *X. fenestrata* did not emerge into adult. The pre-pupae of *X. fenestrata* became transparent white when the grub was entirely occupied with pre-pupae of *C. krishnamurtii*. All the


**Fig. 2.** A) Second grub from the left- Triungulin larva of *Horia sp*. in Bamboo node; B) Predatory activity of grub of *Horia sp*. on the grub of *X. fenestrata;* C) Late-stage grub of *Horia* sp; D) Prepupa of *Horia* sp.; E) Pupa of *Horia* sp.; F) Emerged adult of *Horia* sp.; G) Adult *Horia* sp

pre-pupae of *C. krishnamurtii* became clearly visible from the outside body of pre-pupae of *X. fenestrata* grub. The colour of pre-pupae of *X. fenestrata* was changed from pale white initially to transparent white and then to light brown in colour. Then all the adults of *C. krishnamurtii* completely emerged from the pre-pupae of *X. fenestrata* in the glass vial (Fig. 2). The adults were collected and sent to Zoological Survey of India, Kolkata for authentic identification of parasitoids. The parasitoid was identified as *C. krishnamurtii*.

Triungulin larva of *Horia sp* active, campodeiform (elongated and flattened), with well-developed legs, three claws, having predatory activity on the grub of *X. fenestrata* in Bamboo node. The name triungulin means three claws on each foot and is distinctive when compared to later larval instars. The later instars are apodous, creamy white in colour without having well developed head capsule. Later it transforms into pre pupa within the bamboo node. Exarate pupa having appendages clearly visible and not glued to the integument. Reddish adult with black markings on the elytra having long serrate antennae. Adult beetle abdominal segments exposed beyond the elytra (pygidium). (Fig. 2. A – G). *Coelopencyrtus krishnamurtii* is an endoparasite of *X. fenestrata* prepupal or pupal stage. Female lays an egg inside the prepupa of *X. fenestrata*. The parasitoid larva consumes the host internally. Pupation occurs within the host cell. Emergence occurs through a small circular hole bored through the cocoon or cell wall. (Fig. 2. H – J). Guilding (1824) reported that some species in the genus *Horia* live in the brood colonies of *Xylocopa* bees. *Horia maculata* was introduced to Hawaii to control *Xylocopa* but the beetles did not establish a stable population. (Clausen 1940).

*Horia fabriciana* was identified as a parasitoid of *Xylocopa pubescens* in Egypt (incorrectly listed under *Xylocopa aestuans* (Linnaeus 1758)) in the Palaearctic region (Blair 1924, Cros 1924, 1927, 1929, 1938, Bologna and Laurenzi 1994), as well as of an unidentified species of *Xylocopa* in the United Arab Emirates on the same mulberry tree trunk, inhabited by *X. pubescens*. These results support current findings.Bologna et al. (2013) observed the taxonomic characters of *Horia* sp. Male metafemora inflated, noticeably broader than mesofemora. Males with mandibles short, their length less than half that of head and with head widest at eyes Pronotum length usually greater than head length to apex of mandibles. Fourteen specimens were collected in Papua New Guinea (Port Moresby) that may be assigned to a new species closely related to *Horia blairi*. The first instar larvae of three African and Oriental species were described, which were phoretic and parasitoids of anthophorine bees (Apidae) (Bologna et al., 2013). The scutellum of *Coelopencyrtus krishnamurtii* is large bluish with some bronzy shine medially (Hayata et al., 2014). Segoli et al. (2010) reported that *C. krishnamurthii* had the cerci forwards on the metasoma (and the resulting distortion of the tergites), and a substantially expanded mesopleuron with


**Fig. 2.** H) Pre-pupae of *X. fenestrata* infested by *C. krishnamurtii* (first one from the top near nodal septum); I) The pre-pupae of *X. fenestrata* occupied with pre-pupae of *C. krishnamurtii;* J) Adult parasitoids emerged from larval case of *X. fenestrata;* K) Adult parasitoid *Coelopencyrtus krishnamurtii* (Mahdihassan)

anteriorly positioned mesocoxae make it relatively straightforward to distinguish wasps of this family from other Chalcidoidea.

## CONCLUSION

The present study documents for the first time, both globally and from India, the occurrence of *Horia* sp. (Meloidae) and *Coelopencyrtus krishnamurtii* (Encyrtidae) as natural enemies of the carpenter bee *Xylocopa fenestrata*. This finding emphasizes the complexity of pollinator–natural enemy interactions and highlights the need for further studies on the biology, seasonal occurrence and impact of these species on bee populations.

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## REFERENCES

Basnett S, Bhattarai B and Ohashi K 2024. Floral trait variation along environmental gradients in Rhododendron: Interactive roles of pollinators and climate**.** *Annals of Botany* **135**(1-2): 125-137.

Blair KG 1924. Coleopterous larvae from the burrows of *Xylocopa aestuans. Transactions of the Entomological Society of London* **1924**: 149-150.

Bologna MA and Laurenzi M 1994. Descriptions of the triungulins of Synhoria testacea (Fabricius) and another undetermined African species (Coleoptera: Meloidae), with data on Horiini larvae. *African Entomology* **2**(2): 155-162.

Bologna MA and Pinto JD 2002. The Old World genera of Meloidae (Coleoptera): S key and synopsis. *Journal of Natural History* **36**(17): 2013-2102.

Bologna MA and Turco F 2007. The Meloidae (Coleoptera) of the United Arab Emirates with an updated Arabian checklist. *Zootaxa* **1625**(1): 1-33.

Bologna MA, Turco F and Pinto JD 2013. The Meloidae (Coleoptera) of Australasia: a generic review, descriptions of new taxa, and a challenge to the current definition of subfamilies posed by exceptional variation in male genitalia. *Invertebrate Systematics* **27**(4): 391-427.

Boucher-Bergstedt C, Jankauski M and Johnson E 2025. Buzz pollination: investigations of pollen expulsion using the discrete element method. *Journal of the Royal Society Interface* **22**(222): 20240526.

Burks BD 1958. A recharacterization of the genus Coelopencyrtus, with descriptions of two new species (Hymenoptera: Encyrtidae). *Journal of the Washington Academy of Sciences* **48**(1): 22-26.

Clausen CP 1940. *Entomophagous insects*. McGraw-Hill book Company, Incorporated.

Cros A 1924. Révision des espèces africaines et orientales des genres Horia Fabr. et Cissites Latr., avec description de larves inédites. *Bulletin de la Royale entomologique d'Egypte* 24-80.

Cros A 1927. Révision des genres Horia Fabr. et Cissites Latr. (Note rectificative et complementaire). *Bulletin de la Société Royale Entomologique d'Égypte*, 2-4.

Cros A 1929. *Horia testacea* Fabr.(= *Horia africana* Auriv.), sa larve primaire. *Bulletin de la Société Royale Entomologique d'Egypte* **29:** 1-7.

Cros A 1938. Description de la larve primaire d, une espèce indéterminée de la tribu des Horiini (Col. Meloidae). *Bulletin du Musée Royale d'Histoire Naturelle de Belgique* **14**(47): 1-13.

Guilding L 1824. XIII. The Natural History of *Xylocopa teredo* and *Horia maculata*. Transactions of the Linnean Society of London **14**(2): 313-317.

Hayat M, Ahmad Z and Khan FR 2014. Encyrtidae (Hymenoptera: Chalcidoidea) from the Kingdom of Saudi Arabia. *Zootaxa* **3793**(1): 1-59.

Löbl I and Smetana A 2008. Catalogue of Palaearctic Coleoptera. *Tenebrionoidea* **5:** 670.

Pankiw T, Page Jr RE and Kim Fondrk M 1998. Brood pheromone stimulates pollen foraging in honey bees (*Apis mellifera*). *Behavioral Ecology and Sociobiology* **44**(3): 193-198.

Riccieri A, Capogna E, Pinto JD and Bologna MA. 2023. Molecular phylogeny, systematics and biogeography of the subfamily Nemognathinae (Coleoptera, Meloidae). *Invertebrate Systematics* **37**(2): 101-116.

Segoli M, Harari AR, Rosenheim JA, Bouskila A and Keasar T 2010. The evolution of polyembryony in parasitoid wasps. *Journal of Evolutionary Biology* **23**(9): 1807-1819.

Li H, Tang Y and Huang SQ 2022. Flower morphology and plant-bee pollinator interactions are related to stamen dimorphism in Melastomataceae**.** *New Phytologist* **235**(3): 1176-1187.

Zhang W, Xu D and Duan YW 2024. Multiple insect pollination contributes to differential phenotypic selection on floral traits **in** *Stellera chamaejasme*. *BMC Plant Biology* **24:** 78.

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