Sociobiology 65(3): 491-496 (September, 2018) DOI: 10.13102/sociobiology.v65i3.2837

Sociobiology
An international journal on social insects

RESEARCH ARTICLE - BEES

Nesting Biology, Seasonality and Host Range of Sweat Bee, *Hoplonomia westwoodi* (Gribodo) (Hymenoptera: Halictidae: Nomiinae)

A Udayakumar[1], TM Shivalingaswamy[2]

1 - Scientist (Entomology), Division of Germplasm Conservation and Utilization, ICAR – National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru, India

2 - Principal Scientist (Entomology), Division of Germplasm Conservation and Utilization, ICAR – National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru, India

Article History

Edited by
Gilberto M. M. Santos, UEFS, Brazil
Received 05 January 2018
Initial acceptance 20 March 2018
Final acceptance 28 March 2018
Publication date 02 October 2018

Keywords
Hoplonomia westwoodi, Nomiinae, Seasonality, Solanaceae.

Corresponding author
Amala Udayakumar
Division of Germplasm Conservation and Utilization, ICAR
National Bureau of Agricultural Insect Resources (NBAIR)
Bengaluru, 560024, India.
E-Mail: amala.uday@gmail.com

Abstract

Nesting biology and seasonal dynamics of Halictid bee, *Hoplonomia westwoodi* (Nomiinae: Halictidae) was studied at ICAR-National Bureau of Agricultural Insect Resources (NBAIR) Bengaluru, Yelahanka Campus (13.096792N, 77.565976E) India from July 2016 to May 2017. The bee built subterranean nests on a leveled soil surface with turrets and the main shaft running to a depth of 70.1 cm. In total, nineteen cells were observed in clusters at different depths. Different life stages of the bee were observed in the cells. The life cycle of the bee was completed in 41.80 days. The bees were found actively foraging on different flora belonging to the different families like Acanthaceae, Asteraceae, Convolvulaceae, Fabaceae, Lamiaceae, Malpighiaceae, Polygonaceae, Rubiaceae and Solanceae throughout the year with the peak population during the months of June to November. Marked preference and behavior of buzz pollination was observed on the flowers of Solanaceous crops like tomato and eggplant.

Introduction

Native wild bees provide a valuable pollination service in a wide range of crops in natural and managed ecosystems. With the recent decline in honeybee colonies due to various biotic and abiotic factors, there is an urgent and planned need to conserve the native solitary bees for their valuable ecosystem service. The pollen in some flowers might be concealed or trapped in the anthers and it needs natural or artificial vibratory movement to release the pollen for effecting pollination. The bee with an inherent ability to sonicate the flowers and collect the pollen from the poricidal anthers is an efficient pollinator. They make buzzing movement using their thoracic wing muscles as a result of which the pollen gets released from the terminal pores and gets coated over the bee's abdomen thereby it reaches the nest (Buchmann, 2000). Major buzz pollinating bees belongs to four families viz., Andrenidae, Halictidae, and Colletidae. Few species of bees like blue banded bee, *Amegilla* sp (Apidae) are known to buzz pollinate the flowers with poricidal anthers (Harter et al., 2002; Hogendoorn et al., 2006; Santos et al., 2014). Native bee - *Hoplonomia westwoodi* (Nomiinae: Halictidae) is one such efficient buzz pollinators of *Solanum violaceum* in Sri Lanka (Wanigasekara & Karunaratne, 2012), tomato *Solanum lycopersicum* (Amala & Shivalingaswamy, 2017), *Cleome viscosa*, *Lablab purpureus*, *Vigna* sp, *Ocimum basilicum* (Karunaratne et al., 2005). Seasonal composition of available floral resources as a major factor in the attraction of foraging activity of the native bees (Tomassi et al., 2004; Cane et al., 2006). As the tomato flowers does not provide nectar reward and the pollen being accessible only for buzz pollinators and honey bees do visit the tomato flowers but

Open access journal: http://periodicos.uefs.br/ojs/index.php/sociobiology
ISSN: 0361-6525

seldom pollinates them (Buchmann, 1983; Free, 1993). Amala and Shivalingaswamy (2017) reported the flower visitation and pollination in tomato by *H. westwoodi* resulting in a significant increase in fruit weight (46.96 g) and seed set per fruit (140.50 seeds) compared to the self-pollinated flowers.

These buzz pollinator bees have been reported to improve self-pollination of the crops having poricidal anthers whose pollen grains released are deposited on the stigma of the same flower (King & Buchmann, 2003; Greenleaf & Kremen, 2006). One of the major reasons for the poor fruit formation in some crops was the lack of temporal coincidence between the anthesis and occurrence of pollinators. A decline in pollinator populations due to the habitat loss and fragmentation of farm lands may be the reason for this non-synchrony of anthesis and presence of pollinators (Klein et al., 2007, Winfree et al., 2007). In view of this situation, there is an immense need to understand the nesting behavior of the native buzz pollinating bee, *H. westwoodi* so as to conserve this pollinator in agro-ecosystems and enhance their role in pollination of different crops. Though it is a well reported buzz pollinator, information on nesting biology of *H. westwoodi* is scanty. The present study aims at studying the nesting biology of sweat bee, *H. westwoodi*, its seasonality and spectrum of foraging flora in a farm landscape.

Materials and Methods

Study Site

The present study was carried out in Yelahanka Campus - experimental farm of ICAR-National Bureau of Agricultural Insect Resources (NBAIR) Bengaluru, India (13.096792N, 77.565976E) from July 2016 to May 2017. The study area of 22 acres comprising of cultivated crop lands with various annual crops like cereals and pulses, orchard blocks of mango, sapota, cherimoya. Also, two patches of pollinator gardens of about 1.5 acres with over 100 plant species of diverse plant families were also part of this study location which is right in the heart of a rapidly growing high-tech-city and capital of south Indian state of Karnataka.

Nest architecture and biology of H. westwoodi

Based on our experience on the natural nesting sites of *H. westwoodi*, we used two artificial nesting structures. First one was a polypropylene bag (30x30 cm) and the other one was an earthen flower pot (60x30cm) filled with soil which was similar to the natural nesting area. The soil surface was levelled properly in these structures. Care was taken that these nesting structures were kept in close proximity to flowering plants so as to attract foraging *H. westwoodi* for nesting. Twenty each of these simulated nesting structures were placed in different areas adjoining the study site to invite the bees for nesting. Weekly observations of the nest building activity in the soil filled flower pots and polypropylene bags installed in experimental farm of ICAR-NBAIR Yelahanka campus, Bengaluru were made during July 2016 to May 2017. Active nests were identified by the presence of turrets and tumulus with entrance holes in both the artificial structures provided for nesting. The adult bee activity of entering and exiting from the entrance holes of the nest was observed. Presence of fresh turret and sighting of the pollen laden adult female bee entering the turret was a clear indication of the newly formed nest with broods. Nest excavation was carried out by digging carefully the soil around the nest to study the nest architecture. The number of pollen collection trips made by the adult female was observed between 7.30 am to 5.30 pm and recorded. Tunnel length and width, number of cells built, number of cells with active brood, number of empty cells, number of adult bees were observed and recorded from nineteen brood cells in the laboratory. The distance between each nest, nest dimensions such as length of turret, diameter of entrance, burrow diameters, nest depths were recorded. Presence of foundress in the nest if any was also recorded. The brood clusters were cut opened carefully to examine the inner contents. The larvae observed in the brood cells were reared in the laboratory till pupation and observed for emergence of adults. Egg, larvae and pupae (N=25 each) were taken in meshed boxes (9x4 cm) were maintained in the laboratory and the rate of survival of each stage was recorded. The duration of egg, larva and pupal stages of the bee was observed and recorded. Mortality of life stages of the bee and causes for the mortality if any was also observed.

Seasonal incidence of Hoplonomia westwoodi

The seasonal incidence of *H. westwoodi* was studied in the pollinator garden of ICAR-NBAIR Yelahanka Campus between July 2016 and December 2017. Bees foraging over the flora were sampled using sweep nets at weekly intervals. Sweeping was done between 08.00 hrs to 14.00 hrs during the day of observation. The collected bees were killed using ethyl acetate and brought to the laboratory. The bee specimens were pinned, taxonomically identified and preserved. The total number of adult bees collected were observed and recorded.

Host plant preference of H. westwoodi

A wide array of diverse flowering plants in the experimental farm was observed for the visitation by the bee between July 2016 and May 2017 at fortnightly intervals. The different families of the flowering plants preferred by the bee for foraging was observed and recorded. The number of visits made by *H. westwoodi* per five minutes time period per flower was recorded at different time points, 8.00-9.00 am, 10.00-11.00 am, 12.00-1.00 pm, 2.00-3.00 pm and 4.00 to 5.00 pm. The reward in terms of pollen and nectar collected by *H. westwoodi* during each visit was also recorded.

Results and Discussion

Nesting site

The nests of *H. westwoodi* were observed in the artificial nesting structures- earthen flower pots and soil filled polypropylene bags placed in the experimental farm of ICAR-NBAIR Yelahanka campus Bengaluru. The bees were observed to construct their nests in these structures placed in close proximity to the flowering plants. More number of nests were found in the earthen flower pots filled with dried leaf litters compared to bags. Some of the nest entrances were exposed but a few was found to be hidden under the dried leaf litter. Upon careful observation of adult bee activity of entering inside the entry hole, presence of few nests was confirmed. On a bright morning after a previous day rainfall, the surviving foundress was observed repairing its collapsed nest turrets. The bees were found to actively construct their nests during June to November as evident from the soil trap nests in the present study. Active nesting of *H. westwoodi* during this period could be due to the copious availability of blooming flora providing rich pollen for its broods.

Nest architecture of H. westwoodi

The nest entrance was circular with a diameter of 0.5 cm with a turret measuring 1.2 cm high sometimes appeared hard in few places. The female bee was observed to use more than one nest entrance to gain entry into the tunnel as the nests were branched and found connected with each other in soil. The main tunnel had branches wherein the branches ended in individual or group of cells (Fig 1). The main shaft of the nest tunnel ran to a depth of 70.1 cm with a diameter of 0.5 cm (n=10). Horizontal laterals originated from the main shaft at a depth of 41.7 cm. Cells were observed in clusters at depth ranging from 62.8 to 70.00 cm from the soil surface. This might be to ensure protection of the broods by the foundress as flooding during heavy rains was very less likely to reach brood cells. Similar observations on cell construction at greater depths in the genera *Lasioglossum*, *Agapostemon* and most of *Halictus* species of bees has been reported by Packer et al. (1988). Each cell was typically oval in shape with the walls coated with a water proof secretion. The average length and width of each cell (n=20) ranged between 10.03 to 15.0 mm and 5.25 to 5.5 mm respectively. Each cell was closed with a thin layer of soil. The pollen mass provision appeared to be spherical and measured 2.5 mm high and 5.0 mm diameter placed at the side end of each cell over the top. The translucent egg was laid on the pollen mass by the adult bee. The pollen mass was slightly wet might be due to the secretions of the adult bee. The cells contained different life stages viz., egg, pre-defecating and post defecating larvae (Fig 2).

Abundance of H. westwoodi

Our observations indicated that population of *H. westwoodi* occur throughout the year with a peak occurrence during the month of June 2016 to May 2017. The active nests with foraging female bees were also found during the period of June to October. The reason could be that foundress bee could involve in digging activity in wet and loose soil due to the rains between June and October. The study area with abundance of blooming flora coinciding with the rainy season supplying pollen for the foraging females could also be the influencing factor for higher abundance of the bee during this period. Also another factor could be the availability of standing crop of field bean, *Lablab purpureus* L. planted in the experimental farm provided constant supply of pollen would have supported the active population of *H. westwoodi*.

Number of pollen and nectar rewarding plants in the farm was found to be constant throughout the study period but richness of the flora was comparatively lesser during the later period (mid November to Early December) which was marked by decreased activity of *H. westwoodi* (Fig.3). The

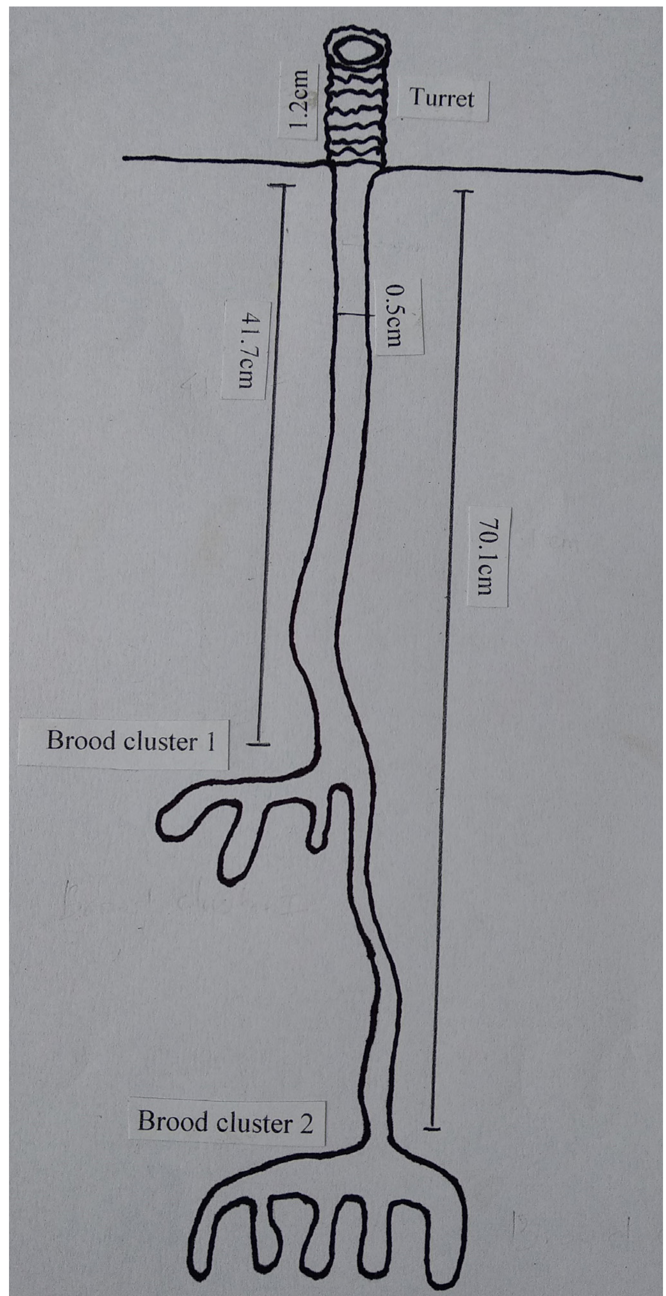

Fig 1. Nest architecture of *Hoplonomia westwoodi*.

Fig 2. A. Nest Turret; B. Female bee visiting the nest; C. Multiple entrance of the nest; D. Egg; E. Different larval stages; F. Late larva and Prepupa; G. Pupa.

seasonal incidence and activity of the bee is influenced by the phenology of flowering plants and their diversity, land use and nesting suitability (Shebl et al., 2016). Availability of an appropriate seasonal floral base that provides nectar and pollen to the foraging bees is vital for the survival and reproduction of the bees. The frequency of a particular flower visitor in the target crop is an important factor that determines its efficiency in pollination of that crop.

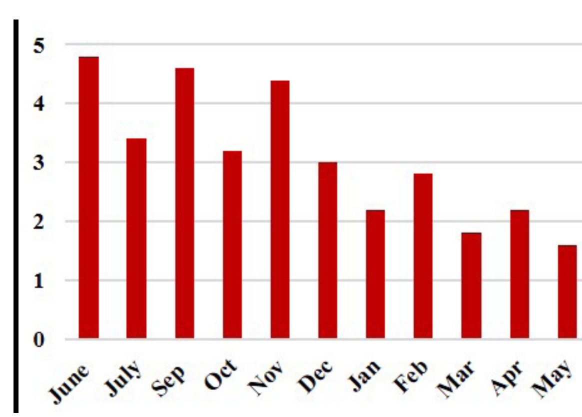

Fig 3. Abundance pattern (number of visitors per flower) of the sweet bee, *Hoplonomia westwoodi* (2016-2017).

Biology of H. westwoodi

The duration of egg, larva and pupal stages lasted for 5.6±1.14, 23.40±3.58 and 12.80±2.17 days, respectively.

Overall egg to adult stage was completed in 41.8 days. The pre-defecating larvae appeared curved, whitish in color covered in the pollen provision. On the contrary, the post defecating larvae appeared fully grown, curved, yellowish white with fecal pellets scattered in the cells and devoid of pollen provision. A marked difference in the color of the eyes during pupal stage was observed. Initially the pupae appeared white eyed, later the color changed to pale brown and finally dark brown in color. None of the pupae was found to be in diapause stage. There was no evidence of brood parasitism in the excavated nests as there was 100 percent rate of emergence of adult bees from the pupal brood. There were no signs of parasitism or predation in the excavated brood cells containing the larvae. During the process of excavation more than four females were found in the shaft, which could be the probable reason for non- incidence of parasitism of the broods inside the nest. The female bee was observed to conduct 8-10 pollen collection trips during in each nest per day. Two females were observed entering through the same nest entrance might be due to the communal nesting behavior of *H. westwoodi*. Wcislo, (1993) reported the communal nesting behavior in pearly-banded bee, *Nomia tetrazonata* with multiple number of female bees occuring in the same nest.

Host plant preference of H. westwoodi

H. westwoodi was found to be broadly polylectic in nature. Our observations showed a marked preference of this bee to Solanaceous crops like tomato and eggplant. The descending order of visitation range of *H. westwoodi* in the flora belonging to different families was found to be in the order of Solanaceae >Lamiaceae >Fabaceae > Asteraceae > Malpighiaceae > Acanthaceae > Rubiaceae > Convolvulaceae. This could be due to the need of buzzing activity of the native *H. westwoodi* which is essential for the pollination of tomato flowers. Apart from the Solanaceous plants, the bees were found to forage on a variety of the flowers of Acanthaceae, Asteraceae, Convolvulaceae, Fabaceae, Lamiaceae, Malpighiaceae, Polygonaceae, Rubiaceae in the study site (Table 1). The bees were observed to collect the nectar reward from the flowers of the foraging plants. Whereas in the Solanaceous flowers viz., tomato and eggplant, the bees were found to buzz pollinate and collect the pollen over the hairs present in the legs and abdomen. Batra (1966) reported many species of *Nomi*a viz., *N. oxybeloides*, *N. capitata* as polylectic in habit exhibiting social and semi-social behavior.

With the growing decline in insect pollinators worldwide, there is an immense need to conserve the native, efficient buzz pollinating bees like *H. westwoodi*. Studies on seasonal abundance and nesting habit of this native bees helps in the understanding their ecology, plant preferences by which they can be conserved in-situ in their natural breeding habitats.

Table 1. Host Plants and rewards collected by *H. westwoodi*.

Family	Plant species	Reward collected	
		Pollen	Nectar
Acanthaceae	*Asystasia gangetica* (L.) T. Anderson		++
Asteraceae	*Gaillardia pulchella* Foug.		++
Convolvulaceae	*Jacquemontia* sp.		++
	Argyreia cuneata Ker Gawl.		++
Fabaceae	*Crotolaria retusa* L.		++
Lamiaceae	*Ocimum basilicum* L.	--	++
	Ocimum gratissimum L.	--	++
	Strobilanthus barbatus Nees	--	++
Malpighiaceae	*Tristellateia australasiae* A. Rich		++
Polygonaceae	*Antigonon leptopus* Hook. & Arn.		++
Rubiaceae	*Hamelia patens* Jacq.		++
Solanaceae	*Solanum lycopersicon* L.	++	--
	Solanum melongena L.	++	--

Acknowledgments

The authors are thankful to Dr. Chandish R. Ballal, Director, ICAR-NBAIR for providing facilities and constant encouragement for conducting the study.

References

Amala, U., & Shivalingaswamy, T. M. (2017). Role of native buzz pollinator bees in enhancing fruit and seed set in tomatoes under open field conditions. Journal of Entomology and Zoology Studies, 5: 1742-1744

Batra, S.W.T. (1966). Social behaviour and Nests of some Nomiinae bees in India (Hymenoptera: Halictidae). Insectes Sociaux, 13: 145-154

Buchmann, S.L. (2000). Buzz pollination in Angiosperms. Handbook on Pollination Biology. 73-113.

Cane, J. H., Minckley, R. L., Kervin, L., & Roulston, T. H. (2006). Complex responses within a desert bee guild (Hymenoptera: Apiformes) to Urban habitat fragmentation. Ecological Applications, 16: 632-644.

Greenleaf, S.S., & Kremen, C. (2006). Wild bee species increase tomato production and respond differently to surrounding land use in Northern California. Biological Conservation, 13: 81-87. doi: 10.1016/2006.05.025.

Harter, B., Leistikow, C., Wilm, S, W., Truylio, B., & Engels, W. (2002). Bees collecting pollen from flowers with poricidal anthers in a south Brazilian Araucaria forest: a community study. Journal of Apicultural Research, 40: 9-16. doi: 10. 1080/00218839.2002.11101063.

Hogendoorn K, Gross CL, Sedgley M, Keller MA. (2006).

Increased tomato yield through pollination by native Australian *Amegilla chlorocyanea* (Hymenoptera: Anthophorinae). Journal of Economic Entomology, 99: 828-833.

King, J., & Buchmann, S.L. (2003). Floral sonication by bees: mesosomal vibration by *Bombus* and *Xylocopa*, but not Apis (Hymenoptera: Apidae), ejects pollen from poricidal anthers. Journal of the Kansas Entomological Society, 76: 295-305.

Klein, A.M., Vaissiere, B., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., & Tscharntke, T. (2007). Importance of crop pollinators in changing landscapes for world crops. Proceedings. Biological Sciences, 274: 303-313. doi:10.1098/rspb.2006.3721.

Packer, L., Sampson, B., Lockerbie, C., & Jessom, V. (1988). Nest architecture and brood mortality in four species of sweat bee (Hymenoptera; Halictidae) from Cape Breton Island. Canadian Journal of Zoology, 67: 2864-2870

Santos AOR, Bartelli BF, Nogueira-Ferreira FH. (2014) .Potential pollinators of tomato, *Lycopersicon esculentum* (Solanaceae), in open crops and the effect of a solitary bee in fruit set and quality. Journal of Economic Entomology, 107: 987-994.

Shebl, M.A., Al Aser, R.M., & Ibrahim, A. (2016). Nesting Biology and Seasonality of Long-Horned Bee *Eucera nigrilabris* Lepeletier (Hym., Apidae). Sociobiology, 63: 1031-1037.

Tommasi, D., Miro, A., Higo, H.A., & Winston, M.L. (2004). Bee diversity and abundance in an urban setting. Canadian Entomologist, 136: 851-869.

Wanigasekara, R. W. M. U. M., & Karunaratne, W. A. I. P. (2012). Efficiency of Buzzing Bees in Fruit Set and Seed Set of *Solanum violaceum* in Sri Lanka. Psyche, ID 231638. 1-7. doi:10.1155/2012/231638

Wcislo, W.T. 1993. Communal nesting in a North American pearly-banded bee, *Nomia tetrazonata*, with notes on nesting behavior of *Dieunomia heteropoda* (Hymenoptera: Halictidae: Nomiinae). Annals of the Entomological Society of America 86: 814-821

SITIENTIBUS