FIELD NOTE

Hornet pests of honey bees in the Indian Himalayas

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Apiculture is an important allied sector of agriculture in India and according to the recent report of National Bee Board, under the agricultural department, India's honey production in 2017-2018 was 1.05 lakh metric tons (MTs) as compared to the 35,000 metric tons (MTs) in 2005-06 (Kumar and Joy, 2018). As per the international demand, the export rate of honey in India has increased by 207% in 2018 and is expected to expand (Bhaskar and Kumar, 2020). Moreover, crop pollination by honey bees increased the crop yield manifold. Agricultural experts say that additional yield obtained due to the pollination by honey bees is 15 to 20 times than the money generated by stockpile products (Aizen *et al.,* 2008). Moreover, Uttarakhand has 4,635 beekeepers and the state produces around 1,193 metric tonnes of honey per year (2017-18) (Anonymous, 2019). Among the major honey producing districts of Uttarakhand, Haridwar, US nagar, Nainital and Dehradun top the list (Uniyal *et al.,* 2018). However, beekeeping in the Indian Himalayas has its own set of problems and the major among them are the insect pest infestations (Shah and Shah, 1991).

More than 12 insect pests are reported to cause damage to honey bees, hives and their products in the Indian Himalayas (Shah and Shah, 1991). Although Greater wax moth (*Galleria mellonella*) and lesser max moth (*Achroia grisella*) are known to cause threat to apiculture. But, recently the hornet pests belonging to family Vespidae have gained the upper hand and are causing direct damages to the foraging bees and are leading to reduction in colony population, making the colonies weak and finally resulting in absconding or deserting of bee colonies (Requier *et al.,* 2020). There are three important hornet species (Figs. 1a to 1c) in the Indian Himalayas that are severe pests in apiary, *viz*., Giant Asian hornet (*Vespa mandarinia*), Yellow legged hornet (*Vespa velutina nigrithorax*) and Greater banded hornet (*Vespa tropica*). These are semi-social hornets that construct horizontal nests on tall trees (Fig. 2), buildings and in abandoned rodent burrows (Dazhi and Yunzhen, 1989). The colony population fluctuates between hundreds to thousands, while the peak population is recorded in the monsoon months of August to September in Uttarakhand. Among the three; *V. mandarinia* is a notorious and most ferocious species that is observed to kill 120-150 forager bees in an hours time (Yoshimoto and Nishida, 2009). The

Fig. 1a. *Vespa mandarinia*

Fig. 1b. *Vespa velutina nigrithorax*

Fig. 1c. *Vespa tropica*

hornets wait at the hive entrance (Fig. 3), catch hold of the foraging bees, decapitate and carry the thoracic part of the bee to their nests to feed the young ones (Nunez-Penichet *et al.,* 2021). The hornet damage is very severe in unmanaged apiaries and in the foot hills, low hills and mid hills of Himalayas, as the climatic conditions are very suitable for the hornet to survive and reproduce (Zhu *et al.,* 2020). The attacks on bee colonies by these hornet species compel the bees to desert the colony and swarm away to a new habitat, thus, causing severe economic losses to the bee keepers. In the present article, we will be briefly elaborating about identification, biology and predatory behavior of *V. mandarinia* an important hornet species of Indian Himalayas.

Fig. 2. Nest of *V. mandarinia* on tall tree branches

Identification, biology and predatory behaviour of Giant Asian hornet (*V. mandarinia*)

V. mandarinia is the largest hornet species in the world and it is known to have originated in temperate and tropical East Asia and South Asia (Smith-Pardo *et al.,* 2020). They prefer to live in low mountains and forests, while almost completely avoid plains and high-altitude climates. They are social hornets that create nests by digging the ground or adapting to pre-existing tunnels of rodents or occupy spaces near rotted pine roots in the mid and low hills of Himalayas (Yamane, 1976).

Identification: *V. mandarinia* is a large hornet with body length of 45 millimeters and wingspan of 70 mm. The sting is around 6 mm long and can inflict very

Fig. 3. Hornet waiting at the hive entrance

painful sting and inject large amount of potent venom. The hornet's head is yellowish orange in colour with brown antenna. The eyes and ocelli are dark brown to black in colour with large clypeus and gena. The mandibles are dark brownish in colour with black distal portion, very strong and used for digging the ground and decapitating the prey. The thorax and abdomen are dark brown or black in colour with yellowish orange hue. The sixth abdominal segment has a sternal gland, also known as van der Vecht's gland. The scent produced from these glands is used to mark the food source. During the months of September and October, the hornets mark the bee colony to attack in groups for mass slaughtering of the bees (Van der Vecht, 1959; Yamane, 1976; Archer, 1993).

Fig. 4. Fully developed nest of *V. mandarinia*

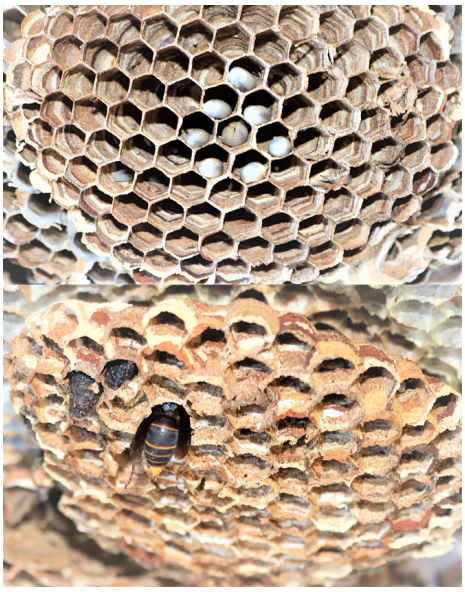

Fig. 5. Queen hornet caring the young ones

Biology and life cycle: The life cycle of *V. mandarinia* consists of six phases (Pre-nesting phase, solitary phase, cooperative phase, polyethic phase, dissolution phase and hibernating phase) and it is consistent with other eusocial hornets. Both the uninseminated and inseminated females end the hibernation period and emerge in mid-April months. The uninseminated females start feeding on sap of oak trees (*Quercus* spp.), while, the inseminated females are initially solitary and along with other females initiate the construction of subterranean or aerial nests. By the end of July, a fully developed nest with 500 cells and 100 workers is formed (Fig. 4) and the queen restricts itself to the colony and worker hornets start foraging. This cooperative phase continues up to late September and once the winter commences (early October), the queen hornet stops laying eggs and shifts its focus to caring the young ones (Fig. 5). The queen dies in late October and the responsibility to produce new queen is taken over by drones and workers. The drones and workers mate mid-air and form inseminated female, while the unmated females are left as uninseminated females. Once again both the females undergo hibernation to start a new colony cycle in the next season (Matsuura and Sakagami, 1973; Stankus, 2020).

Predatory behaviour: The Asian giant hornets primarily feed on larger insects, other eusocial insects, tree sap and honey bees. However, honey bees are the easy targets. The worker hornets wait at the hive entrance, capture the foraging bees, cut apart their head and abdomen and carry the nutritious thoracic region of the bees to their nest for mass provisioning their broods. Usually one hornet can hunt up to 40-60 bees in its hunting phase and 120-150 bees in its slaughtering phase. If the bee colony is weak, the hornets enter into the hive, collect grubs, pupa and honey from the hive and abandon the empty and weak colony.

Designing of the bait trap for managing the hornet menace in the apiaries

Considering the severity of attack and the amount of loss incurred to the apiarists of Indian Himalayas, the Scientists of ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand, India have designed a new low cost, food bait hornet trap for efficiently reducing the menace of hornets in the region. The trap has shown up to 83% efficiency in trapping the hornets and the Indian patent has been filed for the trap design and its ingredients.

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