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Pests and predators of European honeybee *Apis mellifera* as documented from the State of Punjab, India

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Abstract

Honeybees are highly social and cosmopolitan insects of great economic importance to mankind. They not only render economic benefits in the form of a number of hive products like honey, beeswax, royal jelly, bee venom and propolis, but also provide ecosystem services by cross pollination of several cultivated and wild plant species. In recent years, serious losses of bees from beehives and a decline in bee population have been reported. Honeybees are attacked by a number of pests and predators. Punjab is among those states of India where agriculture is the main occupation of the people. The present work was therefore undertaken to study the pests and predators of European honeybee *Apis mellifera* in the State of Punjab. In all, 29 species of pests and predators belonging to different groups were observed/collected from the bee hives. These included 15 insect species, 6 arachnids, 2 molluscans, one anuran, retile and rodent each and two species of birds. Among insects, all the 7 hymenopteran species were predators, while the other insects were pests; among arachnids, except for *Chelifer*, which was both-pest as well as predator, all others were pests; both the molluscan species were found to be pests. All the vertebrate species were found to be predators.

Key words: European honeybee, *Apis mellifera*, pests, predators, Punjab

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Introduction

Honeybees are highly social and cosmopolitan insects of great economic importance to mankind. They not only render economic benefits in the form of a number of hive products like honey, beeswax, royal jelly, bee venom and propolis, but also provide ecosystem services by cross pollination of several cultivated and wild plant species. The pollination activity of honeybees is an important integration function, as they contribute to the sustainability and diversity of agricultural and botanical resources and thereby contribute to increased productivity, environmental health and maintenance of biological diversity (Verma, 1990; Crane, 1990).

Indian sub-continent is very rich from the bee resources point of view. There are at present four or more species of genus *Apis* in this part of world (Otis, 1990; Smith, 1991; Christopher & Raw, 1999). The health of honey bees has a great economic impact worldwide. In recent years, serious losses of bees from beehives and a decline in bee population have been reported. The causes of these losses are not known, although various hypotheses have been put forward, including attack of pathogenic microorganisms and predators. A large diversity of microorganisms is generally associated with honeybee colonies (Gilliam, 1997; Olofsson & Vasquez, 2008).

Honeybee brood and adults are attacked by a wide range of disease causing organisms such as bacteria, viruses, protozoa, fungi and mites. Besides microorganisms, honeybee colonies are also infested by many pests that range from those species that may cause disease such as the mites to almost innocuous insects like flies which may only hinder the movement of queen. Insects, spiders, pseudoscorpions and mites may be both pests and predators (Morse 1980a; Atwal, 2000). Some of these only feed on honey or the pollen in the hive, while others use adult bees as a means of transportation from one flower to other. Many species of mites sometimes enter the bee colonies in this manner, but they are often unable to survive in the bee hives and cause no damage. On the other hand, larvae of wax-moths have been known to destroy thousands of supers and combs (Singh, 1962; Mishra, 1995).

Besides pests, there are also many predators that attack honeybee colonies. Presently beekeeping industry is facing many challenges throughout the world and one of the major

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constrains in beekeeping developmental programs in India is the damage caused to honeybee colonies by various pests, predators and pathogens. Over 100 species of such pests and predators are known to infest or predate upon honeybees in India (Verma, 1990). Although their collective negative impact on Indian beekeeping has not yet been fully evaluated, but they have created more problems in this part of world than elsewhere. This may be due to the diversity in ecological conditions as well as in number of species of honeybees in this sub-continent (Nagaraja & Rajgopal, 2003).

Punjab is among those states of India where agriculture is the main occupation of the people. Honeybees are important source for pollination, acting as pollinators. Various honeybee species recorded from India include *Apis cerana*, *A. dorsata*, *A. florae* and *A. mellifera*, the last one although a European species is very prevalent in Punjab, the reason of its dominance could be attributed to its behaviour and rearing. The present work was therefore undertaken to study the pests and predators of European honeybee *Apis mellifera* in the State of Punjab.

Materials and method

The study area

The study was carried out in different areas of Punjab. The state of Punjab extends between 29º32’ to 32º32’ North latitude and 73º55’ to 76º50’ East longitudes, occupying an area of 50,362 square Kilometres in northwestern part of India. It is bounded in North by Jammu & Kashmir, in East by Himachal Pradesh, in South by Haryana and Rajasthan and in the West by Pakistan. Punjab has an inland subtropical location, being semi-arid to sub humid. Annual rainfall is highest in Shivalik range which receives more than 1,150 mm and lowest in the southwest, which receives less than 30 mm; state wide average annual precipitation is roughly 400 mm. Most of the annual rainfall occurs from July to September, the months of southwest monsoon. Winter rain from the western cyclones, occupying from December to March, accounts for less than one-fourth of the total rainfall.

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Collection, preservation and identification

The observations were made during an annual period from July, 2022 to June, 2023. This was done by:

A. Directly observing vertebrate pests and predators:

- Amphibians
- Reptiles
- Birds
- Mammals

B. Collecting invertebrate pests and predators:

I. Insects

Different insect pests and predators attacking the honeybee colonies (Apis spp.) were sampled by following methods:

i. **Hand picking method:** Small insect pests especially soft bodied hymenopterans were collected by hand picking method. They were collected either with the help of a fine camel brush or by a pair of forceps. Generally soft camel hair brushes of number 0 to 1 were used for the collection of these tiny insects.

ii. **Sweep net method**: Pests and predators belonging to orders Lepidoptera and Hymenoptera were collected by Sweeping method. The sweep net consisted of 50 cm deep bag made up of cloth and suspended on 60 cm handle of stainless steel. Soft handle is especially helpful in making quick sweeps.

iii. **Aerial net method**: Aerial netting method was used to collect insect pests mainly belonging to orders Hymenoptera, Lepidoptera and Diptera. A net essentially consisted of cloth or nylon net bag, a metal ring which holds the mouth of open bag and to which the wooden handle was attached. A ring of diameter 38 cm made up of thick wire or metal was used, whereas, the depth of bag was about 75 cm. For the collection of Lepidopterans, which were generally soft bodied, they were removed gently from the bottom of the bag after they became enclosed in the bag by a rapid twist of the handle. The fold of enclosing net was inserted after they were killed by vapours of killing agent in a bottle.

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II. Arachnids

The hive debris present on the bottom board of bee hives of the two honeybee species understudy was collected by placing paper trays on bottom board for arachnid collection.

Analysis of hive debris

The debris present on the bottom board of the bee hives of two honeybee species was collected regularly and floated in 80 per cent alcohol. The mites and pieces of chitin floated, white wax and other heavy material was drained off in separate Petri dishes and the mite specimen were picked up with the help of fine camel hair brush (Ritter & Ruttner, 1980; Kumar, 1995).

In case of those colonies of *Apis mellifera*, which were relatively clean and had no significant amount of debris, sampling was done by placing white sheet paper trays on the bottom boards. These hives were smoked heavily with tobacco vapours in the evening hours after closing the hive entrances for about 5 minutes. Twenty puffs of smoke were applied at an interval of 15 seconds to each hive (Crozier, 1989). The brood chamber was processed following the above discussed method of Ritter and Ruttner (1980) and Kumar (1995).

Analysis of brood

Analysis of brood mites was done by examining 50-100 capped drone and worker (*A. mellifera*) brood cells in each colony. Only brood cells with perforations on caps or having sunken caps were selected (Aggarwal, 1988; Wongsiri *et al.*, 1989).

Examination of adult bees

Examination of adult bees was done by brushing 250-350 adult worker bees from brood cells into plastic sample tubes containing 80 per cent alcohol. These samples were taken to laboratory, where they were shaken for 30 minutes in a shaker (Environ Shaker 3597-1 LBGMC, Lab line Inst. Illinois, USA) and then filtered. The filtered material was then examined under a research microscope for the presence or absence of mite pests (Woyke, 1987; Aggarwal, 1990). Deformed winged bees, bees with distorted abdomen, missing legs and bees crawling rather than flying indicates the presence of mites in the bee colony (Sharma et al., 2011c).

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Examination of bee trachea

Examination of tracheal mites was done on those bees, which were crawling, hopping, dragging their extended abdomen and uncoupling their fore and hind wings. 80 to 100 such bees of *A. mellifera* were collected from each colony in 80 per cent alcohol. The head, abdomen, legs and wings of these bees were removed in order to get the separate thoraces. These thoraces were then treated with 10 per cent KOH solution for about 20-24 hours. Afterward thoraces were washed in running tap water and prothoracic collar was removed along with trachea. These prothoracic tracheas were observed for mites under a research binocular (Usinger, 1954; Komeilli and Ambrose, 1990; Kumar, 1995).

III. Molluscans

These were hand-picked by wearing gloves.

The specimens belonging to different groups were collected killed, preserved and identified using pertinent literature.

Result and discussion

In all, 29 species of pests and predators belonging to different groups were observed/collected from the bee hives. These included 15 insect species, 6 arachnids, 2 molluscans, one anuran, retile and rodent each and two species of birds. Among insects, all the 7 hymenopteran species were predators, while the other insects were pests; among arachnids, except for *Chelifer*, which was both-pest as well as predator, all others were pests; both the molluscan species were found to be pests. All the vertebrate species were found to be predators (Table 1.).

Earlier some investigators like Venkataru (1945), Dass (1946), Bhutani (1948) and Sharma (1949) have also revealed wax-moths as an enemy of bees, whereas, wasps (like *V. cincta, V. Orientalis, V. auraria, V. ducalis, V. magnifica, V. velutina, V. basalis, Palarus orientalis,* and *Philanthus ramakrishnae*) as serious predators of bees and black ants as important enemies of honeybees in India. Authors also reported garden lizards, skunks and geckos as the thieves of apiary in different parts of the country. Raminej (1949) discovered *A. woodi* in Mallorea Island (Spain). Latif & Yunus (1950) reported *Merops orientalis* as a common predator of honeybees in Pakistan. Sharma (1949) also described bears as enemies of honeybees in India.

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Wasps and hornets are major predators of honeybees in nearly all the countries of the Asian continent. Earlier studies on pests and predators of honeybees in Japan were made by Okada (1956) who reported four species of *Vespa* namely *V. mandarina*, *V. xanthoptera, V. crabroformis* and *V. lewisii* as the important predators. Of these, *V. mandarina* was the most serious predator in most parts of Japan.*Vespa* species are the largest of the social wasps and as such are physically capable of preying on honeybees with ease. But only a few species of wasps like *V. orientalis, V. mandarina, V. auraria, V. tropica, V. crabro* etc. are considered important predators of honeybees in different regions of the world (Wafa, 1956).

A number of moth species such as Greater wax-moth (*Galleria mellonella* L.), lesser wax-moth (*Achroia grisella* F.), dried fruit moth (*Vitula edmandsae serratilineella* R.), Mediterranean flour moth (*Anagasta kuchniella* Z.) and *Vitula edmansae* P. attacked the colonies of honeybees in search of hive products like honey, pollen and beeswax. Death's head moth (*Acherontia* spp.) occasionally fed upon honey and pollen stores of bee colonies (Smith, 1960). Singh & Adlakha (1960) found 10 per cent of *A. cerana* colonies infested by acarine disease in Shimla hills. Many species of spiders and perhaps some pseudoscorpions also act as the bee pests. Several familiar spiders build webs, capture and consume honeybees, whereas, other may be occasional pests of honeybees outside the hives (Smith, 1960). Pseudoscorpions, which resemble scorpions due to presence of pedipalps, are also sometimes harmful to bee colonies (May, 1961). Subhapradha (1961) described black ants as universal enemies as well as wax-moths as pests of bees and from India; *Varroa jacobsoni* was firstly reported by the author in *A.cerana* colonies from Nellore, Andhra Pradesh. She also observed fly catcher bird and the drongo as enemies of bees and observed monkeys as the predators of honeybees in Southern India and gave an account of silverfish (*Lepisma*), cockroach, ticks and lice mites and categorize them as other pests and predators of honeybees.

Delfinado & Baker (1961) made first report regarding the infestation of *T. clareae* on *A. mellifera* in Philippines when they found this mite among dead honeybees. Begna (2007) carried out an assessment over the ant (*Dorylus fulvus*) and regarded this ant as most troublesome for beekeepers and beekeeping industry which causes great damage to honeybee colonies in terms of either bee colony have been killed or they abscond due to regular intolerable attack of *Dorylus*. In addition to ants, spiders, birds, wax-moths, honey badger (Hama), mice, toads, snake, prey

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mantis, lizards, bee lice, beetles, death head hawk and monkey were reported as bee pests by author in Ethiopia. *V. mandarina and V. xanthoptera* as the serious natural enemies whereas, frogs, toads and lizards are reported as enemies of honeybees by Okada & Kurihara (1958) in Japan. Other pests and predators associated with honeybee colonies observed by them included *Promochus yesonicus, Paratenodera senensis.*

Sharma (2011) conducted a study on pests and predators of *Apis cerana* F. and *Apis mellifera* L. and revealed two species of ants (*Formica fusca* L. and *Camponotus compressus* F.) were found invading in honeybee colonies and reported 5 species of wasps *viz*., *Vespa auraria* Smith, *Vespa mandarina* Smith, *Vespa tropica* Vecht, *Vespa orientalis* Linnaeus, *Vespa basalis* Smith, predating upon *Apis* species in Kangra region and adjoining areas of Himachal Pradesh. She also reported the attack of mite *V. jacobsoni* infesting the bee colonies in Kangra and other adjoining areas of Himachal Pradesh. The attack of *Vespa* spp. was more frequent on exotic *A. mellifera* than native *A. cerana* colonies in all the agro-climatic zones of Himachal Pradesh. Predacious nature of wasps that catch bees from blossoms or at the entrances of the hive was reported by Sharma *et al.* (2011 a). Sharma *et al.* (2011) reported infestation of *Achroia grisella* F. in honey combs of *Apis mellifera* from Shiwalik hills of Himachal Pradesh. Seasonal variations of ectoparasitic mites on honeybee colonies in Shiwalik hills were reported by Sharma *et al.* (2011 c). Sharma *et al.* (2011 d) studied the diversity, distribution and seasonal variations of *Vespa* species in honeybee colonies of Himachal Pradesh. Sharma (2011) reported *Dicrurus* sp. and *Merops orientalis* attacking colonies of *A. cerana* and *A. mellifera* in Kangra and adjoining area of Himachal Pradesh.

Besides *Vespa* species, yellow wasps belonging to the genus *Polistes* also caused harm to bee colonies in various continents of the World (Morse & Gary, 1961 and Singh, 1962). Singh (1962) described wax-moths (*Galleria mellonella* and *Achroia grisella*) as the most dreadful and universal enemies of honeybee in South India and Uttar Pradesh respectively. He also described wax-moths to be the major pests of honeybee colonies in different parts of the Asian continent. He reported that wax-moth cause damage by tunneling through combs and gradually weakens the honeybee colonies. He also made an attempt to enlist wasps and hornets and found *V. orientalis, V. cincta, V. auraria, V. ducalis, V. magnifica* and *V. basalis* as important species in different parts of India. He also reported *Polistes hebraeus* attacking Indian honeybee hives. Bee

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hunter wasps (*Philanthus ramakrishnae*) were reported as a predator of hill bees, whereas, in plains, *Palarus orientalis* became troublesome in certain localities. He also reported black ants as important enemy of honeybees. According to the author, ants were found to be quite important in the lower latitudes and altitudes in terms of their total biomass and robbing effect on the honeybee colonies. He also reported spiders as the important enemies of honeybee. Geckos, skunks and lizards have also been observed causing damage to honeybee colonies in different parts of the world (Singh, 1962). According to the author, many insects are preyed upon by birds and honeybees are no exception. Birds which mainly attack honeybee colonies in the Asian continent include bee-eaters (*Merops apiaster* and *M. orientalis*); Swifts (*Cypselus* spp. and *Apus* spp.); drongos or king crows (*Dicrurus* spp.); shrikes (*Lanius* spp.); wood peckers (*Picus* spp.) and honey guides (*Indicator* spp.).

Large mammals such as skunks and bears are generally thought as predators, but where they do a little damage, they are classified as pests (Morse, 1980). Amongst the predators, wasps and hornets pose by far the most serious threat to beekeeping industry (Singh 1962, Spradbery, 1973, Morse, 1980; Gochnauer *et al.*, 1992). Wasps are either semi-social or social insects which build their nests in cavities of trees, walls, cracks in the ground or hang them down from the trees. They are predacious by nature and catch bees from blossoms or at the entrances of the hives (Spradbery, 1990). Wasps are not only fatal to bees, but also rob their eggs, brood and honey stores. A serious attack sometime results in absconding of bee colonies leaving behind a lot of honey and brood (Akre & Davis, 1978).

A large number of mites encountered in bee hives are incidental, some are facultative and some are obligatory in nature (Sumangala & Haq, 1999; Webster & Delaplane, 2000; Putatunda *et al.*, 2001). Honeybee mites are one of the major constraints for beekeeping development programme in India. Among 258 species of arthropods associated with hives, 160 species of *Acarina* have been recorded in honeybee nests (Burgett *et al.*, 1983). The most important mites include *Acarapis woodi* Rennie, *A. externus* Morgenthaler, *A. dorsalis* Morgenthaler, *Pyemotes ventricosus*, *Varroa jacobsoni* Oudemans and *Tropilaelaps clareae* Delfinado-Baker *et al.* (1992). Both parasitic and predatory mites attack different species of honeybees (Grobov, 1975; Burgett *et al.*, 1983). The parasitic mite, *V. jacobsoni* and the tracheal mite, *A. woodi* are wider spread and found more often as pests of honeybee colonies in European bee species, *Apis*

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mellifera in most parts of world. The *Varroa* mite is reported to cause almost 100 per cent mortality in the western world (De Jong *et al.*, 1982). However, the tracheal mite caused an estimated 30-90 per cent of colony losses (Calderon *et al.*, 1997). Other important honeybee mites are: *Neocypholaelaps* spp., *Euvarroa sinhai* and *Parasitellus* sp. (Akratanakul, 1987; Kapil & Aggarwal 1987; Delfinado-Baker *et al.*, 1992). Damage caused by mites may be slight to devastating depending upon the honeybee species and their colony build up (Abrol, 1997; Abrol & Sharma, 2009).

Dragonflies and certain spiders have been observed feeding directly on adult bees (Mishra, 1995, 1997). Although the number of species of parasitic mites are few but they pose a serious problem to bees and beekeeping industry. Honeybee mites can be broadly classified in three groups: parasitic, predatory and phoretic. The primary problem mites are *Tropilaelapsclareae* on Exotic, *Apis mellifera* and *Acarapis woodi* on native honeybee *Apis cerana*. Painkra (2018) carried out studies related to the diseases and enemies of Indian honeybee, *Apis indica* in Surguja of Chhattisgarh state and reported Greater wax-moth (major), wasps, ants, lizard, chameleon and bear were found as minor enemies of honeybees.

References

- Abrol, D.P. 1997. Honeybee diseases and their management. Kalyani Publishers, New Delhi, 450pp.
- Abrol, D.P. & Sharma, D. 2009. Honeybee mites and their management. Kalyani Publishers, Ludhiana, 200 pp.
- Akratanakul, P. 1987. Amitraz for *Varroa* control. In: Honeybee diseases and enemies in Asia. A practical guide, FAO, Rome, 33 pp.
- Akre, R.D. & Davis, H.G. 1978. Biology and pest status of venomous wasps. *Ann. Rev. Entomol*., 23: 215-238.
- Atwal, A.S. 2000. Essentials of beekeeping and pollination. Kalyani Publishers, New Delhi. 394pp.
- Atwal, A.S. & Goyal, N.P. 1973. Introduction of *Apis mellifera* L. in Punjab plains. *Indian Bee J.*, 35(1-4): 1-9.

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- Abrol, D.P. 2013. Integrated pest management: Current concepts and ecological perspective. Academic press.
- Abrol, D.P & Karroo, S.K.1998. Studies on seasonal activity and control of predatory wasps attacking honeybee colonies. *Indian bee J*., 60 (1):15-19.
- Akre, R, D & Davis, H.G 1978. Biology and pest status of venomous wasps. *Ann. Rev. Entomol*., 23:215-238.
- Begna, D. 2007. Assessment of the effect of an ant (*Dorylus fulvus*) on honeybee colony (*A. mellifera*) and their products in West & South-West Shewa Zones, Ethiopia. *Ethiopian Journal Animal Prod.* 7(1): 12-16.
- Bhutani, D.K. 1948. Thieves of the apiary. *Indian Bee J.,* 10: 35-36.
- Brar, A.S., Sharma, H.K. and Rana, K. 2018. Seasonal incidence of wasps in *Apis mellifera* L. colonies at Nauni, Solan (Himachal Pradesh). *Journal of Ento. and Zoology Studies*, 6(2): 3177-3178.
- Burgett, M., Akratanakul, P. and Morse, R.A. 1983. *Tropilaelaps clareae*: A parasite of honeybee in Southeast Asia. *Bee World*, 64: 25-28.
- Calderon, R., Arce, H. and Veen, J.van. 1997. Detection, distribution Y control de *Varroa jacobsoni* Oudemans en Costa Rica. *Ciencias Veterinari as Heredid*, 21: 29-38.
- Christopher, O.T. & Raw, A. 1999. Bees of the world. Blanford. 192 pp.
- Crane, E. 1990. Bees and Beekeeping- Science Practice and World Resources. Heinemann Newness, Oxford, U.K. 614 pp.
- Dass, B. 1946. The little bee as it appears to a layman. *Indian Bee J.*, 3&4: 62-66.
- Davis H.G, McGovern, T. P, Eddy, G.M, Nelson, T. E, Bertun, K.M.R, Beroza, M and Ingangi, J.C. 1968. New chemical attractants for Yellow jackets (*Vespula* sp.) *J. Econ. Entomol*., 61:469-472.
- De Jong, D., Morse, R.A. and Eickwort, G.C. 1982. Mite pests of honeybees. *Annu. Rev. Entomol.*, 27: 229-252.
- Delfinado-Baker, M., Rath, W. and Boecking, O. 1992. Phoretic bee mites and honeybee grooming behaviour. *Int. J. Acarol.*, 18: 315-322.
- Delfinado, M.D. & Baker, E.W. 1961. *Tropilaelaps*: A new genus of mite from Philippines (Laelapidae, Acarina). *Fieldiana. Zool.*, 44: 53-65.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 633-648

- Gilliam, M. 1997. Identification and roles of non- pathogenic microflora associated with honeybees. *FEMS Microbiology letters*, 155: 1-10.
- Gochnauer, T.A., Furgala, B. and Shimanuki, H. 1992. Diseases and enemies of honeybees. *In:* The Hive and the honeybee (eds: Dadant and sons). Hamilton, Illinois. 615-653.
- Grobov, O.F. 1975. Mite Fauna in *Apis* nest and its significance. *Apimondia Grenoble*, 25: 366-370.
- Gupta, V.K and Das, B.P. 1977. Distribution pattern of Indian vespidae (Hymenoptera) with special reference to altitude. *Entomon*, 2: 209-210.
- Kapil, R.P. & Aggarwal, K. 1987. Some observations on the concurrent parasitization of *Apis florae* by *Tropilaelaps clareae* and *Euvarroa sinhai*. *Expt. Appl. Acarol.*, 3: 267-269.
- Kurihara, T. 1959. The life history of Greater wax-moth (*Galleria mellonella* L.) and the lesser wax-moth (*Achroia grisella* Fab.). *Insect Ecol*., 7: 133-139.
- Latif, A. and Yunus, C.M. 1950. The common or green-bee eater as an enemy of honeybees. *Bee World*, 31: 91-92.
- May, A.F. 1961. Beekeeping in South Africa. Haum., Pretoria.
- Michener, C.D. 2000. The social behavior of bees Cambridge, Massachusetts, U.S.A.: Harvard Univ. Press. 418pp.
- Mishra, R.C. 1995. Honeybees and their management in India. *ICAR*, New Delhi, 167pp.
- Mishra, R.C. & Garg, I.D. 1997. Perspective in Indian Apiculture. *Agro Botanica*, Vikas Nagar, Bikaner, 412pp.
- Mishra, R.C, Kumar, J and Gupta, J.K.1989. A new approach to the control of predatory wasps (*Vespa* sp.) of the honey bee, *Apis mellifera*. *Indian J. apic. Res*., 28:126-131.
- Morse, R.A. 1980. Honeybee pests, predators and diseases. Cornell. Univ. Press, Ithaca. London.
- Morse, R.A. & Gary, H.E. 1961. Insect invader of honeybee colony. *Bee World*, 42: 179-181.
- Okada, I. 1956. Notes on the Japanese hornet as a serious pest of honeybees. *Jpn. Bee J.*, 9: 110-114.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 33 Issue 2, December – 2023, Pages: 633-648

- Okada, I. & Kurihara, T. 1958. Natural enemies of the honeybees. *Collect. and Breed.,* 20: 102-105.
- Olofsson, T.C. & Vasquez, A. 2008. Detection and identification of a novel lactic acid bacterial flora within the honey stomach of the honeybee *Apis mellifera. Curr. Microbiol.,* 57: 356-363.
- Otis, G.W. 1990. Diversity of *Apis* in Southeast Asia. In: Social insects and the environment (ed. Veeresh, G.K. *et al.*). Oxford and IBH Publishing Pvt. Ltd., New Delhi.
- Painkra, G.P. 2018. Survey on honeybee diseases and insect-pests in Surguja of Chhattisgarh. *Indian Journal of Applied Res*., 8(3): 180-181.
- Putatunda, B.N., Aggarwal, K. and Mathur, R.B. 2001. Honeybee mites (*Acarina*) a challenge to beekeeping industry-A review. *Agric. Rev.,* 22: 205-214.
- Raminej, G.C. 1949. Discovery of *Acarapis woodi* on the island of Mallorca. Boleitin de la R. Sociedad Espanola de la historia. *Nature,* 47: 611-618.
- Ranabhat, N.B. & Tamrakar, A.S. 2008. Study on Seasonal Activity of Predatory Wasps Attacking Honeybee Apis cerana Fab. Colonies in Southern Belt of Kaski District, Nepal. *Journal of Natural History Museum,* 23:125-128.
- Sharma, O.P; Thakur, A.K and Garg, R. 1985. Control of wasps attacking bee colonies. *Indian Bee J*., 17:27-29.
- Sharma, P.L. 1949. Bee enemies in Northern India. *Indian Bee J.,* 11: 45-51.
- Sharma, I. 2011. Studies on pests and predators of *Apis cerana* F. and *Apis mellifera* L. in Kangra and adjoining areas of Himachal Pradesh. M.Phil. Thesis, Himachal Pradesh University, Shimla, 124pp.
- Sharma, V., Mattu, V.K. and Thakur, M.S. 2011a. Studies on *Varroa,* a parasitic mite on honeybee colonies in Shivalik hills, Western Himalaya. *J. Entomol. Res.,* 35(1): 59-61.
- Sharma, V., Mattu, V.K. and Thakur, M.S. 2011b. Infestation of *Achroia grisella* F. in honey combs of *Apis mellifera* in Shivalik hills, Himachal Pradesh. *International Jr. of Science & Nature* 2(2): 407-408.
- Sharma, V., Mattu, V.K. and Thakur, M.S. 2011c. Studies on seasonal variations of ectoparasitic mites on honeybee colonies in Shivalik hills, Himachal Pradesh. *Int. J. Innov. Bio-Sci.,* 1: 21-23.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
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- Sharma, V., Mattu, V.K. and Thakur, M.S. 2011d. Diversity, distribution and seasonal variations of *Vespa* species in honeybee colonies of Himachal Pradesh. *Ann. Entomol*., 29(2): 1-3.
- Singh, S. 1962. Beekeeping in India. Indian Council Agric. Res., New Delhi. 209pp.
- Singh, S. & Adlakha, R.L. 1960. Survey of acarine disease of adult bees in Shimla hills. *Indian Bee J.*,22: 3-6.
- Smith, D.R. 1991. Mitochondrial DNA and honeybee biogeography. In: Diversity in the Genus *Apis*. (Ed DR Smith), Westview, Boulder, Colorado, U.S.A. 131-176.
- Smith, F.G. 1960. Beekeeping in the tropics. Longmans Green, London.
- Spradbery, J.P. 1973. Wasps on the account of biology and natural history of social and solitary wasp- Uni. Of Washington Press, Seattle, Washington.
- Spradbery, J.P. 1990. Wasps. Sidgwick and Jackson, London.
- Subhapradha, C.K. 1961. Enemies and pests of bees encountered in this area (Nellore). *Indian Bee J*., 23:16-19.
- Sumangala, K. & Haq, M.A. 1999. Acarine association of *Apis cerana* from Kerala. *Asian Bee J*., 1: 80-89.
- Thapa, R, Wongsiri, S and Manandhar, D.N. 2000. Current status of predatory and diseases of honey bee in Nepal. *Proceeding of the 7th international conference of tropical bees and 5th Asian Apiculture Association conference*:221-226.
- Venkatarau, P.N. 1945. Enemies of honeybees. *Indian Bee J.*, 7: 85-87.
- Verma, L.R. 1990. Beekeeping in integrated mountain development. Economic and Scientific perspective. Oxford and IBH Publ. Co., New Delhi. 367pp.
- Wafa, A.K. 1956. Ecological investigation on the activity of the oriental hornet, *Vespa orientalis*. *Bull. Fac. Agric. Cairo. Univ*., 103: 33.
- Walton, G.N and Reid, G.M. 1976. The 1975 New Zealand European wasp survey, New Zealand BKPR,138:26-30.
- Webster, T.C. & Delaplane, K.S. 2000. Mites of the honeybee. Dadant and Sons, Inc. Hamilton, Illinois, 280 pp.
- Wilson, E.O. 1980. Sociobiology. Harward Univ. Press Cambridge, 366 pp.

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Table 1. Pests and predators of European honeybee species documented from the State of Punjab				
INVERTEBRATES				
Phylum : Arthropoda **Class : Insecta**				
S.N.	**Order**	**Family**		**Species/Common name**
I	Thysanura	Lepismatidae	1	*Lepisma* sp.●
II	Odonata	Coenagrionidae	2	*Coenagrion puella* (Dragon Fly)*
III	Blattodea	Blattidae	3	*Blatta* sp.●
IV	Mantodea	Mantidae	4	*Mantis* sp.●
V	Lepidoptera	Pyralidae	5	*Galleria mellonella L.*●
VI	Diptera	Calliphoridae	6	*Lucilia* sp.●
			7	*Calliphora* sp.●
VII	Coleoptera	Tenebrionidae	8	*Platybolium alvearium* ●
VIII	Hymenoptera	Vespidae	9	*Vespa orientalis* L. *
			10	*Vespa auraria* S.*
			11	*Vespa flaviceps* S.*
			12	*Vespa mandarinia* S.*
			13	*Polistes* sp.*
		Formicidae	14	*Formica fusca* L.*
			15	*Camponotus compressus* F.*
Class : Arachnida				
IX	Pseudoscorpionida	Cheliferidae	16	*Chelifer* sp. □
X	Araneida	Varroidae	17	*Varroa jacobsoni* Oudemans ●
		Laelapidae	18	*Tropilaelaps clareae* Delfinado & Baker ●

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		Macrochelidae	19	*Macrocheles* sp. (i)●
		Ameroseiidae	20	*Neocypholaelaps apicola* Delfinado & Baker ●
			21	*Neocypholaelaps indica* Evans ●
XI	Astigmata	Acaridae	22	*Tyrophagus longior* Gervais ●
Phylum : Mollusca Class : Gastropoda				
XII	Stylommatophora	Ariophantidae	23	*Limax sp.*1.●
			24	*Limax sp.2.*●
VERTEBRATES				
Phylum : Chordata (Vertebrates) Class : Amphibia				
XIII	Anura	Bufonidae	25	*Bufo sp.**
Class : Reptilia				
XIV	Squamata	Gekknoidae	26	*Hemidactylus**
Class : Aves				
XVI	Passeriformes	Dicruridae	27	*Dicrurus macrocercus* (Black drongo)*
		Meropidae	28	*Merops orientalis* (Green Bee-eater)*
Class : Mammalia				
XVII	Rodentia	Muridae	29	*Rattus rattus**
* = Predators; ● = Pests; □ □= Both (Pests and Predators)				