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DIVERSITY AND DISTRIBUTION OF PESTS AND PREDATORS OF HONEYBEES IN HIMACHAL PRADESH, INDIA

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ABSTRACT

An intensive survey was conducted in 30 apiaries, located in different agro climatic zones of Himachal Pradesh reveals, among invertebrates, insects and arachnids were the most prominent pest of honeybees. Hymenoptera (17), Diptera (3), Lepidoptera (2) and Coleoptera (2) and Orthoptera (1), Dictyoptera (1), Odonata (1) and Thysanura (1) were prominent. The Arachnids, consisted of Acarina (13) and Araneae (3) and Pseudoscorpionida (1). Besides insects and arachnids, 3 species of molluscs were also observed invading the bee colonies. Not only invertebrates, but, honey bee colonies were also invaded by vertebrates which included 2 species of reptiles, apes and mammals, and 1 of amphibians.

Key words: Apiary, Distribution, Diversity, Honey bees, Predators.

INTRODUCTION

The honey bee was probably the first invertebrate to have its melodies recorded. All living organisms are subjected to infestation by their natural enemies and honeybees belonging to genus *Apis* are no exception. Honeybees like other living organisms, are infested/predated upon by a number of pests and predators that may range from minute bacteria and fungi to large mammals like bear. On one hand, there are pests like mites that can cause serious diseases and may bring about quick demise of a colony, whereas on the other hand, there are innocuous insect-pests like Braula (a fly), which may only hinder the movement of a queen. Thus honey bees are attacked by a variety of pests and predators with results varying from small damages to disastrous ones (Morse, 1980, Gulati and Kaushik, 2004). Honey bee pests and predators include both invertebrate and vertebrate organisms. Among invertebrates, important are wasps and hornets wax moths, black ants, mites, spiders and pseudo scorpions, whereas, amphibians, lizards, birds and mammals are prominent vertebrates attacking bee colonies.

Although beekeepers all over the world face the problem of different enemies including wasps, yet Southeast Asia is important because it is rich in honey bee diversity and has a wide range of ecological conditions (Otis, 1990). All the six species of genus *Apis* mainly *A. cerana* F., *A. mellifera* L., *A. dorsata* F., *A. florea* F., *A. andreniformis* and *A. koschevnikoris* are found here. Among these, most studied and economically exploited honey bee, *A. mellifera* is an exotic species introduced in many parts of Asia (Atwal, 1987). The other five species, with only partly discovered patterns of distribution are native to Southeast Asia. In India, all of these bee species are present except *Apis koschevnikoris* (Verma 1990, Mishra 1995). Because of wide diversity and long evolutionary history of honey bees in India, most if not all of the diseases, pests and predators of genus *Apis* have appeared. The problem has further attenuated with the introduction of *A. mellifera* in different parts of India. Thus there is a need to study the diversity and distribution of these pests and predators in different ecological zones of the Himachal Pradesh.

MATERIALS AND METHODS

A survey of different pests and predators attacking the colonies of Indian hive bee, *Apis cerana* F and European hive bee, *A. mellifera* L. was made in 30 apiaries at different locations in districts of

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Himachal Pradesh having different altitudes, latitudes and climatic conditions. The selected locations of experimental apiaries were Badhani (1125 m), Luna (1130 m), Sarol (1438 m), Judera (1480 m), Holi (1800 m) and Bharmour (2286 m) in Chamba district; Ghallanu (500 m), Ranital (550 m), Pragpur (600 m), Ichhi (700 m), Sherathana (850 m) and Nagrota Bagwan (900 m) in Kangra district; Bajaura (1400 m), Patlikul (1450 m), Katrain (1470 m), Sarsai (1660 m) and Nagger (1688 m), in Kullu district; Bhangrotu (817 m) and Sundernagar (880 m) in Mandi district; Hatkoti (1345 m), Duttnagar (1444 m), Rohru (1524 m), Kotkhai (1676 m), Navbahar (2040 m) and Summer hill (2070 m) in Shimla district, Paonta Sahib (400 m) and Dhaulakaun (540 m) in Sirmour district; Hamirpur (790 m); Bilaspur (587 m) and Solan (1530 m).

Different pests and predators attacking the colonies of *Apis cerana and A. mellifera* were sampled both from ferial and domesticated colonies in experimental apiaries during the experimental period. In addition , these were also sampled at regular weekly intervals in two local apiaries at Summer hill (31°.06') North latitude and 77°11' east longitude at 2070 m altitude) and Navbahar (31°.06') North latitude at 77°11' east longitude at 2040 m altitude) at Shimla. The apiary at summer hill had four colonies of *Apis cerana* and six colonies of *Apis mellifera*, whereas that at Navbahar had six colonies of *Apis cerana* and twenty one colonies of *Apis mellifera*.

All the wasps and hornet species available in the apiary were collected, killed, stretched and pinned for identification. Identification of *Vespa* spp. was done with the help of the earlier records of Sociobiology and Behavioral Ecology Research Laboratory of Department of Biosciences at Himachal Pradesh University, Shimla and later on confirmed by taxonomists of Indian Agricultural Research Institute, New Delhi. Beside wasps, other pests and predators of honey bees were identified at Commonwealth Institute of Entomology, London; Zoological Survey of India, Calcutta; Forest Research Institute, Dehradun and Entomology division of University of Agricultural Sciences, Bangalore.

RESULTS AND DISCUSSION

A survey of different pests and predators attacking the colonies of European bee, *Apis mellifera* and Indian hive bee, *A. cerana* was conducted in 30 apiaries of Himachal Pradesh, located in different agro climatic zones (Fig. 1). Among invertebrates, insects and arachnids were the most prominent pests and predators of honeybees. Of insects, 17 belonged to order Hymenoptera, 3 to Diptera, 2 each to Lepidoptera and Coleoptera and 1 each to Orthoptera, Dictyoptera, Odonata and Thysanura. Of Arachnids, 13 belonged to Acarina and 3 to Araneae and 1 to Pseudoscorpionida. Besides insects and arachnids, 3 species of molluscs were also seen invading the bee colonies. Not only invertebrates, but vertebrates also invaded honeybee colonies which included 2 species of reptiles, apes and mammals and 1 of amphibians (Table 1). These pests and predators can be categorized as follows:

A) Insects

Among insects, wasps and wax moths belonging to orders hymenoptera and Lepidoptera were the serious pests and predators of *A. mellifera* and *A. cerana* in Himachal Pradesh. Ants also caused some problems in certain apiaries of the state.

a) Hymenopterans

I) Wasps and hornets

Among insects, wasps were the most serious and abundant predators attacking the colonies of both *A. mellifera* and *A. cerana* in different apiaries of Himachal Pradesh. Detailed survey of different zones revealed following 10 species (Table 1 and 2) of wasps prevalent in this region of western Himalaya.

II) Ants

Beside wasps, certain species of ants also posed problems in some apiaries of Himachal Pradesh mainly in those located at lower elevations. At higher altitudes no serious predatory activity was observed (Table 1and 2).

b) Lepidopterans

1) Wax moths

Wax moths were one of the most serious pests of honey bees in Himachal Pradesh, particularly at low elevations. Mainly two species of wax moths, i.e. greater wax moth (*Galleria mellonella*) and lesser wax moth (*Achroia grisella*) were seen infesting the colonies of both *A. mellifera* and *A. cerana* in different agro climatic zones of Himachal Pradesh (Table 1 and 3).

FIG 1: Map of Himachal Pradesh showing various experimental apiaries

TABLE 1: Pests and predators attacking *A. cerna* and *A. mellifera* colonies in Himachal Pradesh, with their taxonomic status

	ARTHROPODA INSECTA Order HYMENOPTERA Family Vespidae				INVERTIBRATES ARACHNIDA Order ARANEAE Family Sparassidae		MOLLUSCA GASTROPODA Order STYLOMMATOPHORA Family Ariophantidae		VERTEBRATES CHORDATA AMPHIBIA
1	Vespa auraria S.*	23	Platybolium alvearium*	29	Sparssus sp.*	45	Eaustenia sp.*		REPTILIA
2	Vespa mandarina S.*		Family Scarabidae		Family Lycosidae	46	Limax sp.		Order SQUAMATA
3	Vespa tropica Vecht		Subfamily Cetoninae	30	Paradosa sp.*	47	Snail		Suborder Lacertilia
4	Vespa orientalis L.	24	Protaetia sp.		Order PSEUDOSCORPIONIDA			49	Lizard (unidentified)*
5	Vespa basalis S*		Order ORTHOPTERA		Family Cheliferidae			50	Snake (unidentified)*
6	Vespa flaviceps S*		Family Mantidae	31	Chelifer sp*				AVES
7	Polistes sachach F*	25	Mantis sp.*		Order MESOSTIGMATA**			51	Dicrurus sp.
8	Polistes maculipenis S*		Order Dictyoptera		Family Varroidae			52	Merops orientalis
9	Polistes hebraus F.*		Family Blattidae	32	Varroa jacobsoni				MAMMALIA
10	Polistes stigma F.*	26	Blatta sp.*		Family Laelapidae				Order
	Family Formicidae			33	Tropilaelaps clareae			53	RHODENTIA
	Subfamily Myrmicinae				Family Macrochelidae			54	Mice
11	Myrmica rugosa Mayr.*		Order ODONATA	34	Macrocheles muscaedomesticae				Bear
12	Aphaenogaster rothneyi Forel*	27	Dragonfly (unidentified)		Family Parasitedae				
13	Aphaenogaster sachurii Forel*		Order THYSANURA	35	Parasitellus sp.				
14	Acantholepis cepencis Mayr.*		Family Lepismatidae	36	Neocypholaelaps indica				
15	Acantholepis frauenfeldi Mayr.*	28	Lepisma sp.*		Family Ascidae				
16	Formica fusca Linn*			37	Ascidae mite				
17	Camponotus compressus Fabr.*				Order ASTIGMATA				
18	Galleria mellonella*			38	Acarapis dorsalis				
19	Achroria grisella*			39	Acarapis woodi				
	Order DIPTERA			40	Tyrophagus longior				
	Family Calliphridae			41	Caloglyphus berlesei				
20	Lucilia sp*			42	Rhizoglyphus robini				
21	Calliphora sp*			43	Un identified (i)				
22	Promochus sp.*			44	Unidentified (ii+ D14)				
	Order COLEOPTERA								
	Family Tenbrionidae								

* : Pests and Predators of Honey bees in Shimla

** : Based on Kumar (1995)

TABLE 2: Distribution of different hymenopteran and predators of *A. mellifera* and *A. cerana* bees in Himachal Pradesh

	Vespa auraria	Vespa mandarina	Vespa tropica	Vespa orientalis	Vespa basalis	Vespa flavicaps	Polistes sachachi	Pdistes maculipenis	Polistes hebraeus	Polistes stigma	Myrmica rugosa	Aphaenogaster rothneyi	Aphaenogaster sadhurii	Acantholepis capensis	Acantholepis frauenfeldi	Formica fusca	Camponotus compressus
Chamba																	
Bakani	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Luan	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarol	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Judera	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Holi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bharmaur	+	-	-	-	-	-	-	-	-	+	+	+	-	-	+	-	-
Kangra																	
Ghallaur	+	-	+	+	+	+	-	-	+	-	-	-	+	-	-	-	-
Ranital	+	+	+	+	-	-	+	-	-	-	+	-	+	-	-	-	-
Paragpur	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-
Ichhi	+	+	+	-	+	+	-	+	+	-	-	-	-	-	-	-	-
Sherathana	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nagrota Baqwan	+	+	-	-	-	-	-	-	-	-	+	+	+	-	+	-	-
Kullu																	
Bajaura	+	+	-	-	+	+	-	-	-	-	-	-	+	-	-	-	-
Patlikuhl	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Katrain	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Sarsai	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nagrota	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mandi																	
Bhangrotu	+	+	+	-	+	-	+	+	+	-	+	-	-	-	+	-	-
Sundernagar	+	+	+	-	+	-	+	-	-	-	-	-	+	-	-	-	-
Hamirpur																	
Hamirpur	+	-	+	-	-	-	+	+	+	-	-	-	+	-	-	-	-
Bilaspur																	
Bilaspur	+	-	+	-	-	-	+	+	+	-	-	-	+	-	-	-	-
Shimla																	
Hatkoti	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duttnagar	+	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+
Rohru	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-
Kotkhai	-	-	-	-	-	-	-	-	-	-	+	+	-	+	+	+	+
Navbahar	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Summer hill	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Solan																	
Solan	+	+	+	+	-	-	-	+	+	-	+	+	+	+	+	-	-
Sirmaur																	
Paonta Sahib	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Dhaulakuan	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-

+ : Pest/Predator present

-: Pest/Predator absent

Table 3: Distribution of different insect-pest and predators (except hymenopterans) of *A. mellifera* and *A. cerana*

	Galleria mellonella	Achroia grisella	Lucilla sp	Calliphora spp	Promochus sp.	Platybolium alvearium	Protaetia sp.	Mantis sp.	Blatta sp.	Dragon fly	Lepisma sp.
Chamba											
Bakani	-	+	-	-	-	-	-	-	-	-	-
Luan	-	+	-	-	-	-	-	-	-	-	-
Sarol	-	+	+	-	-	-	-	-	-	-	-
Judera	-	+	-	-	-	-	-	-	-	-	-
Holi	+	-	-	-	-	-	-	-	-	-	-
Bharmaur	-	-	-	-	+	-	-	-	-	-	-
Kangra											
Ghallaur	-	+	-	-	-	+	-	+	+	+	+
Ranital	+	+	-	+	-	+	-	+	+	+	+
Paragpur	-	-	-	-	-	+	-	+	+	+	+
Ichhi	+	+	-	+	-	+	-	+	+	+	+
Sherathana	+	-	-	-	-	+	-	+	+	+	+
Nagrota Bagwan	+	-	-	-	-	+	-	+	+	+	+
Kullu											
Bajaura	-	+	+	-	+	-	+	+	-	-	-
Patlikuhl	-	+	-	+	+	-	+	+	-	-	+
Katrain	-	+	+	+	+	-	+	+	-	-	+
Sarsai	-	-	+	-	+	-	+	-	-	-	+
Naggar	-	-	+	+	-	-	+	-	-	-	+
Mandi											
Bhangrotu	-	-	-	-	-	+	-	-	+	+	-
Sundernagar	-	-	-	+	-	+	-	-	+	+	-
Hamirpur											
Hamirpur	+	+	+	+	-	+	-	+	+	+	+
Bilaspur											
Bilaspur	+	+	+	+	-	+	-	+	+	+	+
Shimla											
Hatkoti	-	-	+	-	-	-	-	-	-	-	-
Duttnagar	-	-	-	-	-	-	-	-	-	-	-
Rohru	-	-	-	-	-	-	-	-	-	-	-
Kotkhai	-	-	-	-	-	-	-	-	-	-	-
Navbahar	+	+	+	+	+	+	-	+	+	+	+
Summerhill	+	+	+	-	+	+	-	+	+	+	+
Solan											
Solan	+	-	+	-	+	-	+	+	+	+	-
Sirmaur											
Paonta Sahib	-	-	-	-	-	+	-	-	+	+	-
Dhaulakuan	+	-	-	-	-	+	-	-	+	+	-

+ : Pest/Predator present
-: Pest/Predator absent

c) Other insects

Besides hymenopterans and lepidopteran pest and predators, insects belonging to order diptera, coleopteran, orthoptera, odonata and thysanura also acted as the minor pests and predators of *A. cerana* and *A. mellifera* colonies in Himachal Pradesh (Table 1 and 3).

B) Arachnids

Arachnids also caused serious problems to *A. mellifera* and *A. cerana* colonies in certain areas of Himachal Pradesh. Parasitic mites were more destructive than spiders and pseudoscorpions (Table 1, 4 and 5)

C) Molluscs

During the present survey, a mollusk, *Eaustenia* sp. belonging to order gastropoda was found inside a wet and damp hive of *A. mellifera* at Shimla. A slug (*Limax* sp.) was also seen eating cells of combs of *A. cerana* in Bilaspur area. An unidentified species of snail was also seen inside a hive of *A. mellifera* at Shimla (Table 1 and 5).

D) Vertebrates

Among vertebrates, 2 species of reptiles, birds and mammals and one species of amphibians were observed as predators of honey bees in different parts of Himachal Pradesh (Table 1 and 5).

These studies are in conformity with the observations of some earlier investigators, as Singh (1962) reported *V. orientalis, V. cincta, V. auraria, V. ducalis, V. magnifica* and *V. basalis* wasps predating upon *A. mellifera* and *A. cerana* colonies in India. Later, Singh (1972) observed the attack of *V. velutina* on *A. indica* colonies in Kashmir valley. Kshirsagar and Mahindre (1975) enlisted eight different species of wasps i.e. *Lianthrena kohlii, V. auraria, V. basalis, V. cincta, V. ducalis, V. magnifica, V. orientalis* and *V. velutina* predating upon *A. cerana* colonies in India. Similarly Sharma and Raj (1988) observed *V. orientalis, V. tropica* and *V. velutina auraria* attacking *A. mellifera* colonies in Kangra Shivaliks of Himachal Pradesh. Abrol and Kakroo (1994) reported six species of wasps viz., *V. velutina, V. orientalis, V. cincta, V. magnifica, V. mandarina* and an unidentified species, preying upon *A. cerana* and *A. mellifera* colonies in Jammu and Kashmir. Among these, *V. orientalis* was the most abundant and serious predator. Predatory activity of wasps have also been reported from other parts of Asian continent. For example, Okada (1956) observed 4 species of wasps viz., *V. mandarina, V. xanthoptera, V. craboformis* and *V. lewisi* predating upon bees in an apiary at Tamagawa, Japan. Abe (1985) also observed the devastating attacks of predatory wasps and hornets like *V. mandarina, V. crabro, V. xanthoptera, V. analis,* etc. on honey bee colonies in Japan. *V. orientalis, V. mandarina, V. auraria, V. cincta, V. tropica* and *V. crabro* have also posed serious problems in other parts of the Asian continent (Akratanakul, 1987).

Bio-ecological studies on predatory wasps in Himachal Pradesh revealed that *V. orientalis* and *V. tropica* were the most prominent species at elevations < 950 meters, whereas, in mid hills, *V. auraria, V. orientalis* and *V. tropica* posed serious problems to *A. mellifera* and *A. cerana* colonies. At higher elevations (> 1550 meters), *V. auraria* and *V. mandarina* were the most prominent species with *V. mandarina* being more destructive. Further, attack of predatory wasps was more severe on *A. mellifera* than *A. cerana* colonies in all the agro climatic zones of Himachal Pradesh. These results are in conformity with the earlier observations of Sharma and Raj (1988) who also found *V. auraria* as the prominent species at higher elevations and *V. orientalis* at the lower altitudes of Kangra Shivalik. In the present investigations, 7 species of black ants i.e. *Myrmica rugosa* M., *Aphaenogaster rothneyi* F., *A. sachurii* F., *Acantholepis cepensis* M., *A. frauenfeldi* M., *Formica fusca* L., and *Camponotus compressus* were observed attacking *A. mellifera* and *A. cerana* colonies at Shimla (Table 1). Mishra (1995) reported *C. compressus, Monomorium indicum* and *M. destructor* intruding the bee hives and taking away honey and pollen stores. Rana *et al.* (2000) reported predatory wasp activity from August to November in Himachal Pradesh (208-252 wasps/day) whereas it was July to September in Jammu (13.5 wasps/day) Abrol and Kakroo (1998).

Besides wasps and ants, 2 species of wax moths i.e. greater wax moth (*Galleria mellonella*) and lesser wax moth (*Achroia grisella*) also infested *A. cerana* colonies in different parts of Himachal Pradesh, and of these, *G. mellonella* was more destructive. However, no infestation of wax moths

TABLE 4: Different mite pests of *Apis* spp. in Himachal Pradesh with their taxonomic status.

Mite species	Sub-order	Family	Honeybee species	Mode of living/ Association	Habitat
Varroa jacobsoni	Mesostigmata	Varroidae	*A. cerana* & *A. mellifera*	Ectoparasitic	Brood cells and adult bees
Tropilaelaps clareae	Mesostigmata	Laelapidae	*A. mellifera*	Ectoparasitic	Brood cells and adult bees
Acarapis dorsalis	Astigmata	Acaridae	*A. cerana*	Ectoparasitic	Adult bees
Acarapis woodi	Astigmata	Acaridae	*A. mellifera*	Endoparasitic	Adult bees
Macrocheles muscaedomesticae	Mesostigmata	Macrochelidae	*A. mellifera*	Predatory	Hive debris
Parasitellus sp.	Mesostigmata	Parasitidae	*A. cerana*	Predatory	Free living
Neocypholaelaps	Mesostigmata	Ameroseiidae	*A. cerana* *A. mellifera*	Phoretic	Adult bees & pollen cells
Neocypholaelaps apicola	Mesostigmata	Ameroseiidae	*A. mellifera*	Phoretic	Adult bees & pollen cells
Tyrophagus longoir	Astigmata	Acaridae	*A. cerana* *A. mellifera*	Phoretic	Adult bees & pollen cells
Caloglyphagus berlesei	Mesostigmata	Acaridae	*A. cerana* & *A. dorsata*	Phoretic	Adult bees
Rhizoglyphus robini	Astigmata	Acaridae	*A. cerana* & *A. dorsata*	Phoretic	Adult bees
Ascidae mite		Acaridae	*A. mellifera*	Phoretic	Adult bees
Unidentified (I)	Astigmata	Acaridae	*A. mellifera*	Phoretic	Adult bees
Unidentified (II)	Astigmata	Acaridae	*A. florea*	Phoretic	Adult bees

was observed on *A. mellifera* colonies. These results are in agreement with the observations of Jyothi and Reddy (1992, 1993). Mishra (1995) found that negligible or no attack of greater wax moth on *A. mellifera* colonies may be due to the fact that these are heavy propolisers and propolis is also incorporated in the combs for reinforcement.

In addition to insect pest and predators, 16 species of arachnids were seen invading the colonies of *A. mellifera* and *A. cerana* in Himachal Pradesh. These comprised of 13 species of mites, 2 species of spiders viz. *Sparssus* sp. and *Paradosa* sp. (Araneae) and 1 species of pseudoscorpion, i.e. *Chelifer* sp. (Pseudoscorpionida). Kumar and Sharma (2003) also reported that September to October was the period of high incidence of *Tropilaelaps clareae* in *A. mellifera* at Bajaura in Kullu valley. Thakur and Sharma (1984) also found spiders as enemies of *A. mellifera* at Palampur, Himachal Pradesh. Similarly, Murthy and Venkatramanan (1985, 1996) observed pseudoscorpion in the hives of *A. cerana* bees in Western Ghats of India.

Other invertebrate enemies, comprised of 3 spp. of molluscs namely *Eaustenia* ap., *Limax* sp. and a snail were seen inside the wet hives of *A. mellifera* at Shimla. Unlike invertebrates, only a few vertebrates enemies like *Bufo* sp. (Amphibia); lizards and snake (reptilian); *Dicrurus* sp. and *Merops orientalis* (Aves) and mice and bears (Mammalia) were found attacking the colonies of *A. mellifera* and *A. cerana* in different parts of Himachal Pradesh. Among these, birds were the most destructive predators especially in mid hills, valleys and plain areas of Himachal Pradesh. Singh (1962) also reported *Dicrurus* sp. and *Merops orientalis* as the common predator of bees from northern part of India. Rishi (1980) also found *Merops supercillious persicus* predating on honey bees in Kashmir valley. Abrol and Kakroo (1994) and Gatoria and Jhajj (1994) reported *Merops orientalis* attacking honey bees in Jammu and Punjab areas, respectively. Birds are also found to be common predators of bees throughout the world (Latif and Yunus, 1950; Akratanakul, 1987). Some investigators have also observed lizards, frogs, toads, mice and snails as common predators of bees in other parts of India (Singh 1962; Abrol, 1994; Abrol and Kakroo, 1994). Similar reports are also available from other parts of the world (Akratanakul, 1987). Our findings about the predation of bees colonies by bears (Table 2) are

TABLE 5: Distribution of different invertebrate and vertebrate pests and predators (except insects and arachnids) of A. *mellifera* and *A. cerana* bees in Himachal Pradesh.

	Sparssus sp.	Paradosa sp.	Chelifer sp.	Eaustenia sp.	Limax sp.	Snail	Bufo sp.	Lizard	Snake	Dicrurus sp.	Merops orientalis	Mice	Bera
Chamba													
Bakani	+	-	-	-	-	-	+	-	-	-	-	-	-
Luan	-	+	-	-	-	-	+	-	-	-	-	-	-
Sarol	-	+	-	+	-	-	+	-	-	-	-	-	+
Judera	+	-	-	-	-	-	-	-	-	-	-	-	-
Holi	+	+	-	-	-	-	+	-	-	-	-	-	-
Bharmaur	-	-	-	-	-	-	+	-	-	-	-	-	-
Kangra													
Ghallaur	+	-	-	+	-	-	-	-	-	-	-	-	-
Ranital	+	-	-	+	-	-	+	-	-	-	-	-	-
Paragpur	-	+	-	-	-	-	+	-	-	-	-	-	-
Ichhi	+	-	-	-	-	-	-	+	-	-	-	-	-
Sherathana	+	-	-	-	-	-	-	+	-	-	-	-	-
Nagrota Bagwan	-	+	-	+	-	-	+	+	-	-	-	-	-
Kullu													
Bajaura	+	-	-	+	-	-	+	+	-	+	+	+	+
Patlikuhl	-	+	--	-	-	-	-	-	-	-	+	+	-
Katrain	+	+	+	+	-	-	-	-	-	+	+	-	-
Sarsai	-	-	-	-	-	-	-	-	-	-	+	+	-
Naggar	+	-	-	-	-	-	-	-	-	-	-	-	-
Mandi													
Bhangrotu	-	-	+	-	-	-	+	-	+	-	-	-	-
Sundernagar	-	+	+	+	-	-	+	+	-	+	+	-	-
Hamirpur													
Hamirpur	+	+	-	+	+	-	+	+	+	+	+	+	-
Bilaspur													
Bilaspur	+	+	-	+	+	-	+	+	+	+	-	-	+
Shimla													
Hatkoti	-	-	+	-	-	-	-	-	-	-	-	-	+
Duttnagar	-	-	-	-	-	-	-	-	-	-	-	-	-
Rohru	-	-	-	-	-	-	-	-	-	-	-	-	-
Kotkhai	-	-	-	-	-	-	-	-	-	-	-	-	-
Navbahar	+	+	+	+	-	+	+	+	+	+	-	-	-
Summer hill	+	+	+	+	-	+	+	+	+	+	-	-	+
Solan													
Solan	+	-	+	-	+	-	-	-	-	-	-	-	-
Sirmaur													
Paonta Sahib	-	-	-	-	+	-	+	-	-	-	-	-	-
Dhaulakuan	-	-	+	-	-	-	-	-	-	-	-	-	-

+ : Pest/Predator present

-: Pest/Predator absent

in accordance with the earlier observations of Thakur *et al*. (1981) who also found bears destroying *A. mellifera* colonies at Dhauladhar in Himachal Pradesh. Gulati and Kaushik (2004) also included that among several hunting factors, honeybee enemies constitute a major factor. Wax moths and wasps cause heavy losses to beekeepers throughout the world, beetles, mites, ants, birds, rodents and mammals occasionally attain the status of serious pests in a particular situation.

REFERENCES

Abe, T. (1985). Hornet in Japan and the composition, properties and pathology of their venoms. *Honey Bee Science*, **10**:13-24.

Abrol, D.P. and Kakroo, S.K. (1998). Studies on seasonal activity and control of predatory wasps attacking honey bee colonies. *Indian Bee Journal* **60**:15-19

Abrol, D.P. (1994). Honey bee diseases, pest, predators and enemies-present status and future needs. Proceedings of National Seminar cum Workshop on honeybee diseases, their diagnosis and management, Bangalore, pp. 7.

Abrol, D.P. and Kakroo, S.K. (1994). Pests and pathogens of Indian bee, *Apis cerana indica* F. in Jammu, India. Proceedings of National Seminar cum Workshop on Honeybee diseases, their diagnosis and management, Bangalore, pp. 7.

Akrantanakul, P. (1987). Honey bee diseases and enemies in Asia. A parasitoidal guide.FAO, Rome.

Atwal, A.S. (1987). Performance and prospects of *Apis mellifera* L. (Apidae: Hymen.) in the Indo-Gangetic plains. *Indian Journal of Ecology* **14**: 92-101.

Gatoria, G.S. and Jhajj, H.S. (1994). Status of bee diseases and enemies of *Apis mellifera* L. in Punjab-A review. Proceedings of National Seminar cum Workshop on honeybee diseases, their diagnosis and management, Bangalore, pp. 8.

Gulati, R. and Kaushik, H.D. (2004). Enemies of honey bees and their management. Agric. rev. **25**(3):189-200.

Jyothi, J.K. and Reddy, C.C. (1992). Rate of larval mobility and orientation of greater wax moth, (*Galleria mellonella* L.) *Geobios*, **19**:168-170.

Jyothi, J.K. and Reddy, C.C. (1993). Influence of different comb parts as diets on the life cycle of greater wax moth (*Galleria mellonella* L.), *Indian Bee Journal*, **55**:29-35.

Kshirsagar, K.K. and Mahindre, D.B. (1975). Some notes on bee predator wasps in India. *Indian Bee Journal*, **37**:4-9.

Kumar, D. (1995). Bioecology of *Apis* and its mite pests in relation to almond and peach pollination. *Ph.D. Thesis, Himachal Pradesh University, Shimla, India.*

Kumar, J. and Sharma, S.D. (2003). Seasonal incidence of ectoparasitic mite, *Tropilaelaps clareae* Delfinado and Bakar (Acarina :Laelafidae) in *Apis mellifera* L. colonies in Kullu valley of Himachal Pradesh. *Pest Management and Economic Zoology*, **11**(9):15-19.

Latif, A.V. and Yunus, C.M. (1950). The common or green bee eater as an enemy of honeybees. *Bee World*, **31**:91-92.

Mishra, R.C. (1995). Honeybee and Their Management in India. ICAR, New Delhi., 168 p.

Morse, R.A. (1980). Honey bee Pests, Predator and Diseases. Cornell University Press, Ithaca, London.

Murthy, V.A. and Venkataraman, R. (1985). Contribution to the biology of Pseudoscorpion, *Elligsennius indicus chambelain*. *Indian Bee Journal*, **47**:34-35.

Murthy, V.A. and Venkataraman, R. (1996). *Elligsennius indicus* (Arachanida: Chelonthi) as a tool to the assessment of the settling nature of honey bee (*Apis cerana indica)* colony in a new habitat. *Indian Bee Journal*, **48**:59-55.

Okada, I. (1956). Notes on Japanese hornet. *Angeqandte Parasitolog Compositiony*, **16**:109-110.

Otis, G.S. (1990). Diversity of *Apis* in southeast Asia. *In: Social Insects and the Environment (ed. Veeresh, G.K.et al.,). Oxford and IBH Publishing Private Limited, New Delhi.*

Rana B.S *et al*. (2000). *Indian Bee Journal*, **62**:96-98.

Rishi, N.D. (1980). On the occurrence of some diseases and predators of *Apis cerana indica* F. In: Conference on Agriculture of Tropical Climates, New Delhi, India. 466-472.

Sharma, O.P. and Raj, D. (1988). Ecological studies on predatory wasp attacking Italian honey bee *Apis mellifera* L. in Kangra Shivaliks. *Indian Journal of Ecology*, **15**:168-171.

Singh, G. (1972). Defensive behaviour of *Apis indica* (Hill Strain) against predatory hornets in Kashmir. *Indian Bee Journal*, **34**:67-69.

Singh, S. (1962). Beekeeping in India, ICAR New Delhi.

Thakur, A.K., Garg, R. and Sharma, O.P. (1981). Vertebrate enemies of honey bees and their control in Dhauladhar (H.P.) India. *Indian Bee Journal*, **43**:112-113.

Thakur, A.K. and Sharma, O.P. (1984). The spider as bee enemy. *Journal of Bombay Natural History Society*, **81**: 208-211.

Verma, L.R. (1990). Beekeeping in Integrated Mountain Development-Economic and Scientific Perspective. Oxford and IBH Publication, New Delhi.