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Bioecological studies on *Vespa* species in honeybee colonies of Himachal Pradesh, India

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Abstract
Present studies revealed that eight species of predatory wasps were found in many experimental apiaries of Himachal Pradesh. Besides diversity and distribution an attempt has also been made to observe the seasonal incidence of most prevalent wasps in hilly areas. Data revealed that the maximum attack of *Vespa auraria* Smith and *Vespa mandarina* Smith were reached during August to November in surveyed areas.
Key words: Predatory wasps, Honeybee

Introduction
Beekeeping industry is presently facing many challenges throughout the world, and one of the major constraints in beekeeping developmental programmes in India is the damage caused to honeybee colonies by various pests, predators and pathogen (Morse and Flottum, 1997). Amongst the predators, wasps and hornets pose by far the most serious threat to beekeeping industry. Wasps are predacious by nature and catch the bees from the blossom or at the entrances of hives (Spreadberry, 1991). Wasps are not only fatal to the bees, but also rob their egg, brood and honey stores. A serious attack some time results in absconding of bee colonies leaving behind a lot of honey and brood (Akre and Devis, 1978). So an attempt has been made to study the diversity, distribution and seasonal variations of *Vespa* species in Himachal Pradesh.

Materials and Methods
Present studies mainly pertain to the diversity and seasonal variations of predatory wasps from different apiaries of Himachal Pradesh, situated between $32^{\circ}12^{'}$ to $33^{\circ}12^{'}$ North latitude, $77^{\circ}47^{'}$ to $79^{\circ}04^{'}$ East longitude and varying altitude from 350 to 7000 metres above mean sea levels from March 2011 to February 2013. The elevation of the area surveyed for the infestation of these predatory wasps varied from 350 to 2700 metres. To evaluate the diversity and distribution of predatory wasps on *Apis mellifera* L. and *Apis cerana* F. colonies, study were conducted in 41 apiaries of Himachal Pradesh. In addition regular fluctuations were recorded in the activity of *Vespa auraria* and *Vespa mandarina* wasps attacking *Apis mellifera* and *Apis cerana* colonies. These counts were made on the experimental apiaries at regular intervals from morning to evening. According to this method, wasps attack was taken as 100 percent and from this data, monthly variations were calculated. Such observations were taken twice a month and repeated during the whole season of the year of wasp attack. Temperature and humidity data were also recorded at the time of taking observations regarding wasp attack. Results were expressed as a percentage of wasps attacking the honeybee colonies (Kerr *et al.,* 1970) during the experimentation in hilly areas of Himachal Pradesh.

Results and Discussion
Present bioecological studies showed that wasps belonging to genera *Vespa* and *Polistes* were the most serious and abundant predators in *Apis cerana* and *Apis mellifera* colonies of Himachal Pradesh. It revealed the occurence 8 species of wasps i.e. *Vespa auraria* Smith, *Vespa mandarina* Smith, *Vespa tropica* (Leefmansi) Vecht, *Vespa orientalis* Linnaeus, *Vespa basalis* Smith, *Vespa flaviceps* Smith, *Polistes sachach* and *Polistes hebraeus*. Of all the species wasps *Vespa orientalis* and *Vespa tropica* were the most predominant at elevation <1000 metres amsl (low lying hills and valleys) whereas attack of *Vespa auraria* was very low. In mid hills (1000-1550 metres) *Vespa auraria, Vespa orientalis* and *Vespa tropica* were the most abundant predators. At higher elevations (>1550 metres) *Vespa auraria* and *Vespa mandarina* were the most destructive predators. These studies are corresponding with the earlier studies of Abrol and Kakroo (1994), Mishra (1995) and Anonymous (2006) conducted in different climatic zones of north- west Himalayan region of India.

The observations also showed that the attack of *Vespa* species was more prevalent on European bee *Apis mellifera* L. than the native *Apis cerana* F. colonies in all agroclimatic zones of Himachal Pradesh. The above findings are in conformity with Free (1970) who reported that the attack on *Apis mellifera* colonies by wasps not only in Asia but in many parts of Europe.

Similarly seasonal variations in the populations of the predatory wasps were also studied on *Apis mellifera* colonies, which revealed that the population of *Vespa auraria* and *Vespa mandarina* were seen maximum during August (58.70±0.57;

3.40±0.40), September (83.80±2.48; 11.50±0.75), October (73.80±0.46; 8.60±0.70) and November (57.90±0.74; 4.70±0.42), 2007 in *Apis mellifera* colonies during 2011- 2012 (Table 1).

During 2012 to 13 it was observed that the attack of most prevalent wasp i.e. *Vespa auraria* and *Vespa mandarina* was highest in August (60.90±0.84; 10.60±0.50), September (81.60±1.01; 15.50±0.50), October (79.00±0.71; 11.60±0.51) and November (71.11± 0.71; 2.60±0.40) (Table1).

A positive correlation was established between number of *Vespa auraria* and *Vespa mandarina* in honeybee colonies with temperature (r=0.592, 0.698; P≤0.01) and relative humidity (r=0.997; 0.856; P≤0.01).

Similar kind of experiments were also conducted by Nagaraja and Rajagopal (2003) they reported that the maximum infestation was observed between October to November in southern region of Indian subcontinent. The minor variations in the peak period of their attack may be due to the differences in physiographic and environmental conditions of experimental areas.

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Table 1: Seasonal Fluctuations in Population of *Vespa auraria* S and *Vespa mandarina* S attacking honeybee colonies at Shimla, Himachal Pradesh ,India.

	2011-2012				2012-2013			
Month	*V. auraria*	*V. magnifica*	Temp (°c)	Humidity (%)	*V. auraria*	*V. magnifica*	Temp(°c)	Humidity(%)
March	0.40±0.16* (0.115)**	–	12.50±0.85	36.50±1.04	–	–	11.25±0.48	26.25±1.25
April	0.60±0.16 (0.172)	–	14.75±0.11	40.50±1.71	–	–	13.75±0.85	31.25±1.11
May	3.10±0.38 (0.990)	–	18.25±1.30	43.25±1.37	3.90±0.31 (0.989)	–	17.50±1.04	36.25±1.93
June	14.60±0.73 (4.189)	–	20.75±1.37	49.25±1.37	17.1±0.60 (4.338)	–	21.75±1.11	45.00±1.96
July	25.10±0.52 (7.202)	2.40±0.27 (7.619)	22.25±1.37	58.25±2.56	31.1±0.97 (7.890)	5.20±0.49 (11.135)	21.00±1.11	56.00±2.48
August	58.70±0.57 (16.844)	3.40±0.40 (10.793)	21.25±1.49	63.75±1.49	60.9±0.84 (15.450)	10.60±0.51 (22.698)	21.25±0.95	61.00±1.29
September	83.80±2.48 (24..046)	11.50±0.75 (36.508)	20.25±0.85	81.75±1.37	81.6±1.01 (20.702)	15.50±0.51 (33.191)	20.25±1.49	78.00±1.83
October	73.8±0.46 (21.176)	8.60±0.70	16.25±0.85	74.25±1.88	79.00±0.71 (18.337)	11.60±0.51 (24.839)	18.50±0.96	74.25±1.49
November	57.90±0.74 (16.614)	4.70±0.42 (14.921)	13.50±0.65	65.00±12.90	71.11±0.74 (18.041)	2.60±0.40 (5.568)	17.75±1.11	68.00±1.47
December	27.70±0.85 (7.948)	0.90±0.23 (2.857)	10.25±0.85	51.75±1.38	41.30±0.52 (10.477)	1.20±0.20 (2.570)	15.25±1.03	49.00±1.29
January	2.80±0.35 (0.803)	–	8.25±0.25	38.25±1.25	12.90±0.67 (3.273)	–	13.50±0.65	37.75±1.38
February		–	7.50±0.65	36.75±1.65	–	–	12.50±1.04	32.00±1.41

*x+S.E Mean ± Standard error about mean
**:Figures in parenthesis indicate per cent population
Population expressed in term of number of Vespa sp./hive/day