ABUNDANCE OF INDIAN HONEY BEE APIS CERANA CERANA AT DIFFERENT ALTITUDES IN HILLY AREAS OF UTTARAKHAND, INDIA

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Abstract: A survey of Indian honey bee *Apis cerana cerana* was carried out in the mountain range of garhwal himalayas at different altitude having specific habitats highlighted the effect of altitude on abundance of honeybee. The study was based on counting of wall hives made by honey bee inside the cavity of mudstone wall of houses or cattle yard. Qualitative analysis of honey produced at various elevations was also carried out.*Apis cerana carana* was found at all the selected altitudes i.e 500msl-2500msl , maximum numbers of bee hives were observed at 1600-2000msl followed by lower altitude 1000-1500msl.Highest and lowest elevations have low bee population. Distribution of honey bee at various elevations indicated that more than 75 per cent bee fauna was found in the range of 1000-2000msl.Area under temperate fruits cultivation i.e.apple,pear,peach,apricot,almond and malta harbored highest percentage of honeybee population(43.57per cent)followed by the area of higher river valley aroecosystem(31.45per cent) where sarso, raye,lemon,coriander and barbery constituted the major bee flora. Forest fire plays important role in inhibiting the honey bee population in low river ally areas. Majority of area is occupied by thick pine forest solely suffered by forest fire in summers. In contrast at highest elevation (above2500msl)with the area frequently covered with mist accompanied by low temperature,the bee population is low and flowering period is short.

Keywords: *Apis Cerana* Different Altitudes, Uttarakhand.

Introduction: Uttarakhand is endowed with wide diversity of animal and plants. Insects were the part of human civilization since time immemorial in these areas. Traditional bee-keeping was an important component of integrated farming system of rural areas of Raath valley region. This Raath area of Uttarakhand is representing thick temperate forest, Perennial rivers, steariform cropping area, enthusiastic people and land of God

In hilly areas of Uttarakhand Indian hive bee *Apis cerana*F is reared since time immoral for the honey gathering. The Indian hive bee is found almost all parts of country but studies on biometry and taxonomy indicate that there are least seven subspecies of *Apis cerana* occurring in India. Kshirsagar and Ranade (1981) observed that hive bee found in North western region of Himalayas including Himachal Pradesh,Uttarakhand and Kashmir is belong to race *Apis cerana ceranas*.Traditionally the bees are also distinguish as hill and plain types. The hill and plain bee types interbreed freely. The hive bee fauna present in the hilly area of Uttarakhand is *Apis cerana cerana* hill type.

The climate ,which is a reflection of the altitude and latitude plays an important role in the distribution of plants and animals in the world and the rule for insects in general and for honeybee in particular. The diversity of bees at different altitude may provide clues to the likely responses of bee species and communities to climate change at any one point over time. Karunaratne and Edirisinghe,2008 reported the abundance of honeybee in Knuckles mountains range of Sri Lankaan forest and found that distribution of bee species decreased with increasing elevation. It was also observed that highest density of bees is at lower elevation where the climate is comparatively warm.

The Uttarakhand mountain range has a rich floristic composition comprises species of flowering plants these provide attractive source of nectar and pollen particularly for bees that may play an important role in the maintenance of flora through pollination.

Apis cerana is gentle in temperament, industrious and well adapted to the ecological condition of hilly areas of Uttarakhand, Bee keeping with Apis cerana is an indigenous industry and forms an integral part of the social and cultural heritage of rural and tribal communities in the country. It is also environment friendly occupation.(Verma,1990 and Verma and Pratap, 1993)

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No reports are available regarding abundance of Indian honeybee at various elevations and their impact on hive formation and honey quality under Himalayan ecological conditions. Present study is based on the assessment of population of *Apis cerana cerana* in various elevations of hilly area of North Western Himalayan region as villages are scattered from the elevation of 500m to 2500 msl. Impact of this elevation change on hive formation, number of comb per hive, honey gathering and quality of honey is also studied.The study examines the abundance of Indian honeybee in an altitude gradient along the lower and upper mountainous region of Garhwal Himalayas.

Materials and Methods: ***Study Area:*** The study area encompasses the western boundary of Dhoodhatoli mountain range in proximity of Pauri-Ramnagar road that runs through Rath area. Four study sites were selected at different altitudes from 500-2500msl based on climatic and vegetation type represents four different habitats. Table 1 gives the location. altitude ,climate zone and the vegetation type of the four study site. The sampling area in each habitat was approximately 1 ha in extent.

Altitude	Name of villages	Forest Type	Vegetation	Water Availability	Temperature
500-1000	Maletha,Bhagwan,Khanda,Kolta, Maleti	mixed	Home gardens, grassland	Dry	10-42
1100-1500	Chipalghat,Dhaur,Kotli,Chiplauri,Sainji	pine	Natural forest	Seasonal streams	7-37
1600-2000	Chair,Buransi,Saknayana, Dhulait,Bharsar	Pine-oak	Natural forest, orchard	Perennial streams	5-28
2100-2500	Panjikhal,Chaurikhal,Musseti, Khandusain,Ainthi	Oak-deodar	Natural forest	Perennial streams	-2.5-26

Climate and Study Period: The Doodhatoli Mountain range is situated in between Garhwal and Kumaun region of Uttarakhand. The lower elevations are seasonally dry while the upper parts have ever-wet climate. The annual rainfall in the area is 115cm.The temperature range between 5-35C at lower altitudes and between -2.5 to 26C at higher altitudes.

Sampling Methods: The four habitats were visited over a period of one year commencing from march 2007 . At each habitat situated at a particular elevation, ten villages were selected for study. from each village 30 houses were randomly selected and data on number of honeybee hives per village, combs per hive ,honey yield were observed. Quality parameters of honey i.e specific gravity, moisture per cent, total reducing sugers(TRS),fructose per cent, glucose per cent, reducing sugar percent and acidity was measured in laboratory of VCSG College of horticulture, G.B.Pant University,Bharsar,Pauri Garhwal.

Results and Discussion: After conducting survey of various villages located at different elevations it was observed that population of *Apis cerana* was concentrated at the elevation of 1600-2000msl(43.57 per cent) followed by 1100-1500msl(31.45 per cent).Lowest number of hives per village(8.840per cent) was observed at elevation of 500-1000msl(Table-1) .Highest elevation also harbor low honey bee population. It was observed from (Table-3) that maximum numbers of cerana bee hive were located at the altitude of 1800-2100msl(0.719hive/house)followed by2100-2500msl elevation(0.519hive/house).At lowest elevation minimum numbers of bee hive have been reported. It was also noticed that at elevation of 1800-2100 msl hive of Apis cerana contains maximum number of combs(5.295) followed by highest elevation and minimum number of combs have been observed at lowest elevation.(Table-4)

Furthermore a distinct pattern was observed with respect to abundance of honeybee to a particular elevation representing a specific vegetation type .While observing the abundance of bee flora in various locations situated at different elevations of hilly region it was found that the plenty of bee flora was available at 1600-2000msl(Table-2) mainly *Plectranthus*(Shain), *Malus domestica*(Apple), *Prunus armeniaca*(Apricot), *Rosa moschata*(Wild Rose), *P.domestica*(Plum) *Trifolium spp.*(Tipatia weed), *Citrus aurentifolia(*Malta),*Brassica compestris*(Sarso).*Ribes grossularia(*Gooseberry),*Pyrus pashia*(Kainth) and Rumex weed constitute the major bee flora of the region whereas at higher heights above, 2000m bee flora was constituted by *Fagopyrum aurantifolia*(Buckweed), *Citrus aurantifolia*(Malta), *Malus domestica*(Apple) and some weeds like *Rumex* and *Trifolium*.While studying the abundance of *Apis cerana* in the different elevation it was clear that majority of bee fauna was situated in the range of 1000-2000msl(75.02per cent).It was also observed that below 1000msl, majority of the hill area was occupied by the Pine forest and a natural water springs in this area is declining day by day. Region behind shrinking of population of *Apis cerana* below 1000msl was may be forest fire which occurs regularly in the region during summers and responsible for depletion of natural water sources in the region. Dense forest of Oak and Deodar, availability of natural water springs together with fruit orchards and plenty of bee floras at elevation of 1000-2000msl may be responsible for abundance of *Apis cerana* population in these areas. Crane (1992)discussed the effect of changes in latitude and altitude on the foraging behavior of honey bees. The change in photoperiod at different times of the year affects plant metabolism and growth. Thus the rate of increase in day length is higher at higher latitudes and most rapid rate of increase occurs at spring equinox, when many plants grow very rapidly. These changes in plants affect the production and quality of bee forage. During present investigation higher elevation(1000-2000msl) acquire more than 75 per cent population.

Although there was difference in abundance of honey bee population at various elevations but in comb number/hive and honey yield/hive there was no significant different was observed. Lower elevation also have same honey yield(Table-5) and combs as higher elevations. Wilson (1965) noticed that moving from lower to higher altitude did not affect the egg laying, brood rearing , bee mortality, pollen and nectar foraging and swarming. It was also noticed that above 2000msl there was less abundance of bee fauna (16.12 per cent). Karunaratne and Edirisinghe (2008) observed that at higher elevations with the area frequently covered with mist accompanied by low temperature, the diversity of flowering herbaceous plants are low and the flowering periods are short. These conditions may have resulted in low bee abundance at higher elevation

A great number of honey bee were confined to a particular elevation(1000-2000msl)are sustained by diverse flora including orchards. The seasonal phonology of bees though not very marked, reflects the climatic variability and availability of host plants along the altitudinal gradient ensuing their presence and absence. In Uttarakhand forest fire plays important role in diminishing the natural population of Indian honey bee. The focus on honey bee diversity in mountainous forest range of Uttarakhand with numerous human activities enhance our understanding of how vegetation and land use pattern as influenced by altitude affect the honey bee population.

Various qualitative parameters of honey were also measured to find out the change of elevation on specific gravity, moisture, sugar per cent and acidity. During present study moisture per cent was in range of 19.36 to 26.13.(Table-6) It was observed that honey extracted from highest elevation have maximum moisture percent. This is due to presence of mist and plenty of water resources in this region. Specific gravity was lowest in the honey extracted from this region. It was also observed that TRS per cent ,fructose and glucose per cent of honey extracted from various elevations were indirectly proportional to moisture content. Wakhle (2002) also reported that generally Indian honey contains more than 20 per cent moisture per cent as compared to European honey bee due to low inversion and evaporation capacity of native *Apis cerana*. He also reported that total reducing sugar, fructose and glucose per cent in honey was 72.78,38.04 and 35.03 per cent respectively and non reducing sugar per cent was 2.01 whereas acidity was 1.174 in honey collected from North Zone of India. Present investigation was in according with above findings.

The seasonal phonology of honey bee though not very marked, reflects the climatic variability and availability of host plants along the altitudinal gradient ensuing their presence and absence. In mountain region region of Uttarakhand bee fauna of *Apis cerana* was abundant in range of 1000-2000msl.Dry periods were experienced in May-June and associated with forest fire resulted in low abundance of bee fauna in lower pine forest areas. In higher elevations weather is cold and mist is the common feature of climate. It is likely that these weather

factors have contributed to the low honey bee population in these areas. Elevation also affects the quality parameters of honey. The study of honey bee abundance in this mountainous forest range of Uttarakhand with numerous human activities enhance our understanding of how vegetation and land use pattern as influenced by altitude affect temperate honey bee population.

Table1: Abundance of *Apis Cerana Carana* at Various Elevations of Hilly Area of Uttarakhand

Elevation of Villages (msl)	Name of Villages	Per Cent of Bee Hive Observed
500-1000	Maletha,Bhagwan,Khanda,Kolta.Maleti	8.840
1100-1500	Chipalghat,Dhaur,Kotli,Chiplauri,Sainji	31.45
1600-2000	Chair,Buransi,Saknayana, Dhulait,Bharsar	43.57
2100-2500	Panjikhal,Chaurikhal,Musseti, Khandusain, Ainthi	16.12

Table2: Dispersion of Bee Flora at Different Elevation of Hilly Region of Uttarakhand

Elevation	Bee Flora (Common Name)	Scientific Name	Flowering Period	Source of Food
500-1000	Simbal	*Bombax ceiba*	Jan-March	Nector/Pollen
	Beol	*Grewia*	May-July	Nector/Pollen
	Litchi	*Litchi chinensis*	March	Nector
	Mango	*Mangifera iIndica*	Jan-March	Nector
	Ritha	*Sapindus edetergens*	May	Nector/Pollen
	Onion	*Alium cepa*	May-June	Nector
	Dharak	*Melia azadiracta*	March-April	Nector
	Sarson	*Brassica compestis*	October-Nov.	Nector/Pollen
	Raya	*B.juncea*	Dec-Feb.	Nector
	Bottle Brush	*Callistemon*	July-August	Nector
	Amaltas	*lanceolatus*	May-June	Nector/Pollen
	Dhania	*Cassia fistula*	Jan-March	Nector/Pollen
	Shishum	*Coriandrum*	March-April	Nector/Pollen
	Safeda	*sativum*	Feb-March	Nector/Pollen
	Sunflower	*Dalbergia sisoo*	July-August	Nector/Pollen
	Amrood	*Eukelyptus spp.*	March-April	Nector/Pollen
	Behda	*Helianthus annus*	April-May	Nector/Pollen
	Hirda	*Psidium guajava*	April-May	Nector
	Toon	*Terminalia bellerica*	April	Nector
	Ber	*Terminalia chebula*	July-Oct.	Nector/Pollen
		Toona ciliate		
		Ziziphus mauritiana		
1100-1500	Kashmal	*Barberis lyeium*	March-April	Nector
	Sarson	*Brassica compestis*	October-Nov.	Nector/Pollen
	Raya	*B.juncea*	Dec-Feb.	Nector
	Bhang	*Cannebis sativa*	July-Sep.	Pollen
	Dhania	*Coriandrum*	Jan-March	Nector/Pollen
	Shishum	*sativum*	March-April	Nector/Pollen
	Sunflower	*Dalbergia sisoo*	July-August	Nector/Pollen
	Behda	*Helianthus annus*	April-May	Nector/Pollen
	Toon	*Terminalia bellerica*	April	Nector
	Tipatia weed	*Toona ciliate*	April-May	Nector-Pollen
		Trifolium		
1600-2000	Kashmal	*Berberis lyceum*	March-April	Nector
	Sarsoo	*Brassica compestis*	March-April	Nector
	Malta	*Citrus aurantifolia*	Dec-Jan	Nector/Pollen
	Apple	*Malus domestica*	March-April	Nector/Pollen
	Shain	*Plectranthus*	Aug-Oct	Nector/Pollen
	Badam	*rogosus*	Feb-March	Nector/Pollen
	Til	*Prunus amygdalus*	Aug-Sep	Nector/Pollen

	Wild Rose	*Sesamum indicum*	April-June	Nector
	Apricot	*Rosa moschata*	Feb-March	Nector/Pollen
	Plum	*Prunus armeniaca*	March	Nector/Pollen
	Pear	*P.domestica*	Feb-March	Nector/Pollen
	Kainth	*Pyrus communis*	Feb-March	Nector/Pollen
	Peach	*Pyrus pashia*	Feb-March	Nector/Pollen
	Tipatia	*Pyrus persica*	April-June	Nector/Pollen
	Almora weed	*Trifolium spp.*	May-July	Nector
	Paja	*Rumex spp.*	April-May	Nector/Pollen
	Jarainith	*Prunus puddum*	April-May	Nector
	Goosberry	*Pyrus serotina*	May-July	Nector/Pollen
	Blackberry	*Ribes grossularia*	May-July	Nector/Pollen
	Rose apple	*Rubus alleghaniensis* *Eugenia jambus*	May-June	Nector/Pollen
2100-2500	Buckwheat	*Fagopyrum*	July-Sep	Nector/Pollen
	Malta	*aurantifolia*	December/Jan	Nector/Pollen
	Apple	*Citrus aurantifolia*	March/April	Nector/Pollen
	Badam	*Malus domestica*	March-April	Nector/Pollen
	Tipatia	*Prunus amygdalus*	April-June	Nector/Pollen
	Almora weed	*Trifolium spp.* *Rumex spp.*	May-June	Nector

Table 3: Distribution of Bee Hives at Various Elevation of Rural Hilly Areas of Uttarakhand

Elevation of villages (msl)	Name of villages	Number of Hives/villg. Mean * Mean Total
500-1000m	Maletha	5.00 0.166
	Bhagwan	7.00 0.233
	Khanda	4.00 0.133
	Kolta	3.00 0.100
	Maleti	3.00 0.100 0.146
		SEm- 0.037
		CV-0.054
1100-1500m	Chipalghat,	15.000 0.500
	Dhaur	17.000 0.566
	Kotli,	16.000 0.533
	Chiplauri	18.000 0.600
	Sainji	12.000 0.400 0.519
		SEm-0.034
		CV-0.147
1600-2100	Chair	23.000 0.766
	Buransi	19.000 0.633
	Saknayana,	20.000 0.666
	Dhulait,	24.000 0.800
	Khandusain	22.000 0.733 0.719
		SEm-0.031
		CV- 0.096
2100-2500	Panjikhal	6.000 0.200
	Chaurikhal	12.000 0.400
	Musseti,	9.000 0.300
	Matoli	8.000 0.266
	Ainthi	5.000 0.166 0.266
		SEm-0.041
		CV- 0.343

* Thirty houses were selected randomly from each village.

Table 4: Observation on Number of Combs per Hive Located at Various Elevations of Rural Hilly Areas of Uttarakhand

Elevation of villages (msl)	Name of villages	Number of combs/hive Mean
500-1000m	Maletha Bhagwan Khanda Kolta Maleti	4.233 3.746 3.600 3.423 3.233 4.243 SEm-0.235 CV-0.147
1100-1600m	Chipalghat, Dhaur Kotli, Chiplauri Sainji	4.833 4.364 4.000 3.888 4.500 4.600 SEm-0.181 CV-0.093
1800-2100	Chair Buransi Saknayana, Dhulait, Khandusain	5.478 5.295 6.631 5.300 4.250 4.818 SEm-0.396 CV-0.167
2100-2500	Panjikhal Chaurikhal Musseti, Matoli Ainthi	3.933 3.887 3.823 3.125 4.388 4.166 SEm-0.261 CV-0.137

Table: 5 Observation on Honey Yield/Hive Located at Various Elevations of Rural Hilly Areas of Uttarakhand

Elevation of villages (msl)	Name of villages	Honey yield(Kg.) /hive/year Mean
500-1000m	Maletha Bhagwan Khanda Kolta Maleti	8.533 7.432 9.243 7.323 5.742 6.323 SEm-0.054 CV-0.042
1100-1500m	Chipalghat, Dhaur Kotli, Chiplauri Sainji	9.833 10.329 10.250 10.111 10.250 11.200 SEm-0.231 CV-0.050
1600-2100	Chair Buransi Saknayana, Dhulait, Khandusain	9.739 10.205 8.263 13.500 10.708 8.818 SEm-0.658 CV-0.113
2100-2500	Panjikhal Chaurikhal Musseti, Matoli Ainthi	11.666 9.741 8.764 8.750 9.277 10.250 SEm-0.481 CV-0.078

Table: 6 Quality Parameters of Honey Collected from Various Elevtions

Elevation of village (msl)	Name of village	Quality Parameter of Honey						
		Specific gravity	Moisture %	TRS %	Fructose%	Glucose%	NRS %	Acidity %
1000-1500	Maletha	1.55	18.22	80.34	32.66	30.12	0.62	0.11
	Bhagwan	1.56	21.50	73.00	37.22	34.67	0.46	0.11
	Khanda	1.49	21.37	72.66	39.75	32.48	0.45	0.12
	Kolta	1.47	16.78	72.00	41.50	33.65	0.43	0.11
	Maleti	1.47	18.97	76.90	33.76	34.68	0.48	0.12
		1.50	**19.36**	**74.98**	**36.97**	**33.12**	**0.48**	**0.11**
1500-1800	Chipalghat,	1.41	19.66	76.89	34.56	32.97	0.67	0.12
	Dhaur	1.43	20.00	74.67	33.32	30.09	0.56	0.11
	Kotli,	1.57	23.90	76.58	32.45	31.90	0.45	0.11
	Chiplauri	1.62	16.90	73.84	31.57	34.87	0.45	0.12
	Sainji	1.56	17.87	70.32	36.76	32.56	0.47	0.12
	Mean	**1.51**	**19.66**	**74.46**	**33.73**	**32.47**	**0.52**	**0.11**
1800-2100	Chair	1.42	23.98	78.34	32.12	34.97	0.60	0.10
	Buransi	1.45	20.00	74.00	30.35	32.00	0.48	0.10
	Saknayana,	1.53	25.90	73.56	32.78	33.70	0.40	0.10
	Dhulait,	1.46	26.90	70.08	34.89	31.67	0.55	0.12
	Khandusain	1.67	19.27	74.30	29.78	33.50	0.50	0.11
	Mean	**1.50**	**23.21**	**74.05**	**31.98**	**33.16**	**0.50**	**0.10**
2100-2500	Panjikhal	1.46	25.88	75.78	30.56		0.64	
	Chaurikhal	1.43	28.00	72.67	32.22	30.00	0.51	0.09
	Musseti,	1.50	27.40	71.56	30.75	30.50	0.48	0.11
	Matoli	1.54	26.40	70.00	27.50	34.20	0.58	0.12
	Ainthi	1.43	23.00	72.32	26.66	32.27	0.51	0.10
	Mean	**1.47**	**26.13**	**72.31**	**29.53**	33.40	**0.54**	0.10
		SEm-0.003	SEm-1.871	SEm-0.269	SEm-2.154	**32.07**	SEm-0.003	**0.10**
		CV-0.004	CV-0.141	CV-0.006	CV-0.112	SEm-0.012 CV-0.038	CV-0.056	SEm-0.318 CV-0.017

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