



Foraging behaviour of Indian honey bee *Apis cerana indica* F. in rubber plantations

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Rubber plants (*Hevea brasiliensis*) form a potential nectar source in south India particularly in Kerala and some parts of Tamil Nadu and Karnataka (Jayarathnam, 1970; Suryanarayana, 1983). Nectaries are active 20-25 days after refoliation and coincide with flowering, which normally occurs during February to April (Jose *et al.*, 1999).

The worker bees begin to forage when they are about 2-3 weeks old and visit flowers having nectar with higher sugar concentration (FAO, 1986). A study was carried out to observe the foraging activity in *Apis cerana indica* F. (Hymenoptera: Apidae) colonies maintained in the rubber plantation for one year from 2005 April to 2006 March. The location of the study area was the Rubber Research Institute of India, Kottayam. The study area is situated between 9°32'N and 76°36'E having an altitude of 73 m above mean sea level. The average maximum and minimum temperature were 36°C and 29°C with an annual rainfall of 3103 mm.

Experiments were conducted to study the foraging behaviour and the factors affecting the foraging activity in *A. cerana indica* colonies maintained in rubber plantation. Three hives were selected for continuous observation. The hives had eight frames conforming to ISI standard. The foraging activities of bees were recorded from 06.00 am to 06.00 pm. The bees going out for foraging were counted as they exited the hive for their flight. Bees loaded with pollen and nectar were also counted on their return at the entrance of the hive. The number of bees going out for collection of food and the bees returning back to the hive with pollen and nectar were worked out for one hour each from 6.00 am – 6.00 pm for one year from April to March. The actual observations were recorded for five minutes per hour. The

experiment was in CRD with three replications. The agrometeorological data such as rainfall and humidity on the date of observation were recorded and the correlation between these factors and foraging activity were worked out.

The observation revealed that honeybee colonies showed variation on exit flight depending on the weather condition. On bright days maximum exit flights of bees were observed between 06.00-11.00 am and the peak foraging activity was recorded during 06.00-08.00 am (Table 1). On rainy and highly humid days bees started their foraging late and it was very low. The peak period of exit flights during monsoon months depended upon the period of bright sunshine.

Return flight of pollen collectors showed variation from day to day, and month to month (Table 2). The activity of pollen collectors was very high between 06.00-11.00 am. The peak period varied as 06.00- 07.00, 07.00-10.00, 08.00-10.00 and 10.00-11.00 am. The pollen collector's activity was very low during afternoon hours.

The peak period of work by nectar collectors were observed to be between 06.00- 08.00 am (Table 3). When the conditions are favourable the peak nectar collection time also varied and it extended up to 11.00 am. The nectar collection was lower later in the day compared with morning hours. In general, the pollen and nectar collection was in the forenoon period i.e., 06.00-11.00 am. But the foraging activity depended upon the period of sunshine during the monsoon period. Whenever there was a dry spell and sunshine availability the bees turned to be active and started intensive foraging. When the relative humidity was high (above 85%) in the morning hours with showers there delay was in the foraging o

bees. Relative humidity thus has no direct effect on foraging (Fig.2). Similarly the flight activity was negatively correlated with rainfall. On rainy days the foraging was very less (Fig.1).

The bee visit to flowers varied on the same day (Viswanath *et al.*, 2003). The bees started foraging early (06.00-09.00 am) in the morning (Mehrotra and Bisht, 1984). The peak period of foraging was observed as 06.00-08.00 am (Swamynathan and Bharadwaj, 1982). Thakur *et al.* (1982) observed that the bees collected pollen in the early hours of the day and their activity decreased after 12.00 noon. The foraging on *H. brasiliensis* was observed to be higher in the morning ie, (06.00 -08.00 am and evening ie 5.00pm -6.00 pm. (Nehru and Jayarathnam, 1985). In the present study the most active period of foraging was 06.00 -08.00 am and moderately high foraging was observed upto 11.00 am. The pollen collection was observed to continue up to 12.00 noon and thereafter a rapid decline was observed. The peak period of nectar collection also was 06.00 -08.00 am. The pollen and the nectar collection were very low in the afternoon. *A. cerana* was reported to begin its activity in

the morning when light intensity and solar radiation are relatively low and they continued to work for longer duration. The flight activity has been reported to be correlated negatively with relative humidity and positively with ambient temperature (Abrol, 1988; Mattu *et al.*, 2003; Chand and Kumar, 2005). In the present study it is evident that rainfall has more significant influence on foraging of bees when compared with relative humidity. High relative humidity did not always promote foraging. When the weather was cool and food scarce in the colony, the bright light promoted the bees to forage even though the out side temperature was as low as 4°C (Atwal, 2000). The bees were observed to be most active in temperature ranging from 20-35°C and a relative humidity ranging from 26-80 percent (Cheriyian *et al.*, 1947). Heavy rainfall had resulted in significant reduction in bee visit (Sharma *et al.*, 2002). In North India the foraging activity during winter was observed to begin at 10.30 am whereas during summer it was in the early morning hours (Bisht, 1978). The present study confirms the earlier observation that high relative humidity on rainy days and rainfall inhibit the bee activity. Intermittent bright sunshine period is favoured for bee activity during the monsoon period.

Table1. Exit flight of *A. cerana indica* (Number)

Time	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
6-7	2540	3047	203	602	2529	2642	2831	2763	1647	1590	3207	4410
7-8	2120	2922	271	1107	2184	2305	2530	2529	1086	1681	2850	4035
8-9	1764	2707	341	1088	1908	1037	2229	2874	1257	1572	2355	3288
9-10	1012	2226	448	1610	1093	1503	1786	2838	1011	1329	1932	2028
10-11	668	1792	418	1235	614	1084	1187	2355	762	834	1324	1638
11-12	406	1135	306	871	421	1021	572	1935	726	657	807	1128
12-13	232	1163	506	565	429	1081	247	1845	414	378	405	1008
13-14	169	749	231	320	364	822	166	966	333	312	411	861
14-15	161	383	212	529	363	697	188	957	174	246	270	723
15-16	140	659	163	1497	324	1132	139	1165	165	288	405	978
16-17	107	213	199	350	160	655	107	1116	153	489	285	1230
17-18	74	150	133	230	137	439	80	897	135	408	372	999
CD p=0.05%	463.	1384	N.S	N.S	651	245	167	730	72	411	643	1281

Table 2. Return flight of *A. cerana indica* with pollen (Number)

Time	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
6-7	643	549	31	169	1351	1269	213	84	6	432	336	684
7-8	539	761	105	164	1198	1104	255	216	15	234	327	705
8-9	512	721	190	275	589	942	285	237	495	369	378	447
9-10	496	735	184	346	216	654	270	516	429	420	278	474
10-11	229	574	241	307	71	270	222	735	339	369	306	450
11-12	143	262	113	236	54	114	198	303	294	291	150	252
12-13	163	199	86	154	73	84	138	132	327	135	78	96
13-14	47	75	21	92	49	45	99	99	69	39	64	84
14-15	30	10	68	102	22	12	39	45	45	24	27	39
15-16	15	3	59	131	22	12	39	45	45	24	27	39
16-17	10	3	37	44	11	6	30	15	30	18	15	42
17-18	8	1	16	4	8	0	6	6	18	21	33	33
CD p=0.05%	342	462	NS	NS	190	104	31	84	132	362.5	128	NS

Table 3. Return flight of *A. cerana indica* with nectar (Number)

Time	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
6-7	1934	2041	181	362	966	1470	220	2904	984	1167	2550	3435
7-8	1168	1941	237	890	849	1470	1993	2904	983	1104	2034	3210
8-9	942	1796	278	905	829	1398	1833	2239	633	834	1575	2316
9-10	683	1435	314	1161	557	1167	1296	2232	516	819	1110	1516
10-11	523	1158	268	833	572	903	414	2127	444	408	684	1278
11-12	517	883	232	633	378	1185	243	1662	387	357	615	780
12-13	545	959	448	946	428	979	228	1671	285	315	318	987
13-14	362	536	250	263	309	724	276	834	171	228	291	777
14-15	371	387	232	533	313	651	276	1170	72	198	204	843
15-16	494	409	230	1324	420	927	252	1092	45	261	327	952
16-17	365	238	359	403	210	426	226	1224	39	354	300	1068
17-18	315	159	296	232	298	534	135	940	36	456	396	990
CD p=0.05%	402	725	NS	NS	253	336	97	422	69	381	562	1091

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