

Research Article**ABSCONDING BEHAVIOR AND MANAGEMENT OF *Apis cerana* F. HONEYBEE IN CHITWAN, NEPAL****S. Pokhrel¹, R. B. Thapa², F. P. Neupane² and S. M. Shrestha²**¹District Agriculture Development Office and ²Institute of Agriculture and Animal Sciences, Chitwan, Nepal**ABSTRACT**

Twelve colonies of five-framed *Apis cerana* F. with about equal brood, hive storage and colony strength were prepared in November 2004 and the colony development parameters recorded. One-third of the colonies absconded in summer and about one-sixth in rainy season, while non-absconded colonies also slowed comb building, brood rearing, colony strength and hive storage in summer and rainy seasons. Feeding sugar candy and pollen substitute prevented absconding in May and July. Three weeks feeding in May resulted higher comb building (15.0%), higher brood rearing (158.8%), stronger colony strength (15.0%) and higher hive storage (171.2% honey, 270.9% pollen) in June. Those colonies having higher brood mite (*Varroa jacobsoni* Oud.) in winter absconded earlier.

Key words: *Apis cerana*, absconding, brood mite, pollen substitute, colony management**INTRODUCTION**

Beekeeping with *Apis cerana* Fab. has been traditionally adopted and is a part of cultural and natural heritage of the mountain communities in Nepal. At present, there are about 119430 *A. cerana* (1,01,684 traditional log and wall hives and 17,744 improved) hives in Nepal (Bee Keeping Section, 2004). Though *A. cerana* are poor honey yielder, they require low management costs, are efficient pollinators and adopted on the harsh mountain environments including pests, diseases and predators in mid hills of Nepal. However, this bee is aggressive, swarms frequently and absconds hindering the commercial bee keeping (Tokuda, 1924, 1935; Roepke, 1930; Kellog, 1941; Sakagami, 1960a, 1960b). In fact, honeybees are known to possess intricate sequence of behavior through which they monitor their environment. When the nest ecology deviates from normal and the situation inside is deteriorated, they react immediately. At extreme situations, the whole members of the colony abscond. However, very little information is available on its absconding behavior (Kafle, 1985). Non-availability of food and water (Smith, 1961; Fletcher, 1978; Sakagami, 1960a; Singh, 2000; Hassan, 2003), abnormal climatic conditions (Ruttner, 1987b), poor ventilation, attack of diseases, pests and robbing, hazardous fumes, pesticide poisoning (Singh, 2000), presence of old combs (Kapil, 1960; Verma, 1970; Ruttner, 1987a), physical disturbances and unusual handling (Singh, 2000) are the causes of absconding in different parts of the Asian tropics. However, absconding is a habitudinal seasonal migration (Smith, 1961; Fletcher, 1978). *Apis cerana* is a single honeybee species adopted by the hilly farmers in north Chitwan. Absconding of this honeybee during summer and rainy seasons is the most severe factor limiting honey production of the Chepang community in this area. Hence, the study was to investigate on the phenomena of seasonal absconding of *A. cerana* and find its cause to suggest subsequent safety measures to the beekeepers.

MATERIALS AND METHODS

The research was conducted at Radha-Krishna Tole, Bharatpur-12, Chitwan (350 masl) during the winter, spring and monsoon seasons from November 2004 to July 2005. Twelve colonies were prepared with about equal brood; hive storage and colony strength in November 2004. None of the colonies were fed until absconding started during dearth period in May, 2005. Sugar feeding was started from 15 May @ 200 g candy (5:1 sugar powder and honey) per colony per week, which was stopped after 3 weeks. The observations on comb building, hive storage, brood rearing, colony strength and the nest hygiene were recorded at 42 days interval. Absconding of the colonies restarted in the monsoon (July, 17) then feeding was restarted with the same dose of candy plus 20 g of modified Godavari (soybean flour 75 g, sugar powder 125 g, skim milk powder 25 g, yeast powder 25 g,

egg yolk 1 piece and honey 20 ml blended in an electric blender) diet alternate a day. The bee brood measuring tool was prepared by using locally available materials i.e. wooden sticks, steel and copper wires (Figure 1) and used for measuring the brood cells, honey cells and pollen cells of the combs.

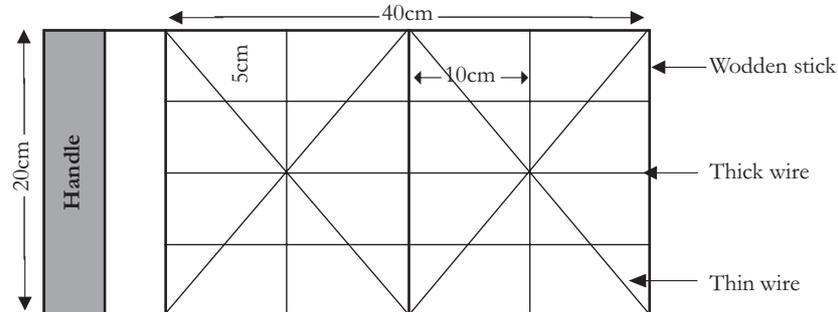


Figure 1. Locally prepared brood measuring tool

The length and breath of the brooded area on both the sides of comb were measured by a locally made brood measuring tool without removing the bees. The number of broods per colony was calculated by subtracting the non-brooded area from the gross brood rearing area (Figure 2). Based on the above calculation, a brood measuring table was developed and used (Pokhrel, 2001).

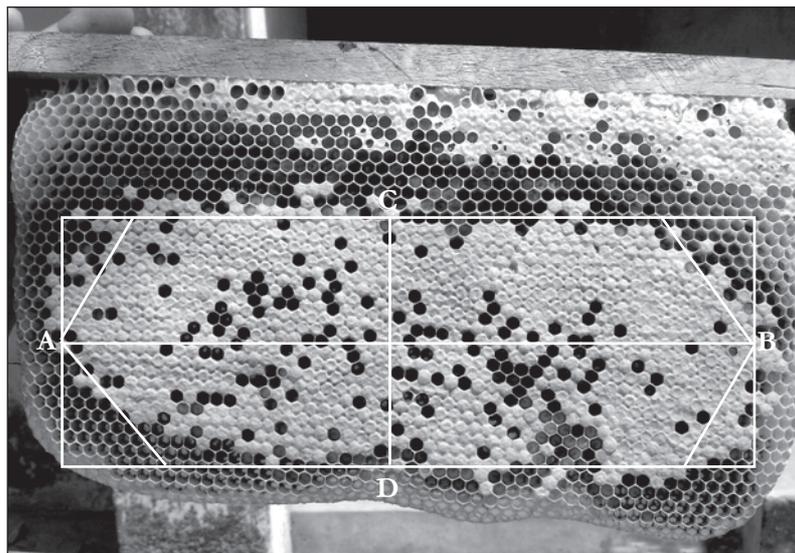


Figure 2. Measurement of the brood cells of *A. cerana* comb, Chitwan, 2004/05

Gross brooded area (cm²) = AB (cm) x CD (cm)

Correction factor = Area of the triangles a+b+c+d or 21.9% of the gross brooded area (mean of 50 samples).

Therefore, number of brood cells per side of a comb = 484/100 x gross brooded area – correction factor

Number of brood cells /colony = \sum (broods from side I of all frames + side II of all frames)

(1 cm² = 4.84 cells, mean of 50 samples).

Honey cell measurement

The length and breath of the honeycomb on both the sides together with the length and the breath of the brooded area and the pollen stored area were measured with the help of a brood rearing tool and number of cells used for honey storage was calculated (Figure 3).

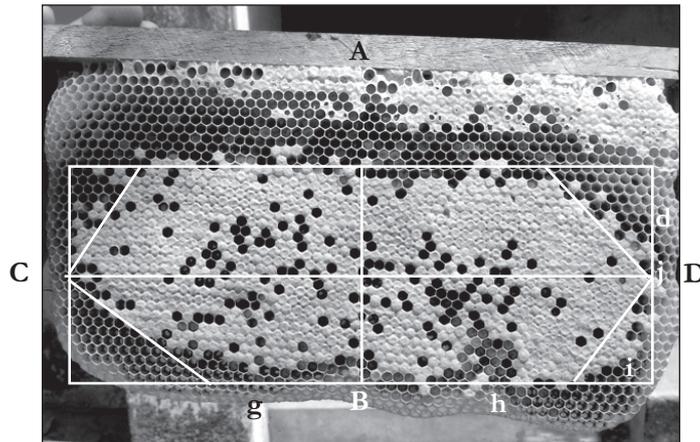


Figure 3. Measurement of the honey cells of *A. cerana* comb, Chitwan, 2004/05

Number of honey cells/side of a comb = $484/100 \times \text{comb size (sq cm)} - \text{brooded cum pollen area} - \text{empty area}$.
Here,

Comb size (sq cm) = $AB \times CD$ (cm).

Pollen cum brooded area (cm²) = gross pollen cum brooded area - correction factor / 2.

Gross pollen cum brooded area (cm²) = $ab \times cd$ (cm).

Correction factor (cm²) = $10.95/100 \times \text{gross pollen cum brooded area}$.

Empty area (cm²) = Area of the rectangle $e+f+g+h+i+j+\dots$ (measured with brood rearing tool)

Number of honey cells per colony = \hat{A} (honey cells of side I of all frames + side II of all frames)

(1 cm² = 4.84 cells).

Based on the length and breath of the gross brooded and pollen stored areas, the brood-cum-pollen cells were found with the help of a brood measuring table (Pokhrel, 2001). Then by subtracting the brooded-cum-pollen stored area and the empty area the numbers of honey cells per comb and per colony were estimated.

Pollen cell measurement

The length and breath of the brooded area together with the pollen stored area from both the sides of the comb was measured as of brood measuring and the number of cells used for pollen storage was calculated (Figure 4).

Pollen stored area (cm²) = (Gross pollen cum brooded area – gross brooded area) - correction factor.

Gross pollen cum brooded area (cm²) = $AB \times CD$ (cm).

Gross brooded area (cm²) = $ab \times cd$ (cm).

Correction factor = $21.9/100 \times \text{gross pollen cum brooded area}$ (mean of 50 samples).

Number of pollen cells/side of a comb = $484/100 \times \text{pollen stored area}$.

Number of pollen cells per colony = \sum (pollen cells of side I of all frames + side II of all frames)

(1 cm² = 4.84 cells).

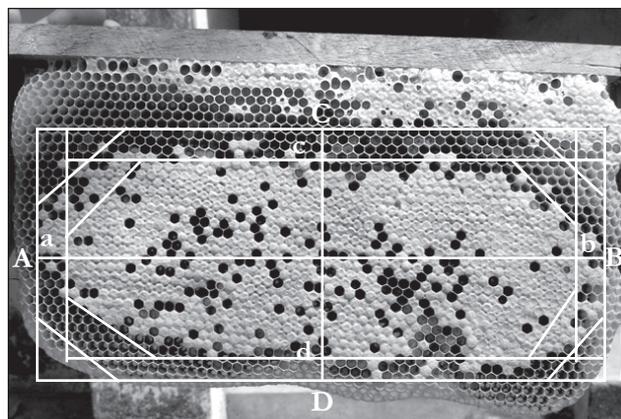


Figure 4. Measurement of the pollen cells of *A. cerana* comb, Chitwan, 2004/05

Based on the length and breath of the gross brooded and brooded-cum-pollen stored areas, the gross brooded and brooded and pollen area were found from the brood measuring table (Pokhrel, 2001). Then by subtracting the brooded area from the brooded-cum-pollen area, the pollen cells per comb and per colony were estimated.

Mite infestation in the nest was observed by visual counting of the number of open, perforated and sunken cells from both the sides of a central comb in a colony. Number of mites from 50 sampled broods of a colony were counted by drawing out the brood from the suspected cells with the help of forceps and counted with the help of a hand lens. The nests of the absconded colonies were carefully examined to find out the leftover hive storage, capped brood and the pest population. During the observation natural enemies and diseases of honeybees were also recorded.

Collected data were tabulated using EXCEL software and necessary tables, graphs and figures were prepared. Means, variance, standard errors, etc. were calculated.

RESULTS AND DISCUSSION

Comb building

The comb building of *A. cerana* colonies accelerated with mustard, *Brassica* spp. and buckwheat, *Fagopyrum esculentum* Moench blooming in December-February and litchi, *Litchi chinensis* Sooner blooming during late March to early April in Chitwan (Table 1). Comb building rapidly declined from May and the colonies prepared for absconding due to shortage of food. The colonies that absconded in May had 23.1% less number of combs covering compared to non-absconded ones. In general, all the colonies had 40.9% less comb covering in late April than that in February. Similarly, the colonies that absconded in July also covered 37.5% less combs as compared to non-absconded colonies. Both absconded and non-absconded colonies had further decreased comb coverings by 13.0% than that of June indicating the worsening of seasons and shortage of flora in July (Table 1).

Artificial feedings during off-season increased comb buildings significantly by 15.0% in June and decreased again in early July by 13.0% when feeding was stopped.

Table 1. Variation in comb building by absconded and non-absconded *A. cerana* colonies, Chitwan, 2004/05

SN	Colony	Mean number of combs/colony				
		25-Dec	22-Feb	22-Apr	24-Jun	17-Jul
1	Absconded	5.00	5.00	2.50	3.00	2.00
		± 0.00	± 0.00	± 0.29	± 0.00	± 0.00
2	Non- absconded	5.00	5.50	3.25	3.56	3.22
		± 0.00	± 0.19	± 0.03	± 0.18	± 0.15
3	Over all	5.00	5.33	3.00	3.45	3.00
		± 0.0	± 0.14	± 0.17	± 0.16	± 0.19

Figure followed by ± is SE

Brood rearing

The average brood rearing was 4852 broods per colony in December, which increased by 70.5% (8275 broods/colony) in February during mustard, *Brassica* spp. and buckwheat, *F. esculentum* blooming. It was decreased in late April (1576 broods/colony) and colonies prepared for absconding (Table 2). The colonies absconded after few days (N=4), which had 29.7% less broods than non-absconded colonies and were broodless at the time of absconding. Then feeding of sugar candy for 3 weeks stopped absconding and improved the brood rearing by 158.7% (4077 broods/colony) in June. Food stopping remarkably decreased brood rearing by 56.7% (1766 cells / colony) in early July and absconding of the colonies started in late July. It clearly showed the significance of food for managing colonies during dearth period.

Table 2. Variation in brood rearing by absconded and non-absconded *A. cerana* colonies, Chitwan, 2004/05

SN	Colony	Mean number of brood/colony				
		25-Dec	22-Feb	22-Apr	24-Jun	17-Jul
1	Absconded	4894.5	8213.5	1228.5	3698.0	1.0
		±340.8	±88.1	±341.1	±304.0	±0.0
2	Non- absconded	4830.3	8305.1	1749.1	4161.8	2158.0
		±194.0	±168.2	±181.2	±272.2	±185.2
3	Over all	4851.7	8274.6	1575.6	4077.5	1765.8
		±163.1	±113.5	±173.2	±246.4	±302.8

Figure followed by ± is SE

Honey storage

Nectar shortage reduced the honey storage in the hive and increased absconding of *A. cerana* colonies. Forager bees started gathering honey in their nest with the availability of mustard, *Brassica* spp. and buckwheat, *F. esculentum* pasture in Chitwan during December-January. The average number of honey cells per colony was the highest (6739 cells, range: 5359-8984 cells/colony) in late December, which decreased by 43.4% (3815 cells, range: 2537- 4816 cells/colony) in February, which was mainly due to honey harvesting in late January and early February (Table 3). Moreover, the honey consumption rate in the nest was higher during this period as the brood rearing was highly accelerated. Hive storage decreased dramatically by 80.5% (743 cells, range: 198-1644 cells/colony) in April, and the absconding of *A. cerana* colonies started (N=4). The colonies having the least honey storage (468 cells/colony) absconded within a few days as compared to others (881 cells/colony). Absconding was stopped after feeding sugar candy for three weeks, which also improved honey storage by 171.0% (2014 cells, range: 1314-2628 cells/colony) in June. In July due to availability of nectar from sesame, *Sesamum orientale* L., considerable amount of honey was stored (2567 cells/colony) in the hive, but scarcity of pollen resulted in low brood rearing and accelerated absconding of the colonies (N=2). Hence, scarcity of feed (both nectar and pollen) was a major cause of *A. cerana* absconding in April and July.

Table 3. Variation in honey storage by absconded and non-absconded *A. cerana* colonies, Chitwan, 2004/05

SN	Colony	Mean number of honey cells/colony				
		25-Dec	22-Feb	22-Apr	24-Jun	17-Jul
1	Absconded	7031.8	3513.3	467.5	1804.0	0.0
		±807.2	±630.9	±184.3	±664.0	±0.0
2	Non- absconded	6592.9	3966.5	880.6	2061.1	3136.9
		±347.8	±270.3	±167.6	±145.8	±132.3
3	Over all	6739.2	3815.4	742.9	2014.4	2566.6
		±338.3	±267.1	±135.8	±151.4	±397.3

Figure followed by ± is SE

Pollen storage

Pollen availability was negatively correlated with absconding of *A. cerana* colonies. The highest pollen storage (1104, range 870-1448 cells/colony) was in late December when the mustard, *Brassica* spp. and buckwheat, *F. esculentum* were in full bloom. The pollen storage was decreased by 28.1% (794 cells, range; 491-984 cells/colony) in February (Table 4) which was due to its higher consumption for brood rearing. The bee population and colony strength were reduced in April with decreasing food supply resulting 70.0% (238 cells, range: 75-435 cells/colony) less pollen storage, which influenced colony absconding (N=4). The absconded colonies in May had having 31.3% less pollen storage (171 cells/colony) in April and had no pollen storage after absconding compared to non-absconded colonies (249 cells/colony). Pollen storage was improved in June by 247.9% (828 cells/colony) at the post-feeding period when the maize, *Zea mays* L. flowers were available. Acute pollen shortage occurred in July, and absconding was re-started (N=2) resulting 92.4% low pollen storage (63 cells/colony) in the hive, just before absconding. It shows that both nectar and pollen shortage was the key factor of *A. cerana* absconding in Chitwan condition during summer and rainy seasons.

Table 4. Variation in pollen storage by absconded and non-absconded *A. cerana* colonies, Chitwan, 2004/05

SN	Colony	Mean number of pollen cell/colony				
		25-Dec	22-Feb	22-Apr	24-Jun	17-Jul
1	Absconded	1075.5 ±81.0	710.8 ±46.0	171.3 ±38.8	920.0 ±146.0	0.0 ±0.0
2	Non- absconded	1118.9 ±55.0	834.9 ±61.9	249.4 ±34.0	807.9 ±144.0	76.4 ±16.9
3	Over all	1104.4 ±43.8	793.5 ±46.1	223.3 ±27.4	828.3 ±119.0	62.6 ±16.5

Figure followed by \pm is SE

Parasitic pressure

Mite, *Varroa jacobsoni* Oud., incidence started from November onward, but its population fluctuated from season to season. Open, perforated and sunken cells were considered as a major symptom of varroasis of *A. cerana*. The colonies having higher number of such cells in February (4.3 cells vs 0.4 cells/comb) and April (11 cells vs 2.0 cells/comb) absconded in early May (N=4) (Table 5). Absconded colonies retained by the use of queen gate in May were broodless. These colonies (N=4) were free from deformed cells in the nest in the post-absconding period. Thus, deformed cells remained almost constant in non-absconded colonies throughout the study period. The mean mite, *V. jacobsoni* population of suspected cells from the central brooded comb was the highest (14.4 mites /50 broods) in February when brood rearing was in peak and declined in the summer (7.6 mites/50 broods) and rainy season (1.8 mites/50 broods) (Table 6). Their population was comparatively higher with the absconding colonies in pre-absconding periods (February 28.0 vs 7.6 mites/50 broods and April 15.8 vs 3.5 mites/50 broods) and was lower in post-absconding periods (July 0.0 vs 2.1 mites/50 broods) (Table 5). Hence, the mite population was one of the factors in absconding of *A. cerana* colonies in Chitwan.

Table 5. Variation in deformed cells in absconded and non-absconded *A. cerana* colonies, Chitwan, 2004/05

SN	Colony	Mean deformed cells/colony				
		25-Dec	22-Feb	22-Apr	24-Jun	17-Jul
1	Absconded	0.0 ±0.0	4.3 ±1.7	11.0 ±2.1	1.5 ±1.5	0.0 ±0.0
2	Non- absconded	0.0 ±0.0	0.4 ±0.4	2.0 ±1.4	2.4 ±1.1	2.1 ±1.0
3	Over all	0.0 ±0.0	1.7 ±0.8	5.0 ±1.7	2.3 ±0.9	1.8 ±0.9

Figure followed by \pm is SE

Table 6. Variation in mite infestation in absconded and non-absconded *A. cerana* colonies, Chitwan, 2004/05

SN	Colony	Mean number of mite/50 broods				
		Dec-25	Feb-22	Apr-22	Jun-24	Jul-17
1	Absconded	1.50 ±0.3	28.0 ±3.9	15.8 ±3.4	9.5 ±0.5	0.0 ±0.0
2	Non- absconded	0.0 ±0.0	7.6 ±2.6	3.5 ±2.4	5.6 ±1.5	2.1 ±1.2
3	Over all	0.5 ±0.2	14.4 ±3.6	7.6 ±2.5	6.3 ±1.3	1.8 ±1.0

Figure followed by \pm is SE

Examination of the combs from the absconded hives showed 5, 12 and 8 dead *V. jacobsoni* per colony, enclosed with drone pupa (Table 7). Thus, presence of mite was one of the causes of *A. cerana* absconding in Chitwan.

Table 7. Mite, *V. jacobsoni* in the hive of absconded *A. cerana* combs, Chitwan, 2005

SN	Absconded date	Capped drone brood (No.)	Dead mites (No.)
1	10-May	12	8
2	25-May	2	5
3	30-May	10	12
	Mean	4.0	4.3

Predatory pressure

Different predators such as hornet, *Vespa orientalis* L. and *V. cincta* F.; bee eater, *Merops orientalis* Latham; kingcrow, *Discrurus macrocercus* Vieillot; spiders, *Nuphila kublui* and *Protaetia aurichalcea* F.; lizards, *Hemidactylus flaviviridis*; frogs, *Bufo melanostictus* S.; rovefly, *Megasalia rufipes* Meig.; robber bees, *A. dorsata* and *A. mellifera* were observed at the study sites. *V. cincta* was the most damaging one, which captured the forager bees during the rainy season. Bee eater, *M. orientalis* was another serious predator found only during rainy season and was counted up to 23 sitting on electrical wire and preying on the bees especially in July. Spiders, *N. kublui* and *P. aurichalcea* were found inside and outside the bee hives throughout the year. These predators also influenced absconding of *A. cerana* colonies.

Storage in the absconded combs

Examination of the combs from the absconded hives showed that the honeybee consumed most of the hive storage before they left. However, the observation of three absconded hives showed the following constituents: some pollen (25, 35 and 201 cells/hive), eggs (100 eggs/ hive) in one hive and sealed dead broods (2, 10 and 12 pupae/ hive) in three hives (Table 8).

Table 8. Storage in the absconded combs of *A. cerana* colonies, Chitwan, 2005

SN	Absconding (Date)	Number of cells			
		Pollen cell (No.)	Capped drone cell (No.)	Honey cell (No.)	Egg (No.)
1	10-May **	25	12	0	0
2	18-May*	201	0	0	100
3	25-May	35	2	0	0
4	30-May	30	10	0	0
5	15-July	0	0	0	0
6	17- July*	0	0	0	0
	Mean	31.8	4.0	0.0	16.7

** Queen killed on pulling out from queen gate while absconding; * Repeated absconding

Bee flora and absconding

Unavailability of major bee flora during summer and rainy seasons in Chitwan was the major cause of absconding of *A. cerana* colonies. During the study period, a serious nectar scarcity occurred specially in April-May and pollen in July. During the period, intermittent rain was responsible for washing away the pollen and killing forager bees. Using the balanced supply of sugar candy @ 200g per week and pollen substitute @ 20g per colony at alternate day for two weeks followed by soya flour feeding during the period solved the absconding problem and colonies started their normal growth and development.

Correlation between various parameters

All the parameters except deformed cells were highly correlated with each other (Table 9). Comb building was highly correlated with brood rearing ($r=0.907$), honey storage (0.795), and pollen storage ($r=0.787$). Brood rearing was correlated with honey storage ($r=0.520$) and pollen storage ($r=0.705$). The honey storage was positively correlated with pollen storage ($r=0.723$). However, deformed cells was negatively correlated with comb building ($r=-0.651$), brood rearing ($r=-0.500$), honey storage ($r=-0.890$) and pollen storage ($r=-0.626$).

Table 9. Correlation between various parameters of *A. cerana* colony development, Chitwan, 2005

SN	Parameter	Comb building	Deformed cell	Brood rearing	Honey storage	Pollen storage
1	Comb building	1.000	-0.651	0.907	0.795	0.787
2	Deformed cell	-0.651	1.000	-0.497	-0.895	-0.626
3	Brood rearing	0.907	-0.500	1.000	0.520	0.705
4	Honey storage	0.795	-0.890	0.520	1.000	0.723
5	Pollen storage	0.787	-0.630	0.705	0.723	1.000

Abandoning of *A. cerana* colonies under Chitwan condition occurred during summer and rainy dearth in May and July due to short supply of nectar and pollen, unfavorable climatic conditions and parasitic and predatory pressures. The pest populations and air temperature were higher and bee flora declined during May to June which accelerated abandoning of this bee in Chitwan. Examination of the combs from the abandoned colonies showed that the bees consumed all the hive storage. Ruttner (1987_a) and Sakagami (1960_a) reported environmental temperature as an important clue for *A. cerana* abandoning in Asia. Singh (2000) reported that high humidity coupled with high temperature enforced the colonies to leave the hive permanently. Smith (1961), Fletcher (1978), Hassan (2003), Sakagami (1960_b) and Singh (2000) also found the colony abandoning due to imminent food shortage. Abandoning was compelled by some external forces i.e. diseases, pests, environment and other disturbances (Singh, 2000).

One-third of *A. cerana* colonies abandoned in summer and about one-sixth in rainy seasons and all colonies slowed their activities during both the seasons and prepared for abandoning. Kafle (1985) reported that honeybees reacted variously when the ecology of the colonies deviated from normal and the situation inside the hive further deteriorated. He reported abandoning of colonies in June in mid hills of Nepal. Abandoning happened during monsoon dearth in Bihar (Singh, 2000). The highest abandoning rate of bee colonies under Egyptian condition were recorded in the months of April, September and October (Hassan, 2003).

The *A. cerana* colonies having higher number of open, perforated and sunken cells in February (4.3 cells vs 0.4 cells/comb) and April (11.0 cells vs 2.0 cells/comb) abandoned earlier in May (N=4). The mean mite, *V. jacobsoni* population was the highest (14.4±3.6 mites/50 broods) in February, when the brood rearing also was in peak and it declined in summer (7.6±2.5 mites/50 broods) and rainy (1.8±1.0 mites/50 broods) seasons, when the number of bee broods was also declined. Singh (2000) and Sakagami (1960_a) also found a positive correlation between *A. cerana* abandoning and the population of brood mite *V. jacobsoni*.

Different predators observed at the study sites were as follows: hornet, *V. orientalis* and *V. cincta*; bee eater, *M. orientalis*; kingcrow, *D. macrocerus*; spiders, *N. kublili* and *P. aurichalcea*; lizards, *H. flaviviridis*; frog, *Bufo melanostictus*; robber fly *M. rufipes* and robber bees, *A. dorsata* and *A. mellifera*. These predators also influenced abandoning of *A. cerana* colonies. Sakagami (1960_b), Singh (2000), Smith (1961) and Fletcher (1978) also reported that causes of *A. cerana* abandoning were: propagation of the pests, robbing of the colonies and the traditional enemies' i.e. giant hornet, mongoose, bear, cockroaches, robber bees, etc.

The comb building of *A. cerana* colonies accelerated with mustard and buckwheat flora during December-February and litchi blooms during late March and early April in Chitwan. Singh (2000) also reported higher comb building by the honeybees in Bihar during winter honey flow. Comb building rapidly declined due to shortage of natural food from May onwards and colony prepared for abandoning. Both abandoned and non-abandoned colonies further decreased in comb covering by 13.0% than that of June, indicating the worsening of seasons and shortage of flora. Artificial feeding during off-season increased comb building significantly in June by 15.0% and decreased again in early July by 13.0% when feeding was stopped.

The average brood rearing of *A. cerana* increased by 70.5% in February during mustard and buckwheat blooming period which decreased in late April and colonies prepared for abandoning. During off-season, the colonies had reduced brood rearing (81.0 in May and 56.7% in July), with weak colony strength (40.0 in late April and 9.0% in July), and honey storage also decreased by 80.5% in late April and acute pollen shortage

occurred in July by 92.4% reduction. Hence, scarcity of feed (both nectar and pollen) was a major cause of *A. cerana* absconding in April and July.

The absconded *A. cerana* colonies retained with the help of queen gate and proper feeding reared more broods (158.7%), built more combs (9.5%) and stored higher amount of honey (171.0%) and pollen (247.9%) in June and normal development of the colonies started. Thus, proper management of bee colonies right from winter honey flow with proper feeding has been recommended. Kafle (1985) also prevented absconding of this bee from heavy feeding, brood supplement and uniting of the colonies in Kathmandu. The suggested ways to prevent absconding are: timely examining bee enemies and diseases and their management, and feeding artificial diet or putting queen gate at hive entrance etc. Koeniger (1976) recommended transporting bee colonies to pasture or intensive feeding during dearth and adopt proper seasonal management practices. Sugar syrup feeding during off-season (rainy, summer and winter) prevented absconding of *A. cerana* (Verma, 1984; Sakagami, 1960a; Smith, 1961; Fletcher, 1978; Singh, 2000).

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