Chapter 3

The Asian Hive Bee (*Apis cerana*) Compared to the European Hive Bee (*Apis mellifera*) As a Crop Pollinator

Currently there is a movement in Asia to import the European honeybee, *Apis mellifera*, for commercial exploitation, and this has become a controversial subject amongst biologists and beekeepers. The pros, cons, and unanswered questions concerning the development of beekeeping with *Apis mellifera* and *Apis cerana* are summed up in the following passages.

Exotic *Apis mellifera*: Problems and Prospects

As a result of continuous research efforts in the area of genetic diversity, selective breeding, and improved management practices, *Apis mellifera* produces three times more honey than *Apis cerana*. Further, *Apis mellifera* is superior to *Apis cerana* because of its maintenance of prolific queens and because of less swarming and absconding tendencies. However, many importations of exoitic *Apis mellifera* into the HKH Region have proved disastrous. When kept sympatrically, *Apis cerana* and *Apis mellifera* colonies frequently rob each other. Another cause of failure in the coexistence of the two species is attempted intermating which produces lethal off-spring. A new problem is the transfer of parasites from one species to another.

A parasitic mite of brood and adults, *Varroa jacobsonli*, can co-exist with *Apis cerana* and causes no serious damage to this native bee species. In several parts of Asia, where these bee species are now kept together, the parasite has infested *Apis mellifera* colonies and has become a serious pest to this unadapted host. There is now apprehension that importation of *Apis mellifera* will lead to the decline of *Apis cerana* populations in their native habitat to a level that threatens their existence as a valuable genetic resource. In Japan and China, *Apis cerana* is now largely replaced by imported *Apis mellifera* colonies. Other Asian countries, such as Pakistan and India, are now following this trend.

Apis cerana: Problems and Prospects

Apis cerana has many valuable characteristics of biological and economic importance. These include their docile and industrious nature, their being less prone to attacks from wasps, and a high level of resistance to nosema disease and the parasitic Asian mites, *Varroa jacobsonii* and *Tropilaelaps clarae*, which plague *Apis mellifera*. *Apis cerana* can coexist with other native bee species and little chemical treatment of colonies is required to control epidemics. However, as yet, this native bee species has not become popular amongst beekeepers because of several behavioural characteristics. These inlcude their frequent swarming and absconding, their tendency to rob, their production of a large number of laying workers, and their lower honey yields. These negative traits show eco-geographical variations, depending upon the sub-species, geographic ecotype, and management efficiency of the beekeepers, and are amenable through research.

Some of these undesirable behavioural traits, from a beekeeping point-of-view, emerged in *Apis cerana* during the process of evolution as a result of harmful exploitation of this bee species by man. For example, through traditional methods of beekeeping, which are in vogue even today, most of the bees during honey harvesting were killed and no honey store was left behind in the nest for consumption by bees during

dearth periods. As a result of this, the colonies of *Apis cerana* that survived and propagated in nature have developed the traits of frequent migration and absconding to safer and better pastures. In order to reverse such trends, a strategy through development and promotion of beekeeping with *Apis cerana* in modern movable hives is needed where moderate honey harvests are collected in a timely manner without harming the bees. In order to make such strategies successful, the foremost requirement is exploration and evaluation of different sub-species/geographic ecotypes of *Apis cerana*, which is now a major research focus at ICIMOD.

A recent survey conducted in ICIMOD by the authors revealed that *Apis cerana* is suffering a precipitous decline and is threatened with extinction throughout its entire range. The major threat comes from its replacement with the exotic and more prolific *Apis mellifera* and the recurrence of sacbrood virus disease which earlier had killed more than 95 per cent of the colonies in the region. While the consequences of a decline in *Apis cerana* in its native habitat can be speculated upon, it is clear that such a decline is undersirable in terms of economic development, maintenance of biodiversity in natural ecosystems, and productivity of farming ecosystems.

Comparative Foraging Behaviour of *Apis cerana* and *Apis mellifera* on Indian Mustard (*Brassica juncea*, var Khumal Broad Leaf)

The investigations carried out by our research group at ICIMOD on the foraging behaviour of these two species are summarised below (see plates of these species, page 30).

Apis cerana began foraging earlier in the morning (mean time 0626) than *Apis mellifera* (mean time 0649). In the evening *Apis mellifera* stopped earlier (mean time 1811) than *Apis cerana* (mean time 1821). The average duration of foraging activity was 11.55 for *Apis cerana* and 11.22 hours for *Apis mellifera*. Differences in all three parameters were significant at P= 0.01.

The duration of an individual foraging trip by *Apis cerana* was 23.24 ± 0.22, significantly shorter (P = 0.01) than the time of 25.29 ± 0.57 for *Apis mellifera* (Table 3.1).

Table 3.1: Comparative Foraging Behaviour of *Apis cerana* and *Apis mellifera* on Indian Mustard flowers during February/March in the Kathmandu Valley, Nepal

(Values are Mean ± S.E.)

Parameter	*Apis cerana*	*Apis mellifera*
Initiation of foraging (time of day)	0626 ± 0.65	0649 ± 0.65**
Cessation of foraging (time of day)	1821 ± 0.36	1811 ± 0.35**
Duration of foraging activity (h)	11.55 ± 0.92	11.22 ± 0.57**
Peak foraging hours (time of day)	1200 - 1300	1300 - 1400**
Duration of foraging trip (min)	23.24 ± 0.22	25.29 ± 0.57**
Time spent on flower (sec)		
0900 h	3.23 ± 0.15	3.22 ± 0.22
1200 h	2.75 ± 0.16	3.06 ± 0.16
1500 h	2.75 ± 0.15	2.74 ± 0.16
Time taken to shift from flower to flower (sec)		
0900 h	1.96 ± 0.17	1.81 ± 0.17
1200 h	1.75 ± 0.13	1.61 ± 0.13
1500 h	1.64 ± 0.13	1.61 ± 0.11
Number of flowers visited per min.		
0900 h	11.65 ± 0.29	12.20 ± 0.37
1200 h	11.68 ± 0.57	13.43 ± 0.52
1500 h	13.75 ± 0.52	14.23 ± 0.39
Pollen loads (mg)		
0900 h	13.05 ± 0.48	21.14 ± 1.00
1200 h	12.05 ± 0.62	23.58 ± 0.62
1500 h	13.57 ± 0.46	25.74 ± 0.70
Number of bees per plant.		
0900 h	2	2
1200 h	3	4
1500 h	3	3
Top vs side workers	A few, about 1-5% of side workers of both species were observed during morning hours.	

For times of initiation; cessation and duration of foraging activity, duration of foraging trip; and weights of pollen loads, differences between species are significant (P = 0.01).

Both species of honeybee did not differ significantly in behavioural characteristics such as time spent while foraging on each flower, time taken to shift from one flower to another, number of flowers visited on each plant at a time and the ratio between top versus side workers (Table 3.1).

Nectar collectors outnumbered pollen collectors (P = 0.01) for both species throughout the day, except at 1200h in *Apis mellifera* when pollen collectors were significantly more than nectar collectors. The ratio of nectar collectors to pollen collectors varied considerably with the time of day and between species at different times of the day (Table 3.2). For *Apis cerana*, more bees were collecting nectar than pollen at 1500 and 1200h; whereas, for *Apis mellifera,* nectar collectors were more numerous at 0900 and 1500h, pollen foragers of *Apis mellifera* outnumbered those of *Apis cerana* at 0900, 1200, and 1500h.

Table 3.2: Percentage of *Apis cerana* and *Apis mellifera* Honeybees Collecting Pollen, Nectar and Both from Indian Mustard Flowers during Different Hours of the Day in March in the Kathmandu Valley, Nepal

(The data are based on ten observations)

	0900 h		1200 h		1500 h	
Forager	*cerana*	*mellifera*	*cerana*	*mellifera*	*cerana*	*mellifera*
P	17	39	29	60	11	38
N	38	61	71	40	89	62
PN	0	0	0	0	0	0
P:N	1.0:4.9	1.0:1.6	1.0:2.4	1.5:1.0	1.0:8.1	1.0:1.6

P<N at 0900h, 1200h, and 1500h for *Apis cerana* and at 0900h and 1500h for *Apis mellifera* (at P=0.01)

P<N at 1200 h for *Apis mellifera* (at P=0.01)

P = Pollen collectors
N = Nectar collectors
PN = Pollen plus nectar collectors
P:N = Ratio between pollen and nectar collectors

The peak of activity for *Apis cerana* (mean number of incoming bees/ three minutes) occurred between 1200 - 1300 hours when the temperature was 25.8 to 27.4°C; relative humidity range 52.2 to 58.4; and, for *Apis mellifera*, it occurred between 1300 to 1400 hours when the mean outside temperature was 25.6 to 27.4°C and the relative humidity ranged from 52.2 to 56.6 per cent (Table 3.1).

Apis mellifera

Apis cerana

The mean pollen load of *Apis mellifera* workers was consistently heavier (P = 0.01) than that of *Apis cerana* (Table 3.1). *Apis mellifera* bees on the average visited slightly more flowers per minute than *Apis cerana* but the difference was not significant.

Based on the above data on the foraging behaviour of *Apis cerana* and *Apis mellifera*, and on data collected by other investigators, it can be established/concluded that *Apis cerana* has several distinct advantages over *Apis mellifera* for the pollination of agricultural crops. These are described below.

Initiation of Foraging Activity

Apis cerana begins foraging activties earlier in the morning and at lower temperatures than *Apis mellifera*. According to reports, the foraging activities of *Apis cerana* take place at temperatures from three to five degrees centigrade lower than those known to initiate *Apis mellifera* foraging activities. Further, the peak foraging activities of *Apis cerana* are observed at temperatures from five to six degrees centigrade lower than those of *Apis mellifera*. Thus, *Apis cerana* could be used for crops in early spring and at latitudes at least as far north (or south) as those where *Apis mellifera* are used.

Flight Range

The flight range of *Apis cerana* is less than half that of *Apis mellifera*. This is of particular interest, especially in the case of pollination, because the foraging activity of *Apis cerana* is more focussed on a smaller area and thus this bee species is better suited to the pollination of specific crops grown on smaller plots. An *Apis cerana* hive placed in the vicinity of a specific crop will pollinate that crop without wandering/escaping to different areas. Because of its shorter flight range, it will forage in areas closer to the hive than *Apis mellifera*.

Duration of Foraging Activity

The average duration of foraging activity per day of *Apis cerana* is more than one hour longer than *Apis mellifera*. This is because of the

early initiation and late cessation of foraging activity. *Apis cerana* may thus ensure adequate pollination of the crop in bloom in a lesser period of time, particularly during adverse weather conditions, e.g., during the monsoon or frosty spring seasons when honeybee activities become severely limited.

Competition for Food and Nesting Site

The exotic species, *Apis mellifera*, may compete for food, i.e., nectar and pollen sources with the *Apis cerana* and other native pollinators. The exotic, *Apis mellifera*, will also take away nesting and resting space from the *Apis cerana* and other native pollinators, including birds. As a result of the habitat loss caused by severe deforestation and rapid agricultural transformation, both food sources (nectar and pollen) as well as nesting sites are becoming an increasingly limiting factor throughout the range of *Apis cerana*. Thus, the introduction of *Apis mellifera* will reduce the populations of native pollinators or cause them to be maintained at much lower levels than if these exotic honeybees were not present. The deletrious effects of such competition are more likely to be found in the case of *Apis mellifera* and *Apis cerana* as both these honeybee species occupy the same ecological 'niche' and are also more closely related to each other in habits, constitution, and structure. Since the *Apis mellifera* is more aggressive and prolific than the *Apis cerana*, according to the competitive exclusion principle, this exotic species of honeybee will completely displace *Apis cerana*.

Co-evolution of Native Bees and Crops

A large number of native plants in the Asian region (for example native fruits and vegetable crops) and *Apis cerana* evolved together. It is also true that honeybees collect nectar and pollen from a large number of these plants. Thus the plants that have evolved closely with *Apis cerana* as vectors of pollen have developed symbiotic relationships with them and they are thus indispensable one to the other. Exotic *Apis mellifera* may inefficiently pollinate such native crop plants and reduce their reproductivity.

Low Cost of Colony Maintenance

Beekeeping with *Apis cerana* requires low maintenance costs in comparison to beekeeping with *Apis mellifera* which requires expensive technology, and small and marginal farmers in the developing countries of Asia cannot afford it. *Apis mellifera* colonies also require chemical treatment to control epidemics, and this is undesirable for both economical and environmental reasons. In contrast, colonies of *Apis cerana* require a lesser degree of chemical treatment to control epidemics.

Native Bees are an Integral Part of the Cultural and Natural Heritage

Beekeeping with *Apis cerana* is a traditional occupation which forms an integral part of the cultural and natural heritage of rural communities in Asia. Such an environmentally - friendly craft may soon be discontinued as a result of the introduction of the exotic *Apis mellifera*.