

## CHAPTER - 7

### DISCUSSION

#### 7.1. Relatedness of colonies seasonally occupying the same nest site

The microsatellite data reveal that swarms of *A. dorsata* occupying the same nest site in subsequent seasons were not related and did not confirm the hypothesis that relative colonies might seasonally occupied the same nest site after migration (Table 13). Why the same nest site is occupied by unrelated colonies of *A. dorsata*? There are several hypotheses plausible.

##### 7.1.1. Values of old combs

Comb primarily made from wax producing from the abdominal gland (Snodgrass, 1956) and modified by mandibular glands secretion of honey bees (Hepburn, 1986) is relatively a stable and important source for nest site recognition cues (Breed et al., 1988; Page et al., 1991). Lindauer (1956) explained that *A. dorsata* migrate leaving the empty combs behind as a sign of old nest site and the same nest site is occupied during the favorable conditions in the consecutive year where previous year combs are existed (Husain, 1938, Pandey, 1974, Ahmad, 1989). The genetic data demonstrate that the same nest site is seasonal occupied by unrelated colonies. The most plausible explanation is that *A. dorsata* swarms occupy the old nest site 1-2 weeks earlier than honey flow season in the favorable conditions carrying honey with them. In this circumstance, curtain formation bees carrying honey in their honey stomach can not adhere on each other for a long time. Therefore, they immediately need a comb to store their honey. As a consequence, the swarms used wax from old comb that they left to construct the new nest. As a consequence, that means, swarms always occupy to the old nest site. The alternative explanation is that after surviving in a prolong over rainy resting season, swarm is unable to make a

comb due to lack of wax producing young bees. As a consequence, they need extra source of comb (wax) to construct a nest which can be obtained from old nest to get start until the young bees emerged from the new colony.

To determine the value of combs, old combs were manipulated around the window frames of the health care center building. One window frame manipulated with old comb and the wax bulbs was attracted a colony while the other window frames with old combs, but without the wax bulbs were failed to attract colonies. The combs manipulation experiment suggests that *A. dorsata* employ both old combs to construct a new nest and wax bulbs to determine protectiveness of a new site. These experiment validated the previous reports of Mahindra et al., (1977) and Reddy (1980). They have also reported that *A dorsata* swarms seasonally reoccupied the old nest sites use the old deserted combs to construct or to get start new nests.

#### **7.1.2. Protected nest sites**

Deserted empty combs are also a source for the recognition cue of the old nest site used by honey bees (Lindauer, 1956). It is possible that the existed comb is not only confirmed the physical enclosure of the nest site, but also the protectiveness of the nest site. Lindauer (1956) explained that scout bees mainly used 3 characters to select a new nest site. First, protectiveness of the nest site from climatic changes. The nest site chosen by *A. dorsata* swarm for nesting is usually not directly exposed to wind currents and partially sheltered (Deodikar et al., 1977; Mardan, 1989; Crane, 1990). This could be a reason that *A. dorsata* swarms always occupied the same window frame (east site) of the health care center building. Second the size of the nest support and third the distance from the swarms. Swarms closer to the old nest site have first opportunity to occupy the protective nest site rather than migrant swarms.

## **7.2. Relatedness of aggregated colonies on a single support**

This study is the report to explain the hypothesis-II: about the relatedness of aggregated of *A. dorsata* on a single support. The microsatellite data demonstrate that colonies of *A. dorsata* aggregated on a single water tower of the Maejo University were combination of related and unrelated families (Table 15). Why the aggregated colonies are related and unrelated? Several hypotheses are plausible:

### **7.2.1. Aggregation is a result of short distance migration of the first swarm**

The most plausible explanation is that aggregations may have arisen as results of a swarm from one or other colony nesting adjacent to the parent. The first move of swarms (*A. mellifera*) prefer to move short distance when the abundant suitable nest sites are available (Seeley and Morse, 1977; Jaycox and Parise, 1980, 1981; Gould, 1982; Rinderer et al., 1982). Lindauer (1955) described as a mechanism of reproductive swarming in *A. dorsata* which he called "budding". In this process, a large number of workers leave the parent colony and set up a nucleus at a short distance. This process does not involve a combless bivouac stage as is observed in *A. mellifera* reproductive swarming. Workers leave the parent nest over a period that extends for several days. Lindauer does not report whether the old queen or a virgin queen leaves to head the nucleus.

### **7.2.2. Aggregation is to enhance mutual defense**

Other possible explanation is that the nests of *A. dorsata* are heavily predated by large animals (Singh, 1962; Koeniger and Koeniger, 1980; Seeley et al., 1982; Mardan, 1989; Wongsiri et al., 1996a). The worker bees of *A. dorsata* release a high amount of alarm pheromone (iso-pentyl acetate) when disturbed (Morse et al., 1967; Koeniger et al., 1979) usually cause alter to other colonies and ultimately sting (Maschwitz, 1963; Frisch, 1967; Morse et al., 1967). Koeniger (1975) disturbed a colony of *A. dorsata* in Sri Lanka, colony took 2 days to become calm. Lindauer was pursued for more than a

kilometer by bees of a colony that he disturbed. Another example is in Thailand, an old lady was killed by massive attack of *A. dorsata* (Bangkok post 1997). On the other hand, Seeley et al., (1982) disturbed an *A. dorsata* nest in Khao Yai National Park Thailand in order to determine aggressiveness of other aggregated colonies nearby. They found that the nearby colonies did not attack the nest intruder. If the previous experiment of Seeley et al., (1982) is true, then aggregation has nothing to do with mutual defense. However, they have not mentioned the colony disturbed time. The aggressive behavior of *A. dorsata* is extremely governed by temperature, hours (time of day), distance between the nests and indeed the nest site (Morse and Laigo, 1969). Therefore, additional experiments are need to test this hypothesis. The observations suggest that aggregation phenomena, even though a mimicking strategy, provides an additional mechanism of cooperative defense to minimize nest intruders (Brock and Riffenburg, 1960).

### 7.2.3. Aggregation is to accelerate outbreeding

The plausible explanation is that the virgin queens of *A. dorsata* mate with 13-39 drones (Oldroyd et al., 1996) during her short mating flight period at a short distance around 700 m from her nest site (Koeniger et al., 1994). The aggregation may probably reduce mating and predation risk. It is very important that a drone congregate area must consists of a diverse population of drones from multiple nests. As a consequence, aggregation phenomena can minimize the time required for virgin queens to locate a drone congregate area (Ruttner and Ruttner 1972; Koeniger et al., 1994) mate and return to nests. During the mating periods, a virgin queen fly several time for mating with many drones. So, aggregation may minimize mating with her brothers and genetic load imposed by diploid males (Oldroyd et al., 1995). This hypothesis is validated by the genetic results of this study that the swarms genetically related may settle distantly from related colonies to minimize the inbreeding and unrelated colonies may settle closely with each other to accelerate outbreeding. The multiple mating of *A. dorsata* queens is a potentially risky of predation (Moritz, 1985). However, the queens mate in dusk and below the canopy (Koeniger and Koeniger 1980) and the mating

period of *A. dorsata* queens is relatively very short less than 10 minutes with many drones in one flight then to minimize the predation risk (Rinderer et al., 1993; Koeniger et al., 1994).

### 7.3. Seasonal migratory patterns of *A. dorsata*

The results of this research suggest that *A. dorsata* swarms seasonally abandoned their exposed nest sites and return to the same nest sites during the favorable conditions, however, they do not undertake a long distance migration in Chiang Mai northern Thailand as observed in Sri Lanka (Koeniger and Koeniger, 1980). The migration of *A. dorsata* observed during this study period from 1995-1998 can be divided in to two migratory phases; dry and wet migratory phases (Figure 21).

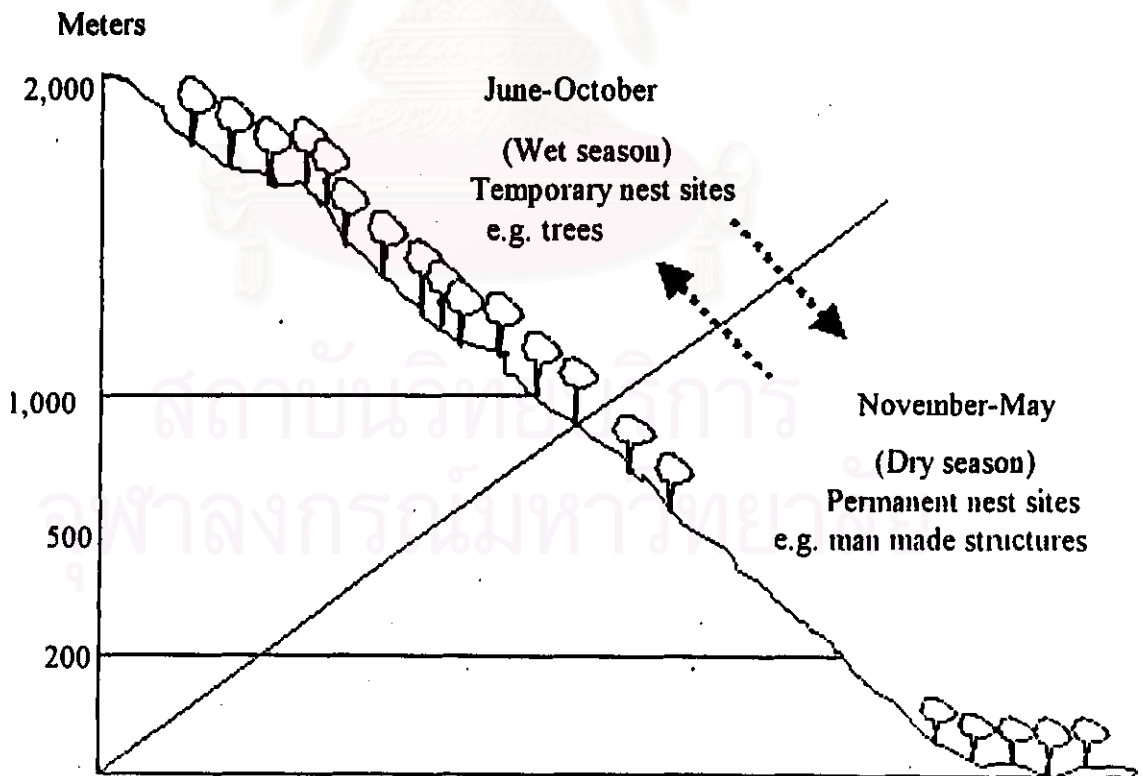


Figure 21. *A. dorsata* colonies movement in Chiang Mai.



### 7.3.1. Dry migratory phase due to favorable conditions

During the dry season, *A. dorsata* swarms commence reoccupation of the old nest sites from November coincided with abundant *Eupatorium odoratum* blooms (Thapa and Wongsiri, 1997). It is interesting to notice that *E. odoratum*, a major honey plant of Thailand, abundantly blooms in land clearing areas and waste lands (Thapa and Wongsiri, 1997). *A. dorsata* appeared to preferentially migrate to disturbed areas like road sides, deforestation, and shifting cultivation areas (personal observation). When *E. odoratum* disappeared from the end of December, *A. dorsata* migrated to agricultural areas at elevation of 310 m (Figure 22) where *L. chinensis* and *D. longana* are grown on a commercial scale bloom immediately after *E. odoratum* (Wongsiri et al., 1998). The peak returning time of *A. dorsata* swarms in Chiang Mai is February correlated with peak the flowering periods of *L. chinensis* and *D. longana*. This type of migration pattern clearly indicates that *A. dorsata* swarms follow the phenological pattern of bee flora and are consistent with previous reports (Wongsiri et al., 1996a, 1998) that they have also observed similar pattern of migratory behavior of *A. dorsata*.

### 7.3.2. Wet migratory phase due to harsh environmental conditions

During the rainy season, when the food source is limited and intensively rainfall, *A. dorsata* migrated up to 1000 m in the mountainous (forests) areas where teak trees; *Tectona grandis* (Figure 21) and *Mimos*a species are abundantly bloom. From the observation, the forager bees of *A. dorsata* frequently visited flowers of teak trees and *mimos*a species.

Lindauer (1957) reported that the swarms of *A. dorsata* occasionally rest a few weeks without building combs. Koeniger and Koeniger (1980) observed that *A. dorsata* nest sites were normally hidden in foliage and bushes in the rainy season. They have reported that *A. dorsata* foragers collected the pollen in the rainy season in Sri Lanka. Ahmad (1989) reported similar results that *A. dorsata* migrated into deeper

and inaccessible forests during the rainy season in Port Blair, Andaman Islands India, but, none of the above authors have not reported the comb construction and brood rearing activities of *A. dorsata* in the rainy season. The results of this study show that *A. dorsata* built a small comb and rear the brood in the rainy season. Once the colonies have started brood rearing in the rainy season, the swarms spend more than 2 months on a single nest site.

#### **7.4. Migration due to variable environmental factors**

##### **7.4.1. Broodnest temperature versus ambient temperature**

The results suggest that the worker bees of *A. dorsata* can not actively thermoregulate broodnest temperature when the ambient temperature is dropped below 16°C. As the ambient temperature drops, the bees (*A. mellifera*) reduce closer together to form tight cluster (Southwick, 1988; Southwick and Mugaas, 1971) to maintain broodnest temperature 35°C in extremely low temperature (-80°C) (Southwick, 1987) hypothesis seems difficult to test in case of open nest honey bee; *A. dorsata*. The most plausible explanation is that when *A. dorsata* swarm occupied the exposed new nest site in November, they immediately rear the brood under thick curtain. The curtain formation bees of *A. dorsata* do not hang parallel against the comb, but they always stay by projecting their abdomen outwards at angle of 5 degree (Morse and Laigo, 1969). Resulting, cold wind speed 4-8 km/hr can penetrate and cause the broodnest temperatures to drop precipitously. Another possibility is that the curtain formation bees are old age and body hairless. The body hairs are plumose when bees are packed in layers, the hairs form an effective insulating coat for the entire colony (Southwick, 1985) and orange black abdomen of worker bees of *A. dorsata* are not good heat insulator (Otis et al., 1990). This is a reason that *A. dorsata* migrate to the new nest site and keep the small nest size then house bees can spread to cover the whole comb for 2-3 months most of the activity has decreased at the end of rainy season to winter season.

Viswanathan (1950) reported that *A. dorsata* nest maintained a broodnest temperature between 30-33°C when the ambient temperature was 24°C in India. He suggested that bees are unable to maintain the nest activities and brood are viable at much low temperature. However, he did not report the low value of brood viable temperature and temperature measuring period. Likewise, Morse and Laigo (1969) measured the broodnest temperature 30-32°C when the ambient temperature was 27°C in the sunny and rainy days in Philippine. The present results did not agree with the previous reports that *A. dorsata* broodnest temperature was ranged from 30-33°C (Viswanathan, 1950; Morse and Laigo, 1969). Because, the measurement of the broodnest temperature in different seasons of the year. The results of this study show that when the ambient temperature drop below 16°C, the broodnest temperature of *A. dorsata* (n = 3 nests) is ranged from 22°C and 28°C in winter (January) in Chiang Mai, Thailand.

Dyer and Seeley (1987) reported that the bees of *A. dorsata* can not maintain their body temperature sufficiently for flight activities when the ambient temperature was below 17°C, but they have not measured the broodnest temperature. In contrast to summer, *A. dorsata* start to migrate when the ambient temperature reached 40°C in summer which is 6°C above the critical temperature 34°C reported by Mardan (1989). In this study of *A. dorsata* did not migrate and the broodnest temperature did not measure in the summer.

#### 7.4.2. Rainfall

The results show that in Chiang Mai, *A. dorsata* colonies started abandon their nests from June–August is coincided with heavy rainfall. The results reveal that the intensive rainfall for a long time (23 days in June) may cause directly or indirectly water logged into the nests which probably create unsuitable environment to kill the brood.



### 7.4.3. Wind

Analysis of variance tests demonstrate that wind played a significantly inverse role in colony migration. This results suggest that southward nests are highly susceptible to be stronger wind than other sites (eastwards and northwards). In fact, *A. dorsata* nest is large in size and constructed on a solid substrate (Morse and Laigo, 1969; Seeley et al., 1982; Wongsiri et al., 1996a) continuously exposed to solar radiation that cause the combs to become very soft where up it is easily dislodged by strong wind. Deodikar et al., (1977) reported that the nest construction and alignment is extremely governed by wind directions and southern nests are highly susceptible to wind. In the rainy season, the wind directions is southwest (SW) to north (N) hit directly to the southward nests and dislodged. The present results are supported by the previous report of Ahmad (1989) that a wind speed of 8-21 km/h is enough to dislodge *A. dorsata* nests. This could be a reason that the particular window (eastwards facing) of the health care center building is regularly occupied by (unrelated) swarms.

### 7.5. Migration due to predator pressures

The results demonstrate that the predator (honey hunters) is a key factor induce colony migration in *A. dorsata*. In honey harvesting time, the whole colony including the adult house bees and possible the queen were burnt in the peak period of brood rearing in order to harvest good brood and honey. In that circumstance, queen may possibly burn. The observations show that hunted colonies did not migrate immediately if the queen was survived after hunting which indicating that queen probably could not take emergency flight and she needed few days time to reduce her weight.

Results of earlier experiments (Morse and Laigo, 1969; Seeley et al., 1982; Mardan, 1994; Wongsiri et al., 1996a) support this report that unscientific hunting and excessive smoking with fire enforce colonies to abandon their nests. Similarly, Morse

and Laigo (1969) observed that nests of *A. dorsata* are completely destroyed by using fire and smoke in the night in Philippine. Valli and Summers (1988) and Underwood (1990) have also reported similar devastation honey harvesting method used by the Nepalese honey hunters to harvest *A. laboriosa* colonies in Nepal.

#### 7.6. Migration due to parasitic mites pressure

The results indicate that the ectoparasitic mites (*T. clareae*) do not appear to be a significant impact on colony migration of *A. dorsata*. The mite infestation rate was negligibly low as reported by Burgett et al., (1990). The most plausible explanation is that when the mite population is build up beyond the grooming limitation, then possibly *A. dorsata* abandon their nest (Wongsiri et al., 1989). Previous reports suggest that *A. dorsata* can detect the mite infestation sealed brood which they never opened would be limited the spread of mites in the colony. As a consequence, adult bees carry those mites which are clung on their body might not survive during the migratory phase without brood (Woyke, 1987; Koeniger and Muzaffar, 1988) more than 3-4 days (Koeniger and Muzaffar, 1988; Rinderer et al., 1994). Therefore, feeding on brood is obligatory for survival of *T. clareae*. In this study mites were not found in young 1-2 month old nests whereas 6-7 month old nests were infested with mites which indicating that mites population would gradually build up in long lasting nests and are consistent with previous report (Mardan, 1989).

The alternative explanation is that the grooming behavior of *A. dorsata* may not only clean the mites from the body of bees, but also killed them (Koeniger and Koeniger, 1980; Wongsiri et al., 1989; Rath, 1989) due to the mite populations might minimum. However, when the mite populations is built up beyond the grooming capacity then colonies might start migration in order to minimize the mite populations by abandoning their nest leaving the mites behind.