Chapter 9

Migration of *Apis dorsata* in Northern Thailand

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Migration is the act of an animal moving from one spatial habitat to another usually to exploit new resources. It is usually seasonal. In the western honeybee (*Apis mellifera*) colony migration is unusual (Chandler, 1976; Fletcher, 1975), but in the open-nesting Asian species – *A. dorsata, A. florea* and *A. andreniformis* – migration is a normal part of the seasonal cycle (Wongsiri et al. 1996). Adaptive explanations for colony migration in these open-nesting species are poorly understood. However, migration may increase colony fitness by improved food availability, enhanced out-breeding (Oldroyd *et al.*, 1996) and reduction in brood-parasite pressures. Colonies may migrate (abscond) in response to predator pressure and other reasons, for example, when combs are examined after colony departure they often contain no brood or pollen indicating absconding can occur because of imminent starvation.

The purpose of this study was to determine the causative factors of colony migration in *A. dorsata* in northern Thailand. Three possible factors that may initiate *A. dorsata* migration were examined: predators, parasites pressure and environmental conditions.

Materials and Methods

Study sites

The migratory behaviour of *A. dorsata* was observed at 27 established nesting sites in three locations in northern Thailand. These nesting sites were classified into control sites (non-hunted areas: Chiang Mai) and hunted sites (Mae Tung Ting and Mae Hong Son) where colonies were seasonally harvested during the main honey-flow season.

Meteorological data

Meteorological records of northern Thailand were obtained from the Agriculture Extension Division, Department of Agriculture, Chiang Mai University, Chiang Mai (Table 1). There are three seasons: rainy (June–October), winter (November–February) and summer (March–May). January is the coldest month with partial cloud, strong wind and thunder showers. Temperature gradually increases from February and often exceeds 36°C in the summer (May).

Determining effect of predator disturbance

Fifteen colonies (N=12, n=15) were hunted in the traditional way using professional honey-

Table 1. Meteorological data of Chiang Mai city, northern Thailand

Month	Air temperature (°C)						Relative humidity (%)						Rainfall (mm)			Wind speed (km/day)		
	1995		1996		1997		1995		1996		1997		1995	1996	1997	1995	1996	1997
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min						
Jan	-	-	30.6	12.2	29.8	12.7	-	-	89.8	38.0	92.0	37.2	-	0.00	0.00	-	54.3	63.3
Feb	-	-	30.7	15.5	32.5	13.0	-	-	87.7	44.0	81.8	32.0	-	47.5	0.00	-	73.0	77.4
Mar	-	-	35.8	19.0	35.5	17.4	-	-	87.7	44.0	79.4	41.0	-	19.1	0.35	-	86.4	80.7
Apr	-	-	36.2	22.2	30.6	20.2	-	-	77.2	39.0	80.6	50.7	-	209.6	0.80	-	93.1	96.2
May	-	-	34.9	23.5	36.4	23.6	-	-	79.1	47.6	77.3	32.4	-	117.1	0.28	-	96.3	108.2
Jun	-	-	33.5	23.4	34.1	24.2	-	-	84.7	56.6	78.4	52.4	-	107.0	0.20	-	106.9	97.3
Jul	-	-	32.6	23.6	32.2	23.2	-	-	88.5	67.1	85.6	66.8	-	142.0	219.3	-	86.0	81.9
Aug	-	-	31.7	23.0	32.0	23.4	-	-	91.9	71.0	90.8	72.0	-	267.0	223.9	-	75.0	78.0
Sept	-	-	32.7	22.8	32.1	22.8	-	-	91.9	66.7	90.7	67.9	-	257.4	107.2	-	74.0	63.9
Oct	-	-	33.0	21.9	33.8	22.0	-	-	91.4	60.8	91.9	59.9	-	257.2	148.9	-	64.5	65.2
Nov	30.1	19.6	31.7	19.8	31.6	19.5	91.2	59.0	92.8	56.7	89.3	52.3	20.5	156.8	19.8	6.8	60.2	65.2
Dec	29.1	14.3	39.8	15.2	20.8	16.9	90.7	69.0	91.8	46.2	92.1	46.7	0.00	0.00	0.00	6.7	68.9	66.3

Source: Department of Agriculture, Chiang Mai University.

hunters during the main season (March–April) (Wongsiri *et al.*, 1996). After hunting, the colonies were regularly observed and the absconding date recorded.

Determining parasite pressure

Adults bees were collected directly from nests in the evening around 1730 h after the bees had stopped flying and killed in 90 % ethanol. Dead bees were examined microscopically for mites. Sealed brood was cut open randomly and checked by opening caps. Any mites were counted and recorded. Similarly, when colonies migrated (absconded), deserted combs were immediately checked and the number of mites counted.

Determining effect of environmental conditions

A single-comb open-nest honeybee, *A. florea*, was considered an ideal species to act as a control. Two colonies were observed regularly to determine influence of environmental conditions. Brood-nest temperature (T_b) in winter (January) of *A. dorsata* (N=3, n=3) was measured by inserting a thermometer between the curtain formation bees and the brood over 24 h at 2-h intervals. Another thermometer was hung next to colonies of *A. dorsata* and *A. florea*.

Observation of migratory behaviour 1995–1998

Established nesting sites were visited monthly, and the presence or absence of colonies and the number of colonies that arrived, and departure date from their old nesting sites were recorded.

Data analysis

We used non-parametric techniques; c^2 test, and Spearman correlation analysis that were considered as appropriate to examine the relationships between predator-parasites pressure, and environmental parameters with colony migration.

Results

Migration due to predator disturbance

All harvested colonies (N=12, n=15) in Mae Tung Ting and Mae Hong Son migrated after 3–7 days.

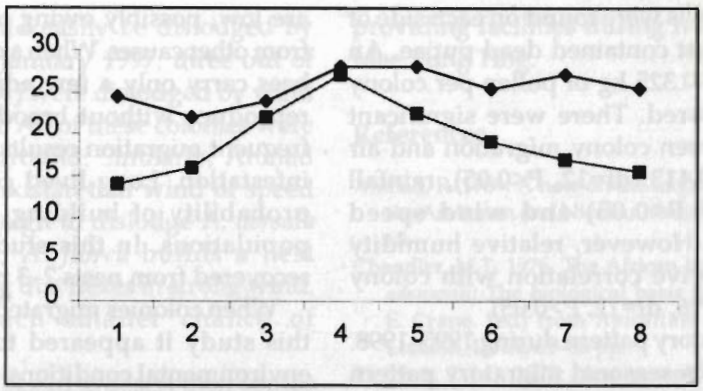

Fig. 1. Brood-nest temperature (T_b) of *A. dorsata* in winter (January)

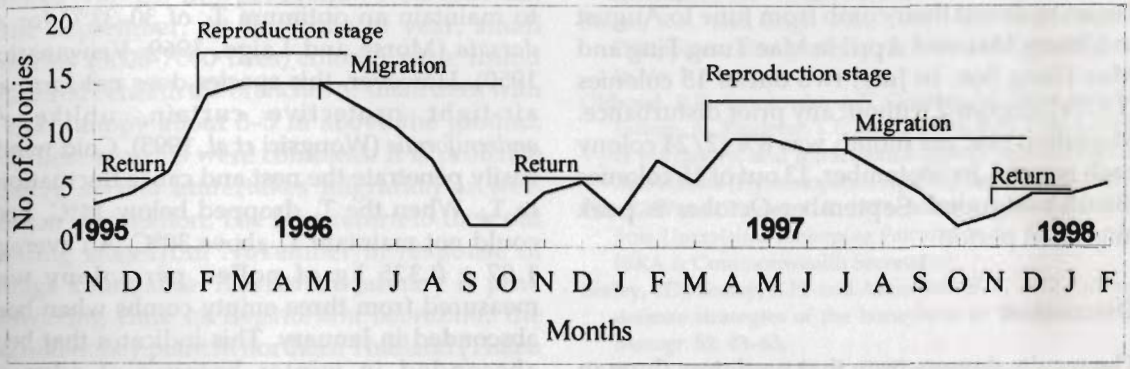

Fig. 2. Seasonal migratory pattern of *A. dorsata* in Chiang Mai, northern Thailand.

No colonies (N=13, n=15) migrated from control nesting sites. Eight out of 15 colonies (60 %) remained 6–9 months (mean=7.2 ± 1.24 months, N=15, n=15), and three out of 15 colonies (20.0 %) remained more than a year (14 months) in control nesting sites. There was a strong correlation between predator disturbance and colony migration (Spearman correlation r=1.00, df=12, P<0.05).

Migration due to parasites pressure

Four out of eight colonies (50 %) had parasite infestation. However, the infestation rate of parasites was negligible. All parasites (*Tropelaelaps claerae*) were collected from adult bees, and three parasites were collected from deserted combs. There was no significant correlation (r= -1.00, df=12, P>0.05) between colony migration and parasite infestation rate.

Colony migration due to environmental conditions

Figure 1 shows T_b of *A. dorsata* and ambient temperature (T_a) (N=3, n=3) in winter (January). The T_b ranged from 22–28°C ($T_{b\ diff}$ = 6°C) reaching a maximum at 1500 h. The T_a ranged from 14-27 °C($T_{a\ diff}$ = 13°C) also reaching a maximum at 1500 h. The greatest difference between T_a-T_b (7°C) occurred at 0900 h.

Temperature fluctuation strongly influenced colony migration in *A. dorsata*. During 2–13 January 1997, four out of 15 colonies (26.6%) migrated when the T_a ranged from 12–14°C. When deserted combs were checked, around 10–

15 sealed brood cells were found on each side of the comb and most contained dead pupae. An average of 1.07 ± 0.325 kg of pollen per colony (N=3) was measured. There were significant correlations between colony migration and air temperature (r=0.413, df=12, P<0.05), rainfall (r=0.756, df=12, P<0.05) and wind speed (r=0.703, df=12). However, relative humidity (RH) had a negative correlation with colony migration (r=-0.996, df=12, P>0.05).

Seasonal migratory pattern during 1995–1998. Figure 2 shows the seasonal migratory pattern (N=13, n=15) in Chiang Mai. Two seasonal migrations, with and without prior aborted swarming preparation, were observed. Bees began to desert their comb from June to August in Chiang Mai, and April in Mae Tung Ting and Mae Hong Son. In July, two out of 15 colonies (13.3%) migrated without any prior disturbance. Migration rate per month was 8% (2/24 colony each month). In September, 13 out of 15 colonies (86.6%) migrated. September-October is peak migration period.

Discussion

The results demonstrate that predators (human honey-hunters) are a significant causative factor in colony migration in *A. dorsata*. Hunters harvested not only honey-storage areas but the entire comb including brood. This is devastating for colony reproduction and survival. Mardan (1994), Morse and Laigo (1960), Seeley *et al.* (1982) and Wongsiri *et al.* (1996) reported similar results for *A. dorsata* in southeast Asia. Underwood (1990) and Valli and Summers (1988) reported similar results for *A. laboriosa* in Nepal. This type of migratory behaviour has also been observed in other honeybees: *A. mellifera scutellata* (Flecther, 1975; Otis and Taylor, 1978; Winston et al. 1979), *A. florea* (Seeley et al. 1982) and *A. andreniformis* (Wongsiri *et al.* 1995).

Our results suggest that parasites do not significantly impact on migration rates of colonies of *A. dorsata*. Parasite infestation rates are low, possibly owing to frequent migration from other causes. When a colony migrates, adult bees carry only a few adult mites that cannot reproduce without brood. As a consequence, frequent migration results in low levels of mite infestation. Long-lived colonies have a high probability of building up significant mite populations. In this study, mites were only recovered from nests 2–3 months old.

When colonies migrated from nesting sites in this study it appeared to be due to adverse environmental conditions. When *A. dorsata* bees return to old nesting sites in autumn, they immediately start to build comb and rear brood. As soon as brooding commences, it is essential to maintain an optimum T_b of 30–33°C for *A. dorsata* (Morse and Laigo, 1969; Viswanatha, 1950). However, this species does not form an air-tight protective curtain, unlike *A. andreniformis* (Wongsiri *et al.* 1995). Cold winds easily penetrate the nest and cause fluctuations in T_b. When the T_a dropped below 14°C, bees could not maintain T_b above 30°C. An average 1.07 ± 0.325 kg of pollen per colony was measured from three empty combs when bees absconded in January. This indicates that bees absconded in winter because of adverse environmental factors not scarcity of foraging resources. It can be concluded that *A. dorsata* starts to migrate when T_a falls to 12°C. This is confirmed by observations mabe by Ahmad (1985). Similar phenomena were observed in *A. laboriosa* (Underwood, 1990). In contrast *A. florea*, observed at the same time, did not abscond despite being directly exposed to wind and rain. The probable reason for this is that *A. florea* does not rear brood in winter, and also forms two to four protective air-tight curtains at the centre of the comb covering honey and pollen areas (Seeley *et al.* 1982; Wongsiri *et al.* 1995).

Strong wind can easily dislodge *A. dorsata* combs. Several colonies nesting on the southern side of buildings, water tanks and trees were directly exposed to strong solar radiation, presumably making the comb soft. As a result,

these soft combs could easily be dislodged by strong wind. On 23 January 1997, three out of seven colonies (42.8 %) were dislodged by wind of speed 32–37 kmph. All of these colonies were 25–40 m above the ground. Similarly, Ahmad (1989) reported in Pakistan that wind of speed 8–21 kmph were enough to dislodge *A. dorsata* combs. In contrast, *A. florea* builds a nest encircling a small twig that flexes in strong wind. So, there is a much smaller chance of dislodgement.

A. dorsata colonies began to desert their combs from June–August in Chiang Mai which coincided with peak rainfall. The maximum rainfall (107–267 mm per month) occurred from June-September. At this time of year, small swarms (3000-7000 bees/colony) were found clustered beneath the branches of small trees with a thin canopy about 3–5 m above the ground. All these swarms were combless. It is probable that *A. dorsata* undertakes migration or wet-season hibernation. The bees return to their old nesting sites from November in response of forage abundance. November–January is peak flowering time of *Eupatorium odoratum*, the second honey plant in northern Thailand (Thapa and Wongsiri, 1997).

In conclusion, if colonies of *A. dorsata* are not disturbed by predators then adverse environmental factors and falling floral resources induce migration.

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