

SEASONAL MIGRATION AND COLONY BEHAVIOR OF THE TROPICAL HONEYBEE *APIS DORSATA* F. (HYMENOPTERA: APIDAE)

Sih Kahono¹, Koji Nakamura² and Moh. Amir¹

1) Division of Zoology, Research and Development Centre for Biology- LIPI
Jl. Raya Bogor Km.46 Cibinong 16911, Indonesia,
E-mail: mzb@indo.net.id

2) Faculty of Science, Kanazawa University, Japan

Abstract

A study on seasonal migration of the tropical honeybee, *Apis dorsata* was conducted in the protected habitat of the Bogor Botanic Garden, West Jawa, Indonesia by monitoring the arrivals and departures of colonies of the honeybee. The colonies arrived in the garden during both the higher mean monthly rainfall and the lower number of rainy days per month and departed during the time of increasing the number of both total monthly rainfall and monthly rainy days. During their stay in the garden, the colonies occupied a certain location and host plant patches. Their duration of stay in the garden was variable. It was 77%, 9% and 4% of the colonies developed, stable and decreased their colony member, respectively. The colonies (23%) performed reproduction by reproducing new queens. Early arriving colonies stayed in very long periods and reproduced colony fission.

Introductions

Tropical honeybee *Apis dorsata* F. is the biggest in both body size and colony members within the species of honeybees. The honeybee distributes widely throughout India and Southeast Asia including Palawan, Borneo

and the chain of islands of Indonesia from Sumatra to Timor and eastward to the Kai Islands (Otis, personal communication).

The species is a well known long-distance traveller and a seasonal migrant between geographically discrete sites (Dingle, 1980). Various lines of evidence indicate that seasonal migration occurs in some populations of *A. dorsata* in Sri Lanka (Koeniger and Koeniger, 1980) and Thailand (Dyer and Seeley, 1991;1994). Observation of nocturnal foraging on moonlit night by colonies of African bee *A. mellifera* was made by Fletcher (1978).

Among rural people their seasonal arrivals and departures are rather common knowledge in some parts of Indonesia. Despite their economic importance and their impressive role in pollination, surprisingly no research has been addressed to their role in the nature.

The purpose of this study is to investigate the seasonal pattern of migration of the colony, their host plant patches, nesting sites, foraging, reproduction, development and natural enemies of the tropical honeybee *A. dorsata* F. in the Bogor Botanic Garden (Kebun Raya Bogor), West Jawa, Indonesia.

Materials and Methods

The Bogor Botanic Garden (Kebun Raya Bogor) is located at 6°37'S, 106°32'E and 260 m elevation from the sea level. Mean monthly temperature fluctuates from 25.3°C in January to 26.8°C in May and September. The average annual rainfall is 3850 mm (range, 2000 to 5500 mm). The driest months of the year are June to August and the wettest are November to January, although cycles of dry and wet seasons are less clear and more irregular than those of central and east Jawa (Nakamura, *et al.*, 1994). The Bogor Botanic Garden was selected as a study area because it is sparsely inhabited by human and colonies of the tropical honeybee *A. dorsata* are frequently observed. Large nests are presented at certain trees in the garden hanging on branches which we could observe easily.

Seasonal changes in the number of colonies of *A. dorsata* was observed by weekly censuses from June 1995 to February 1997 by direct counting of both new arriving and departing colonies, they were separately observed. The behaviour of the colonies in connection to the colony growth and reproduction were examined by (1) individual (specific) naturally occurring colony in the field, (2) investigating the development of both comb and colony member, (3) examining new queen cells and colony fission, and (4) checking and measuring the left nests after departing colony. Because of difficulty in the investigations, we observed the colonies qualitatively by using a telescope. We monitored their natural enemies and factors may responsible to the destruction of the honeybee colonies. Indirect information was also accumulated by questioning to the people and the gardeners. Rainfall data was gathered from the garden during the observations for the extensive discussions.

Results and Discussions

Nesting patches and selection of nesting sites

The Bogor Botanic Garden (the BBG) is relatively undisturbed "natural" habitat. Colonies of *A. dorsata* construct single large combs in relatively open location. The combs were suspended underneath the branches and protected by thick curtain workers, hanging on the horizontal angle of less than 50 degrees of the branch to the trunk of the trees. The colonies tend to hang around at high position of the trees and the nest patches bend upward, 18 m high above the ground level. Surprisingly, of the 23 (88.4%) colonies nesting in that such patches, only 3 colonies were selected at the lower nesting patches (below 10 m) during the 2 years observation. Nesting patches of this species was also observed by Nakamura (second author) in Padang (West Sumatera), however the nest patches were at the roof of a very high building of a bank.

Colonies of *A. dorsata* are big, exposed and tend to use the former nesting patches and aggregate in the former tree. In case of overcrowding of the colony numbers which were nesting in an individual tree (*Ficus albipila*), the later arrival colonies occupied patches in another comfortable near by the tree of the same species.

The distribution of nesting sites of *A. dorsata* inside the BBG was plotted in the map (Figure 1). Nesting site was located from the surrounding of the main gate of the BBG. There were some plant collections *i.e.* *Intsia bijuga* (Calebr.) O.K. (Leguminosae) and *Artocarpus altissimus* J.J. Smith (Moraceae) used for the honeybee patches (see site 1 on the map and Table 1); extended to northeast direction prolonged the Ciliwung river, there were *Chisocheton macrophyllus* King (Meliaceae) and *Canarium decumanum* Baetrn. (Burseraceae) (see site 11 on the map and Table 1); and up to the northern part of the BBG was *Drybalonops arontanlica* Gaetrn.f. (Dipterocarpaceae) located (see site 111 on the map and Table 1), and the last site was mainly *Ficus albipila* (Mic) King (Moraceae) and other surrounding trees (see site IV on the map and Table 1).

Almost each individual of the traditional bee tree usually only consist of one or two colony patches of *A. dorsata* at the same time, however, a giant ficus tree, *F. albipila*, could accommodate more than 25 colonies at the same time of the observation. The frequency of each species of traditional bee tree occupied by the colony of *A. dorsata* during the whole observations was absolutely high in *F. albipila*, 26 colonies (72%) and very low in almost other host plant species, ranged from 1 colony (3%) in *C. decumanum*, 2 colonies (6%) in each *I. bijuga*, *C. macrophyllus* and *A. altissimus*, and 3 colonies (8%) in *D. arontanlica* (Figure 1 and Table 1).

From the gathered information of the host plant patches and their distribution of nesting sites of the honeybee, it seems that the nesting sites of the honeybee was allocated separately from the nesting or roosting sites of other animals in the BBG. If we considered with other major important nesting and roosting site of animals in the BBG, such as gathered of many "noisy and reek" Black-Crowned Night Herons (*Nycticorax nycticorax*)

which were settled along the main street "Kenari street" *Canarium* sp. collections and hundreds of gregarious "reek" fruit bats settled on *Pinus* sp. collections and sometime at the big trees in the surrounding of the BBG's Guest House, the honeybees have selected a different nesting sites inside the BBG and compose a separated "niche" from others. These selections may in order to keep the colony healthy and minimize from competitors and natural disturbing animals.

Migration and seasonal pattern

The first arrival colony in each year of migration season was always single colony in the same date of 20th. June 1995 and 22th. May 1996. The foremost colony of June 1995 and May 1996 stay in a very long period (165 and 195 days, respectively), developed their colony members and reproduced colony fissions. The facts of both long stay period and colony fission of the first arrival colonies in the BBG was opposite to Dyer and Seely (1994) observations of the *A. dorsata* in Khao Yai National Park, Northeast Thailand, as their finding of initially swarms stayed only temporarily (<1 week) and departed some days later, leaving a small disk (≈ 30 cm diameter) of pure white, freshly-built comb (Dyer and Seely, 1991).

After the foremost colonies, progressive wave of immigration occurred at the successive observations, created a huge of the colony numbers (Figure 2, middle). Seasonal changes in number of colonies of *A. dorsata* exhibited distinct seasonal pattern with single high peak at every year of the observations (Figure 2, middle). Almost new arriving colonies came to the BBG during both the higher number of mean of monthly rainfall and the lower number of rainy days per month from August to October of all year observations (Figure 2, bottom). However, the departing colonies started at the time of increasing of both the number of total monthly rainfall (Figure 2, top) and number of rainy days (Figure 2, bottom) from October to December of both year of 1995 and 1996. These contrasting of "seasonal" climate patterns of the BBG may suggest the corresponding to the arriving

and the departing of the colonies of the honeybee *A. dorsata* in the BBG. It was unknown as to where the arriving colonies came from and whether they were new or precedent visitor in the BBG.

Foraging and reproduction

The honey bee could visit to almost every flowering plants in the BBG, however, they frequently visit the flowers of some species belong to the family Palmae, so it may be the most preferred plant. In a different occasion, we also observed the honey bee was collecting something from a wet stone of Ciliwung river, inside the BBG.

We observed some of the honey bee workers was visiting flowers of 2 species of weeds, *Mimosa pigra* and *M. pudica* (Leguminosae) and corn flowers at Baranangsiang, located about 2 km distance from the BBG. Considering the nest of *A. dorsata* colonies did not exist nearby this foraging location (Baranangsiang and surrounding areas), it is likely that the mostly close colonies nest was only the nests occupied in the BBG, so we belived that it was the member of the colonies in the BBG.

Flowers were available throughout the years in the garden but they were more abundant during dry season (the BBG, unpublished data). It seems that an increase in the arrival colonies of the honeybee was correlated to the increase of the food resources availability in the garden, and an increase of the departing colonies was supposed to be dependent on a decrease in the availability of floral resources in the garden. However, further observations and data of flowering phenology in the BBG are needed to the support those assumption.

Colony behaviour

Period of stay of the colonies of *A. dorsata* was very variable in the BBG. Some colonies performed a short (7-15 days), moderate (28-50 days), and long visit (57-195 days). It was 19% (n=5), 31 % (n=8) and 50% (n= 13) in the garden, respectively (Table 2, Figure 3).

The short visiting colonies were arrival colonies of August 1995, October 1995 and November 1995 (1, 3 and 1 colonies, respectively). They constructed only white nest but did not develop the colony member before continuing the journey. However, these all short visiting colonies were not the earliest arrival colonies as happened in Thailand (Dyer and Seely, 1994). Moreover, all short visiting colonies occupied at the giant ficus tree, *F. albipila*.

Colony growth was known by development of the comb and established a dark yellowish-brown comb, indicating that it had been used for rearing their brood. There were 23 colonies (88%) developed the comb and 20 (77%) of them increased and developed their colony members (Table 2). It seemed 5 colonies (9%) of the honeybees did not develop their colony members and 1 (4%) decreased the colony members (Table 2). Of the decreasing colony members, we expect that the colony was in a post reproduction periods and it was in senescent.

Some colonies apparently reproduced by colony fissions as evidenced by the presence of a queen cell along the bottom margin of the comb in October and November. During 2 years observations, 6 colonies reproduced new queens (Table 2). The honeybees take collective decisions concerning the timing of reproduction as well as the number and sizes (e.g. worker populations) of the offspring they produce (Otis and Wilde, 1992).

Available data suggest that the seasonal cycles of *A. dorsata* tend to raise brood and produce reproductive swarms during less rainy months. Colonies of honeybee, *A. dorsata*, exhibited high seasonal pattern of growth and development of the colonies which is supposed to be dependent in parts upon the abundant flowering availability in the garden, from middle to the end of dry period (The BBG, unpublished data). Schneider and Mc. Neely (1993) observed that brood productions in the *A. dorsata* colonies was greatest in the hot dry season between August and October.

Unusual occasion of 13th. of June 1996, a small colony of *A. dorsata* was hanging on the vertical fences (1.5 m upper ground level) in the BBG. The queen did not seem in good condition, however, after 3

days the colony disappeared to somewhere else. I expected that colony was aged and waiting for damaging of the colony.

Natural enemies

From the gardener of BBG, it was informed that some peoples were attacked by the angry honeybees in the same time when the colony of the honeybees was damaging by unknown animal.

Honey harvesting by rural people using fire in Java could affect a decrease in the colony members because many of them were killed and may also kill queen bees. However, no evidence of honey harvesting by the people in the BBG.

In the morning time of 16th. November 1996, a part of a developed comb, fully with honey, pollen and brood was fallen down by unknown agent at night. Workers of the honeybee were still busy to recollect the honey from the fallen comb. Soon later, the disturbed colony disappeared. We expect that disturbances to the honeybee colony may force their migratory movement.

We also observed some wax-caterpillars attacked the leafing comb after the honeybee colonies departed, however we did not suspect that the waxcaterpillars had attacked the nest when the honeybee was occupying the combs.

In Ciomas village (about 8 km from the BBG) a big *Ceiba petandra* tree was used as an annual patch site of *A. dorsata*. Every year some colonies of *A. dorsata* stayed and developed their broods. Unfortunately, in 1992 the tree was cut. The successive years after cutting the tree, we observed the annual migration of the colonies in some locations nearby the former patch site (near the cutting free), however, we did not find the migratory colonies there. We suspect that the migratory colonies select only certain tree for their survival in a certain environment. We have no sufficient data to say that a decrease in the number of their nesting patches and the quality of the environment may affect to a decrease in the number of colonies. However, it was interrupted to the important part of their long roadway of the migration (Dingle, 1980).

A decrease in the number of traditional patch caused by cutting of big trees in nature makes the existence of the garden more important in relation to the availability of floral resources and host patches for their success in migration.

It is suggested that more detail study on their migration activity, flowering information and other related knowledge in the BBG is necessary.

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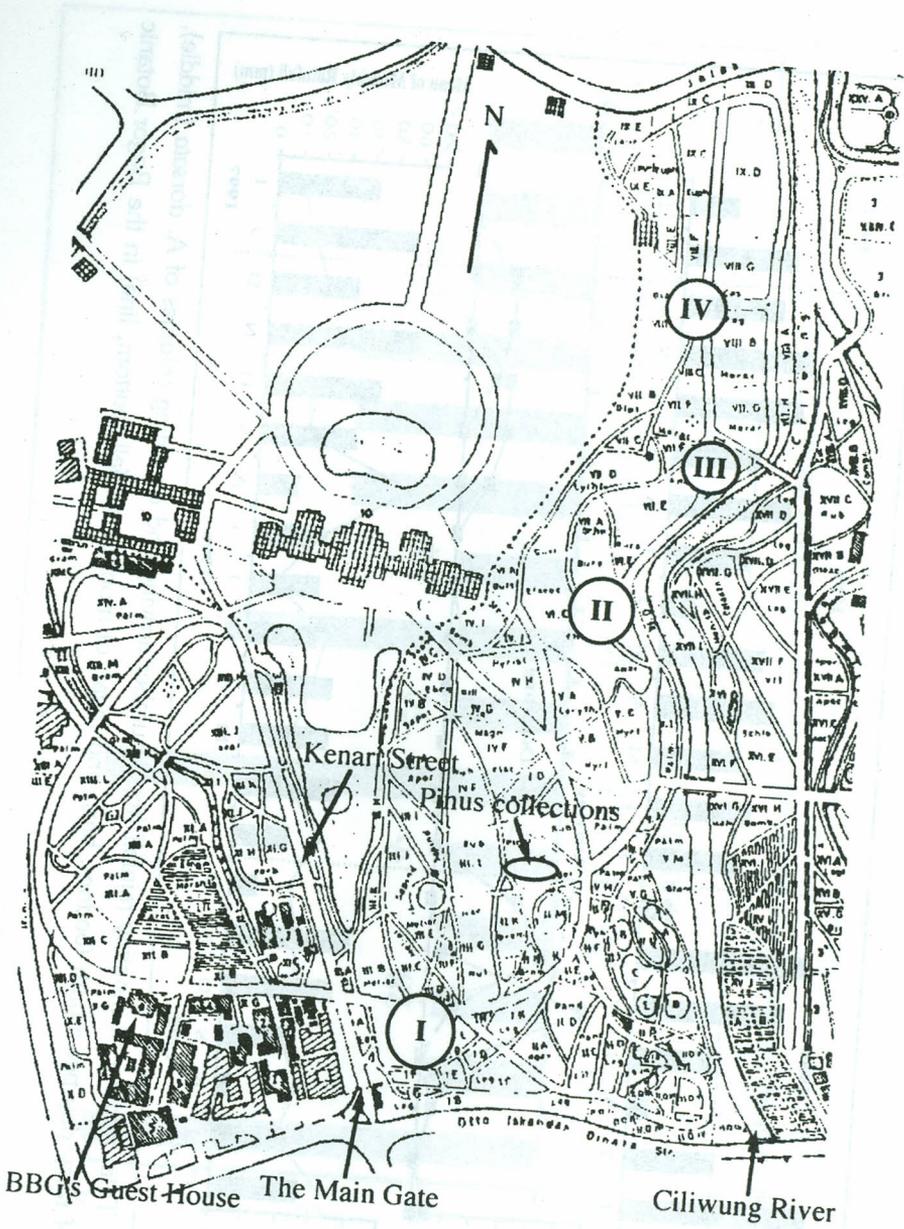


Figure 1. A map of the Bogor Botanic Garden with the nesting sites of tropical honeybee, *A. dorsatu* (I, I, III, and IV).

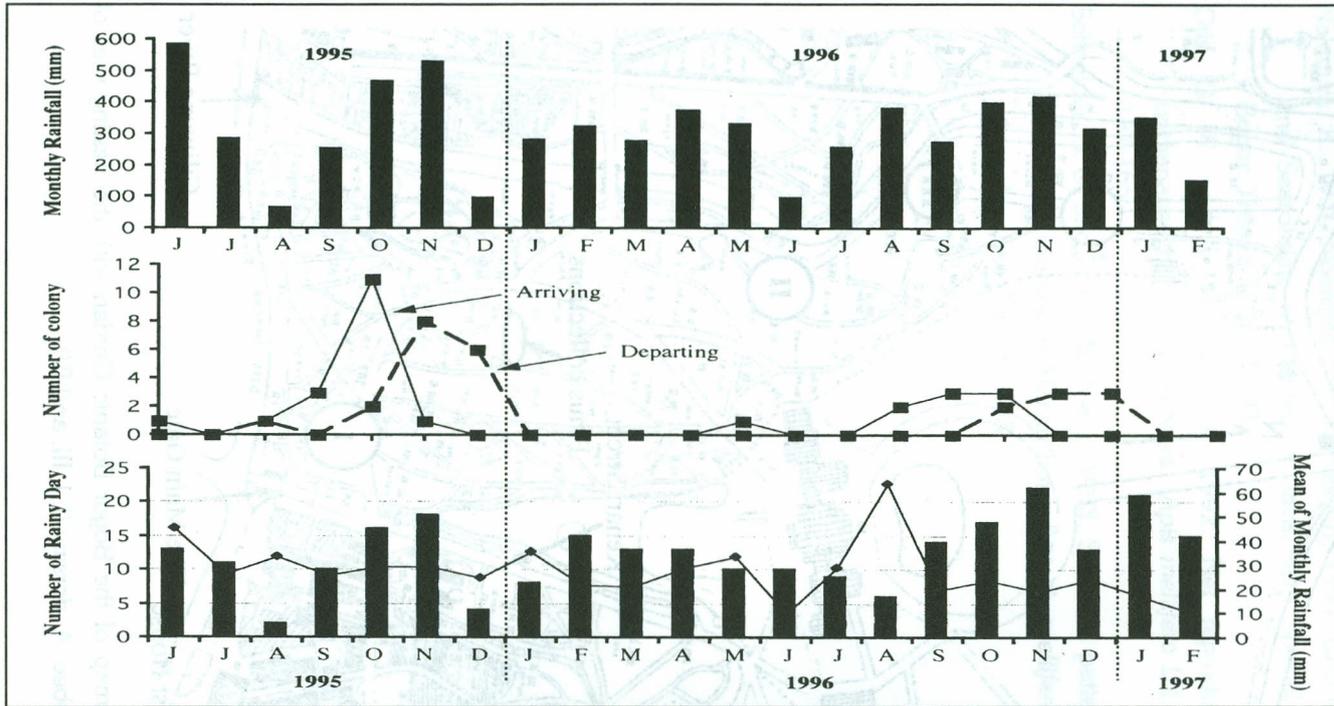


Figure 2. Total number of monthly rainfall (top), number arriving and departing colonies of *A. dorsata* (middle), number of rainy day per month (bottom, bar), and mean of monthly rainfall (bottom, line) in the Bogor Botanic Garden.

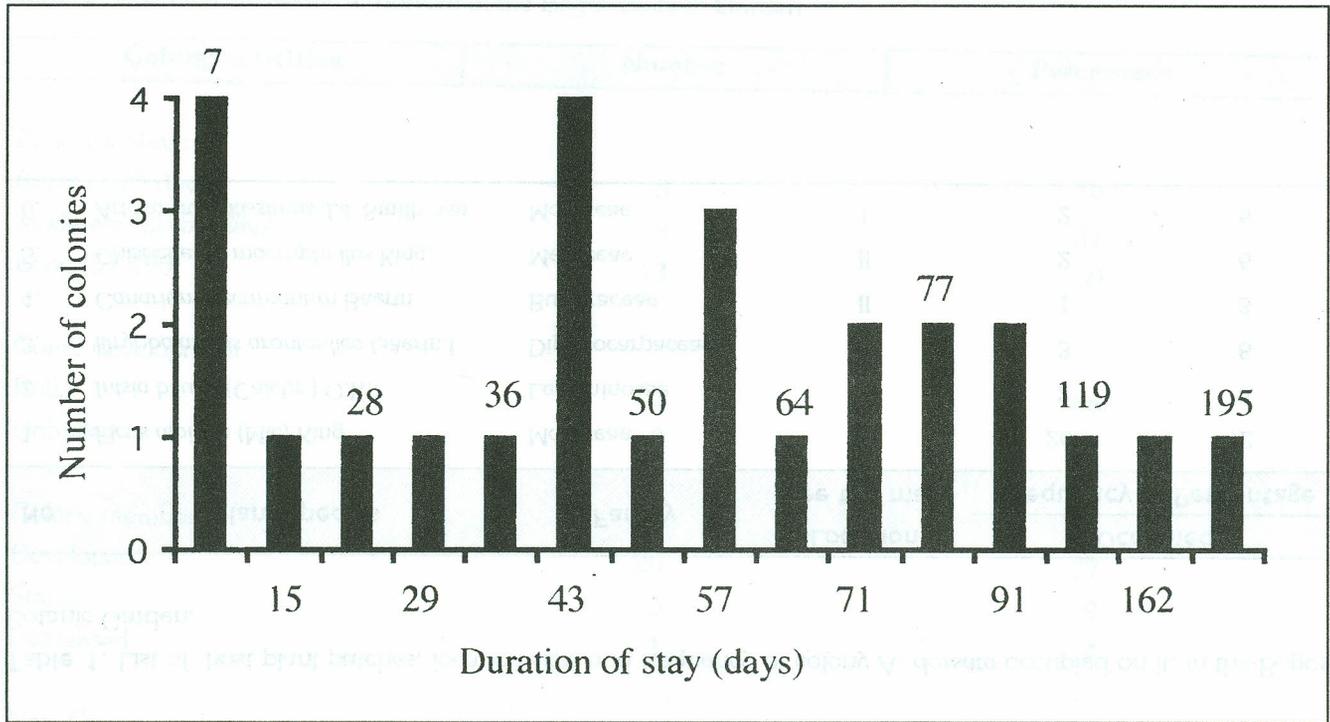


Figure 3. Duration of stay of the tropical honeybee, *A. dorsata* in the Bogor Botanic Garden.

Table 1. List of host plant patches, location sites and frequency of colony *A. dorsata* occupied on it, in the Bogor Botanic Garden.

No.	Plant Species	Family	Location (see the map)	Occupied	
				Frequency	Percentage
1.	<i>Ficus albipila</i> (Mic) King	Moraceae	IV	26	72
2.	<i>Intsia bijuga</i> (Calebr.) O.K.	Leguminosae	I	2	6
3.	<i>Dryobalanops arontanlica</i> Gaertn.f	Dipterocarpaceae	III	3	8
4.	<i>Canarium decumanum</i> Baertn	Burseraceae	II	1	3
5.	<i>Chisocheton macrophyllus</i> King.	Meliaceae	II	2	6
6.	<i>Artocarpus altissimus</i> J.J. Smith. var.	Moraceae	I	2	6

Table 2. Colony activities of *A. dorsata* in the Bogor Botanic Garden

Colony activities	Number	Percentage
Period of stay :		
Short (7-15 days)	5	19
Moderate (28-50 days)	8	31
Long (57-195)	13	50
Comb development :		
Build	23	88
Unbuiled	3	12
Colony member :		
Developed	20	77
Stable	5	19
Decreased	1	4
New Queen emerged	6	23
Total colonies observed	26	100