

BEEKEEPING METHOD AND LIFE CYCLE OF EUROPEAN HONEYBEE, *Apis mellifera* Linnaeus, 1758 IN MAGWAY REGION

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Abstract

Beekeeping method and life cycle of European honeybee, *Apis mellifera* Linnaeus, 1758 were conducted in the campus of Pakokku University and Pauk Kone Village, Magway Region during September, 2017 to May, 2018. Migratory beekeeping method was more suitable in the study area instead of stationary methods due to unavailable food sources in main station throughout the year. It was observed that three different castes of honeybee were included in a colony (queen, worker and drone). Honeybees have five stages in their life cycle: egg, larva, prepupa, pupa and adult. The developmental period of the drone from egg to adult stage was the longest (24 days) and followed by worker (21 days) and queen (16 days). Among the castes, queen is the largest and heaviest than drone and worker. Understanding of life stages of *Apis mellifera* may help the proper management of honeybee colonies. The sizes of honeybee were assumed to be depended on the sufficient of food sources and environmental factors. The data of the present study would provide the information to further researches concerned with beekeeping and ontogenetic development of the honeybee and other related researches. Beekeeping could create the good opportunities of job for livelihood of rural people.

Keywords: European honeybee, *Apis mellifera*, Beekeeping methods, life cycle.

Introduction

Honey bees are the main insects which help in pollination of different species of plants (Sawyer, 1981). Honey bees play an important role for cross-pollination, or the transfer of pollen from one plant to the stigma of another plant leading to the process of fertilization (Suwannapong *et al.*, 2012).

In Asia, a total of 11 honey bee species were recorded (Michener, 2000). Some species are being domesticated and employed as pollinator and production of bee product such as honey, beeswax, bee pollen etc, were used in various ways (McGregor, 1973). A colony of honeybee consists of a queen, several thousand workers and in a certain season of the year- a few hundred drones. Among the members of the colony there is a division of labor and specialization in the performance of biological functions (Wintson, 1987).

Beekeeping is one of the oldest known forms of food production. Some of the earliest known evidences of beekeeping are from a rock painting, dating to around 13,000 BC (Kleinjans *et al.*, 2012). Beekeeping can also create social benefits when small-scale farmers join together to form an association, either formal or informal (Hilmi *et al.*, 2011).

Beekeeping had been practiced with two methods such as stationary and migratory method for providing food for human and serving as pollinators to improve the crop quality and quantity. In stationary method, the beehives were maintained in only one place which gives enough food for the bees. When the food sources were rare in that place, the bees can be kept by giving them supplementary feeding without migrating to other places for food sources. In migratory method, the beehives were always moved to various places where plants were enough to provide sufficient food sources for bees throughout the year.

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The present work was conducted with following objectives: to investigate the suitable beekeeping method practicing in the study sites of Magway Region, to record the life cycle of European honeybee, *Apis mellifera* keeping in the study sites.

Materials and Methods

Study Area and Study Period

The study was carried out in Pakokku University Campus, 21° 21' 06.11" N and 95° 04' 18.44" E, and Pauk Kone Village, 20° 26' 27.24" N and 94° 49' 41.59" E in Magway Region during September, 2017 to April, 2018.



Plate 1 Map showing the study sites (Source: Google Earth 2018)

Apparatus Used in Beekeeping

Apparatus used in beekeeping were wooden box (61 cm × 43 cm × 34 cm), wooden frame (6 frames for each box), smoker, hive tool, bee brush, Bee veil, gloves and bee suit.

Source of Honeybees

Three beehives of honeybees, *Apis mellifera*, were purchased from Department of Apiculture, Magway Region.

Food Source Plants in Study Sites

In Pakokku University Campus, Magway Region, there are several plum trees and various flowering plants providing nectar and pollen as favorable food source for honeybees. In Pauk Kone Village, Magway Region, honeybees preferred food source such as sunflower, gram and maize were abundant during the study period.

Data Collection

Beehives were checked weekly at the apiary of study sites between 8:00 AM to 11:00 AM. Each 20 samples for all life stages such as eggs, larva, prepupa (cell capped), pupa and adult stages were collected and recorded their length and weight.

Identification

The honeybees collected were identified according to Bingham (1897).

Beekeeping Methods

Beekeeping was practiced according to Cramp (2008).

Environmental Parameters

Monthly mean temperature, relative humidity and rainfall were recorded from Hydrology and Metrology Department, Magway Township, Magway Region.

Statistical analysis

Collected data were statistically analyzed by using Microsoft Excel (2010) and presented as mean and standard deviation, and expressed with graph.

Results

Characteristic of Recorded Honeybee, *Apis mellifera*

Body length of worker is 12.2 ± 0.54 mm (n=20). The male drone is 15.3 ± 0.67 mm (n=20), and the queen is 19.5 ± 1.35 mm (n=20) long. Body is golden brown and black, with pale yellow rings on the abdomen. The head, antenna, and legs are almost black; fine hairs cover the thorax and only lightly cover the abdomen. Wings are translucent. Pollen baskets are made of specialized hairs and are located on the outer surface of the tibiae of the hind legs. All observed characters of recorded bee are similar to the characters of *Apis mellifera* mentioned by Bingham (1897).

Classification of *Apis mellifera*

Phylum	- Arthropoda
Class	- Insecta
Order	- Hymenoptera
Family	- Apidae
Genus	- <i>Apis</i>
Species	- <i>A. mellifera</i> Linnaeus, 1758

Beekeeping Method Used in the Present Study

A total of three beehives were designated as hive A, B and C. In each hive there are stacks of six vertical wooden square frames with two parallel steel strings. In each cell frame, there were need to be a full of honeybees. So that, each beehive colony was prepared placing a queen, about 9000 workers and a few hundreds of drones. And then, these beehives were placed near the plum trees in the Pakokku University Campus. Beekeeping in the Pakokku University Campus was started in September 2017. At that time, sufficient food source nectar from plum trees were sufficient for honeybees. Regular monitoring was weekly conducted in the beehives to know the situation of honeybee such as death rate, presence of predators, parasitic infection and other diseases.

In February 2018, the flowering season of plum tree was ended, food sources from plum trees were insufficient for honeybees, besides, other available food sources were also became rare in the Pakokku University Campus. Therefore, honeybees were fed the supplement food as sugar solution placing near the beehives.

In March 2018, populations of honeybee in hives were decreased due to scarcity of food sources for honeybees in Pakokku University Campus. Therefore, these beehives were moved to Pauk Kone Village, Magway Region where food sources from sunflower, maize and various bean plants were available to forage by honeybees. After moving to food sources abundant place, the populations of honeybee in studied beehives were increased again.

According to the present experiment, migratory beekeeping method was the more suitable than stationary method in the study area, since availability of food sources for honeybee is the main factor in beekeeping during the study period.

Life cycle of studied bee, *Apis mellifera*

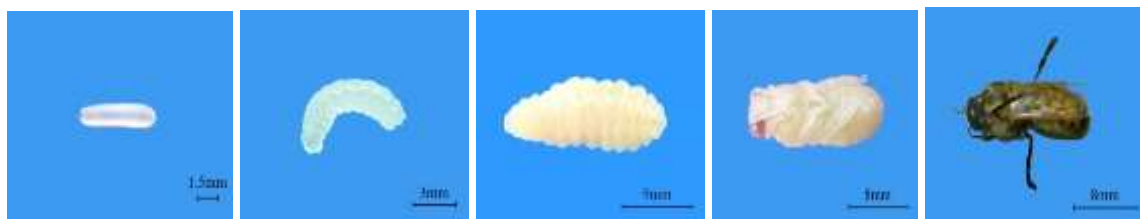
In the studied beehives, altogether five stages such as egg, larva, prepupa, pupa and adult were observed in all casts (Plate 2). In the colony, egg and larva are called open brood and prepupa and pupa are referred to as sealed brood because of the capped cells. Among the casts, different durations of developmental stages were recorded (Figure 1).



Egg Larva Prepupa Pupa Adult
(A) Developmental stages of queen



Egg Larva Prepupa Pupa Adult
(B) Developmental stages of worker



Egg Larva Prepupa Pupa Adult
(C) Developmental stages of drone

Plate 2 Developmental stages of honeybee, *Apis mellifera*

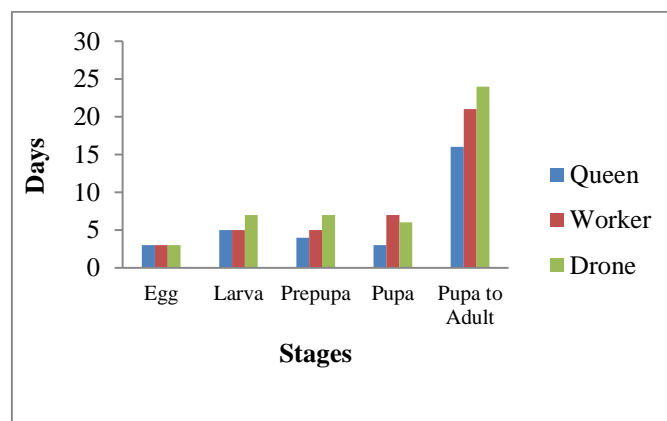


Figure 1 Duration of developmental stages of three casts of *Apis mellifera*

Egg

The queen laid eggs in wax cells in the brood area of the comb (Plate 1). The position of the egg after immediately laid by queen was upright about 90° at the bottom of the cells. In the next day, the egg was slightly tilting about 45° and in the 3rd day, the egg was horizontal position in the wax cell. After 3 days, egg hatched and larvae emerged. The egg of honeybee was very tiny and difficult to see, but their presence was indicated by a laying queen in the colony, or with the help of light or under sunlight. The duration of egg to emerging larva can be determined by looking its position. The egg lasted 1-3 days to hatch (Table 1). The length of egg was measured about 1.5 mm and the weight of egg was less than 0.001 g (Table 2, 3).

Larva

The duration of the larval stage varies among the casts, the duration of larval development was recorded in queen (5 days), workers (5 days) and drones (7 days), respectively (Table 1). Morphological features of larvae were whitish wormlike grub with no leg, eyes, antennae, wings, or sting (Plate 2). It was “C” shaped and easily seen at the bottom of their wax cell. In larva stage, drone and queen showed the same length (15 mm) and worker had the shortest length (9.6 mm) (Table 2). The weight of the drone showed the highest (0.28g), followed by worker (0.15g) and queen (0.11g) (Table 3).

Prepupa

The duration of this stage varied among the caste, drone showed the longest development time span was recorded in drone (7 days) and followed by worker (5 days) and queen (4 days), respectively (Table 1). The last larval stage was referred to as the prepupal stage, since the final larval molt included a metamorphosis into the pupae (Plate 2). The last few days of larval life were spent constructing a cocoon within the cell. To spin the cocoon, the larvae uncurled and stretched out fully in the cells with their heads toward the capped end. In prepupa stage, drone had the longest length (17 mm), followed by queen (16.9 mm) and worker (10.9 mm) (Table 2). The weight of the drone showed the highest value (0.36g), followed by queen (0.28g) and worker (0.18g) (Table 3).

Pupa

This stage lasted 7 days for worker, 6 days for drone and 3 days for queen (Table 1). The pupal stage is the last period before the final molt to the adult. The head, eyes, antennae, mouthparts, legs, thorax and abdomen showed adult characteristics, but only the wings were still small and undeveloped. As the pupa developed, coloration of eyes gradually changed from light pink to dark pink, purple and finally dark color. The color of body also changed gradually from white to dark color (Plate2). In pupa stage, the longest length was recorded in drone (16.5 mm), followed by queen (15.7 mm) and worker (12.2 mm) (Table 2). The weights of pupae were found to be varied among the casts as queen (0.28g), drone (0.26g) and worker (0.22g) (Table 3).

Adult

After complete metamorphosis, adult emerged from its cell by chewing the capped cell with its mouthparts. The duration of emergence from the cell varied among the castes: drone showed longest duration (24days), followed by worker (21days), and queen (16 days) (Table 1). A newly emerged honeybee was pale in color. In adult stage, queen had the longest length as 17.6 mm, followed by that of 16.8 mm in drone and 12.2 mm in worker (Table 2). The weights of the bees among the different casts were recorded as drone (0.29g), queen (0.26g) and worker (0.22g), respectively (Table 3).

Table 1 Duration of the developmental stages of three casts of *Apis mellifera*

Cast	Egg hatched (days)	Larva stage (days)	Prepupa/capped stage (days)	Pupa stage (days)	Developmental period (Days until emergence)
Queen	3	5	4	3	16
Worker	3	5	5	7	21
Drone	3	7	7	6	24

Table 2 Maximum length of developmental stages of honeybee

Cast	Open Stage		Seal Stage		Adult (mm)
	Egg (mm)	Larva (mm)	Prepupa (mm)	Pupa (mm)	
Queen	1.5±0.00	15.0±0.35	16.9±0.55	15.7±0.27	17.6±1.52
Worker	1.5±0.00	9.6±0.46	10.9±0.53	12.2±0.34	12.2±0.54
Drone	1.5±0.00	15.0±0.5	17.0±0.35	16.5±0.35	16.8±0.27

Table 3 Maximum weight of developmental stages of honeybee

Cast	Open Stage		Seal Stage		Adult (g)
	Egg (g)	Larva (g)	Prepupa (g)	Pupa (g)	
Queen	0.001±0.00	0.11±0.01	0.28±0.01	0.28±0.01	0.26±0.01
Worker	0.001±0.00	0.15±0.01	0.18±0.01	0.22±0.02	0.22±0.01
Drone	0.001±0.00	0.28±0.01	0.36±0.01	0.26±0.01	0.29±0.01

Discussion

Beekeeping of honeybee species *Apis mellifera* involved two methods, the stationary and migratory methods applied based on the availability of food sources (Cramp, 2008). Since the study area is situated in the central dry zone of Myanmar, the annual rainfall is low and growing of plants and flowering times are varying season to season. Therefore, beehives are not impossible to maintain constantly in only one place, Pakokku University Campus, because food sources for the bees were not enough throughout the year. As a result, beehives were move to Pauk Kone Village where seasonal crops were abundance as the food sources of honeybee. Cramp (2008) stated that when the food sources were rare in beekeeping place, the bees can be kept by giving them supplementary feeding without migrating to other places for food sources, otherwise moving them to food abundance places. The disadvantages of supplementary feeding are more expenditure and extra work for beekeeper, unhealthy of honeybee in long term feeding. Therefore, migratory beekeeping method was more suitable in the study area instead of stationary method. This migratory method is also commonly used by commercial beekeepers in the study area. Thus, migratory method was more promising than stationary method for beekeeping practice. Moreover, migratory beekeeping practices can increase dual incomes from the production of bee products, especially honey, and also in enhancing the crop yield by pollination of honey bees. Hence, there is a need to implement relevant beekeeping method for successful honey yield and crop yield as well.

According to Sharma, *et al.* (2013), migratory beekeeping are able to harvest 50-60 kg of honey/colony/year which is about five times more than obtained with stationary beekeeping. In addition, bee colonies could increase by at least 20% and save the maintenance of cost during

dearth period by migratory beekeeping. This was confirmed with the present findings that migratory beekeeping was more profitable than stationary beekeeping for commercial beekeepers.

During the study, the duration of life cycle from egg to emerging bee varied to the caste, the queen emerge in 15-16 days, workers in 21 days and drones in 24 days. Stone, (2005) stated that honeybee exhibits a complete development or metamorphosis during their life including life stages as egg, larva, pupa and adult and development from egg to adult in general takes two to three weeks.

Among the casts in the experimental beehives of the present study, the queen (fertile female) had the higher length than drone (male) and worker (sterile female). This finding was in coincidence with the finding of Kilani (1999) that the queen was higher measurements than drone and worker due to having long and heavy abdomen of the queen.

The developmental stages of honeybees in the present study indicated that the duration of each developmental stage varied among the different casts in the same hive. The larval stage lasted 5 days for queen, 5 days for worker and 7 days for drone respectively. Tribe and Fletcher (1977) mentioned that the duration of the larval period was about 4.5 days for queen, 5.5 days for worker and 6.5 days for drone. This larval period was slightly different with the present data. It was assumed that the casts, genetic and environmental factors are depending to the duration of metamorphosis as stated by the previous authors (Tribe and Fletcher, 1977; Winston, 1992).

Fasasi *et al.* (2011) stated that measurement of adult drone is 19.7 ± 0.2 mm, that of queen is 18.3 ± 0.5 mm and that measurement of worker is 17.0 ± 1.3 mm. In the present study, the length of drone was 16.8 ± 0.27 mm, followed by that of queen was 17.6 ± 1.52 mm and worker was 12.2 ± 0.54 mm respectively. The size of all casts of honeybee in the present study was smaller than the bee recorded of Fasasi *et al.* (2011). It was assumed that the sizes of honeybee depend on the sufficient of food sources and environmental factors.

In this study, mean temperature, relative humidity and rainfall recorded were as low as 26.28°C , 51.08% and 0.2 mm and as high as 31.45°C , 80.55% and 9.65 mm respectively. No significant changes of the developmental period and measurement of life stages of *A. mellifera* were observed during the study period. Therefore, the result of this work showed that weather parameters had no effects on the life cycle of *A. mellifera*.

Therefore, the data recorded in the present work contribute the information to further researches concerned with beekeeping and ontogenetic development of the honeybee and other related researches.

Conclusion

It was concluded that *Apis mellifera* had been preferred for beekeeping which can provide dual income from the production of bee products and also enhancing the crop yield by pollination. Moreover, understanding of life stages of *Apis mellifera* may help the proper management of honeybee colonies to get more bee products and good quality of the crop. Therefore, beekeeping could create the good opportunities of job for livelihood of rural people.

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