

Developmental Cycles of the Red Dwarf Honeybee, *Apis florea*

Preecha Rod-im, Randall Hepburn, and Orawan Duangphakdee

Abstract— Published analyses of the structure of the single comb nests of *A. florea* are literally “instamatic snapshots” of nests. We have photographically documented the developmental changes and report on the details of the cyclical process of nest building until eventual abandonment of the nests by swarming or migration after 13-17 weeks. Nests changes occur in fifteen distinct stages. The growth curves of the nests show daily changes in comb length, width and area at a rate of 40 cm²/week and provide a final structure which is close to circular. The crown comb is constructed more quickly than the brood comb. The results are given ecological meaningfulness when they are placed in the context of related data on the immigration, emigration and stability of nests over a full year.

Keywords— Honeybee, *Apis florea*, Development cycle, Comb construction

I. INTRODUCTION

A. florea nests are single, exposed combs, vertically attached to one or two thin branches in trees and bushes throughout Southeast Asia, and have been described many times [1]. Analyses of the structure of these nests have been comprehensively reported by Sakagami and Yoshikawa [2], who described and illustrated the arrangement of honey, pollen, worker and drone brood cells as well as reproductive swarm cells. Further details on the nests of *A. florea* such as the arrangement and dimensions of cells and their physical relationships to one another were tabulated [3].

Virtually all the nest specimens of *A. florea* that have been described in relevant publications were purchased at Chatuchak Weekend Market in Bangkok. Because there are not always drone cells at the bottom of the combs purchased, it is questionable that they can be considered to be mature nest specimens. Nonetheless, the works published to date provide what are literally “instamatic snapshots” of nests on their day of harvest for market. However, there have not yet been any accounts of the life history or chronological growth and development of the nests of *A. florea* from their inception by

Preecha Rod-im is with the Division of Natural Resource Management, School of Bioresources and Technology, King Mongkut’s University of Technology Thonburi, Bangkok, Thailand (corresponding authors’s phone: +6624709965; email: Preecha.rod@hotmail.com)

Orawan Duangphakdee is with the King Mongkut’s University of Technology Thonburi, Ratchaburi Campus, Bangkok, Thailand (email: Orawan.dua@kmutt.ac.th)

Randall Hepburn is with the Department of Zoology and Entomology, Rhodes University, Grahamstown, South Africa (email: r.hepburn@ru.ac.za)

II. MATERIALS AND METHODS

Origin of bees

Observations were initially conducted on 6 colonies of the red dwarf honeybees, *Apis florea* between 2011-2012 at the Ratchaburi Campus of King Mongkut’s University of Technology, Thonburi, Thailand at Chom Bueng (13.37N, 99.35E, altitude 86 m). The *A. florea* nests were collected from nearby forest lands, were moved at dusk, and were then hanged on small trees maintaining the vertical position of the combs. Colonies were allowed a few days to adapt to the new ambient conditions and to resume normal activities and foraging.

Experimental preparations

After few days, the brood comb extending below the crown comb and nest twig was cut away, at dusk, and removed to induce absconding [4],[5]. On subsequent days, new nest site selection processes were conducted when the whole colony took off to a new nesting site. We then followed each swarm until the colony settled in a new nesting tree. The colonies were nesting about 2-5 m above ground so we erected scaffolding as an observation platform right next to the colony for close-up photography.

Sampling observations

In preliminary observations each colony was inspected for growth and development of the nest every 2 hours after settling. Unfortunately, this frequency of inspection resulted in the interruption of nest development followed by the whole colony absconding within 48 hours. Our procedure was then modified and consisted of observation periods of 1, 2, 4, 7 days, and then weekly. These observations were carried out until each colony began to develop drone cells and queen cells after which the colonies swarmed and absconded to new nesting sites after 13-17 weeks.

During inspections of comb growth and development, we gently pushed the curtain of worker bees to the other side of their combs and took photographs of the bared combs with a reference scale and then did the opposite side of the comb. This method required about 5 minutes after which the workers bees gradually moved back onto the comb to form a multi-layered curtain covering the nest within 3-5 minutes.

Photographic analysis

The comb photographs were analyzed using ImageJ, a Java-based image processing programme to measure height, length, sealed brood area, opened brood cell area, crown area, drone area and total area. Note that photographs were calibrated with the reference scale before measurement.

III. RESULTS

The areas of brood comb in the nests of the dwarf, medium-sized and giant honeybees, all consist of concentric regions in the plane of the comb. However, in the medium-sized, cavity-nesting honeybees, the use of multiple parallel combs means that, in a three-dimensional perspective, the concentric rings of sequential brood combs approximate a sphere, while those of honey and pollen are ovals or inverted saucers. Because the dwarf honeybees usually construct a single comb, we used this species to illustrate the chronological changes that occur from the onset of building to maturity of the comb and its final abandonment as documented by Hepburn et al [6]. Changes in the development of an *A. florea* vertical, single comb nest of over seventeen weeks once a swarm has settled are shown in Fig. 1.

We have divided the changes in the nests of *A. florea* over time into about fifteen distinct stages as follows: (1) by just the sixth day after settling, sufficient comb has been constructed that eggs have been laid and young larvae have appeared in some cells; (2) by the eighth day, the nest has already been partitioned into an area for honey (comb crown above the nest twig) with an underlying pollen layer, below which both capped and uncapped brood cells occur. Some of the brood cells have been capped and more eggs and larvae are in the cells below, maintaining the concentric pattern. This basic pattern remains until the mature colony swarms or absconds some three-to-four months later; (3) on the tenth day the progression of cell cappings continues as does the expansion of the uncapped brood area; (4) by the seventeenth day, the concentric rings of capped and uncapped brood have increased in area and workers have begun storing nectar in the crown; (5) on the twenty day, the oldest brood patch has emerged as adults, and extensive capping of brood cells continued (note that the brood area never extends to the periphery of the comb). By the twenty-seventh day (6), the previously empty cells of (5) now contain capped brood of what will be the second generation of adults and the cells in the area surrounding these contain newly laid eggs, while the outer band contains capped brood; (7-11) sequences between days 34 and 93 show the staggered distribution of concentric brood of various ages and generations with drone cells finally constructed by day 93; (12) by day 104 drones emerged from their cells at the bottom of the comb; (13) on the 111th day the drones have left the nest; (14) on the 118th day there were no eggs, no open brood and few sealed cells (15) on day 125 the colony absconded.

The dimensional growth curves of the nests of three colonies of *A. florea* (three others absconded) show daily changes in comb length, width and area from inception of the nests to their maturity and completion. Initially, the lengths

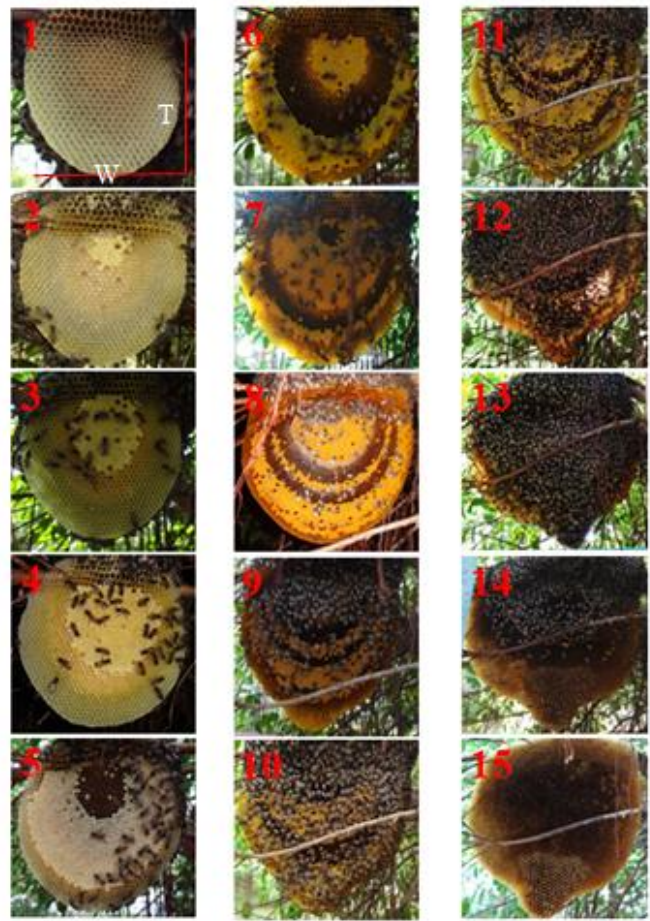


Fig. 1 Morphological changes in the construction and utilization of the single combs nests of *A. florea* (for explanation see text below) (Colony 2, Start date 13 Feb 2012, Absconded date 14 June 2012) (l = length, w = width).

of the nests increase by about 4.2 cm/week, thus double in length over the first three weeks. In the subsequent twelve weeks the nests continued to lengthen by about 8.4 cm/week with a final spurt to reach about 23 cm at full maturity after four months (Fig. 2).

The widths of the single combs nests of *A. florea* increased at about 3 cm/week from about 7 cm from their inception over the first three weeks to reach about 15 cm. In the next phase of continued expansion, the nest widths increased to about 20 cm or 1 cm/week and slowly continued to increase at about 0.4 cm/week until reaching some 23 cm at maturity.

Over the four months required to reach maturity, the combs are growing at about the same rates in changes of lengths and widths providing a final structure which is close to circular, except for the addition of drone comb which protrudes downwardly from the bottom of the combs (Fig. 1, photos 9-15).

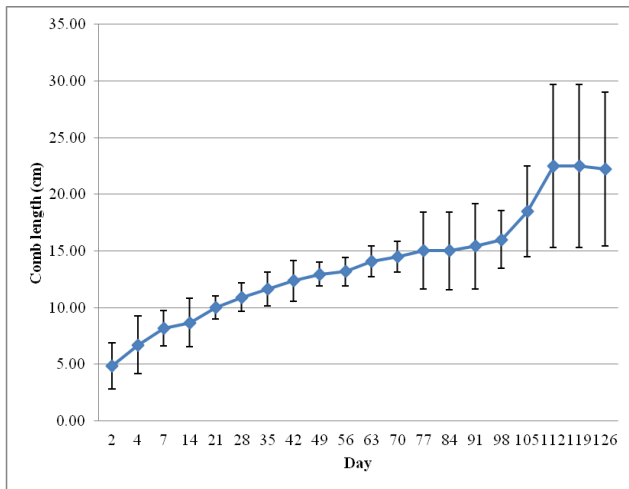


Fig. 2 Changes in the lengths (see Fig 1-1) of the single combs nests of *A. florea* from their inception until maturity some for months later (N=3, colony1: start date, 28 Feb 2012, absconded date, 6 June 2012; Colony 2: start date, 13 Feb 2012, absconded date 14 June 2012, Colony 3: start date 11 Mar 2012, absconded date, 14 July 2012).

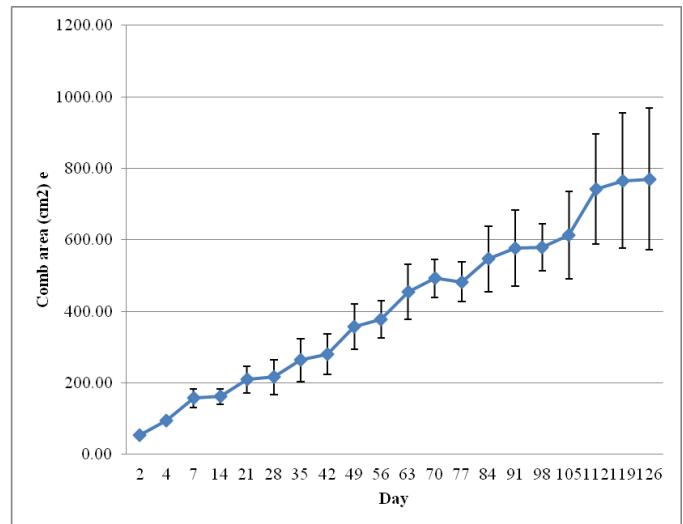


Fig. 4 Changes in the areas of the single combs nests of *A. florea* from their inception until maturity some for months later (N=3, colony1: start date, 28 Feb 2012, absconded date, 6 June 2012; Colony 2: start date, 13 Feb 2012, absconded date 14 June 2012; Colony 3: start date 11 Mar 2012, absconded date, 14 July 2012).

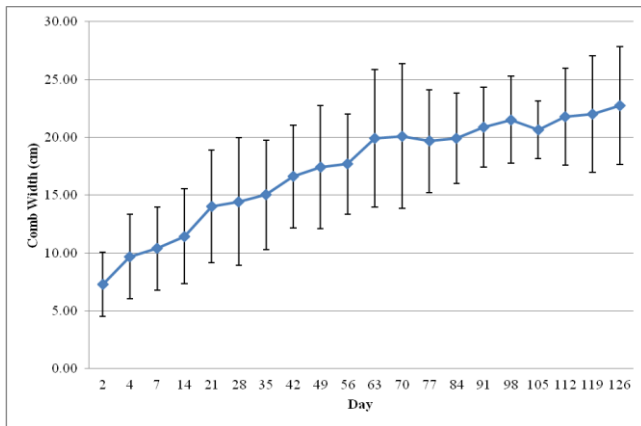


Fig. 3 Changes in the widths (see Fig 1-1) of the single combs nests of *A. florea* from their inception until maturity some for months later (N=3, colony1: start date, 28 Feb 2012, absconded date, 6 June 2012; Colony 2: start date, 13 Feb 2012, absconded date 14 June 2012; Colony 3: start date 11 Mar 2012, absconded date, 14 July 2012).

Obviously, the changes in the areas of the combs are simply a geometric consequence of the paired and concomittant changes in the lengths and widths of the combs over time. The relationship is quite linear and progresses at a rate of about 40 cm²/week. The development of the crown comb would seem to be both structurally and biologically somewhat independent developments.

Obviously there is no necessary relationship between changes in the crown comb and the subtending brood comb. Nonetheless, (2) a substantial amount of crown comb construction is already apparent on the 4th day and by the 8th day the honey has been capped (4). It remains as such until (6)



Fig. 5 Changes in the structural development of the crown comb from its inception until maturity is reached about 4 months later are documented in the photographic series.

on the 23rd day when some cells have been opened and honey removed. By the 72nd day (9) the cappings acquire a yellowish hue which slowly intensifies (13) until the 98th day when observations were terminated.

Over the same period there are changes in the length and width of the crown comb (Fig. 6 and 7). One week after settling, the colonies have gradually expanded the length of the crown comb by about 2 cm/week. However, the width of the comb expands early (2) and by the 4th day is already 10 mm. The crown comb continues to thicken slowly at about 2 cm/week until maturity is reached.

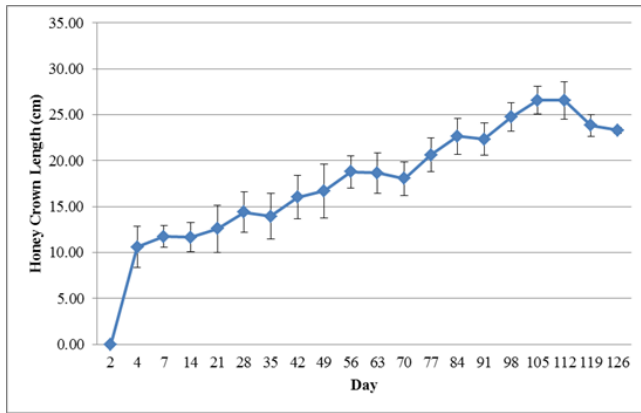


Fig. 6 Changes in the lengths of the crown comb of the single comb nests of *A. florea* from their inception until maturity some for months later (N=3, colony1: start date, 28 Feb 2012, absconded date, 6 June 2012; Colony 2: start date, 13 Feb 2012, absconded date, 14 June 2012; Colony 3: start date, 11 Mar 2012, absconded date, 14 July 2012).

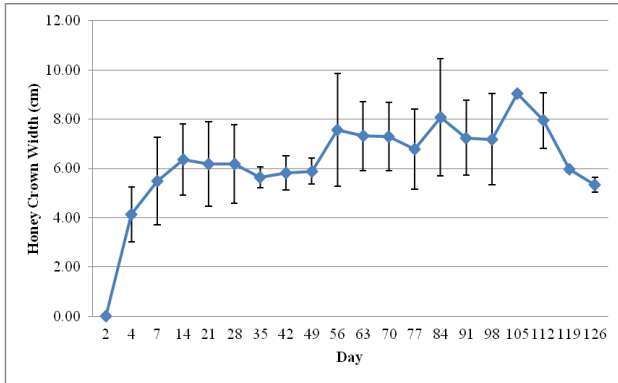


Fig. 7 Changes in the widths of the crown comb of the single combs nests of *A. florea* from their inception until maturity some for months later (N=3, colony1: start date, 28 Feb 2012; absconded date, 6 June 2012; Colony 2: start date, 13 Feb 2012; absconded date, 14 June 2012; Colony 3: start date, 11 Mar 2012; absconded date, 14 July 2012).

IV. Discussion

The time of development data from inception of a nest to reaching full comb maturity from extended observations confirms that the growth and maturation of an *A. florea* nest requires about three to four months. And, it does not matter whether the colonies swarm reproductively or merely abscond/migrate. The rates of growth of the combs in width and length are very similar so that the final comb is circular in appearance with the exception of a protruding area of drone

comb at the bottom of the nest, next which queen cells are constructed for reproductive swarming. The results are confirmed and really given ecological meaningfulness when they are compared to related data on the immigration, emigration and stability of nests over a full year [7].

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