

Some Aspects of the Biology, Nesting Behavior, and Nest Architecture of *Apis florea* F. in Iraq

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Abstract

The present study carried out in early 1990's is the first work in Iraq on the biology of the dwarf honey bee, *Apis florea* F., after its colonies had crossed the Iraqi-Iranian border and settled in frontier areas in Diyala province. The colonies were found in farms, woods, plains, and residential areas. Each colony builds only one wax comb attached to a support such as tree branch, niche ceiling, water pot stand . . . etc. The combs were found at different heights ranging from as low as two centimeters to as high as 10 meters above the ground. Largest comb measured 45.5 and 24cm in width and depth, respectively. Comb thickness at the worker brood area ranged from 1.8 to 2.0cm. Mean numbers of worker and drone cells per linear decimeter were 32.15 and 21.35 cells, respectively. Open and sealed brood areas of workers and drones in a comb reached 912 and 260cm², respectively. One of the colonies consisted of 16293 adult workers, and it was possible to extract 1.645 kilograms of honey from one comb. It seems that the colonies practice a long distance seasonal migration in late fall and / or early winter toward unknown destination and return to the area during following spring. This study; however, represents an introduction to the biology of this exotic species, and the subject needs further extensive investigations.

الخلاصة

هذه الدراسة ، التي أجريت في أوائل التسعينات ، هي أول دراسة في العراق عن حياتية نوع دخيل (exotic) من نحل العسل لم يكن موجوداً أصلاً ألا وهو نحل العسل القزم *Apis florea* F. بعد أن عبرت طوائفه الحدود العراقية - الإيرانية واستقرت في محافظة ديالى وبعد أن نشر الباحث أول تسجيل علمي لدخوله العراق في عام 1992 . وجدت الطوائف في المزارع ، الأجرار ، السهول ، ودور السكن والأبنية في القرى والقصبات . تبني الطائفة قرصاً شمعيّاً واحداً مثبتاً على مسند كغصن شجرة أو سقف كوة في حائط أو سفح تل أو حامل كوز ماء . . . الخ . وجدت الأقراص على ارتفاعات مختلفة تراوحت بين 2سم إلى حوالي 10م فوق سطح الأرض . أكبر قرص كان بأبعاد 45,5 × 24سم . ثخن القرص عند منطقة تربية الحضنة تراوح بين 1,8 إلى 2سم . معدل عدد العيون السداسية على امتداد ديسمتر واحد بلغ 32,15 و 21,35 عيناً للشغالات والذكور على التوالي . بلغت مساحة الحضنة في أحد الأقراص 912 و 260سم² للشغالات والذكور على التوالي . وبلغ عدد أفراد الشغالات الكاملة 16293 فرداً في إحدى الطوائف . كان بالإمكان استخراج 1,645كغم من العسل من قرص واحد . يبدو إن الطوائف في العراق تمارس هجرة موسمية لمسافات بعيدة في نهاية الخريف أو أوائل الشتاء إلى منطقة أخرى غير معروفة لدينا ، ومن ثم تعود من جديد خلال فصل الربيع . وأخيراً فإن هذه الدراسة لا تمثل إلا مدخلاً لموضوع يحتاج مستقبلاً لدراسات أشمل وأعمق .

Introduction

The native European honey bee *Apis mellifera* L., was the only honey bee species known to occur in Iraq before 1990. Brother Adam believes that the native race is *A. m. syriaca* as cited by Abdellatif *et al.*, (1977). Other races, especially *A. m. carnica*, have officially and privately been introduced in Iraq since 1970's from different countries, especially Egypt.

Another non-native honey bee species, *Apis florea* F., was noticed to occur in Iraq in September 1990, and the first definite record of its occurrence was published in 1992 (Glaiim, 1992) after the identification was confirmed by the Iraqi Museum of Natural History and the International Institute of Entomology in London. Colonies of this species were found in Diyala province along the Iraq-Iran border, but it is not known how long these bees have been in Iraq. Since the species occurs on the slopes of Zagros mountains in Iran (Ruttner *et al.*, 1995), we believe its swarms have crossed the border from neighboring province of Kermanshah. Hepburn and Hepburn (2005)

reported that *A. florea* exhibits an invasive potential as it has become established as an exotic in Sudan, Indonesia and Saudi Arabia beside Iraq.

The present study represents the first work carried out in Iraq to deal with some aspect of biology and nesting behavior of this species.

Materials and Methods

In 1992-1993 persence and activities of the exotic *Apis florea* F. colonies were pursued and investigated during different months and in different areas along the Iraq-Iran border in Diyala province. It was impossible to survey neighboring areas in the Iraqi province of Sulaimaniya (north of Diyala) and the Iranian province of Kermenshah (east of Diyala) because of security restrictions. Since all the colonies live ferally and found in diversified sites in farming and residential areas we were seeking the help of local residents and farmers to find the colonies and dislodge some of them, such as those suspended from leaf-stalks of high date palm trees. The pursuit was carried out to determine seasonal presence and absence of the colonies in Iraq. Other information were taken about brood rearing activity, colony size, and honey production. Nesting behavior and nest architecture and design were studied as well.

It is worth mentioning that studying such a species is not as easy as that carried out on the common (European) honey bee, *Apis mellifera* L., due to the following reasons: 1) *Apis florea* colonies live ferally in the open air and cannot be kept in hives, 2) each colony builds only one comb which is firmly attached to an object such as a tree branch, 3) we had no control on any colony since it might be attacked by people at any time, 4) the colonies were found in very limited numbers and this might have been due to the recency of their occurrence in the area, and 5) the colonies usually desert their combs from time to time because of their natural habits of absconding and migration. or due to disturbances practiced by some people. This explains why we were not able, in most cases, to take successive information at different times on same colony. Such a difficulty might be solved, to some extent, in the future when *A. florea* colonies in Iraq would be managed by applying the same management method that has been practiced in the Sultunat of Oman (Free, 1981).

Results and Discussion

1. Areas of *Apis florea* populations in Iraq

The colonies were found in the following areas belonging to Diyala province: 1. Mandeli, 10km west of the border and about 150km east of Baghdad; 2. Khanaqin about 60 km north of Mandeli and 10km west of the border ; 3. Jalowla, 30km west of Khanaqin, and 4. Al-Mikdadia, about 70 km west of the border (Figure1). The geographical coordinates of these four areas, respectively, are: 33 44 37 N 45 32 47E; 34 20 94 N 45 24 02 E; 34 16 47 N 45 09 58 E; and 33 58 43 N 44 56 13 E. The altitudes of these areas, respectively, are 130, 181, 150, and 55m. There are large plantations of date palm, citrus, and deciduous fruit trees in these areas beside vegetable fields. We found no colonies in Bedra area (Wasit province) located along the border to the south of Mandeli.

In Iran *Apis florea* nests were discovered well above 1000m and the northern most nesting sites of it were found at Ghasr-E-Shirin in the province of Kermenshah,

at almost 35° Lat. and 500 km north of the Gulf (Ruttner *et al.*, 1995). This is why we believe that the colonies have crossed the border from Iran.



Figure (1). Map showing area of *Apis florea* populations in Iraq (shaded area indicated by arrow)

2.Nesting Behavior

a. Choice of Nesting Site and Comb Support

Table (1) shows the kinds of nesting sites and comb supports of *Apis florea* in Diyala province. The colonies were found in farming areas, woods, uncultivated areas, and residential areas of villages and towns. Also, the combs were built at different heights ranging from as low as two centimeters to as high as 10 meters above ground. Rinderer *et al.* (2002) found that *A. florea* nested at height averaging about 4m. Booncham *et al.* (1995) stated that nesting height in Thailand is about 1-15m.

Table (1). Kinds of nesting sites and comb supports of *Apis florea* in Diyala province

Comb number*	Height of comb above ground (m)	Nesting site and comb support	Notes
1	0.60	Attached to a pomegranate twig (about one cm. in diameter)	
2	1.00	Attached to a willow twig (about one cm. in diameter)	
3	1.50	Attached to a curved reed stem (about two cm. in diameter)	At a row of dry reed plants along a ditch
4	2.00	Attached to a pomegranate twig (about 1.7cm. in diameter)	
5	2.40	Attached to a bougainvillea branch (about 1.5cm. in diameter)	
6	3.80	Attached to an apricot twig (about 1.5cm. in diameter)	
7	10.00	Attached to a date palm leaf stalk (about four cm. in diameter)	At the second lower row of fronds and about 25cm from trunk
8	0.06	Attached to ceiling of a niche measuring 21x80x60cm	At hillside
9	0.02	Attached to an unused metal oil barrel	Found in a house courtyard
10	0.15	Inside an unused clay bread oven (about 50x100cm.)	Found in a house courtyard
11	0.20	Attached to a wooden stand of a refrigerator (about two cm. in diameter)	Found in shaded house courtyard
12	0.30	Attached to a wooden stand of a water pot (about two cm. in diameter)	Found in a house courtyard
13	0.30	Attached to a niche measuring 30x40x20cm	In an adobe fence
14	1.00	In side unused sewage tank	Found in a school backyard

* First seven combs were found in farming areas and woods; comb no.8 was found in an uncultivated area and the last six combs were found in residential areas.

In farming areas and woods the combs were attached to branches of apricot, pomegranate, willow, bougainvillea, reed plant, ... etc or to date palm leave-stalks. Onlamai and Thanee (2004) stated that *Apis florea* combs in northeast Thailand were attached to branches of mango trees, bamboo bushes, and trees of dipterocarp forest. In uncultivated areas where there were no trees and shrubs the combs were attached to ceilings of niches at the hill slopes. There were different kinds of sites and comb supports for the colonies in the villages and town. Some combs were attached to tree and shrub branches in the gardens and house courtyards. Other combs were attached to the following shaded and / or partially shaded supports: outer surface of an unused metal oil barrel , inner surface of unused clay bread oven, wooden stands of refrigerators and water pots, and ceiling of an unused sewage tank. Figure(2) shows different sites of colonies. Although the combs were built in the open, they were usually found under different sources of shade such as dense foliage of trees and shrubs, niche ceilings, house eaves, . . . etc. The colonies in the Sultanate of Oman build their nests in mountain caves, rock niches, or attached to tree and shrub branches when they live in arboreal regions (Dutton and Free, 1979; Free, 1981).

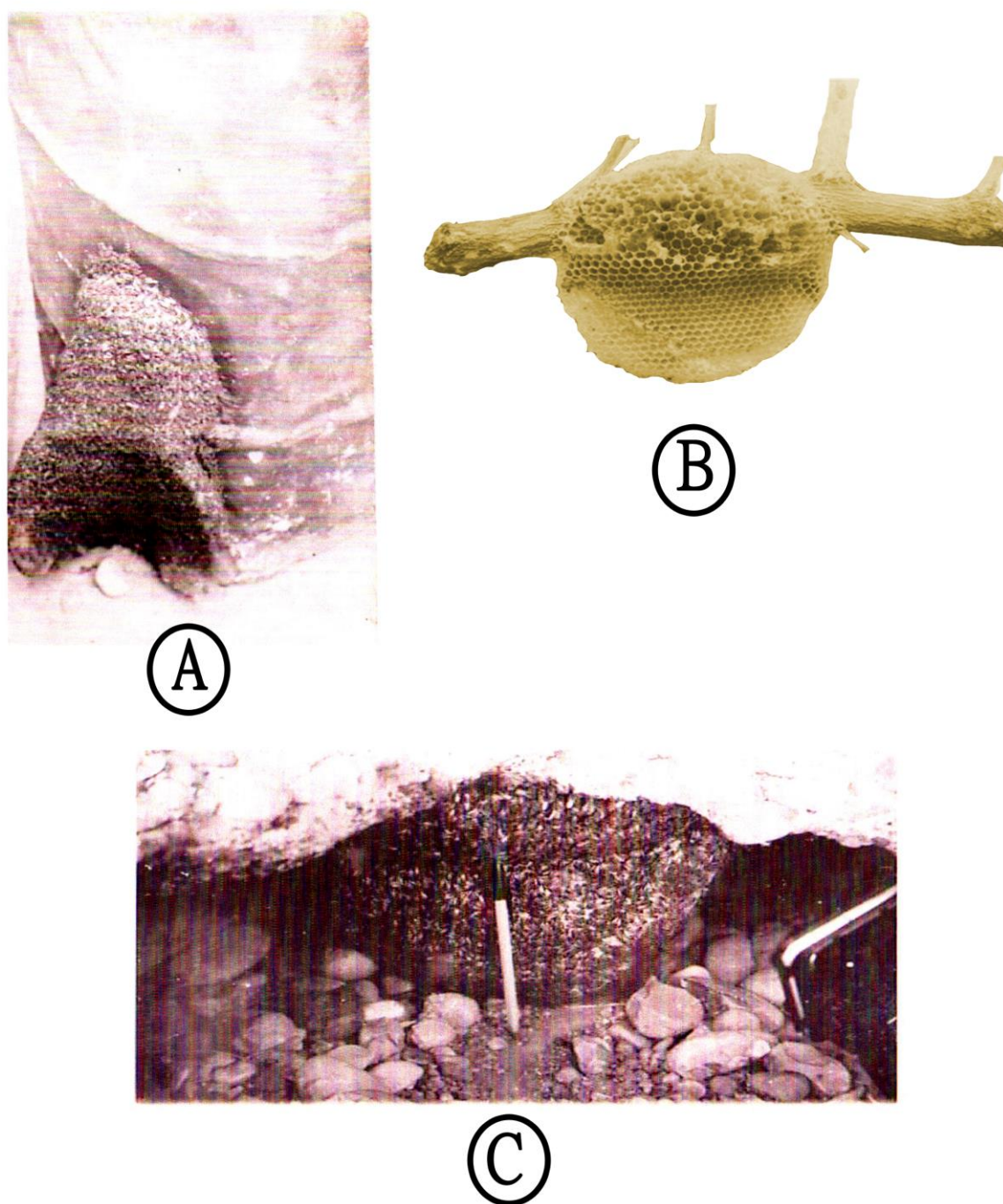


Figure (2). Different sites of *Apis florea* nests in Diyala province

- (A) A colony covering a comb attached to an unused metal barrel
- (B) An abandoned comb suspended vertically from a tree branch
- (C) A colony covering a comb attached to a niche ceiling

b. Comb Design and Architecture

In all areas surveid each colony builds only one wax comb , and the latter is suspended vertically from a support. There is no definite shape for the combs but most of them take semicircle or semielliptic shapes while some take triangular shape.

The honey storage area occupys the upper part of the comb, i.e. above and around the supporting branch. Pollen is stored below the honey storage area. Brood area, occupying most of the comb , is below the stripe of pollen-storing cells. Drone cells are found at the lower part of brood nest, i.e. below the area of worker cells. Queen swarm cells protrude vertically from the lower edge of the brood nest.

When the comb is attached to a slender branch of a tree or shrub or to a similar object such as a metal or wooden rod of refrigerator or pot stands, . . . etc. its upper part forms a horizontal flat platform (the crest) that surrounds the support. On the other hand, the comb is without a crest when it is attached to a wide surface such as a niche ceiling, barrel, unused clay bread oven, . . . etc. This is, of course, one of the features chareterizing *Apis florea*, combs found everywhere (Michener, 1974).

In a comb attached to a date palm leaf stalk the platform measured 11.5 x 23cm. in width and length, respectively. Comb thickness at the worker brood area ranged from 1.8 to 2.0cm. The widest part of the comb is almost always found at the worker brood area. The largest comb in this study measured 45.5 x 24cm. in width and depth, respectively. In this comb the area used for honey storage, which oocupys the upper part, measured 41 x 4.5cm. while that used for brood rearing measured 45.5 x 19.5cm. This means that the part used for brood rearing occupies most of the comb area (Table 2).

Akratanakul (1976) reported that the largest comb of *A. florea*, he found in Thailand was measuring 38 x 50cm. Rinderer *et al.* (Rinderer *et al.*, 1996) found that the height (H) and width (W) of *A. florea* brood area in Thailand were (H = 12.00 ± 3.32cm, W = 16.85 ± 5.28cm)and the height and width of the honey storage were (H=4.20±1.05cm, W=12.49 ± 5.27cm).

Table (2). A comparison between sizes of different areas of *Apis florea* combs

Comb number*	Comb shape	Comb thickness (cm)**	Comb width x depth (cm)***	Honey storage area (width x depth in cm.)****	Brood rearing area (width x depth in cm.) ****	Crest width x length (cm.)*****
1	Semielliptical	1.9	26x26	23x6.5	26x19.5	11.5x23
2	Semielliptical	1.8	18.5x19	17.5x7	18.5x12	No crest
3	Semielliptical	1.8	30x25	28x8	30x17	No crest
4	Triangular	2.0	45.5x24	41x4.5	45.5x19.5	No crest

* Comb 1 attached to a date palm leaf stalk, other combs attached to niche ceilings

** Measured at worker brood area.

*** Comb width represents widest area of the comb which is almost always at the worker brood area.

**** Widths of honey area, brood area, and crest area are represented by the widest part of each one of them

c. Measurements of Comb Cells

The number of worker cells per linear decimeter varied from 30 to 34 cells (32.15 ± 1.20 cells) while that of drone cells varied from 20.5 to 22 cells (21.35 ± 0.67 cells). Cell depth of worker cells ranged from 0.85 to 1.0cm (0.95 ± 0.08 cm) while that of drone cells ranged from 1.20 to 1.25cm (1.21 ± 0.02 cm). The length of sealed queen cells ranged from 1.0 to 2.5cm (1.74 ± 0.47 cm) while the width at cell base ranged from 0.6 to 1.4cm (1.06 ± 0.23 cm) (Table 3 and Figure 3).

Measurements of *A. florea* comb cells conducted in other countries show approximate values although they include some levels of variation. For example, Mutto (1956) stated that the number of cells counted per dm² varied from 1190 in northern India to 1560 in southern India. Such a variation is expected according to Ruttner *et al.* (1995). They studied the distribution and variation of size of *Apis florea* F. in Iran and concluded that a south-north geographical variation (geocline) exists in size characteristics of *A. florea* over about the same range as for *A. mellifera*. These authors added, " In *A. florea* the pattern of climate-related variation was identical in principle: each measurement is larger in the mountain population compared with the bees of the coastal population, resulting in exclusively positive size / altitude correlations ".

Table (3). Measurements of brood cells of *Apis florea*

Kind of measurement	Range	Mean \pm S.D.	Sample size (n)
Number of worker cells per linear decimeter	30-34	32.15 ± 1.20	100
Number of drone cells per linear decimeter	20.5-22.0	21.35 ± 0.67	100
Depth of worker cell (cm)	0.85-1.00	0.95 ± 0.08	100
Depth of drone cell (cm)	1.20-1.25	1.21 ± 0.02	100
Length of sealed queen cell (cm)	1.0-2.5	1.74 ± 0.47	13
Width of sealed queen cell at cell base (cm)	0.6-1.4	1.06 ± 0.23	13

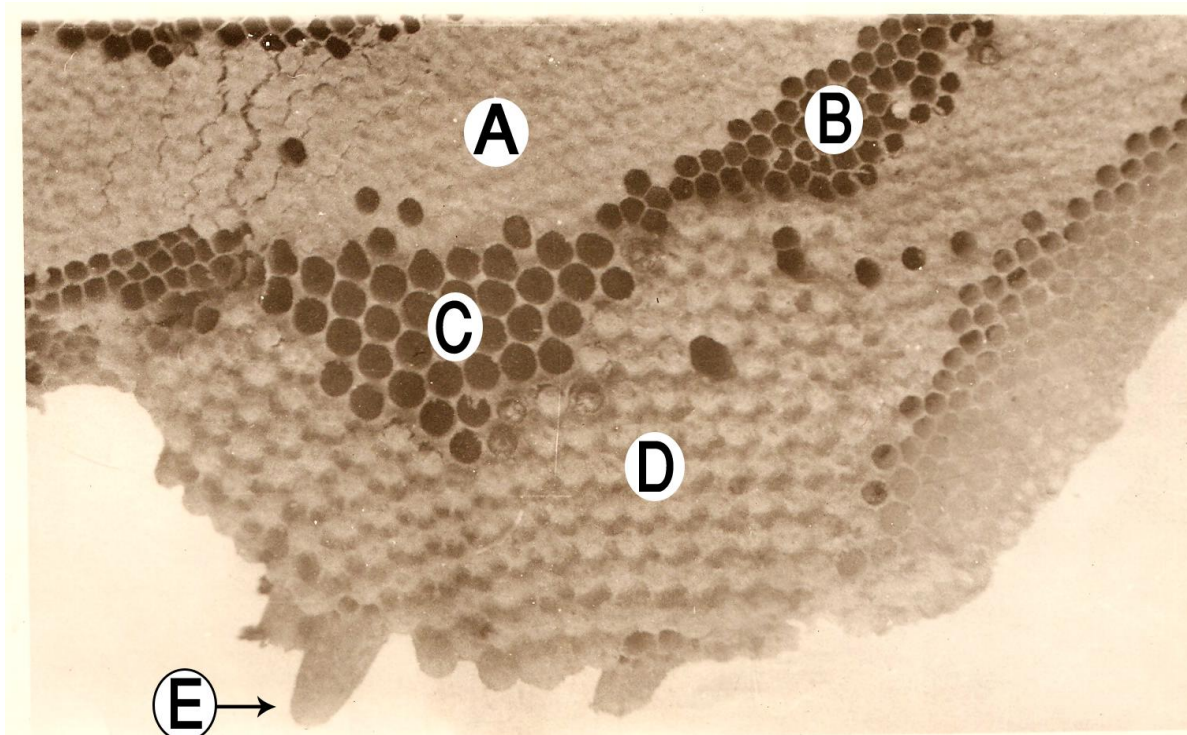


Figure (3). Locations, shapes, and sizes of *Apis florea* comb brood cells

Ⓐ Sealed worker cells Ⓑ Open worker cells Ⓒ Open drone cells

Ⓓ Sealed drone cells Ⓔ Sealed queen cell

3. Colony Activity

a. Seasonal Presence and Absence of *A. florea*

In Diyala Province

A. florea colonies were found during October and November, 1992. After that , and until the end of March 1993 , no colonies were observed despite the extensive surveys that were conducted in different areas. The first colony to be observed again was found in Khanaqin on 31st of March, 1993. The presence of colonies continued until termination of this study at the end of September 1993. Our survey results agreed with the observations of rural families, especially “ honey hunters ”, who claimed that the colonies leave systematically in late fall of each year and come back during next spring season. Beside our search to look for *A. florea* colonies in farming areas, woods, villages, towns, . . . etc. we were also observing different species of insects visiting plant flowers during that period. Again, we did not observe *A. florea* among these numerous species. This may mean that *A. florea* in Diyala province practices a seasonal long-distance migration to another area. Neither we nor the “ honey hunters ” know the destination of such a migration.

We may speculate that the colonies spend the winter and early spring inside mountain caves either across the border in Iran or in the mountains found in the Iraqi northern province of Sulaimaniya. Such caves may offer a good shelter for the bees during a relatively cold climate, especially the combs are built naturally in open air rather than hives or well protected cavities.

Many researchers stated that *A. florea*, in India practices systematic seasonal and long-distance migration due to either shortage of food or adverse climate conditions (Sandhu and Sardar, 1960; Thakar and Tonap, 1962 ; Pandey, 1974). Same trend of practice have been noticed in Oman (Dutton and Free, 1979; Free, 1981). In Iran Ruttner *et al.* (1995) mentioned that *A. florea* colonies practice migrations between different zones of altitude.

b. Colony size and Honey Production

During all times the colonies were seen as “ curtains ” covering the whole combs to ensure a tight coverage of both sides. The “ curtain ” is made by layers of workers that cling to each other. This means that most of the workers are assigned for such a task to protect the colony from enemies and adverse climatic conditions, especially the comb is built in the open rather than a protected dark cavity. This, of course, hampers worker activity in foraging and collecting pollen and nectar (Michener, 1974).

On November 11 , 1992 in Khanaqin we found a colony consisting of 16293 adult workers and nothing at all of adult drones. The honey quantity reached 1.645kg. On May 3, 1993 in Jalowla we found a colony containing 1172cm² of brood: 77.8% of worker brood (912cm²) and 22.2% of drone brood (260cm²). There might have been, however, other colonies that were more populous and productive than these colonies.

Annual colony production of honey varies from country to another and even from region to region in the same country according to the biotic and abiotic factors. Bee literature; however, cited that the production ranges from about 0.2 to 3.0kg of honey per colony (Phadke, 1968; Targari, 1971; Akwatanakul, 1976; Dutton and Simpson, 1977; Williams, 1979; Free, 1981). Akwatanajul (1976) stated that *A. florea* honey and nest products have increased the income of villagers in Thailand.

c. Brood Rearing and Reproductive Swarming

Although brood rearing of the three castes took place in spring and fall, the timing of initiation and termination of such an activity was different depending on the caste involved. While worker brood was occupying most of the combs on 11/11/1992, 31/3/ 1993, 6/4/ 1993, 21/4/1993 and 3/5/1993 , there was neither drone brood nor queen brood at all at the first three dates. On 21/4/1993 there were no queen cells but the drone brood rearing was at its start of initiation, for there was only open brood of drones. On 3/5/1993 drone open and sealed brood represented 22.2% of total brood area per colony compared with 77.5% of open and sealed worker brood. Also, at this date there were eight queen cells in this colony with remarkable numbers of adult drones. Large numbers of queen cells and adult drones were found later on 11/9/1993. According to these results it seems that the reproductive swarming of *A. florea* in Diyala province takes place in spring and fall.

Reproductive swarming of *A. florea*, in the Sultanate of Oman starts at the end February and terminates in early summer and the colonies may resume swarming during the fall season (Dutton and Free, 1979; Williams, 1979 ; Free, 1981).

d. Absconding

In addition to long-distance seasonal migration, we often noticed indications of short-distance absconding. From time to time we found combs containing a quantity of honey and bee brood without a colony but a few adult workers. It seems that these colonies had deserted their nests to other places in the area because of emergency conditions.

The few workers found on such combs may have been individuals of the absconding colony which return to the old comb to collect honey and wax to the new nest. Wongsiri et al. (1996) stated, “ After, short distance absconding, *A. florea* workers return to the old nest and collect wax from the old comb. Only a few bees come to collect the wax from the old comb ”.

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