SPATIAL DISTRIBUTION OF HONEYBEE DRONES "*Apis mellifera* L." AND CERTAIN FACTORS AFFECTING THEIR PRODUCTION IN THE COLONY

By

MOHAMED SALAH ABDALLAH EL-MASARAWY
B.Sc. Agric. Sci. (Plant Protection), Fac. Agric., Cairo Univ., 2004
M.Sc. Agric. Sci. (Economic Entomology), Fac. Agric., Cairo Univ., 2010

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APPROVAL COMMITTEE

Dr. MOHAMED BAHGAT SHAWER .....
Professor of Economic Entomology, Fac. Agric., Kafr El-Sheikh University

Dr. MOHAMED ATTIA EWIES.....
Professor of Economic Entomology, Fac. Agric., Cairo University

Dr. MOHAMMAD ABDAL-WAHAB ABD AL-FATTAH.....
Professor of Economic Entomology, Fac. Agric., Cairo University

Dr. AHMED ABDEL-HALIM EL-SHEMY.....
Professor of Economic Entomology, Fac. Agric., Cairo University

Date: 8 / 6 / 2016

SUPERVISION SHEET

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Professor of Economic Entomology, Fac. Agric., Cairo University

Dr. MOHAMMAD ABDAL-WAHAB ABD AL-FATTAH
Professor of Economic Entomology, Fac. Agric., Cairo University

Name of Candidate: Mohamed Salah El-Masarawy **Degree:** Ph.D.
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Supervisors: Dr. Ahmed Abdel-Halim El-Shemy
Dr. Mohammad Abdal Wahab Abd Al-Fattah
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ABSTRACT

This study was carried out in the apiary of the Agricultural Experimental Station, Faculty of Agriculture, Cairo University, Giza Governorate, Egypt, during years 2012 to 2015 to estimate the various activities of honeybee colony all over the year such as rearing rate of drone & worker brood, stored pollen and construction the queen cups & queen cells. Also, studying the effect of certain factors e.g. limited & unlimited access of pollen, age of mated queen, type of hybrid and different types of supplemental diets on the rearing rate of drone & worker brood . The main aim of this study is to determine the spatial distribution of drone brood and adult drones in the colony.

The obtained results clarify that:

The highest mean values of sealed drone and worker brood throughout 2012 were 104.0 in^2/colony & 521.8 in^2/colony induced in May. No drone brood was produced in November and the lowest mean value of worker brood was in January with value 108.8 in^2/colony. Also, the highest & lowest mean values of stored pollen occurred in August & March with values 300.3 in^2/colony & 32.3 in^2/colony, respectively. Moreover, the highest rate of construction queen cups and queen cells was occurred in spring with mean values of 14.3 queen cup/colony & 4.2 queen cell/colony, respectively.

Superiority of Carniolan hybrid in drone brood production compared with Italian hybrid, with means 8.8 in^2/colony & 6.4 in^2/colony for both hybrids, respectively. Also, Carniolan hybrid had superiority and significantly higher than Italian one in weight of drones with means 201.7mg/drone & 194.6mg/drone for both hybrids, respectively . Also, pollen made a positive effect by increasing rate of drone brood rearing, colonies without pollen traps reared drone brood with a general mean 13.1 in^2/colony compared with 8.0 in^2/colony for colonies with traps. Also, pollen traps caused a drone brood reduction ranged from 45.9% (in spring) to 50.0% (in summer), in addition colonies without pollen traps had increasing in drone weight reached 231.3mg/drone compared with 217.4mg/drone for colonies with traps. The mean values of drone brood reared were 3.3 in^2/colony & 6.1 in^2/colony for the young & old queens, respectively. Furthermore, the supplemental feeding consists of chickpea plus yeast was considered the best one compared with soybean plus yeast and sugar syrup only in both of drone brood rearing & weight of newly emerged drones, with means 10.2 in^2/colony, 5.5 in^2/colony & 4.4 in^2/colony for the three supplemental treatments, respectively. Also, in drone weight; 238.8mg/drone , 236.7mg/drone and 226.3mg/drone, respectively.

Behavior study of rearing and distribution of drone brood and adult drones in the colony indicated that the rearing of drone brood was concentrated in the colony centre with mean percentages reached 44.8% while it was 36.1% in the left outer brood nest, whereas the lowest percentage in the right outer brood nest area, (19.1%). Concerning the distribution of drone brood on the bee comb, data clarify that 60.7% of drone brood was reared in upper part of comb and 39.3% of drone brood reared in lower part of comb. Also, the drone brood was significantly higher, (54.1%) in the peripheral octads of combs than those presented in the central (45.9%) ones. The majority of young drones were concentrated on the brood combs in spring & summer seasons with mean percentages 69.3% & 67.0%, respectively. As well as mature drones tend to congregate on the brood combs during spring season with percentage (55.8%), but contrary induced during summer, mature drones tend to congregate on the lateral combs (No. 1&9) with range from 17.3% to 27.1% of total No. of drones.

Key words: Honeybee "*Apis mellifera* L." - Spatial distribution of drone brood and honeybee adult drones – Pollen – Supplemental feeding of honeybee colonies – Carniolan & Italian hybrids

DEDICATION

This work is dedicated to all members of my family who strongly and effectively supported and encouraged me throughout the whole course of my life. In fact, their cordial encouragement and assistance represented a strong and emotional push to me to complete this study.

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CONTENTS

INTRODUCTION

A honeybee *Apis mellifera* L. colony consists of a mated queen, several thousands of workers and numbers of drones which represented 10 - 15% of the adult population, (Abou-Kourah, 1972; Ghoniemy, 1984 and Czekonska *et al*., 2015), and equivalent to about 20% of the workers number, (Abou El-Enain, 1992 and Sasaki *et al*., 2004). However, Free and Williams (1974) found a large percentage of eggs were sometimes laid in drones cells before the end of April, but few were reared. Also, Page and Metcalf (1984), mentioned that drone brood represented 14-15% of the total brood and reached 24% of that for workers, as reported by Rowland and Mclellan (1987).

There are continuous changes in the ratio of drones to workers depend on the season, the colony population, the age and state of queen and the abundance of food stores, (Allen, 1963; El-Dakhakhni, 1980; Currie, 1987, Schmickl & Crailsheim, 2002 & 2004; Wharton *et al*., 2007 & 2008; Marzouk, 2009 ; Boes, 2010; Brodschneider & Crailsheim, 2010 and Faley *et al*., 2012).

Under sub-tropical climate, the drones of honeybee, (*Apis mellifera* L.) are appeared in colonies from January until the end of September and disappeared from October to December, (Khattap, 1976; El-Dakhakhni, 1980; Abou El-Enain, 1992; Zeedan, 2002 and Marzouk, 2009).

Honeybee drones are responsible for producing semen and transmitting it to the virgin queens during the mating flight. Therefore, they appeared in numerous during swarming season, (spring and summer seasons) which varied according to climatic conditions in each

region, (Free & Williams, 1975; Currie, 1987; Page & Peng, 2001 and El-Kazafy & Al-Kahtani, 2013).

It would be desirable to increase drone brood and adult drone population for some of the following reasons: to saturate the area with drones of known genetic origin for controlled mating of queens, (Hellmich, 1991 and Hellmich *et al*., 1993), to use capped drone brood removal for controlling *Varroa destructor*, (Szabo, 1994), to build combs for wax production, (Szabo, 1994) and to rear drone brood for human consumption, (Abd Al-Fattah *et al*., 2010 and Nour El-Deen, 2013).

Temperature degrees in the brood area, especially during spring season in Egypt, are not uniform. The central brood nest temperature is the warmest and most stables, which ranged from 33.9°C - 34.5°C than other positions in the hive, which more variable and ranged from 30.2°C – 32.4°C. In reverse, the central and outer brood nest temperatures are approximately similar, (34.8°C & 34.4°C, respectively) during summer season, (Fathy, 1980 and El-Dakhakhni, 1980).

Free (1969) showed that drone cells don't always build at the periphery or on outside combs, but Taber and Owens (1970) found that as the worker population increased, the quantity of drone comb increased and this occurred closer to the centre of the brood nest. On the other hand, Owens and Taber (1973) reported that drone cells and drone brood are normally found at the periphery of the brood nest. So, Levin and Collison (1990) found that drone brood temperatures were significantly lower than those of workers in the upper, lower and

peripheral octads of the comb, while not significantly different in the central octads.

Contrary compared with workers, the adult drones of honeybee are more numerous on the peripheral combs, (Free, 1957; Ohtani & Fukuda, 1977 and Kovac *et al*., 2009). In the breeding programs, the capability of drones to coupling with virgin queens or to gather suitable amount of semen is mainly dependent on the maturity of these drones, (Mackensen, 1955; Woyke, 1955; Kepena, 1963 and Stürup *et al*., 2013).

The main aim of this study is to determine the spatial distribution of drone brood and adult drones in the colony. Also, studying the effect of some factors e.g., limited and unlimited access of pollen, age of mated queen, type of hybrid and different types of supplemental diets on the rearing rate of drone and worker brood.

In addition, assessment of the various activities of honeybee colony all over the year such as rearing rate of drone brood, worker brood, stored pollen and construction the queen cups & queen cells.

REVIEW OF LITERATURE

1. Brood rearing activity

a. Drone brood rearing

Fresnay *et al*. (1961) used one square inches wire grid which was placed on brood comb, the brood area was measured by counting each square inch that was occupied with brood.

Allen (1965) mentioned that drone brood rearing started with slowly rate before mid-May then increasing till mid-July, after late of July increasing again but in small numbers till the end of September. Drone production had no effect on the economic performance of col., and non relationship between drone production and both of worker brood produced or the honey yield. The presence of queen larvae or virgin queen stimulated the drone brood rearing.

Washington (1967) reported that the drone production is seasonal, and is dependent upon col. conditions like population density, age of queen and stored pollen. Colonies normally begin rearing drones in early spring or late spring depending upon locality. In Scotland, drone season ranges from early May to late August. In California, drones begin appearing in late February and are last seen around late October.

Free (1969) demonstrated that the production of drone cells reached its annual peak in April and May, in colonies building their own combs. The amount of drone comb produced was controlled by the already present. The presence of an immature or adult queen stimulated worker comb production; the presence of occupied queen cells did so.

El-Shirbiny (1970) found that there were no significant differences between the three combs divisions and five combs ones in rearing brood or honey production in Giza city.

Abou-Kourah (1972) noted that the total amounts of drone brood reared in Carniolan, Italian, F_1 Italian, Egyptian and F_1 Carniolan colonies throughout the year were 2757, 1235, 1593, 1667 and 2303 individuals, respectively.

Taber (1973) established that the presence or absence of drones indicated the potential of a colony to change into worker population. Small bee population of 5000 bees (a large queen rearing number) will rear drones if they receive enough pollen and nectar. He said that the drones do not indicate a population level.

Free and Williams (1974) mentioned that the larger deeper cells are used for the rearing of drone brood, whereas the smaller ones for the rearing of worker brood and the cells for honey storage may be extended to twice the depth of cells used for brood. Bees prefer to store honey in worker combs rather than in drone combs, also, they store little or no pollen in drone comb. The preference for brood rearing in drone or worker cells differed with the time of the year and the tendency of the colony concerned to rear drones. Workers with developed ovaries preferred to lay in drone cells, whereas queens that laid unfertilized eggs only showed no such preference. Bees preferred to store nectar and pollen, especially the latter, in comb that had previously (a) been used for brood rearing rather than in new comb (b) been used for storing food rather than in new comb (c) been used for brood rearing rather than in comb that had been used for storing food.

However, the results showed that even when a choice of drone and worker cells is available to a queen she will often lay several consecutive eggs that have either all been fertilized or are all unfertilized.

Free and Williams (1975) indicated that the honeybee colonies were built greatest proportion of drone cells in May, June and July; the proportion of drone comb built by a colony depended on the amount of drone comb already present. They added that the amount of drone brood and the number of adult drone present in the colony were correlated positively with the number of workers. Removing drone brood from colonies encouraged its production. A large percentage of eggs was sometimes laid in drone cells before April, although few were reared. The proportion of drone brood was in its maximum in May and June. A colony could be evict its drones by preventing it from foraging, and in autumn eviction be was greatly delayed by providing forage or by removing the queen.

El-Sayed (1977) under Giza city conditions found that the colonies of the first hybrid Carniolan bees could rear drones all over the season of activity from February to September. The colonies reared abundantly drone brood during the period from March to July, while the exception of two periods at early April and late July at which the colonies drifted the drones and the rearing of drone brood diminished.

Free (1977) in England reported that the number of drones being reared and the drone to workers ratio reaches a peak in May and June, and few eggs are laid in drone cells after July.