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Effect of Antennae on the Honey Bee Queens Behavior Inside and Outside of their Hives

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ABSTRACT

The present study was carried out during season 2014 using honey bee colonies headed with open mated local Italian queens, *Apis mellifera lugustica*, at the apiary belonging to Faculty of Agriculture, Ain Shams University, to explain the role of antennae of queens in controlling or managing their behavior. The experiment was done by using 12 virgin or mated queens. Each of them was divided equally into four treatment i.e queens with only one flagellum, queens without the last segments of both flagella, queens without both flagella and control. The results showed that the virgin queens with one (single) flagellum could be mated and laid eggs regularly but the virgin queens without flagellum did not leave their hive. On the other hand, when the last segment of both flagella was cut in virgin queens, they could not return to their hive and may be lost. The mated queens with one (single) flagellum and without the last segment (No 10) of flagellum could lay their eggs regularly in combs as the control but mated queens without flagellum stopped laying eggs for one week then began to lay eggs unregularly in the comb, lay two eggs in the same cell and put the drone's eggs in small cells (25 cells/ inch^2). The number of sealed brood cells in the first and second treatments was significantly as the same as control (mated queen with single flagellum and mated queens without the last segment of flagellum). On contrast, the mated queens without both flagella had significantly less numbers of brood cells than other treatments.

Keywords: Honey bee queen– *Apis mellifera* – Flagellum – Sense organs – Behavior .

INTRODUCTION

The antenna of honey bees carries a lot of sense organs (Abdelmegeed & Sawires, 2015; Al-Ghamdi, 2006; Naik *et al,* 1995) such as mechanoreceptors (trichoid and campaniform) and chemical sense organs such as placoid (Getz and Akers, 1994) and basiconicum and different diameter of pores such as sensilla coeloconica and sensilla ampullacea (Stort and Malaspina, 1997) which affected on behavior of honey bee workers. (Jung *et al*., (2014); Rogers *et al, (*2013) ; Muenz *et al, (*2012); Rigosi *et al,* (2011) studied the effect of sense organs on the behavior of bees (i.e. hive land marker, hygienic (Gramacho *et al,* 2003), pollen & nectar collecting). (Tsuruda and Page (2009); Sanchez *et al* (2005); Haupt (2004) also studied the defense of bee about their hive and behavior of queens (i.e. mating and method of laying the eggs regularly. So that, the antenna is play an important role in behavior of honey bees.

Therefore, the present study aimed to explain the role of antennae in affecting behavior of honey bee queens inside and outside their hives.

MATERIALS AND METHODS

The experiments of the present work were conducted at the apiary belonging to Faculty of Agriculture, Ain Shams University. The used bee colonies were headed with open mated local Italian queens, *Apis mellifera lugustica*

The queens were divided into two parts (virgin queens or mated queens) each part contained 12 queens divided to four groups each one consisted of three queens:-

The first group: contained queens with one flagellum (virgin or mated) by removing or cutting the other one from the pedicel part.

The second group: contained queens (virgin or mated) without the tip of flagellum by cutting segments number 10.

The third group: contained queens without both flagella by removing both of them from the pedicel part.

The fourth group: contained normal queens with pair of flagella (control).

All the treated queens (virgin or mated) were introduced to colonies each colony consists of three combs (two closed brood combs + one honey and pollen comb) in spring season.

Number of sealed brood cells

Number of sealed brood cells in colonies with queens at all treatments was calculated every 13 days , according to :

Area of sealed brood = л x r1 x r2

л = 22/7

Number of sealed brood cells = area of close brood x 3.875

3.875 = number of cells/1cm^2

Statistical analysis

Chi Square (Fisher's Exact Test) and Tukey test (ANOVA) were used by using SAS program (2005).

RESULTS AND DISCUSSION

- **The virgin queens:**

From Table 1, it can be concluded that all virgin queens with single flagellum went outside their hives for mating and returned to their hives. They laid the eggs regularly in the combs, one egg inside each cell. The worker's eggs were laid inside small cells (25 cells/ inch^2) and drone's eggs were inside large cells (16 cells / inch^2). All virgin queens without last segment of flagella (segment number 10) went outside their hives; two queens did not return to their hives and lost but one queen could return to its hive but still virgin. All virgin queens without pair of flagella stayed inside the hives and were still virgin. In the control (normal virgin queens), all the virgin queens went out their hives, returned and put the eggs regularly.

Table 1. Behavior of treated virgin queens in mating

Behavior / treatments	Exit & mated	Exit & losted	Not mated
1	3	-	-
2	-	2	1
3	-	-	3
4	3	-	-
	Fisher's Exact Test:-	2.165E-04	
	Pr <= P	0.0026	
	Contingency Coefficient:-	0.7746	

***(1) The virgin queens with single flagellum.**
***(2) Queens without the segment number 10 of the two flagella.**
***(3) Queens without pair of flagella.**
***(4) Normal queens (control).**

- **The mated queens:**

Data arranged in Table 2, showed that, the mated queens with single flagellum laid their eggs regularly in the combs, put one egg inside one cell and acted normal (the worker's eggs put in small cells (25 cells/ inch^2) and drone's eggs in large cells (16 cells/inch^2). The mated queens without last segment of flagellum (segments number 10) acted normal as the previous treatment and control while, the mated queens without pair of flagella stopped putting eggs for one week and acts in abnormal behavior, or odd manner. The queens moved inside the hive quickly under stress and looked inside the cell and again looked inside the other cell but did not put the eggs inside the cells (Fig. 1). Week after, the queens started to put the eggs not regularly in the comb. They put more than one egg inside one cell and the drone's eggs in small cells (25 cells/inch^2) (Fig. 2). The mated untreated queens (control) acted normal in their behavior, all the queens put the eggs regularly in the comb, put one egg inside one cell, put the worker's eggs in small cells (25 cells/ inch^2) and drone's eggs in large cells (16 cells/inch^2).

Table 2. Behavior of treated mated queens in laying their eggs.

Behavior / treatment	eggs laid in the same day of cutting	Eggs laid week after cutting
1	3	0
2	3	0
3	0	3
4	3	0
	Fisher's Exact Test:- 0.0045	
	Pr <= P 0.0182	
	Contingency Coefficient :- 0.7071	

***(1) Queens with single flagellum.**
***(2) Queens without the last segment of flagellum (segment number 10).**
***(3) Queens without pair of flagella.**
***(4) Normal queens (control).**

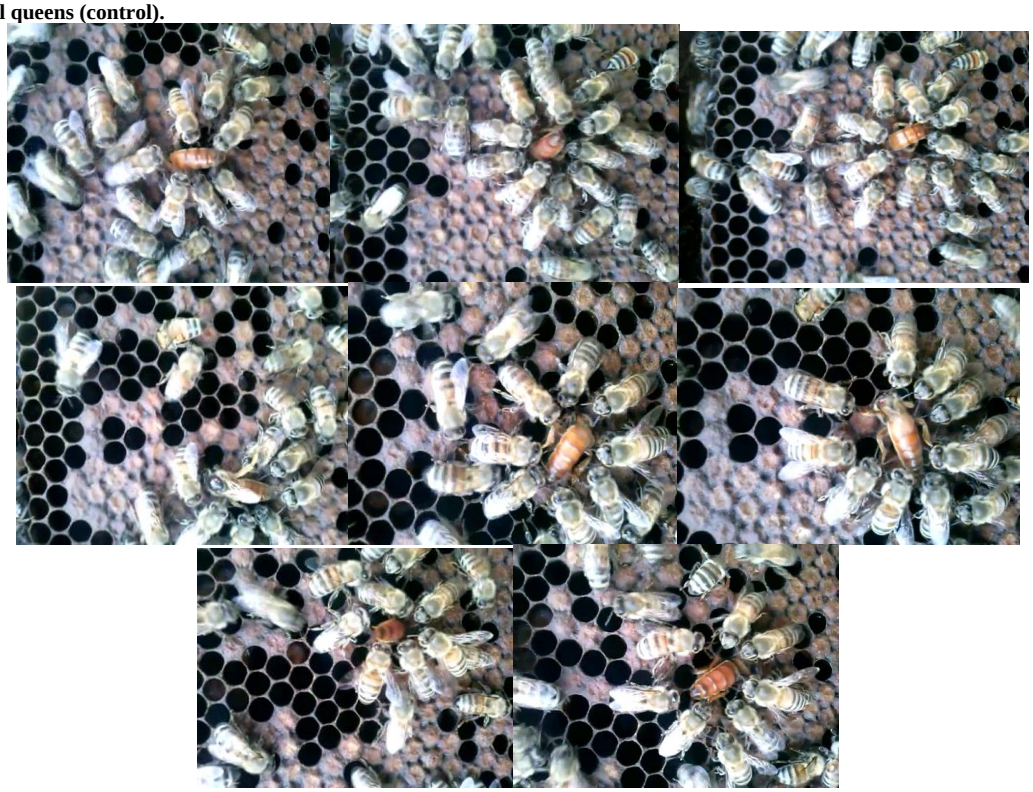

Fig 1. Parts of video showed the odd behavior of mated queens after cutting the pair of flagella in laying eggs in their hives.

In the present work, role of flagellum is very important where they affected on behavior of queens honey bee inside their hives such as laying eggs regularly and outside their hives such as mating and land marker their hives. Jung *et al* (2014) found that the olfactory organs are important sensory modalities on individual discrimination, perception and efficient orientation to get nectar and pollen in honey bees. Rogers *et al* (2013) showed that the honeybees preferred to use their right flagellum in social interactions. Gil & Marco (2010) studied the tactile hair on flagellum, enables bees to estimate the direction relative to gravity and the length of the waggle phase (waggle dance).

Number of sealed brood cells

The data given in Table ,٣ clearly showed that mean number of brood cells was affected by present or absent of flagellum in different treated queens.

In the beginning of experiments, the number of sealed brood cells did not significantly differ in all treatments and control. In second date (5/10/2014) the number of sealed brood cells was significantly differ between the first two treatments and control from one side and queens without both flagella from other sides which have no sealed brood cells. The number of the sealed brood cells at the second date was 7002.0, 6942.3 and 6942.3 in the control, queens with one flagellum and queens without the last segment of flagellum, respectively in comparison with queens without pair of flagella (0.00). In the third and fourth dates the number of brood cells was significantly higher in the queens with pair of flagella(control), with single flagellum and without the last segment of flagellum than queens without pair of flagella.

Table 3. Number of sealed brood cells/hive produced from treated mated queens every 13 days.

Dates	No. sealed brood cells/colony			
treatments	**22/9**	**5/10**	**18/10**	**31/10**
1	7276.7	6942.3[a]	5785.3[a]	5389.0[a]
	±91.3175	±73.7126	±87.4274	±56.8741
2	7459.7	6729.0[a]	5548.3[a]	5223.7[a]
	±130.2314	±96.8538	±132.2229	±57.7888
3	7539.0	0.0[b]	1828.0[b]	1833.3[b]
	±79.4858	±0.0000	±104.5498	±63.6884
CONT	7612.7	7002.0[a]	5876.7[a]	5481.3[a]
	±149.3906	±131.4762	±80.3008	±128.3883
F.Value.	3.09	2962.12**	722.5**	928.59**
L.S.D.		286.87	330.11	262.86

:*means with the same superscript in the same column were not significantly different) p(٠.٠٥>

1. Queens with single flagellum.
2. Queens without last segment of flagellum.
3. Queens without pair of flagella.

Fig 2. Sealed brood cells produced from mated queens without flagellum at both the third and fourth dates.

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تأثير قرون الأستشعار على سلوك ملكات نحل العسل داخل وخارج الخلية

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تم دراسة تأثير قرون الاستشعار للملكات فى منحل كلية الزراعة جامعة عين شمس خلال موسم الربيع 2014 فى طوائف ذات ملكات هجين ايطالى تم تلقيحها طبيعيا .التجارب أجريت باستخدام ١٢ ملكة عذراء أو ملقحة. كل واحدة منهم قسمت بالتساوى الى أربع معاملات (ملكات ذات قرن استشعار واحد و ملكات بدون العقلة الأخيرة من السوط و ملكات بدون قرون استشعار وكنترول. أظهرت النتائج أن الملكات العذاري التى لها قرن استشعار واحد قادرة على التزواج ووضع البيض بانتظام داخل خليتها بينما الملكات العذارى التى تم قطع العقلة العاشرة (الطرفية) من قرن الاستشعار خرجت للتزاوج ولم تعود مما يدل على انها تاهت عن خليتها بينما الملكات العذارى التى تم قطع السوط بالكامل من زوج قرن الاستشعار لم تستطيع الخروج من الخلية وظلت بداخلها وذلك بالمقارنة مع الملكات العذارى التى بها زوج من قرن الاستشعار كامل (كونترول) خرجت وتلقحت وعادت الى خليتها ووضعت البيض بانتظام. كما أظهرت النتائج أن الملكات الملقحة التى لها قرن استشعار واحد والملكات الملقحة التى تم قطع العقلة العاشرة للسوط والملكات التى بها زوج من قرن الاستشعار كامل (كونترول) قادرين على وضع البيض بانتظام داخل الخلية بالاضافة الى وضع بيضة واحدة داخل كل عين ووضع بيض الذكور فى عيون سداسية واسعة وبيض الشغالات داخل عيون سداسية ضيقة. أما الملكات الملقحة التى تم قطع السوط بالكامل من قرنى الاستشعار توقفت عن وضع البيض لمدة أسبوع واصبحت متوترة وتتحرك حركة سريعة وتنظر داخل العين السداسية وتخرج دون ان تضع بيض ثم تعاود النظر مرة أخرى داخل عين سداسية أخرى وهكذا دون ان تضع بيض وبعد أسبوع بدأت فى وضع البيض ولكن بدون انتظام ومبعثر على القرص وتضع أكثر من بيضة داخل العين السداسية الواحدة بالاضافة الى انها تضع بيض الذكور فى عيون سداسية ضيقة. تساوت أعداد الحضنة المقفولة فى كل من المعاملة الأولى (ملكات ملقحة ذو قرن استشعار واحد) والمعاملة الثانية (ملكات ملقحة بدون العقلة الطرفية لقرنى الأستشعار) مع الكنترول بينما انخفضت اعداد الحضنة فى المعاملة الثالثة (ملكات ملقحة بدون قرنى الاستشعار) انخفاض معنوى واضح عن بقية المعاملات والكنترول.