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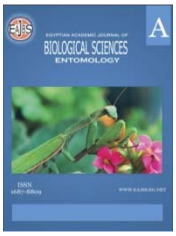

Ultrastructure Studies of Antennal Sensor Organs of Drones: Egyptian Honeybee vs Carniolan Honeybee

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ABSTRACT

This study compared the ultrastructure of some sensor organs on the drone's antennae of Egyptian, *Apis mellifera lamarckii,* bees to that of Carniolan, *A. m. carnica*, bees. The following characteristics were compared: antennal length; number and measurements of different sensilla was studied using scanning electron microscopy. A highly significant difference was observed between the antennal length of Egyptian and Carniolan honeybee drones, with means of 3.746 ± 0.081 mm. and 4.248 ± 0.126 mm, respectively. Obtained data revealed that there were significant differences in the number of different sensilla between the two tested honeybee populations. Also, the same trend was noticed for the measurements of the tested sensor organs. It can concluded that, the highest numbers of the different sensilla appeared, is due to their important functions for honeybee social organization.

INTRODUCTION

The domestic honeybee, *Apis mellifera* L., has an original large area of distribution in Africa, Europe and in the Middle East. All the honeybee races from the different regions give fully fertile hybrids when crossed.

However, different types which develop, during evolution, in the different areas, separated from each other by geographical barriers, or by ecological conditions are the geographical races. For beekeepers, these races are very important, and their biological characters may be predicted to some extent. Generally, these races differ in their morphometrics, activities, behaviour and production.

The most known races are: the Carniolan race, *Apis mellifera carnica* Pollman, the Italian race, *Apis mellifera ligustica* Spinola, the Caucasian race, *Apis mellifera caucasica* Gorbatchow. In addition, the Egyptian race, *Apis mellifera lamarckii* Cockerelle, is found in Egypt, especially in Assiut region. The geographical races can be discriminated by morphological differences, and biometric-statistic methods can be used for an exact analysis of their characters.

Carniolan bees are about the same size as the Italian bee, but they are physically distinguished by their generally dusky brown-grey color that is relieved by stripes of a subdued lighter brown color. Their chitin is dark, but it is possible to find lighter colored or brown colored rings and dots on their bodies. They are also known as the "grey bee".

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Carniolan bees are nearly as big and long as the Western European black bees, though their abdomens are much slimmer. Furthermore, Carniolan bee has a very long tongue (6.5 to 6.7 mm, which is very well adapted for clover), a very high elbow joint and very short hair.

Egyptian bee is a dark honey bee with yellow abdomen, and is a small subspecies like the races South of the Sahara. The Lamarck's mitotype can also be identified in honey bees from California and in feral bees from Florida.

Honeybees from different castes have different functions in their colony and exhibit different external and internal morphology. This is especially true for the antennae and for the antennal sensilla. For example, honeybee drones, the most important use for their olfactory sensilla is to detect queen pheromone (Frisch, 1967).

Ai *et al*., (2007), referred to that, at the end of the honeybee's antennae are segmented structures called flagella. These are highly sensitive movement detectors, which respond to displacements of the flagellar tip of just 20 nanometers (20 billionths of a metre) that occur in response to movements of air. These movements are detected by the Johnson's organs, which, in the honeybee, are found in the second segment of the antenna (the pedicel), within the joint between the flagellum and the basal region of the antenna (the scape). It perceives movement of antennal flagellum and flight speed indicator.

The classification of the different sensilla types in honeybee is done on the basis of cuticular morphology supported by studies of ultrastructure and electrophysiology and also the functional differences among these sensilla. The traditional classification for bee antennal sensilla is that of (Lacher, 1964), who classified those of *Apis* into 9 types on the bases of phenetic similarity. Esslen and Kaissling, (1976) split some of Lacher's classes even further, but (Agren, 1977) lumped some classes because he was unable to reliably distinguish them phonetically using SEM.

Zacharuk, (1985) and Zacharuk & Shields, (1991) revealed that, within each of the morphological types of insects' sensilla, there are variations in the number of small pores on the cuticle that are believed to be due to functional differences.

Schneider, (1964) indicated that, one of the possible adaptive resons for increasing the antennal length might be to have more surface area available for sense organs. However, obtaining additional surface area can certainly be accomplished also by developing branches, leaflets, etc. The density of sensilla on long antenna is, in many cases, not as high as one would expect. It seems much more probable that, long antenna are long because they are literally used as feller.

Specitically, sensivity may depend on the size, number or structure of sensory organs. For instance, the olfactory sensivity of bumblebee correlated with the length of their antennae.

Therefore, the aim of this study to compare the morphology of the antennae and the ultrastructure of its sensory organs. We examined number and measurement of sensory organs in the terminal segments of the antennae of two stocks of *Apis mellifera* commonly used in Egyptian beekeeping. First stock was *Apis mellifera lamarckii* Cockerell, is the endemic bee of Egypt and is well adapted to the local conditions and pests of the region. Second stock was a large population of honeybees, *A. m. carnica* Pollmann and is maintained commercially in Egypt.

MATERIALS AND METHODS

The present work was carried out in two apiaries yard. The first is located at

Refa location, Assiut Governorate. The other is located at Al-Dakhla, New Valley Governorate during May, 2016. This study compared the ultrastructure of some sensor organs on the drone antennae of Egyptian, *Apis mellifera lamarckii,* bees to that of Carniolan, *A. m. carnica*, bees.

Preparation and determination of flagellum ultra-structure:

Foragers' matured drones, were collected from the entrance of the hives. Forty drones or four replicates each of ten drones, from each race were used to examination. According to Stort and Rebustini, 1998 in each drone, one antenna (right) was examined. As shown as in Micrograph 1, the morphological structure of the antennae (Geniculate antennae), each antenna consists of one segmented scape, a pivoted pedicel and a long slender flagellum, which is composed of 10 segments. The drones' flagellomeres were numbered 1, 2, 3, 8, 9 and 10, beginning distally and examined from the dorsal side per unit area (122µm x 82µm) by scanning electron microscopy (SEM) (JEOL 5400LV. in Scanning electron microscopy (SEM) Unit, Assuit University. SEM was done as described by Awad, 1999.

The length of the antennae was determined in mm, according to the magnification force. Identification of sensilla types was carried out according to (Snodgrass, 1935, 1956; Agren, 1977 and Méndez-Vilas & Díaz, 2010). The sensilla were counted and measured according to the magnification force and depending on the morphological shape and the different functions of the sensilla.

Hence the measurement of Basiconica, Chaetica and Tricodea indicated by length in µm and the measurement of Ampullacea, Campaniformia and Coeloconica indicated by diameter in µm, but the measurement of Placodea calculated by area in µm² and this according to the following formula used by (Maurizio, 1954):

$$Surface\ area = \Pi \times \frac{a \times b}{2}$$

Where:

a = maximum length in µm, b = maximum width in µm and Π = 3.14

Statistical analysis:

Means of the two stocks were tested for differences using T- test at 0.05 probabilities using MSTAT-C software program (MSTAT-C, Michigan University, Version. 2. 10), and presented as mean ± SD (standard deviation).

RESULTS AND DISCUSSION

Determination of antennal length:

The behavior of the bees is influenced by external stimuli that can be detected by sensory organs. Honeybee queens produce vital pheromones that regulate many aspects of colony organization and worker morphology, behaviour and physiology (Slessor *et al*., 2005 and Le-Conte & Hefetz, 2008).

As shown as in Fig. 1, the mean of antennal length was 3.746 ± 0.081 mm. with a range from 3.451 to 3.957 mm. for the Egyptian honeybee drones. The antennal length of Carniolan bee drones was 4.248 ± 0.126 mm. (with a range from 4.038 to 4.376 mm.). Comparison of data for the two strains colonies gave a T-value 5.2204 at 5% significant level. Obtained results revealed that there was a highly significant difference between the antennal length of Egyptian and Carniolan honeybee drones (P=0.0073). This result agrees with those of Abdel-Rahman (2014) and Mahbob & Abdel Aziem (2014), they found a highly significant difference between the flagellum length of Egyptian and Carniolan honeybee workers. Spaethe *et al*., (2007) stated that long flagellum or large antennae exhibit an increased capability to catch odor molecules and thus are more sensitive to odors than small antennae.

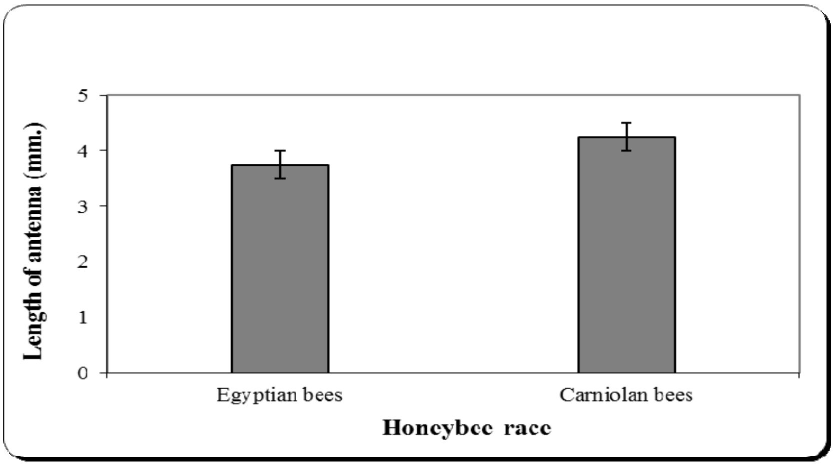


Fig. 1: The antennal length (mm.) of Egyptian and Carniolan honeybee drones.

Results can be explained that the Egyptian bees perhaps more sensitive to the odors. Carniolan bees less sensitive to the odors so, it need to a large antenna to catch more odor. Schneider, (1964) indicated that, one of the possible adaptive reasons for increasing the antennal length might be to have more surface area available for sense organs. However obtaining additional surface area can certainly be accomplished also by developing branches, leaflets, etc. the density of sensilla on long antenna is, in many cases, not as high as one would expect on the premise mentioned above. It seems much more probable that, long antenna are long because they are literally used as feller, sensivity may depend on the size, number or structure of sensory organs.

Numbers and measurements of the various types of sensilla per unit area (122µm x 82µm) on the dorsal side of different flagellomeres of the drones:

Scanning electron microscopy SEM showing the morphological structure of the antenna of the honeybee drones in the two strains (Geniculate antenna). Each antenna consists of one segmented scape, a pivoted pedicel and a long slender flagellum, which is composed of 10 segments. We focused on the last three basal and the last three terminal flagellomers to see the difference between the two strains. We classified the different types of sensilla into seven types and nine subtypes; sensilla Ampullacea (Am), sensilla Basiconica (Ba), sensilla Campaniformia (Cf), sensilla Chaetica (Ch) I, II, sensilla Coelloconica (Co), sensilla Placodea (PL) I, II, III and sensilla Trichodea (Tr) I, II, III, IV. (Micrograph 1, 2, 3 and 4).

The results agreed with those recorded by (Méndez-Vilas and Díaz, 2010), who indicated that, these types of sensilla are sensilla Trichoidea, sensilla Chaetica, sensilla Basiconica, sensilla Coeloconica, sensilla Ampullacea, sensilla Campaniformia and sensilla Placodea, that have been traditionally classified on the basis of the morphology of their cuticular parts, as well as the location on the insect.

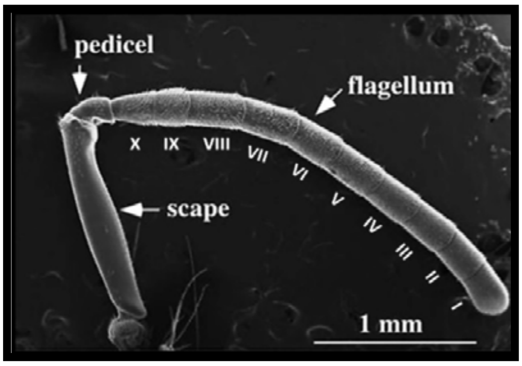
The numbers and measurements of antennal sensilla per unit area (122µm x 82µm) on the dorsal side of different flagellomeres of Carniolan and Egyptian honeybee drones are presented in (Table 1 & 2), and (Micrograph 1, 2 & 3).

Table 1: Mean number of different sensilla per unit area (122µm × 82 µm) of some flagellum segments of honeybee drones.

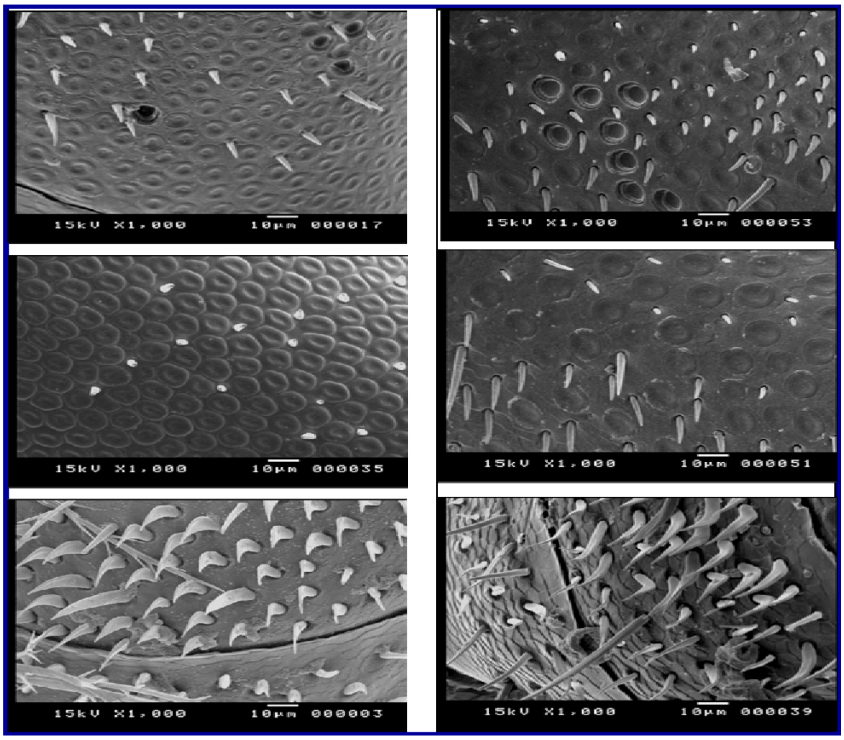
	Segment No.	Types and numbers of sensilla												
		Ampullacea	Basiconica	Campaniformia	Chaetica		Coelloconica	Placodea			Trichodea			
					I	II		I	II	III	I	II	III	IV
Carniolan bee	1	–	–	–	–	27	–	103	6	32	–	–	–	–
	2	-	6	–	-	17	–	69	32	2	–	–	–	–
	3	1	11	–	5	13	–	–	–	73	29	22	20	-
	8	-	1	–	3	18	–	5	3	116	–	–	–	–
	9	-	14	–	-	-	–	–	–	132	–	–	–	–
	10	-	-	–	2	3	–	–	–	–	4	–	–	37
	Total ± SD	1 ± 0.5	32 ± 5.8	0	10 ± 4.6	78 ± 27.8	0	177 ± 40.5	41 ± 9.4	355 ± 59.6	33 ± 15.2	22 ± 8.0	20 ± 4.4	37 ± 14.5
Egyptian bee	1	1	4	–	12	13	–	–	–	5	56	34	11	16
	2	5	2	2		82	2	1	67	6	–	–	–	–
	3	2	–	–	1	75	1	–	70	-	–	–	–	–
	8	3	2	3	5	37	–	8	38	–	2	–	–	–
	9	1	4	1	12	11	–	–	37	–	4	–	–	–
	10	–	–	–	6	–	–	–	–	–	4	–	–	27
	Total ± SD	12 ± 6.0	12 ± 4.8	6 ± 2.5	36 ± 11.4	218 ± 83.5	3 ± 0.8	9 ± 2.0	212 ± 63.8	11 ± 4.6	66 ± 12.8	34 ± 16.4	11 ± 5.0	43 ± 16.0
T- value		4.5252	3.205	-	-3.7326	-4.968	-	5.1855	-2.8695	3.0616	-3.0072	-2.0473	2.884	3.9246
Probability		0.0134	0.0292	-	0.0253	0.0105	-	0.0098	0.0473	0.0381	0.0543	0.0481	0.0469	0.0197

Table 2: Measurements of different sensilla per unit area (122µm × 82 µm) on the dorsal side of some flagellum segments of honeybee drones.

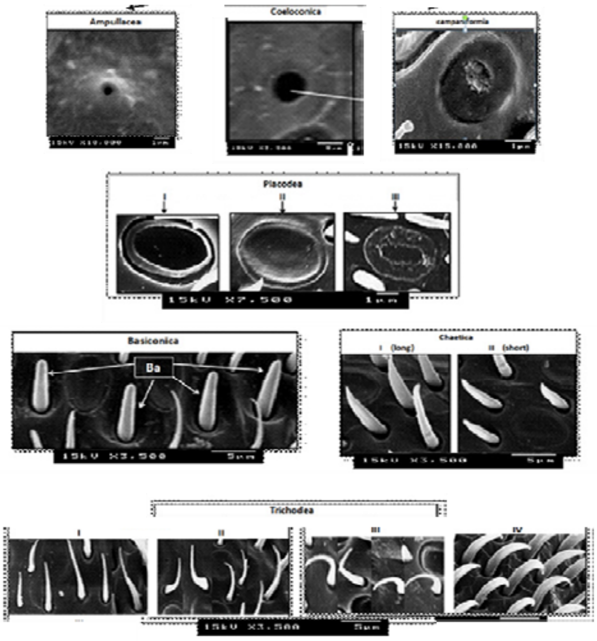
Strains	Segment No.	Measurements of sensilla organs																		
		Ampullacea	Basiconica	Campaniformia	Chaetica		Coeloconica	Placodea									Tricodea			
					I	II		I			II			III			I	II	III	IV
		Diameter	Length	Diameter	Length	Length	Diameter	Length	Width	Area	Length	Width	Area	Length	Width	Area	Length	Length	Length	length
Carniolan bee	1	-	-	-	-	6.56	-	8.75	6.81	93.55	7.81	7.25	88.9	10.25	5.93	95.43	-	-	-	-
	2	-	-	-	-	4	-	10.44	6.37	104.41	11.43	9.06	162.58	9.18	6.37	91.81	-	-	-	-
	3	0.19	5.56	-	17.06	6.37	-	-	-	-	-	-	-	8.75	5.43	74.59	7.31	9.06	10.18	-
	8	-	8.25	-	8.12	3.31	-	4.43	4	27.82	4.37	3.31	22.71	4.68	4.43	32.55	-	-	-	-
	9	-	4.94	-	-	-	-	-	-	-	-	-	-	10.87	7.25	123.73	-	-	-	-
	10	-	-	-	22.75	7	-	-	-	-	-	-	-	-	-	-	26.06	-	-	14.68
Mean		0.19	6.25	-	15.97	5.45	-	7.87	5.726	70.75	7.87	6.54	80.81	8.74	5.882	80.71	16.68	9.06	10.18	14.68
Egyptian bee	1	0.94	6.44	-	-	-	-	-	-	-	-	-	-	8.43	6.18	81.79	12.25	8.31	10	13.5
	2	1	8.88	3.68	-	4.06	1.75	10.25	8.18	131.64	10.12	6.43	102.16	11.25	7.5	132.47	-	-	-	-
	3	1.31	4	-	11.06	5.75	2.12	-	-	-	-	-	-	10.75	7.18	121.18	-	-	-	-
	8	2.31	9.12	3.69	11.44	6.56	-	9.37	6.81	100.18	10.19	9.06	144.94	-	-	-	19.87	-	-	-
	9	1.56	4.94	3.14	19.63	6.69		-	-	-	7.25	10.43	118.72	-	-	-	33.18	-	-	-
	10	-	-	-	6.62	-	-	-	-	-	-	-	-	-	-	-	21.56	-	-	25.18
Mean		1.424	6.676	3.503	12.187	5.765	1.935	9.81	7.495	115.44	9.18	8.64	124.52	10.14	6.953	110.69	21.715	8.31	10	19.34



Micrograph 1: The morphological structure of the antenna of the honeybee drone.



Micrograph 2: The morphological structure of the last basal flagellomers of the honeybee drone.



Micrograph 3: The different of sensilla types on the flagellum of honeybee drones

Sensilla Ampullacea (Am) appear only on the third flagellomere of Carniolan drones, but these sensilla were distributed on the different flagellomeres of Egyptian drones except for the 10th flagellomeres. The highest total number of these sensilla (12) was recorded in Egyptian race. The measurements of (Am) were very small in Carniolan drones 0.19 µm, but it was normal size in Egyptian drones about 1.424 µm in diameter (ranged from 0.94 to 2.31 µm).

Our findings suggest that, sensilla (Am) are olfactory or smell chemoreceptor involved in perception of temperature, carbon dioxide and humidity, this is agreeable with (Kuwabara and Takeda, 1956), as the sensilla Ampullacea are hygroreceptors, respond to temperature and humidity. Since sensilla Ampullacea are considered to be hygroreceptor organs, the males and workers probably do not differ in sensitivity in terms of perceiving variations in these factors in the environment. Kleineidam and Tautz, (1996) identified the sensilla Ampullacea as CO_2 receptors, by recording action potentials in response to CO_2 and subsequent marking of the recording sites. They also observed that the CO_2- receptive cells are associated with temperature sensitive neurons in the same sensilla.

Sensilla Basiconica (Ba) didn't coexisted on the first two and ninth flagellomeres in Carniolan drones, but they disappeared on the tenth only in Egyptian drones. The highest total number of these sensilla (32) was recorded in case of Carniolan drones. The length of Ba was 6.25 µm (ranged from 4.94 to 8.25 µm) in Carniolan drones. The length of Ba ranged from 4 to 9.12 µm with a mean 6.676 µm in Egyptian ones.

Snodgrass, (1935 & 1956) revealed that, sensilla Basiconica are chemical receptors. Similar findings were reported by (Méndez-Vilas and Díaz, 2010), that sensilla Basiconica can be solely mechano-, contact chemo-, and olfactory receptors. Contrary to them our results vary with that of (Ba) can be also thermo- and hygrosensitive in function.

Sensilla Campaniformia (Cf) didn't occur on all flagellomeres of Carniolan drones and appeared on 2nd, 8th and 9th flagellomeres of Egyptian drones, with total number was 6. These sensilla are 3.503 µm in diameter and ranged from 3.14 to 3.69 µm.

The electrophysiological findings of (Lacher, 1964) for *Apis mellifera*, that sensilla Campaniformia is sensitive to temperature, carbon dioxide and humidity or a combination of these factors. These results is agreeable with those obtained by (Dietz and Humphreys, 1971), that the sensilla Campaniformia, allow the perception of temperature, CO_2, and humidity henceforth; it is referred to as a coelocapitular sensillum (campaniform sensilla). Also, our results are similar to the data reported by (Yokohari *et al*., 1982), on the antennal hygroreceptors of the honeybee and the sensillum containing these receptors. Moist and dry hygroreceptors have been identified along with a thermal receptor in a specialized coeloconic sensillum. The data obtained by (Yokohari, 1983) agreed with our obtained results for that, the campaniform sensilla, a hygro- and thermoreceptive sensillum of the honeybee.

The long Chaetica (Ch I) was found on most of the 3rd, 8th and 10th flagellomeres of Carniolan drones. These sensilla was recorded on the 3rd, 8th, 9th and 10th flagellomeres of Egyptian drones. The lowest total number (10) of these sensilla exhibited in the Carniolan drones. These sensilla ranged from 8.12 to 22.75 µm in length with a mean is 15.97 µm in case of Carniolan drones. For Egyptian race, the same sensilla ranged from 6.62 to 19.63 µm in length with a mean is 12.187 µm.

While, the short Chaetica (Ch II) is relatively ascended on most of the different flagellomeres of the drones under the two races, with varying in number distribution on these different flagellomeres. The highest total number (218) of these sensilla appeared in Egyptian drones, but the lowest total number (78) noticed in Carniolan race. These sensilla ranged from 4 to 7 µm in length with a mean is 5.44 µm in case of Carniolan drones. In Egyptian race, the same sensilla ranged from 4.06 to 6.69 µm in length with a mean is 5.765 µm.

Ruth, (1976) showed that, the long Chaetica responded to sugar, fatty acids and alcohols and also to air. Altner, (1977), found that, bristles (sensilla Chaetica) act as receptors for touch and air flow, they can also act as chemoreceptors. Haupt, (2004) showed that, chaetic sensilla are very sensitive to sucrose stimulation. Gabriela, (2011) indicated that, taste is crucial for honeybees for choosing profitable food diet sources, resins, water sources, and for nest mate recognition. These sensilla respond with varying sensitivity to sugars, salts, and possibly amino acids, proteins, and water.

Sensilla Coelloconica (CO) with very slightly protrusive peg, didn't uprise on the different flagellomeres under Carniolan drones. Also they uprise only on the second and third flagellomeres of Egyptian ones. The mean diameter of these sensilla was 1.935 µm, and ranged from 1.75 to 2.12 µm.

Stort and Rebustini, (1998) found correlation between numbers of the Campaniformea and Coeloconica sensilla organs and the defense behavior in Africanized honeybees.

Both sensilla Placodea type one (PL I) and type two (PL II) were absent on the 3rd, 9th and 10th flagellomeres of the Carniolan drones. The total number of PL I was 177 for Carniolan drones and 9 for Egyptian ones. On the contrary, the total number of PL II was 41 and 212 for Carniolan an Egyptian drones, respectively. Sensilla Placodea type one ranged from 27.82 to 104.41 µm² in area with a mean was 70.75 µm^2 for Carniolan drones. In Egyptian race, the mean area of same sensilla was 115.44 µm^2. However, PL II ranged from 22.71 to 162.58 µm² in area with a mean was 80.81 µm² for Carniolan drones. In case of Egyptian drones, the mean area of PL II was 124.52 µm² and ranged from 102.16 and 144.94 µm². Sensilla Placodea type three (PL III) disappeared on the tenth flagellomere only in Carniolan drones, but they didn't coexisted on the last three flagellomeres for Egyptian drones. The highest total number of these sensilla (355) was recorded in Carniolan drones. The mean area of PL III was 80.71 µm² (ranged from 32.59 to 123.73 µm²) in Carniolan drones. The mean area of the same sensilla was 110.69 µm² in Egyptian ones.

This result contrasted with those of Abdel-Rahman (2014) who found that there were non-significant differences in both the number and the area of sensilla placodea between Carniolan and Egyptian honeybee populations. Electrophysiological recordings revealed that the neurons of sensilla Placodea respond to the components of the honeybee pheromones as well as to a variety of plant and flower odors (Lacher & Schneider, 1963; and Vareschi, 1971). The same results were found by Free, (1987), who stated that, the sensilla Placodea have been shown to be odour receptors. Arnold & Masson, (1981) and Winnington *et al*., (1996) found that, during the first week of workers' life, the sensilla Placodea and the neuropil of the olfactory centre undergo changes. Ander and Wulfila, (2010) found differences in sensory sensivity also depend on the bee's maturation or age. So the possibility that task specialization and sensory sensivity in honeybees are associated with variation in size or number of sensory organs.

Sensilla Trichodea are considered as mechanoreceptors for tactile, chemoreceptors for smell (olfactory organs) and chemoreceptor for taste (gustatory organs) and also they can be auditory organ. Sensilla Trichodea (Tr), with their different types, were concentrated on the 3rd flagellomere of Carniolan drones and on the 1st flagellomere of Egyptian race. Sensilla Trichodea type one (Tr I) recorded the highest total number (66) on Egyptian drones. While, the lowest total number (11) was noticed for Sensilla Trichodea type three (Tr III) on the drones of the same race. The length of these sensilla with their different types ranged from 7.31 to 26.06 μm for Carniolan drones. Meanwhile, the length of the same sensilla ranged from 8.31 to 33.18 μm for Egyptian ones.

Our results contradictory to Altner, (1977) and Antonio & Nilson, (1981), who revealed that, the sensilla Trichodea and Placodea are present in the highest amount in honeybee. The same trend was noticed by (Gupta, 1992), who concluded that, Sensilla Trichodea (type A) are considered the most common structures on the antenna.

According to (Ai *et al*., 2007), the Johnson's organs, which, in the honeybee, perceive movement of antennal flagellum, response to movements of air and considered as flight speed indicator, and this appeared in our results as there is no significant difference in the (Tr IV) in the two tested races.

In general, significant differences were noticed in the number of all tested sensilla between Egyptian honeybees' strains and Carniolan ones. It can concluded that, the highest numbers of the different sensilla appeared, is due to their important functions for honeybee social organization. Salem *et al*., (2001) and Hussein *et al*., (2005) concluded that the high counts of the sensilla organs in the flagellomeres of the antennae in tolerant worker bees to varroa mites may be due to occurrence of one or more natural defense mechanisms towards the mites particularly grooming and brood removal behavior.

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ARABIC SUMMERY

دراسة التركيب الدقيق لأعضاء الحس على قرون الإستشعار في الذكور: مقارنة النحل المصري بالنحل الكرنيولي

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تمت هذه الدراسة لمقارنة التركيب الدقيق لأعضاء الحس الموجودة على قرون الإستشعار لذكور النحل المصري *Apis mellifera lamarckii* والنحل الكرنيولي *A. m. carnica* . وفي هذه الدراسة تم مقارنة الخصائص التالية: طول قرن الإستشعار وعدد وقياسات الشعيرات الحسية المختلفة وذلك بإستخدام الميكروسكوب الأليكتروني. وجد أن هناك إختلاف معنوي جدا بين طول قرون الإستشعار لذكور كلا من السلالتين للنحل المصري والكرنيولي وذلك بمتوسط أطوال ٣.٧٤٦ ±٠.٠٨١ مم و٤.٢٤٨ ± ٠.١٢٦ مم للسلالتين على التوالي. وقد عكست النتائج المتحصل عليها أنه توجد إختلافات معنوية في أعداد الشعيرات الحسية المختلفة بين ذكور كلا السلالتين. وقد لوحظ أيضا نفس الإتجاه بالنسبة لقياسات الشعيرات الحسية. ويمكننا إستنتاج أن تواجد أعداد كبيرة من الشعيرات الحسية المختلفة يعزى لأهمية وظائفها من أجل التنظيم الإجتماعي لنحل العسل.