J. Plant Prot. and Path., Mansoura Univ., Vol. 5 (11): 959 - 972, 2014

MARPHOMETRICAL STUDIES OF SOME ANTENNAL SENSOR ORGANS OF EGYPION AND CARNIOLAN HONEYBEE WORKERS.

Mahbob, M. A.[1] and M. A.I. Abdel Aziem[2]

1 – Faculty of Science, Assiut University, New Valley Branch, Egypt

2– Apiculture Department, Plant Protection Research Institute, ARC, Dokki, Giza, Egypt

ABSTRACT

This study compared the ultrastructure of some sensor organs on the antennae of Egyptian, *Apis mellifera lamarckii,* bees to that of Carniolan, *A. m. carnica*, bees. Egyptian bees 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 and is maintained commercially in Egypt. The following characteristics were compared: the antennal length; the number and the measurements of sensilla of placodea, trichodea and chaetica of the flagellomeres 1 to 8 of the antennae of workers of the two honeybee races was studied by scanning electron microscopy. There was a highly significant difference between the antennal length of Egyptian and Carniolan honeybee workers (P=0.0097) with means of 3.858 ± 0.162 mm. and 4.321 ± 0.076 mm. respectively. Statistically, the numbers and the measurements of sensor organs of the antennae of Egyptian and Carniolan honeybees did not deffer from one another in most flagellomers.

Keywords:Honeybee, *Apis mellifera lamarckii*, *A. m. carnica*, antenna, flagellum, sensilla placodea, trichodea, chaetica.

INTRODUCTION

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 queens use their antennal sensilla to perceive colony odors, while workers use their antennal sensilla to detect odors such as queen pheromone, brood pheromone and floral perfumes, workers can distinguish the odors of plants in bloom. For drones, the most important use for their olfactory sensilla is to detect queen pheromone (Frisch, 1967). Workers may change between different tasks depending on their physiological maturation or age (temporal castes; Michener, 1974 and Johnson, 2002) the antennae are particulary responsive to the stimuli of to touch and (Snodgrass, 1956).

The geographical bee races can be discriminated by morphological differences, and biometric-statistic methods can be used for an exact analysis of their characters (Abdel-Rahman, 2004)

Releaser pheromones influences workers' behavior and the sensitivity of their antennal receptors to queen extract odour, or affects the maturation of the antennal lobes of the worker bee brain, etc., where the antennae are the major channel of sensory input, including receptors for volatile odors and pheromones, contact chemoreception, sound perception and touch (Ehmer & Gronenberg, 1997 and Renthal *et al.,* 2003), because honeybee live inside tree cavities (natural) or hives (man-made), both of which have little light away from the entrance, smell and touch therefore are much important for them than visual when inside the colony for communication and social organization. Also the age of worker honeybees has an influence on their ability to learn to discriminate olfactory stimuli.

Scanning electron microscopic (SEM) studies of worker honeybees, *Apis mellifera*, have been carried out earlier by (Slifer, 1970 and Dietz & Humphreys, 1971) and also on many other Hymenopterans (Norton & Vinson, 1974 and Agren, 1977).

Six types of the sensilla organs; Trichodea type (A&B), Placodea, Basiconica, Coeloconica and Campaniformia in the flagellomeres No. 2, 4, 6, 8 &10 of the worker honeybee antennae. In addition, there were significant differences in the mean numbers, measurements and distribution of the sensilla organs between and within different tested antenna segments of *Apis florea* and *Apis mellifera* (Al-Ghamdi, 2006).

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 (Spaethe *et al.,* 2007), presumably because longer antennae carry more olfactory sensilla (pore plates). Consistent with these morphological changes, that antennal sensitivity to odors increases with body size. Antennae of large individuals show higher electroantennogram responses to a given odor concentration than those of smaller nestmates. This finding indicates that, large antennae exhibit an increased capability to catch odor molecules and thus are more sensitive to odors than small 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 the apiary yard at Refa location, Assiut Governorate, Upper Egypt, during August, 2013.

A total of ten honeybee colonies were divided into two groups containing two stocks. First were five colonies of Egyptian bees, *Apis mellifera lamarckii* Cockerell and second was five colonies Carniolan bees, *A. m. carnica* Pollmann. Egyptian bee colonies were collected from mud tube hives at March, 2013, and then transferred into modified wooden moveable frame hives. Carniolan bee queens were produced from Al-Dakhla, New Valley at May 2013, and then introduced into honeybee colonies.

Preparation and determination of flagellum ultra-structure:

Newly emerged workers (0-12 hrs. age), were collected from sealed brood combs screened at wire cages and placed in incubator at temperature of 30+1°C. Fifty workers or four replicates each of ten workers, from each race were used to examination. According to Stort and Rebustini, 1998 in each worker, one antenna (right) was examined. The workers' flagellomeres were numbered I, II, III, IV, V, VI, VII and VIII, beginning distally and examined from the dorsal side per unit area (122µm x 82µm) by scanning electron microscopy (SEM) (JEOL 5400LV. in SEM Unit, Assuit University).

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. We classified the different types of sensilla into three types and seven subtypes; sensilla Chaetica (Ch) I, II, sensilla, sensilla Placodea (Pl) I, II, III and sensilla Trichodea (Tr) I, II. (Micrograph.1).

Hence the measurement of Chaetica and Tricodea indicated by length in µm, but the measurement of Placodea calculated by area in μm^2 and this according to the formula used by (Maurizio's, 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 (1988) (MSTAT-C, Michigan University, Version. 2. 10), and presented as mean ± SD (standard deviation).

RESULTS AND DISCUSSION

Determination of flagellum length:

The antennae are the main sensory organs of the bee for smelling, tasting and hearing, as well as detecting changes in temperature, vibration, wind and humidity. There are a variety of the sensory organs (sensilla) on the different flagellomeres of the honeybee workers and this as previously indicated by (Warnke, 1976), that 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 Figure 1, the mean of antennal length was 3.858 ± 0.162 mm. with a range from 3.451 to 4.105 mm. for the Egyptian honeybee workers. The antennal length of Carniolan bee workers was 4.321 ± 0.076 mm. (with a range from 4.069 to 4.533 mm.). Comparison of data for the two strains colonies gave a T-value – 4.6481 at 5% significant level. Obtained results revealed that there was a highly significant difference between the antennal length of Egyptian and Carniolan honeybee workers (P=0.0097).

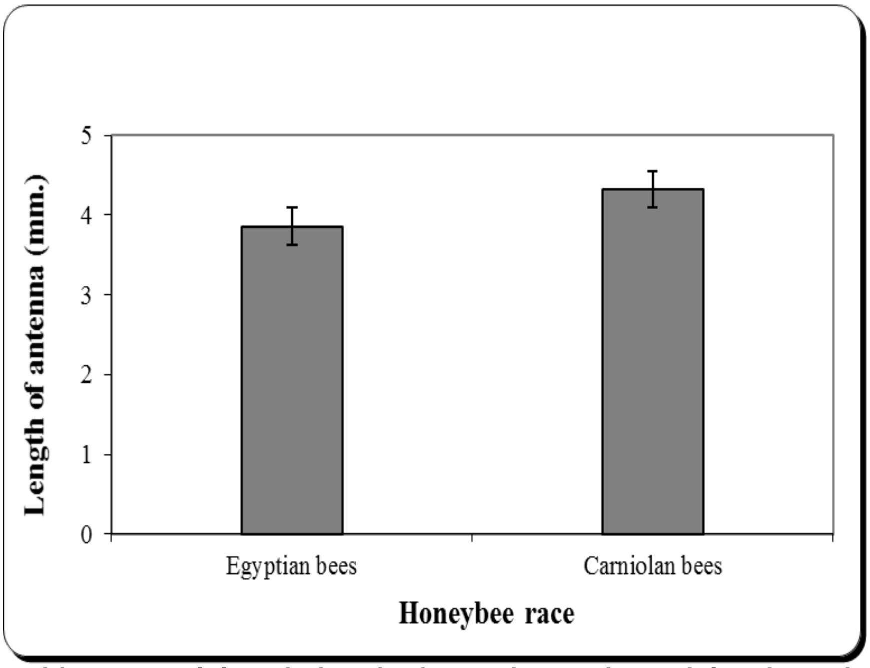

Fig. (1): Antennal length (mm.) of Egyptian and Carniolan honeybee workers.

Results can be explained that the Egyptian bees perhaps more sensitive to the odors of dead and diseased brood. Carniolan bees less sensitive to the odors of dead and diseased brood so, it need to a large antenna to catch more odor. This result agree with those of Abdel-Rahman (2014) who found a highly significant difference between the flagellum length of Egyptian and Carniolan honeybee workers.

Hussein *et al.,* (2005a) recorded that lengths of antennae were 3.957 and 4.272 mm. for the Egyptian and Carniolan newly emerged workers, respectively. 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.

Several data were obtained to indicate the relationship between sensilla numbers and measurements with the antennal length. 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. For instance, the olfactory sensivity of bumblebee correlated with the length of their antennae, presumably because longer antennae carry more olfactory sensilla (pore plates). This finding indicates that long flagellum or large antennae exhibit an increased capability to catch odor molecules and thus are more sensitive to odors than small antennae (Spaethe *et al.,* 2007).

Determination of sensilla placodea numbers:

Frasnelli, 2008, stated that there are no olfactory receptors on the first two proximal (9, 10) segments of the honeybee flagellum. The numbers of sensilla placodea of Egyptian and Carniolan honeybees are presented as. The number of placodea ranged from 21.0 to 30.0 with a general mean 23.0 for Egyptian worker bees. In case of Carniolan honeybees, the placodea number ranged from 23.0 to 31.0 with a mean 24.25.

Table (1): Mean number of sensilla placodea, types Pl I; II and III per unit area (122µm × 82 µm) of the flagellum segments 1 to 8 of honeybee workers.

Flagellum segments		Bee race		T- value	Probability
		Egyptian bees ± SD	Carniolan bees ± SD		
1	Pl I	9.4 ± 3.6	0.0	-	-
	Pl II	5.4 ± 2.01	0.0	-	-
	Pl III	11.8 ± 7.6	24.2 ± 5.2	-2.225	0.0901
2	Pl I	9.4 ± 2.07	0.0	-	-
	Pl II	6.4 ± 5.33	2.8 ± 1.3	1.9354	0.1250
	Pl III	5.2 ± 2.8	20.8 ± 4.9	- 3.7122	0.0206
3	Pl I	14.2 ± 6.04	0.0	-	-
	Pl II	0.0	6.0 ± 1.25	-	-
	Pl III	12.7 ± 9.2	18.2 ± 10.3	- 0.9556	0.3934
4	Pl I	16.2 ± 7.7	2.7 ± 1.2	4.4042	0.0117
	Pl II	9.2 ± 4.6	13.4 ± 11.7	- 1.5669	0.1922
	Pl III	4.9 ± 1.9	9.3 ± 7.0	- 1.5238	0.2022
5	Pl I	21.6 ± 5.0	8.6 ± 6.2	5.7553	0.0045
	Pl II	1.3 ± 0.8	13.4 ± 12.2	- 2.3414	0.0793
	Pl III	4.5 ± 2.0	9.4 ± 4.2	- 0.4328	0.6875
6	Pl I	24.8 ± 4.9	11.8 ± 10.8	2.3889	0.0821
	Pl II	0.4 ± 0.2	13.0 ± 5.8	- 1.000	0.3739
	Pl III	0.0	6.6 ± 2.04	-	-
7	Pl I	21.8 ± 1.9	18.8 ± 9.9	0.6594	0.5457
	Pl II	0.0	5.0 ± 1.7	-	-
	Pl III	0.0	0.4 ± .13	-	-
8	Pl I	21.2 ± 4.3	20.6 ± 13.4	0.0906	0.9322
	Pl II	0.0	6.6 ± 1.11	-	-
	Pl III	0.0	0.0	-	-

In general, non-significant differences were noticed in the number of placodea between Egyptian and Carniolan honeybee workers. Significant differences were noticed between the numbers of both Pl III and Pl I in the 2nd and 4th segments (P=0.0206 and 0.0117, respectively). Obtained results showed that there was a highly significant difference between the number of Pl I in 5th flagellum segment of Egyptian and Carniolan honeybee workers (P=0.0045).

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, 1964 and Vareschi, 1971)**.

Table (2): Mean number of sensilla trichodea, types Tr I and II per unit area (122µm × 82 µm) of the flagellum segments 1 to 8 of honeybee workers.

Flagellum segments		Bee race		T- value	Probability
		Egyptian bees ± SD	Carniolan bees ± SD		
1	Tr I	4.6 ± 3.2	3.2 ± 1.5	0.8584	0.4391
	Tr II	8.8 ± 4.0	7.8 ± 3.3	1.000	0.3739
2	Tr I	4.0 ± 2.9	2.8 ± 1.1	0.9097	0.4144
	Tr II	5.8 ± 1.9	5.6 ± 1.9	0.1612	0.8798
3	Tr I	3.0 ± 1.4	3.0 ± 1.9	0.000	1.000
	Tr II	6.8 ± 3.1	3.4 ± 0.5	2.3134	0.0817
4	Tr I	2.6 ± 0.9	1.8 ± 1.3	0.9300	0.4050
	Tr II	4.6 ± 2.3	3.6 ± 2.2	0.6901	0.5281
5	Tr I	2.2 ± 1.3	1.6 ± 1.1	1.5	0.2.8
	Tr II	4.6 ± 2.5	2.4 ± 0.9	2.5574	0.0628
6	Tr I	1.4 ± 0.9	1.2 ± 1.1	0.25	0.8149
	Tr II	3.2 ± 8.3	2.8 ± 1.3	0.2722	0.799
7	Tr I	1.2 ± 1.1	1.1 ± 0.8	0.5345	0.6213
	Tr II	2.2 ± 1.9	2.8 ± 1.3	- 0.4399	0.6827
8	Tr I	0.9 ± 0.8	1.4 ± 1.0	- 0.2063	0.8466
	Tr II	3.0 ± 1.0	1.0 ± 0.7	3.1623	0.0341

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. Zacharuk and Shields, (1991) indicated, Sensilla Trichodea have been ascribed as having mechanosensory function with some also having chemosensory and/or thermosensitive functions.

Sensilla Trichodea type one (Tr I) were subsisted on the all of the different flagellomeres of the workers under the two lines with varying in the number distribution. The lowest number of these sensilla appeared in case carniolan bees. However, Sensilla Trichodea type two (Tr II) indicated on the all of the different flagellomeres of the workers under the two tested races, with varying in the number distribution. Méndez-Vilas and Díaz, (2010), defined the sensilla Chaetica- as hairs similar to the sensilla Trichodea, but have thicker cuticular and they can be mechano- or contact chemosensitive in function.

Table (3): Mean number of sensilla chaetica, types Ch I and II per unit area (122µm × 82 µm) of the flagellum segments 1 to 8 of honeybee workers.

Flagellum segments		Bee race		T- value	Probability
		Egyptian bees ± SD	Carniolan bees ± SD		
1	Ch I	22.2 ± 12.5	30.6 ± 5.0	- 1.5502	0.196
	Ch II	13.1 ± 6.8	1.8 ± 0.8	1.1859	0.3013
2	Ch I	17.4 ± 14.6	28.2 ± 4.9	- 1.3559	0.2466
	Ch II	14.5 ± 12.4	0.9 ± 0.4	1.9191	0.1274
3	Ch I	14.0 ± 11.5	23.0 ± 3.8	- 1.6800	0.1683
	Ch II	14.0 ± 12.6	4.5 ± 3.0	1.5748	0.1904
4	Ch I	9.0 ± 8.2	18.4 ± 10.6	- 1.7498	0.1551
	Ch II	19.6 ± 10.2	10.5 ± 5.2	2.7580	0.0510
5	Ch I	10.8 ± 5.8	16.8 ± 10.9	- 1.2621	0.2755
	Ch II	14.6 ± 10.9	11.7 ± 7.0	1.3022	0.2628
6	Ch I	5.0 ± 4.2	11.2 ± 10.6	- 0.9417	0.3996
	Ch II	17.2 ± 7.0	12.8 ± 12.5	0.6158	0.5714
7	Ch I	6.7 ± 5.2	6.6 ± 4.8	0.0998	0.9253
	Ch II	15.8 ± 8.3	15.6 ± 10.3	0.0352	0.9736
8	Ch I	7.2 ± 5.7	6.5 ± 6.4	0.4833	0.6541
	Ch II	12.4 ± 5.9	16.0 ± 10.9	- 0.6921	0.5270

The long Chaetica (Ch I) is relatively ascended on most of the different flagellomeres of the workers under all worker sampling, with varying in number distribution on these different flagellomeres. The lowest number of these sensilla, 5.0 ± 4.2, exhibited in the 6th flagellomer of Egyptian bees. While, the highest number, 30.6 ± 5.0, was recorded in the 1st flagellomer of Carnilan ones. The highest total number of Chaetica (Ch II), 17.2 ± 7.0, 6th flagellomer of Egyptian bees, but the lowest number, 0.9 ± 0.4, appeared in the 2nd of Carniolan workers. Ruth, (1976) showed that, the long Chaetica responded to sugar, fatty acids and alcohols and also to air.

The two types of sensilla Chaetica (Ch I) and (Ch II) are contrasting in most of the flagellomers for the two tested races, so that they may be functionally completed to each other, sensilla (Ch: I, II) are mechanoreceptors to tactile stimuli and contact chemoreceptor sensitive to gustative stimuli, moreover, they are considered as auditory organ, probably (Ch I) are considered as taste hairs and also as auditory organs, while (Ch II) are considered as tactile hair only.

These conclusions have previously been indicated by (Martin & Lindauer, 1966; Whitehead & Larsen, 1976 a, b and Haupt, 2004), that the terminal flagellar antennomere of honeybee workers is covered with a number of large taste hairs. (Eichmüller & Schäfer, (1995), found that, the terminal flagellar antennomere of honeybee workers is covered with numerous small hairs, which are assumed to be unmodal tactile hairs.

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, antennal chaetic sensilla are very sensitive to sucrose stimulation.

The different types of sensilla were quantified to calculate the average percentage of each sensilla type, on the other flagellomeres.

According to our results, this study could indicate the difference in the distribution, numbers and measurements of the different sensilla according to their location on the different flagellomeres and according to their function, where the function of different sensilla types that located on honeybee flagellum may be inferred by using the morphological criteria together with the results obtained by previous authors from honeybee studies. The results of the present study are almost agree with those reported by (Gupta, 1991), where the micromorphology of the antennae of the honeybee *Apis florea* F., the types, number and distributions of the various types of sensilla were examined. He found that, the location of different types of sensilla on antenna of *Apis florea* is similar to those of *Apis mellifera*, also the distribution of various types of sensilla along the antenna is similar to those found in other *Apis* species.

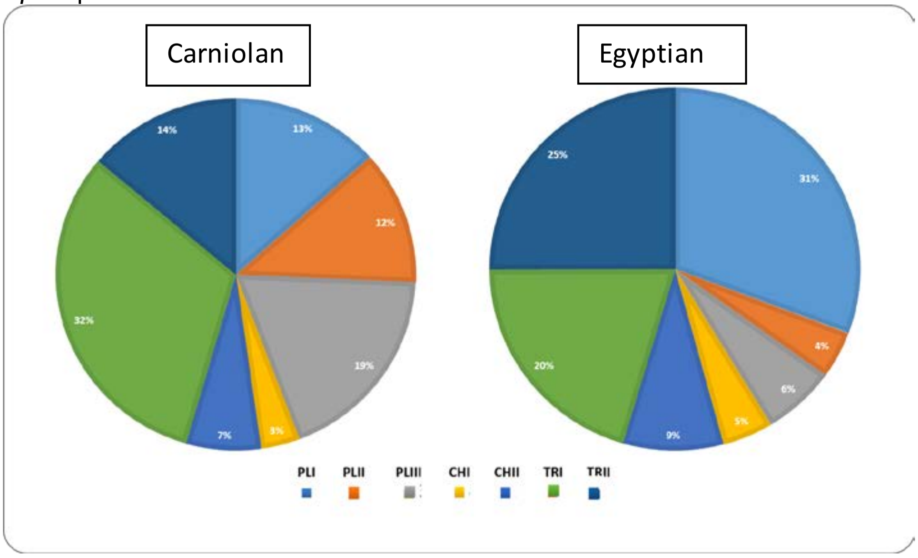

Fig. (2): Percentages of antennal sensilla on Carniolan and Egyptian worker bee per unit area (122µm x 82µm) on the dorsal sides of different flagellomeres.

The highest percentage of placodea (Pl I), 31%, appeared on the Egyptian honeybee workers, but it is found 13% for the Carniolan bees. Whereas, the highest percentage of trichodea (Tr I), 32%, recorded on the Carniolan race, but it is noticed 20% for the Egyptian one. The Carniolan bee workers have relatively low percentage of chaetica (Ch I), 3%, and nearly the same result was found on Egyptian bees, and it was 5%. The highest percentage of trichodea (Tr II), 25%, showed on the Egyptian line, but it is recorded 14% for the Carniolan one. The percentages of placodea (Pl II & Pl III) and chaetica (Ch II) were (4&12; 6&19 and 9&7%) for the Egyptian and Carniolan bee workers, respectively.

There is difference in the percentages of each (Pl I, II, III) between the different stocks, this can be explained according to their morphology, location on the 8-distal flagellomeres, their function. Our findings suggesting that, sensilla Placodea provide sense of smell (smell chemoreceptor), they are considered the main olfactory sensilla in honeybee and also they can measure the air pressure.

Salem *et.al*., (2001) and Hussein *et al.,* (2005b) 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. Altner, (1977) and Antonio & Nilson, (1981) revealed the sensilla Trichodea and Placodea are present in the highest amount in genus *Apis*.

Table (4): Area (μm^2) of sensilla placodea, types Pl I; II and III per unit area (122μm × 82 μm) on the dorsal side of the flagellum segments 1 to 8 of honeybee workers.

Flagellum segments		Bee race		T- value	Probability
		Egyptian bees ± SD	Carniolan bees ± SD		
1	Pl I	109.9 ± 25.06	0.0	-	-
	Pl II	99.976 ± 28.19	0.0	-	-
	Pl III	124.82 ± 56.72	138.16 ± 8.8813	- 1.7386	0.1571
2	Pl I	109.90 ± 18.89	0.000	-	-
	Pl II	106.76 ± 36.517	113.04 ± 14.553	0.962	0.3905
	Pl III	124.03 ± 29.334	129.996 ± 80.699	- 1.2377	0.2835
3	Pl I	120.89 ± 27.311	0.000	-	-
	Pl II	131.88 ± 14.253	131.88 ± 19.762	0.000	1.000
	Pl III	131.88 ± 37.451	127.17 ± 57.486	- 0.9604	0.3912
4	Pl I	118.692 ± 14.45	98.91 ± 9.783	4.878	0.0082
	Pl II	140.52 ± 27.682	136.59 ± 66.864	- 1.2597	0.2763
	Pl III	125.6 ± 9.857	143.945 ± 29.14	- 1.1239	0.39
5	Pl I	116.18 ± 16.615	119.344 ± 27.286	1.662	0.18
	Pl II	103.62 ± 11.34	124.815 ± 27.317	2.8804	0.045
	Pl III	118.69 ± 14.415	136.094 ± 24.57	1.07	0.3449
6	Pl I	118.692 ± 25.31	101.241 ± 13.54	3.063	0.0098
	Pl II	113.61 ± 11.127	120.89 ± 12.637	- 1.000	0.3739
	Pl III	0.000	100.48 ± 10.11	-	-
7	Pl I	131.566 ±20.42	96.71 ± 25.63	1.5014	0.2077
	Pl II	0.000	109.272 ± 41.96	-	-
	Pl III	0.000	124.17	-	-
8	Pl I	126.856 ± 27.31	116.965 ± 35.209	1.1107	0.329
	Pl II	0.000	101.547 ± 14.62	-	-
	Pl III	0.000	0.000	-	-

The area of sensilla (Pl I) ranged from 96.71 to 131.566 μm², where the smallest one appeared in the 7th flagellomer of the Carniolan workers and the largest one appeared in the same flagellomer of the Egyptian ones. The sensilla (Pl II) ranged from 99.976 to 140.52μm² in area, where the smallest one appeared in the 1st flagellomer of Egyptian bees and the largest one noticed in the 4th flagellomer of the same race. While, The (Pl III) ranged from 100.48 to143.945 μm² in area, where the smallest one measured in the

6th flagellomer of Carniolan workers and the largest one appeared in the 4th flagellomer of the same line.

Pham-Delegue *et al.,* (1991) proved that improvements in olfactory (oudour receptors) learning performance during the first days of adult life correlate in time with the increased sensitivity of workers' antennal receptors to queen pheromone. During the first days of adult life; more and more bees retinue of the queen, i.e. their behavior changes. Also, Winnington *et al.,* 1996 found that, during the first week of workers' life, the sensilla placodea and the neuropil of the olfactory center undergo changes. According to, (Esslen and Kaissling, 1976), the main olfactory sensilla of honeybee, *Apis mellifera*, are the sensilla placodea. Each sensillum placodeum consists of a 9 × 6 mm. thin oval cuticular plate with numerous minute pores and is innervated by 15 to 30 olfactory sensory neurons.

Kaissling & Renner, (1968) and Free, (1987), recorded the same results on *Apis mellifera*, the sensilla Placodea have been shown to be odour receptors. Pham-Delègue *et al.,* (1991), proved that, improvements in olfactory learning performance during the first days of adult life correlate in time with the increased sensitivity of workers' antennal receptors to queen pheromone. During the first days of adult life; more and more bees join the retinue of the queen, i. e. their behaviour changes.

Ray and Ferneyhough, (1997) studied olfactory conditioning among bees from one day after emergence to older stages, they found that younger bees, until 10 days of age, exhibited lower levels of conditioned response than older foragers.

Table (5): Length (µm) of sensilla trichodea, types Tr I and II per unit area (122µm × 82 µm) on the dorsal side of the flagellum segments 1 to 8 of honeybee workers.

Flagellum segments		Bee race		T- value	Probability
		Egyptian bees ± SD	Carniolan bees ± SD		
1	Tr I	11.4 ± 0.894	11.0 ± 1.0	0.5345	0.6213
	Tr II	12.00 ± 1.58	12.2 ± 1.308	- 0.343	0.7489
2	Tr I	9.4 ± 3.7	10.6 ± 0.894	- 1.2377	0.2835
	Tr II	10.2 ± 1.98	11.6 ± 1.817	- 1.5097	0.2056
3	Tr I	8.96 ± 2.236	9.6 ± 0.894	- 1.324	0.256
	Tr II	9.2 ± 1.789	10.2 ± 1.789	- 0.7255	0.5083
4	Tr I	8.8 ± 2.168	9.0 ± 4.438	0.9631	0.39
	Tr II	9.2 ± 1.923	9.75 ± 4.711	0.5687	0.6
5	Tr I	9.25 ± 4.336	10.0 ± 4.5826	- 0.7385	0.5012
	Tr II	8.8 ± 1.923	9.8 ± 2.775	- 0.8165	0.4601
6	Tr I	8.25 ± 3.847	8.34 ± 4.899	0.4298	0.6895
	Tr II	8.8 ± 2.0494	8.75 ± 4.062	0.8847	0.4263
7	Tr I	7.67 ± 4.5607	9.0 ± 4.98	0.2732	0.7982
	Tr II	8.5 ± 4.3243	8.8 ± 1.3038	- 1.0	0.3739
8	Tr I	7.33 ± 4.1593	9.0 ± 5.1284	0.1961	0.8541
	Tr II	7.6 ± 1.1402	7.75 ± 3.8341	0.7638	0.4876

The sensilla (Tr I) ranged from 7.33 to 11.4 µm in length, where the shortest one appeared in the 8th flagellomer of Egyptian race and the longest one appeared in the 1st flagllomer of the same race. The sensilla (Tr II) ranged from 7.6 to 12.2 µm in length, where the shortest one found in the 8th flagellomer of Egyptian workers and the longest one in the 1st flagellomer of the Carniolan bees.

Table (6): Length (µm) of sensilla chaetica, types Cr I and II per unit area (122µm × 82 µm) on the dorsal side of the flagellum segments 1 to 8 of honeybee workers.

Flagellum segments		Bee race		T- value	Probability
		Egyptian bees ± SD	Carniolan bees ± SD		
1	Ch I	10.0 ± 1.4142	10.0 ± 0.7071	0.000	1.000
	Ch II	4.0 ± 0.49	4.0 ± 0.42	0.000	1.000
2	Ch I	7.2 ± 4.3243	9.6 ± 0.5477	- 1.3728	0.242
	Ch II	3.67 ± 1.0494	4.0 ± 0.2411	1.2999	0.2635
3	Ch I	10.5 ± 1.1402	9.6 ± 1.1402	- 2.058	0.1087
	Ch II	3.6 ± 0.8944	3.5 ± 0.9494	1.9005	0.1302
4	Ch I	8.0 ± 3.7815	10.5 ± 4.827	3.1623	0.0341
	Ch II	3.6 ± 0.5477	3.5 ± 0.9494	1.9757	0.1194
5	Ch I	8.2 ± 2.1679	10.5 ± 4.827	- 0.0882	0.9339
	Ch II	3.2 ± 0.4472	3.67 ± 0.7889	-0.6942	0.5258
6	Ch I	13.34 ± 1.4142	15.84 ± 4.3359	0.215	0.8403
	Ch II	3.4 ± 0.8944	3.67 ± 1.0494	1.000	0.3739
7	Ch I	7.67 ± 0.2778	9.33 ± 1.1284	- 1.5811	0.189
	Ch II	3.4 ± 0.5477	3.75 ± 1.1213	0.3563	0.7396
8	Ch I	7.5 ± 3.4641	9.5 ±4.2778	- 0.6247	0.5660
	Ch II	3.6 ± 0.5477	3.75 ± 2.0	0.647	0.5529

The sensilla (Ch I) ranged from 7.2 to 15.84 µm in length, where the shortest one appeared in the 2nd flagellomer of Egyptian race and the longest one appeared in the 6tht flagllomer of Carniolan race. The sensilla (Ch II) ranged from 3.2 to 4.0 µm in length, where the shortest one found in the 5th flagellomer of Egyptian workers and the longest one in the 1st flagellomer of both the two lines and in the 2nd flagllomer of Carniolan race.

REFERENCES

Abdel-Rahman, M.F. (2014). Hygienic behavior: Egyptian honeybee vs Carniolan honeybee. Journal of International Academic Research for Multidisciplinary, 2 (3): 508-517.

Abdel-Rahman, M.F. (2004). Comparative studies between the characters of some races and hybrids of honeybee in Assiut region, Upper Egypt. Ph.D. Thesis, Fac. Of Agriculture, Assiut Univ., Assiut, Egypt.

Agren, L. (1977). Flagellar sensilla of some Colletidae (Hymenoptera, Apidae). Int. J. Insect Morphol. & Embryol., 6, 137–146.

Al-Ghamdi, A.A. (2006). Scanning electron microscopic studies on antennal sensilla organs of adult honeybee workers in genus *Apis* (Hymenoptera: Apidae). Bull. Entomol. Soc. Egypt, 83, 1-11.

Altner, H. (1977). Insect sensillum specificity and structure: an approach to a new typology. Olfaction Taste, 6, 295-303.

Antonio C. and Nilson, B. (1981). Antennal sensory structure of *Scaptotrigona postica*,(Hymenoptera, Apidae), J. Kans. Entomol. Soc. 54(4), 751-756.

Dietz, A. and Humphreys, W.J. (1971). Scanning electron microscopic studies of antennal receptors of the worker honeybee, including sensilla Campaniformia. Ann. Entomol Soc. Am., 64(4), 919-925.

Ehmer, B. and Gronenberg, W. (1997). Proprioceptors and fast antennal reflexes in the ant Odontomacus (Formicidae, Ponerinae). Cell tissue Res., 290, 153-165.

Esslen, J. and K.E. Kaissling (1976). Zahl und Verteilung antennaler Sensillen bei der Honigbiene (*Apis mellifera* L.). Zoomorphologie, 83: 227- 251.

Frisch, K.V. (1967). The Dance Language and Orientation of Bees, The Belknap press of Harward Univ. Press, Cambridge , Mass., P. 566.

Gupta, M. (1991). Scanning electron microscopic studies of antennal sensilla of adult worker *Apis florea* F. (Hymenoptera: Apidae), Apidologie, 23, 37-81.

Haupt, S.S. (2004). Antennal sucrose perception in the honeybee *Apis mellifera* L.: behaviour and electrophysiology. J. Comp. Physiol., A., 190, 735–745.

Hussein, M.H.; M.O.M. Omar; M.F.Abdel-Rahman and S.M. Abo-Lila (2005a). Comparative studies between morphometrical characters of some races and hybrids of honeybee in Assiut Region, Upper Egypt. Proceedings of 39th Apimondia International Apicultural Congress, Dublin, Ireland, pp. 38-39.

Hussein, M.H.; M.O.M. Omar; S.M. Abo-Lila and M.F.Abdel-Rahman (2005b). Behavioural studies on some races and hybrids of honeybee in Assiut Region, Upper Egypt. Proceedings of 39th Apimondia International Apicultural Congress, Dublin, Ireland, pp. 88.

Johnson, B.R. (2002). Reallocation of labor in honeybee colonies duringheat stress: the relative roles of task switching and the activationof reserve labor. Behav. Ecol. Sociobiol., 51,188–196

Kaissling, K.E. and Renner, M. (1968). Specialized chemoreceptors in the pore plates of *Apis*. Z. Vergl. Physiol. 59, 357-361.

Lacher, V. (1964). Elektrophysiologische Untersuchungen an einzelnen Rezeptoren für Geruch, Kohlendioxid, Luftfeuchtigkeit und Temperatur auf den Antennen der Arbeitsbiene und der Drohne (*Apis mellifera*). Z. Vergl. Physiol., 48, 587–623.

Le-Conte, Y. and Hefetz, A. (2008). Primer pheromones in social hymenoptera, Annu. Rev. Entomol., 53, 523–542.

Martin, H. and Lindauer, M. (1966). Sinnesphysiologische Leistungen beim Wabenbau der Honigbiene, Z. Vergl. Physiol., 53, 372–404.

Maurizio, A. (1954). Pollen nutrition and vital processes in the honeybee (*Apis mellifera* L.). Landwirtsch. Jahrb. Schweiz. Bienen-Zeitung., 68(6): 115-128.

Méndez-Vilas, A. and Díaz, J. (2010). Microscopy: Science, Technology, Applications and Education, 322, 1001-1007.

Michener, C.D. (1974). The Social Behavior of the Bees. The Belknap Press of Harvard University Press, Cambridge, Mass., P. 404.

MSTAT-C Software program (1988). MSTAT-C Michigan State University, Version 2.10.

Norton, W.N. and Vinson, S.B. (1974). A comparative ultrastructural and behavioural study of the antennal sensory sensilla of the parasitoid Cardiochiles nigriceps (Hymenoptera: Bracoidae). J. Insect Morphol. 142, 329-350.

Pham-Delègue, M.H.; J. Trouiller; E. Bakchine; B. Roger and C. Masson (1991). Age dependency of worker bee response to queen pheromone in a four-armed olfactometer. Insects Sociaux, 38: 283–392.

Ray, S. and Ferneyhough, B. (1997). The effects of age on olfactory learning and memory in the honeybee *Apis mellifera* Neuro. Report, 8, 789–793.

Renthal, R.; Velasquez, D.; Hampton, J. and Wergin, W. (2003). Structure and distribution of antennal sensilla of the red imported fire ant. Micron, 34(8), 405-413.

Ruth, E. (1976). Electrophysiologie dear sensilla Chaetica auf den antennan von *periplaneta Americana*. J. Comp. Physiol., 105-155.

Salem, M.S.; M.E. Nour; N.Z. Dimetry and T.E. Abdel-Wahab (2001). Scanning electron microscopic studies of some antennal receptors of the worker honey bees tolerant to varroa mite. Integrated pest management proceeding of the 1st congress. Fac. Agric., Cairo Univ., 22-23, April: 68-72.

Schneider, D. (1964). Insect antenna. Annu. Rev. Entomol., 9, 103-122.

Slessor, K.N.; Winston, M.L. and Le-Conte, Y. (2005). Pheromone communication in the honeybee (*Apis mellifera* L.). J. Chem. Ecol., 31, 2731–2745.

Slifer, E.H. (1970). The structure of arthropod chemoreceptors. Annu. Rev. Entomol., 15, 121- 142.

Snodgrass, R.E. (1935). Principles of Insect Morphology. M.Sc. Thesis, Graw-Hill Book Company, London, UK. Chapter XVII.

Snodgrass, R.E. (1956). Anatomy of the Honeybee. Comstock Publishing Associates, Cornell University Press, Ithaca, NY, USA.

Spaethe, J.; Axel, B.; Christine, H. and Jürgen, T. (2007). Size determines antennal sensitivity and behavioral threshold to odors in bumblebee workers. Naturwissenschaften, 94, 733–739.

Warnke, U. (1976). Effects of electric changes on honeybees. *Bee World 57*: 50-56.

Whitehead, A.T. and Larsen, J.R. (1976a). Electrophysiological responses of galeal contact chemoreceptors of *Apis mellifera* to selected sugars and electrolytes. J. Insect Physiol., 22, 1609–1616.

Whitehead, A.T. and Larsen, J.R. (1976b). Ultrastructure of the contact chemoreceptors of *Apis mellifera* (Hymenoptera: Apidae). Int. J. Insect Morphol. & Embryol., 5, 301–315.

Winnington, A.P.; R.M. Napper and A.R. Mercer (1996). Structural plasticity of identified glomeruli in the antennal lobes of the adult worker honeybee. J. Comp. Neurol., 365: 479-490.

Zacharuk, R.Y. and Shields, V.D. (1991). Sensilla of immature insects. Annu. Rev. Entomol., 36, 331-354.

دراسات مورفومتريه لبعض أعضاء الحس على قرون الإستشعار في شغالات النحل المصري والنحل الكرنيولي

محمد عبد المعز محبوب[1] و محمد علي إبراهيم عبد العظيم[2]
١ – كلية العلوم – جامعة أسيوط – فرع الوادي الجديد – مصر
٢ – قسم بحوث النحل – معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – الجيزة – مصر

النحل المصري هو النحل المستوطن في مصر وتكيفت جيدا مع الظروف المحلية والآفات في الإقليم بينما السلالة الثانية هي الأكثر شعبية وإنتشارا ويتم تربيتها على نطاق تجاري. ولذا تمت هذه الدراسة لمقارنة التركيب الدقيق لبعض أعضاء الحس الموجودة على قرون الإستشعار لشغالات النحل المصري والنحل الكرنيولي. وشملت المقارنة: طول قرن الإستشعار وعدد وقياسات أعضاء الحس placodea; trichodea and chaetica وذلك على العقل من ١ إلى ٨ لقرون الإستشعار وذلك للنحل المصري والنحل الكرنيولي وذلك بإستخدام الميكروسكوب الإليكتروني. وجد أن هناك إختلاف معنوي جدا بين طول قرون الإستشعار لكلا السلالتين (P=0.0097) وكان متوسط الأطوال ٣.٨٥٨ ± ٠.١٦٢ مم و ٤.٣٢١ ± ٠.٠٧٦مم وذلك على الترتيب. وإحصائيا لم تكن هناك إختلافات بين أعداد وقياسات أعضاء الحس على قرون الإستشعار بين شغالات النحل المصري والنحل الكرنيولي وذلك في معظم العقل.