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**MORPHOMETRICAL AND HISTOLOGICAL
STUDIES ON SOME BEE GLANDS IN GENUS
APIS IN SAUDI ARABIA (KSA)**

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INTRODUCTION

The productivity of a bee colony depends upon many factors including good preparation of colony to the new season, sufficient stimulating feeding, controlling of bee diseases and enemies, and race of bees (Szabo and Mueller, 1996). The geographical races can be discriminated by morphometrical differences and for an exact analysis of their characters (Gromisz and Przychodzen 1981). Bee glands play an important role in bees life particularly for food material products (Dade, 1962). The hypopharyngeal and mandibular glands produce important proteins rich food in honey bee workers as royal jelly. The hypopharyngeal glands of old bees produced digestive enzymes for honey ripping process (Nour, 1986). The development and physiological activity of the food glands vary with the work of the bees, the glands being fully functional when the worker is serving in the hive as a nurse bee feeding larvae and queens (Snodgrass, 1956). Graham (1992) stated that healthy bees are able to perform their normal activities including bee milk, enzymes and venom products. Varroa mite infesting worker bees caused sever damage to hypopharyngeal, mandibular and head salivary glands (Zakaria, 2002). Measurements of the hypopharyngeal glands are often used to describe the physiological status of honey bee workers and consider arbitrary scale classification and have been estimated by different methods, such as acinus size (Wang and Moeller, 1971 & Hrassning and Crailsheim, 1998). Dwarf honey bees *Apis florea* was recorded and identified for the first time in the kingdom of Saudi Arabia during 1985, and it distributed in most parts of the country (Al Ghamdi, 2006). So this work aimed to study and

evaluate some morphometrical and histological aspects of some organs in some honey bee races and hybrids in Kingdom Saudi Arabia.

MATERIAL AND METHODS

I - Morphometric studies:

1- Sampling

Fifty individuals of nurse worker bees were collected from different honey bee colonies represented the following races and hybrids of *Apis mellifera* (L.); Yemenitica race (*Apis mellifera yemenitica*), Italian race (*A. m. ligustica*), Carniolian race (*A. m. carnica*) and Yemenitica hybrid. Whereas, twenty five samples of *Apis florea* (F.) workers were collected randomly from different nests in trees at Riyadh Region, Kingdom Saudi Arabia.

2- Tested bee glands

A- Hypopharyngeal glands (HG)

To estimate the differences between different honey bee races and hybrids of *Apis mellifera* as well as between *Apis florea* workers, the hypopharyngeal glands (HG) of bee workers were dissected and mounted using saline solution (0.09% Na Cl) according to method described by Wang and Moeller (1969). The following parameters were measured; Mean length and width of the hypopharyngeal gland's lobules (μm / lobule) and mean lobule surface area (mm^2 / lobule) according to method of Maurizio (1954).

B- The mandibles and their glands

The mandibular gland of tested bee workers were dissected and mounted using saline solution (0.09% Na Cl) as described by Wang and Moeller (1971). The mean mandibular gland's length (mm/bee) and mean length and width of the mandible (mm/bee) were measured.

C- Wax glands (WG)

The wax glands of the tested worker bees were measured for length and width of the wax mirrors and the sterns related with the 4 wax glands according to method described by Alpatove (1929) and Wafa *et al.*, (1967).

II- Histological studies

Twenty five individual of worker bees were collected from each honey bee colony representing the following races and hybrid of *Apis mellifera* L.; Yemenitica race (*Apis mellifera yemenitica*), Italian race (*A. m. ligustica*), Carniolian race (*A. m. carnica*) and Yemenitica hybrid. Whereas, twenty individual of *Apis florea* (F.) workers were collected from the trees at Riyadh Region, Kingdom Saudi Arabia.

Serial histological sections of the hypopharyngeal (HG) and head salivary glands (HSG) of worker bees were made using the method described by Gad (1951). The following parameters were evaluated; length and width of (HG) and (HSG).

RESULTS AND DISSCUION

I-Morphometric studies

1- The hypopharyngeal glands (HG)

Data presented in Table (1) showed clear differences between measurements of the hypopharyngeal glands in the tested honey bee races and hybrid of *Apis mellifera* as well as between *Apis florea* workers. The average measurements of the (HG) and number of the lobules of the tested *Apis mellifera* races and hybrid recorded the highest values in comparison with those of the *Apis florea* workers (Table 1). Honey bee workers of Italian, Carniolian and Yemenitica races recorded the highest mean length, width and area of the (HG) measurements, while Yemenitica hybrid recorded the lowest values. Yemenitica hybrid recorded the higher number of the (HG) lobules (lobules/1mm) followed by Carniolian, Italian and Yemenitica races.

2- The mandibles and their glands

Data presented in Table (1) showed clear differences between *Apis florea* and honey bee races and hybrid of *Apis mellifera* workers in the mandible and mandibular gland measurements. Length and width of the mandibles and the mandibular glands length were lower in *Apis florea* workers than those of the *Apis mellifera* races and hybrid. Italian race recorded the maximum length of the mandibular gland as well as in the length and width of the mandible, while the lowest values were detected with Yemenitica hybrid.

TABLE (I)
Measurements of the hypopharyngeal and mandibular glands of *Apis mellifera* and *Apis florea* workers.

Bee species/race	Hypopharyngeal gland's lobules				Mandibular glands length (mm)	Mandible (mm)		
	Length (μm)	Width (μm)	Area (mm^2)	Mean Number of lobules /1mm		Length	Width	
<i>Apis mellifera</i> L. LLKLLraces	Yr	172 a (66.70-213.3)	98.38 c (66.7-173.3)	0.0265	30.45	2.40 b (2.25-2.55)	1.1727 ab (1.15-2.55)	0.4954 b (0.45-0.50)
	Yh	106.1 d (53-160)	67.88 e (46.7- 110)	0.0113	59.70	2.56 ab (2.5-2.75)	1.138 ab (1.1-1.2)	0.4604 b (0.35-0.55)
	Cr	154.4 b (93.3-2.0)	110.57 b (53.3-160)	0.0268	38.08	2.61 ab (2.45-2.70)	1.2916 a (1.25-1.35)	0.5958 a (0.55-0.65)
	It	151.11 b (93.3-200)	115.55 a (66.7-120)	0.0274	32.85	2.73 a (2.70-2.90)	1.3125 a (1.25-1.35)	0.6308 a (0.55-0.66)
Av.	145.90	98.09	0.023	40.27	2.5750	1.2287	0.5456	
<i>A. florea</i> F.	139.3 c (66.7-186.6)	85.99 d (39.9-120)	0.0144	37.33	0.8375 c (0.80-0.90)	0.9075 b (0.8-.95)	0.40 c (0.38-0.45)	
LSD _{0.05}	3.6397	3.638			0.2399	0.2451	0.04247	

LSD : Least significant differences between the means

Yr: Yemenitica race.

Yh: Yemenitica hybrid.

Cr: Carniolian race .

It: Italian race .

3-Wax glands (WG)

Data illustrated in Table (2) showed clear differences in the mean length and width of the wax glands measurement (wax mirrors and their sternus) between tested honey bee races and hybrid of *Apis mellifera* and *Apis florea* workers. Lower measurements of the mean length and width of all four wax mirrors were recorded in *Apis florea* in comparison with those of *Apis mellifera* workers. The four sternus related with the wax glands recorded higher values in *Apis mellifera* workers in comparison with those of *Apis florea*.

As shown in Table (2) Italian bees recorded the highest mean length and width of the wax mirrors, followed by Carniolian and Yemenitica hybrid among tested honey bee races and hybrid. Italian and Carniolian races recorded the highest mean length and width of the four sternus which related with the wax glands, followed with Yemenitica hybrid and Yemenitica race.

II -Histological studies

1- The hypopharyngeal glands (HG)

Data illustrated in Table (3) showed clear differences in the measurement of the hypopharyngeal glands (HG) between the different honey bee races and hybrid of *Apis mellifera* as well as between *Apis florea* workers. Higher length, width and area of the (HG) were recorded in the *Apis mellifera* workers in comparison with those in *Apis florea*. Carniolian, Yemenitica and Italian honey bee workers recorded the highest mean length, width and area of the (HG) measurements, while, Yemenitica hybrid recorded the lowest values. As shown in (Fig.1) there were clear differences in the cytoplasm pigmentation, fragmentation, size, secretion cells distribution and the nucleus diameters in the sections of the (HG) lobules of the honey bee *Apis mellifera* workers and between *Apis florea* as well as among the tested *Apis mellifera* races and hybrid.

2- The head salivary glands (HSG)

Data presented in Table (3) showed that the head salivary glands (HSG) length was higher in *Apis florea* workers in comparison with that of *Apis mellifera* workers. While the highest values were recorded in Carniolian followed with Italian bees, whereas the lowest values were recorded in Yemenitica hybrid and Yemenitica race. Clear differences were detected in

TABLE (II-a)
Measurements of the wax glands of honey bee *Apis mellifera* and *Apis florea* workers.

Item	Bee species/race	Wax glands (mm)																
		1 st		2 nd		3 rd		4 th										
		Length	width	Length	width	Length	width	Length	width									
Wax mirrors	Yr	1.1562d (0.95-1.25)	1.7562d (1.35-2.0)	1.2593d (0.85-1.40)	1.9437c (0.85-1.950)	1.2218d (0.9-1.309)	1.7562c (1.5-1.85)	1.1781c (0.90-1.30)	1.2062c (0.95-1.25)	Yh	1.30c (1.15-1.95)	1.96c (1.25-2.10)	1.325c (1.15-1.75)	1.915d (1.60-2.05)	1.275c (1.15-1.35)	1.78b (1.70-1.85)	1.21c (1.05-1.40)	1.28c (1.10-1.50)
		1.35b (1.25-1.50)	2.26b (2.15-2.45)	1.44b (1.35-1.60)	2.285b (2.15-2.45)	1.42b (1.30-1.45)	2.125a (1.95-2.25)	1.405b (1.35-1.55)	1.415b (1.15-1.60)									
	1.46a (1.40-1.60)	2.33a (2.15-2.40)	1.54a (1.40-1.80)	2.34a (2.10-2.40)	1.5390a (1.40-1.65)	2.140a (2.10-2.20)	1.65a (1.40-1.70)	1.46a (1.15-1.65)										
	1.3265	2.0765	1.3910	2.1209	1.3639	1.9503	1.3607	1.3403										
	0.810e (0.75-0.85)	1.245c (1.22-1.27)	0.800e (0.75-0.85)	1.385c (1.32-1.45)	0.790e (0.75-0.85)	1.38d (1.3-1.40)	0.725d (0.65-0.80)	1.24d (1.1-1.32)										
	0.0335	0.0284	0.0463	0.01077	0.01685	0.01849	0.04188	0.02847										
	LSD _{0.05}																	

LSD: Least significant differences between the means

Yr: Yemenitica race. Yh: Yemenitica hybrid

Cr: Carniolian race. It: Italian race.

TABLE (II-b)
Measurements of the wax glands of honey bee *Apis mellifera* and *Apis florea* workers.

Item	Bee species/race	Wax glands (mm)											
		1 st			2 nd			3 rd			4 th		
		Length	width		Length	width		Length	width		Length	width	
Stemus	<i>Apis mellifera</i> L.	Yr	1.4512c (1.35-1.55)	4.1687b (3.90-4.30)	1.5311c (1.40-1.80)	4.125d (4.10-4.20)	1.5787c (1.45-1.80)	3.70c (3.60-3.80)	1.3562d (1.25-1.45)	2.6065d (2.60-2.65)			
		Yh	1.3892d (1.15-1.50)	4.25b (4.10-4.60)	1.4607d (1.30-1.55)	4.1785c (4.05-4.35)	1.5464d (1.50-1.65)	3.7892b (3.65-3.90)	1.5464c (1.50-1.65)	3.7892a (3.65-3.90)			
		Cr	1.752a (1.60-1.85)	4.80a (4.10-4.90)	1.5850b (1.55-2.05)	4.83b (4.60-5.0)	1.805b (1.65-1.95)	4.51a (4.20-5.30)	1.64b (1.40-1.85)	3.22b (2.85-3.30)			
		It	1.6535b (1.55-1.85)	5.0038a (4.80-5.15)	1.7464a (1.60-1.90)	5.0035a (4.75-5.15)	1.8230a (1.75-1.90)	4.5571a (4.35-4.75)	1.7153a (1.55-2.0)	3.08c (2.65-3.50)			
		Av	1.5614	4.5556	1.5808	4.5342	1.6882	4.139	1.5644	3.1739			
	<i>Apis florea</i> F.	0.905e (0.80-0.95)	2.560c (2.45-2.75)	0.970e (0.90-1.05)	2.885e (2.60-2.95)	0.980e (0.90-1.05)	2.935d (2.80-3.0)	0.825e (0.65-0.90)	2.500e (2.20-2.65)				
	LSD _{0.05}	0.0044	0.04898	0.00411	0.0250	0.0043	0.08178	0.01635	0.02301				

LSD: Least significant differences between the means

Yr: Yemenitica race.

Yh: Yemenitica hybrid

Cr: Carniolian race.

It: Italian race.

the shape, diameter of the nuclei and the cytoplasm pigmentation of the (HSG) between *Apis florea* and *Apis mellifera* workers as well as within the different tested honey bee races and hybrid of *Apis mellifera* (Fig. 2).

TABLE (III)
Measurements of the hypopharyngeal and head salivary glands of *Apis mellifera* and *Apis florea* workers in dissected sections.

Bee Species	Item	Hypopharyngeal glands lobules			Head salivary gland
		Length (μm)	Width (μm)	Area (mm^2)	Length (μm)
<i>Apis mellifera</i> L.	Yr	183.46 c (86.66-300)	139.9 b (86.66-200)	0.04020	333.33 e
	Yh	103.68 d (66.7-173.3)	63.199 e (53.3-106.7)	0.01028	573.3 d
	Cr	190.01 a (93.3-239.9)	154.66 a (39.3-164.6)	0.04613	693.33 a
	It	188.696 b (160-266)	129.52 c (113-166)	0.03800	626.66 c
	Av.	166.46	121.81	0.0336	556.65
<i>Apis florea</i> F.		96.16 e (66.6-99.0)	77.59 d (73.3-110)	0.01170	666.66 b
LSD _{0.05}		0.05272	0.02134		0.1176

LSD: Least significant differences between the means

Yr: Yemenitica race.

Yh: Yemenitica hybrid.

Cr: Carniolian race.

It: Italian race.

It could be summarized that there were clear significant differences in the measurements between the tested glands in the examined bee races and hybrid of *Apis mellifera* as well as between *Apis florea* workers. It could be suggested that the bee race and the ecological factors play an important role in this differences. The results obtained are agreement with the finding of Hrasning and Crailsheim (1998), they reported that the parameters of the hypopharyngeal glands often used to describe the physiological state of the bee workers, whereas Brouwers (1982) decided that neither size of the acini of the (HG) nor the protein content can be consider a reliable parameter for (HG) development. Mohamed and Omar (1992) reported that the development of (HG) is considered as parameter reflects nutritive quality in honey bee food with best assimilation in gut. Kubisova and Haslbachova (1985) found that the (HG) development could be affected by many factors including brood pheromone which can promote the (HG) development. Suwannapong *et. al.*, (2004) found similarities in the histochemical structure of the hypopharyngeal gland between *Apis andreniformis* Smith and *Apis florea* Fabricius workers

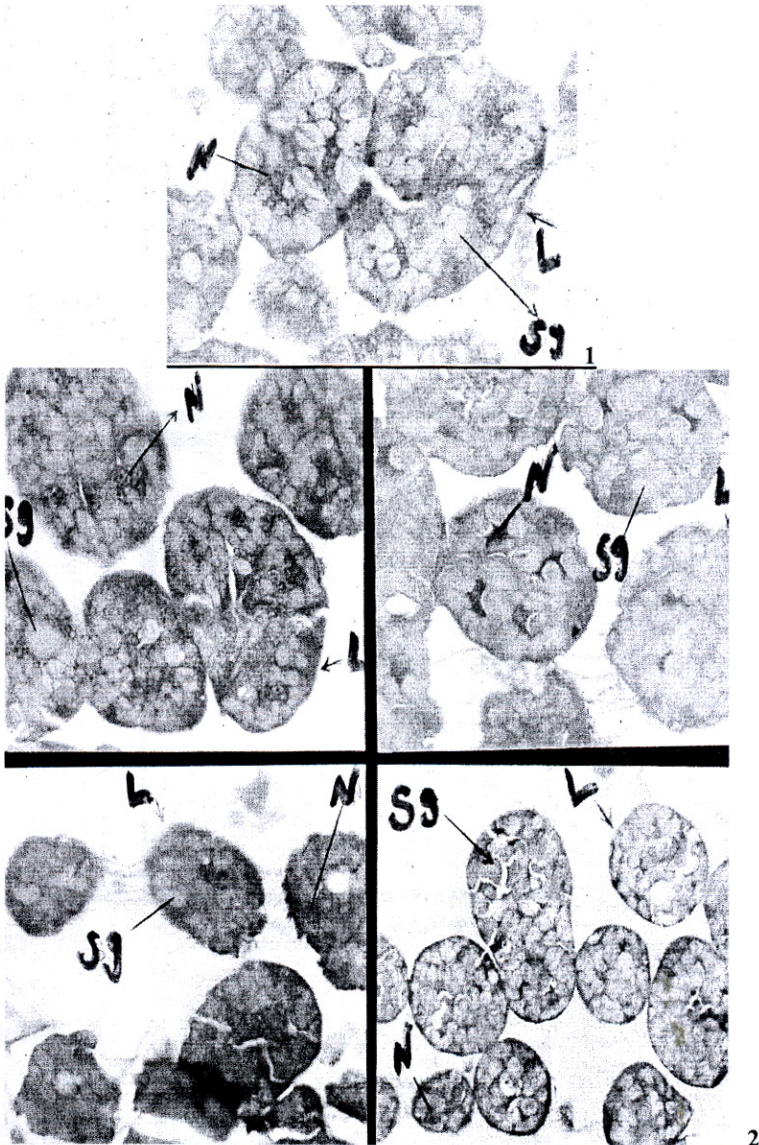


Fig.(1): The hypopharyngeal gland's lobules (HG) of honey bee workers. (x-400)

1-HG of *Apis florae* (F.) workers.

2-HG of *Apis mellifera* (L.) workers.

Yr- Yemenitica race.

Yh- Yemenitica hybrid.

Cr- Carniolian race.

It - Italian race.

Sg- Secrete globule.

N- Nucleus.

L- Glandular lobule.

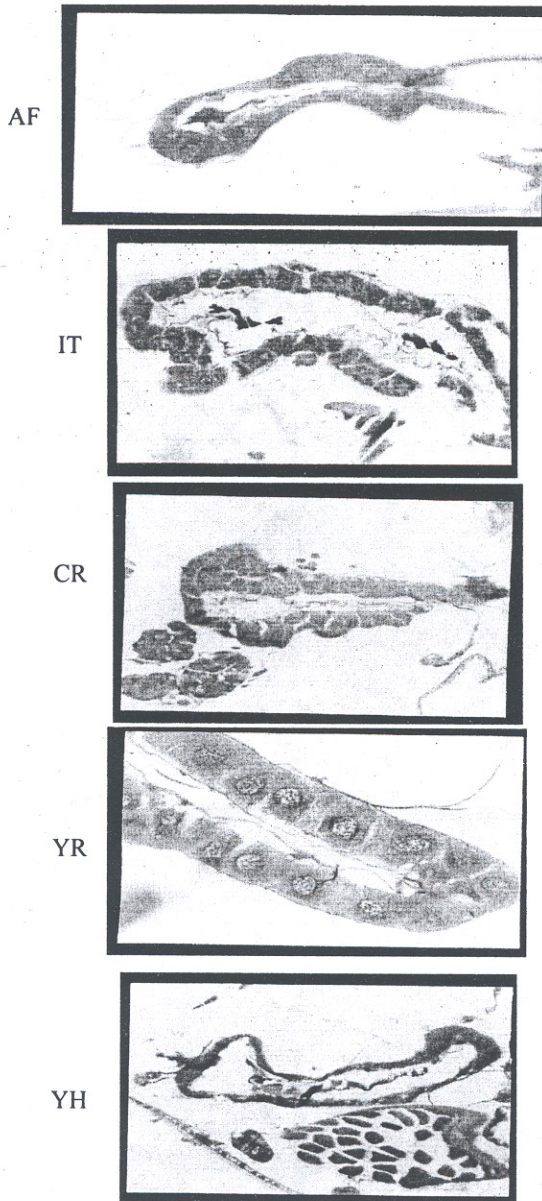


Fig (2): The head salivary glands of worker honey bees. (X-160)
 AF- *Apis florea* (F.). IT - Italian race.
 CR- Carniolian race. YR- Yemenitica race.
 YH- Yemenitica hybrid

among pupae, nursing and foraging bees, however, differences were found among the three stages within each species. Zakaria (2002) found that the mean length and width of the hypopharyngeal gland's lobule in Carniolian hybrid workers were 126.30 & 82.85(μm) while the mean acinus surface area of the (HG) was 0.0164 (mm^2) and the mean number of the lobules was 40.74/1mm; in addition, the mean mandible and mandibular gland lengths were 1.23mm and 2.40 mm, respectively. Khater (1998) found clearly differences in (HG) and (WG) measurements between the first Carniolian hybrid, Caucasian and Italian honey bees and differences in most honey bee drone glands showing varroa infestation.

SUMMARY

Morphological and histological characters were investigated to evaluate the differences in the hypopharyngeal, salivary, mandibular and wax glands of *Apis florea* F. and *Apis mellifera* L. representing Yemenitica, Carniolian & Italian races and Yemenitica hybrid workers in Saudi Arabia. The results showed significant differences in the measurements and some histological aspects of the tested glands of different bees.

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