Biometrical Studies on the Venom Gland of the Honey Bee *Apis mellifera L.* Under North Sinai Conditions

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Abstract: Insects have many ways to defend themselves and the most effective defending behavior in social insects is stinging behavior, which is only found in many species of the Order Hymenoptera. The sting apparatus in worker and queen honey bees is the ovipositor which plays an important role in defense of the colony. Attention has been made to the biometrics of venom gland of honey bee workers fed on different proteinaceous food types beside 50% sugar solution during the different seasons under the local conditions of the north Sinai. Feeding the experimental colonies on different types of proteinaceous food generally and perceptibly increased the length of venom gland in adult bee workers to a various average according to season of measuring during different ages considered. Though it reaches a final length at a certain age, ahead of that age the length venom (acidic) gland is dependent on the age of the workers and rearing season. Moreover, this length is affected positively by feeding proteinaceous rations to adult bee workers

Keywords: Honey Bee (*Apis mellifera L.),* venom gland

INTRODUCTION

Insects have many ways to defend themselves and the most effective defending behavior in social insects is stinging behavior, which is only found in many species of the Order Hymenoptera. There are FOR BEES hymenopterans families significance in insect stinging, including: Apidae (honey bees), Bombidae (bumble bees)], Vespidae (wasps & yellow jackets), and Formicidae (ants) (Palmer, 1961).

The sting apparatus in worker and queen honey bees is the ovipositor which plays an important role in defense of the colony. Stinging behavior is most commonly observed in the proximity of the hive or nest. Pheromones secretion is considered as one of the main stimuli for inducing an aggressive attitude amongst defending worker bees. (Gary, 1974).

Attention has been made to the biometrics of venom gland of honey bee workers fed on different proteinaceous food types beside 50% sugar solution during the different seasons under the local conditions of the north Sinai.

MATERIAL, METHODS AND TECHNIQUE

Experiments were conducted in the apiary of Faculty of Environmental Agricultural Sciences in El-Arish, Suez Canal University on the first hybrid Carniolan honey bee during the period from September 2006 to August 2008 in order to study the effects of food types, worker ages and rearing seasons on the biometrics of the venom gland. For this goal the following experiments were carried out.

The main experiments

Feeding regimes of the experimental colonies:

20 first hybrid Carniolan bees, relatively equal in their vigor were chosen and divided into four groups, each consisting of five colonies and supplied with one of the following feeding regimes

- **First group:** mixture of yeast and pollen grains (1:1 w:w).
- **Second group:** yeast only (pollen traps were situated on the entrance of each hive to avoid the presence of pollen grains in it).
- **Third group:** pollen grains only (pollen gathered by workers in addition to pollen found in the traps from the second group).
- **Fourth group:** without proteinaceous food, either pollen or yeast (pollen traps were situated on the hives entrance).

All experimental colonies of the four groups were fed on 50% sugar solution in addition to the fore-mentioned feeding regimes.

Biometric measurements of venom gland in worker sting:

To study the effect of age, feeding regime and rearing season of worker bees, in relation to the length of venom gland, which secretes the bee venom, the following procedure was conducted:

Obtaining adult workers of required ages:

Sealed brood comb was transferred to an electric incubator at 43°C and 30% RH. Inspection was made till emergence of adult workers of the known age. The known adult workers were labeled with several colors of nail polish (Smith, 1972) in order to obtain the desired ages of workers, and these workers were introduced into the experimental colonies with different feeding regimes. Five workers from each feeding regimes group aged 5,10,15,20 and 27 days were dissected, and the measurements of venom gland were recorded.

Dissection technique:

Adult worker bees of known age from each feeding regime group were cooled until they had been immobilized for several minutes and afterward kept in 70 % ethyl alcohol before dissection. The abdomen was cut away from the thorax, opened by a ventro-lateral incision and the gut carefully removed. The intact venom apparatus (Fig. 1 and 2), consisting of the sting, venom duct, venom reservoir and venom gland, was carefully picked up according to the scheme each time 20 marked bees (5 bees / experimental group) of known age were taken for the dissection.

Measurements of parts of sting apparatus:

To obtain the lengths of the venom gland, each intact venom apparatus was carefully transferred to a slide and examined under a binocular with aid of an ocular micrometer eye piece.

RESULTS AND DISCUSSION

Length of venom glands in worker sting of different ages:

The present work examines the relation between the length of venom gland in adult bee workers of different ages and the different proteinaceous food types during different seasons. To facilitate the presentation, the obtained data will be discussed separately for each season.

Length of venom gland in winter:

In winter, the mean length of the venom gland in adult bee worker sting averaged approximately 10.5 mm. (Table 1). This length increased as the age of adult worker progressed to reach the maximum at the worker aged of 27 days.

Feeding the experimental colonies on different types of proteinaceous food caused an obvious increase in the length of venom glands in adult bee workers sting, so that the means increased with time 8.1, 12.2, 14.0, 15 and 16.9 mm (Table 1).

The data given in Table 1 clearly show that feeding the adult workers bee on yeast-pollen mixture gave the longest venom gland, followed by food consisting of pollen grains alone, while those feed on yeast produced the shortest venom gland. Means of 14.76, 13.31, and 11.72 mm were recorded for the length of venom gland in the stings of workers bees feed on yeast-pollen mixture, pollen grains and yeast respectively, irrespective of the age of adult workers. From the fore-mentioned data it could be concluded that the greatest length of venom gland was found in adult worker aged 27 days fed on yeast-pollen mixture (1:1 w:w) during the winter season.

Length of venom glands in spring:

In spring, the mean length of worker venom gland averaged about 14.9 mm. This gland elongated gradually from emergence of the worker and reached the maximum after 20 days, then decreased 27 days from eclosion.

Feeding honey bee colonies on different types of proteinaceous food caused an apparent increase in the length of the tested gland in adult bee workers so that the means averaged about 18.13 mm (Table 2).

Generally, feeding adult honey bee workers on yeast – pollen mixture, as proteinaceous food, produced the longest venom gland in the worker sting, followed by pollen grains alone and yeast alone. Means of 19.42, 18.77 and 16.20 mm were recorded for the length of venom gland in sting worker bees fed on yeast – pollen mixture, pollen grains and yeast, respectively irrespective of the age of adult worker bees.

Length of venom glands in summer:

As shown in Table 3, the mean length of worker venom gland in the summer season averaged about 14.83 mm. This length increased as the worker age progressed to reach the maximum 20 days from eclosion, the relatively same length was, however, obtained in workers 27 day old.

Feeding the experimental colonies on different types of proteinaceous food obviously increased the length of venom gland in adult bee workers to an average of about 17.8 mm (Table 3).

The data given in Table 3 clearly show that feeding adult worker bees a yeast – pollen mixture gave the longest venom gland, followed by food consisting of pollen grains alone and yeast alone. Means of 19.19, 18.01 and 16.17 mm were recorded for the length of venom gland in stings of worker bees fed on yeast – pollen mixture, pollen grains and yeast, respectively, irrespective of the worker age.

Length of venom glands in autumn:

In autumn, the mean length of venom gland in the sting of adult bee workers average approximately 12.00 mm (Table 4). This length increased as the age of worker progressed to reach the maximum in workers 27 days old. Offering the experimental colonies different types of proteinaceous food caused an obvious increase in the length of venom glands in adult bee worker stings, so that the gland length averaged about 15.4 mm. (Table 4). The data given in Table 4 clearly show that supplying the adult worker bees with yeast – pollen mixture gave the longest venom gland, followed by food consisting of pollen grains alone and yeast alone. Irrespective of the age of workers, means of 16.98, 15.46 and 13.65 mm were recorded for the lengths of venom gland in the stings of worker bees fed on yeast – pollen mixture , pollen grains and yeast,

Length of venom glands during different seasons:

From the fore-mentioned data given in Tables 1 – 4 , it is clear that the maximum length of venom gland in the bee sting was found in adult worker bees aged 27 days after feeding on yeast – pollen mixture (1 : 1 w:w), followed by those fed on pollen grains alone and those supplied with yeast alone as proteinaceous food.

In the data given in Table 5, the longest venom gland was noticed in spring and summer seasons with no apparent difference between both seasons at any tested age of adult worker. Winter season produced the shortest venom gland. However, in autumn, a slight increase was found in the length of the tested gland. It is important to notice that this decrease in venom gland length may be due to insuitable weather conditions for bee activities in winter and the dearth of flowering plants in autumn in the North Sinai Governorate.

Feeding the experimental colonies on proteinaceous food during the different seasons, in the company of the 50% sugar syrup, increased the length of the venom glands. This increase was more pronounced in the dearth period during autumn, when the rates of increment in the venom glands reached 10.70, 37.33, 37.57, 34.18 and 18.87% in workers 5, 10, 15, 20 and 27 day old, respectively. The lowest rates of increment were, however, recorded in the summer season when the following plants were presented in dense areas in North Sinai Governorate. In this case, rates of increment of

12.12 , 27.14 , 20.10 , 20.74 and 17.92 % were recorded for the lengths of venom glands from stings of 5 , 10 , 15 , 20 and 27 day old worker bees in summer , respectively.

In the available literature, the mean venom gland length in *A. mellifera adansonii* was 11.7 mm, compared with 12.8 mm, for *A. mellifera ligustica* (Owen, 1983). Arruda *et al* ., (2005) found that the length of this gland in *A. mellifera* workers varied from 6.22 to 21.98 mm with an average of 12.86 mm. This length was dependent on the age of the workers and rearing season (Notched, 2003). He added that the maximum length (16.8 mm) was observed during the summer in 17 day old workers.

Table (1): Lengths of acidic glands (mm) in adult bee worker stings of different ages in winter season of 2007 as affected by proteinaceous food types* (means of 5 replicates± S.E).

Worker Age (Days)	Types of proteinaceous food				Control (non-proteinaceous food)
	Yeast + Pollens (1 : 1 w : w)	Yeast	Pollen Grains	Mean ± S.E	
5	8.42 ± 0.291	7.475 ± 0.250	8.341 ± 0.043	8.078 ± 0.303 ^{D}	6.925 ± 0.217 ^{C}
10	14.24 ± 0.459	10.865 ± 0.556	11.465 ± 0.314	12.19 ± 1.040 ^{C}	9.915 ± 0.489 ^{B}
15	16.37 ± 0.631	12.185 ± 0.602	13.585 ± 0.624	14.046 ± 1.231 ^{B}	10.845 ± 0.450 ^{B}
20	16.318 ± 0.759	13.61 ± 0.308	15.382 ±0.630	15.103 ± 0.794 ^{B}	12.365 ± 0.382 ^{A}
27	18.443 ± 0.725	14.475 ± 0.548	17.752 ± 0.463	16.89 ± 1.255 ^{A}	12.52 ± 0.268 ^{A}
Mean ± S.E	14.758 ± 1.722 ^{a}	11.722 ± 1.320 ^{c}	13.305 ± 1.619 ^{b}		10.514 ± 1.022

" F " between types of food = 145.65 **
L.S.D at 0.05 = 1.032
" F " between worker ages = 110.09
L.S.D at 0.05 = 1.78
*All experimental colonies were supplied with 50 % sugar solution.

Table (2): Lengths of acidic glands (mm) in adult bee worker stings of different ages in spring season of 2007 as affected by proteinaceous food types* (means of 5 replicates ± S.E).

Worker Age (Days)	Types of proteinaceous food				Control (non-proteinaceous food)
	Yeast + Pollens (1 : 1 w : w)	Yeast	Pollen Grains	Mean ± S.E	
5	9.797 ± 0.556	9.065 ± 0.398	9.865 ± 0.503	9.575 ± 0.256 ^{D}	8.66 ± 0.412 ^{C}
10	18.41 ± 0.342	15.385 ± 0.428	16.995 ± 0.392	16.93 ± 0.874 ^{C}	13.65 ± 0.325 ^{B}
15	20.765 ± 0.281	17.138 ± 0.637	20.125 ± 0.244	19.342 ± 1.119 ^{B}	15.26 ± 0.419 ^{B}
20	24.645 ± 0.273	20.416 ± 0.414	23.979 ± 0.236	23.013 ± 1.314 ^{A}	18.63 ± 0.673 ^{A}
27	23.486 ± 0.337	18.996 ± 0.517	22.888 ± 0.201	21.794 ± 1.409 ^{A}	18.38 ± 0.408 ^{A}
Mean ± S.E	19.420 ± 2.645 ^{a}	16.200 ± 1.980 ^{b}	18.770 ±2.540 ^{a}		14.916 ± 1.830

" F " between types of food = 83.47
L.S.D at 0.05 = 1.6
" F " between worker ages = 599.3
L.S.D at 0.05 = 1.22
*All experimental colonies were supplied with 50 % sugar solution.

Table (3): Lengths of acidic glands (mm) in adult bee worker stings of different ages in summer season of 2007 as affected by proteinaceous food types* (means of 5 replicates ± SE)

Worker Age (Days)	Types of proteinaceous food				Control (non-proteinaceous food)
	Yeast + Pollens (1 : 1 w : w)	Yeast	Pollen Grains	Mean ± S.E	
5	10.25 ± 0.425	9.1 ± 0.410	10.925 ± 0.517	10.091 ± 0.533 ^{D}	9.005 ± 0.279 ^{D}
10	17.85 ± 0.520	14.215 ± 0.365	15.405 ± 0.376	15.823 ± 1.071 ^{C}	12.445 ± 0.327 ^{C}
15	20.645 ± 0.271	17.335 ± 0.518	18.61 ± 0.274	18.863 ± 0.965 ^{B}	15.705 ± 0.283 ^{B}
20	24.204 ± 0.374	19.996 ± 0.422	22.878 ± 0.315	22.359 ± 1.243 ^{A}	18.51 ± 0.413 ^{A}
27	23.005 ± 0.253	20.203 ± 0.523	22.245 ± 0.223	21.817 ± 0.837 ^{A}	18.5 ± 0.537 ^{A}
Mean ± S.E	19.190 ± 2.492 ^{a}	16.169 ± 2.080 ^{b}	18.012 ± 2.230 ^{a}		14.833 ± 1.840

" F " between types of food = 156.91
L.S.D at 0.05 = 1.06
" F " between worker ages = 180.7
L.S.D at 0.05 = 2.13
*All experimental colonies were supplied with 50 % sugar solution.

Table (4): Lengths of acidic glands (mm) in adult bee worker stings of different ages in autumn season of 2007 as affected by proteinaceous food types* (means of 5 replicates± SE).

Worker Age (Days)	Types of protcinaceous food				Control (non-proteinaceous food)
	Yeast + Pollens (1 : 1 w : w)	Yeast	Pollen Grains	Mean ± S.E	
5	9.55 ± 0.484	7.84 ± 0.256	9.595 ± 0.555	8.995 ± 0.578 ^{D}	8.125 ± 0.384 ^{E}
10	15.36 ± 0.462	12.785 ± 0.296	14.685 ± 0.610	14.276 ± 0.771 ^{C}	10.395 ± 0.598 ^{D}
15	19.09 ± 0.662	14.32 ± 0.429	15.725 ± 0.450	16.378 ± 1.416 ^{B}	11.905 ± 0.419 ^{C}
20	20.25 ± 0.577	15.904 ± 0.449	17.83 ± 0.749	17.994 ± 1.258 ^{A}	13.41 ± 0.349 ^{B}
27	20.645 ± 0.595	17.409 ± 0.157	19.489 ± 0.436	19.181 ± 0.947 ^{A}	16.135 ± 0.750 ^{A}
Mean ± S.E	16.979 ± 2.084 ^{a}	13.651 ± 1.650 ^{c}	15.464 ± 1.690 ^{b}		11.994 ± 1.358

" F " between types of food = 120.31
L.S.D at 0.05 = 1.33
" F " between worker ages = 270.88
L.S.D at 0.05 = 1.34
*All experimental colonies were supplied with 50 % sugar solution.

Table (5): Lengths of acidic glands (mm) in adult bee worker stings of different ages during different seasons all over the year of 2007 and rates of increment (%) as affected by proteinaceous food types (The data are based on those recorded in tables 1– 4).

Worker Ages (Days)	Winter		Spring		Summer		Autumn		Mean	
	P	C	P	C	P	C	P	C	P	C
5	8.078 (16.64)	6.925	9.575 (10.56)	8.66	10.091 (12.12)	9.005	8.995 (10.7)	8.125	9.184	8.178
10	12.19 (22.94)	9.915	16.93 (24.02)	13.65	15.823 (27.14)	12.445	14.276 (37.33)	10.395	14.804	11.601
15	14.046 (29.51)	10.845	19.342 (26.74)	15.26	18.863 (20.1)	15.705	16.378 (37.57)	11.905	17.157	13.428
20	15.103 (22.14)	12.365	23.013 (23.52)	18.63	22.359 (20.74)	18.51	17.994 (34.18)	13.41	19.617	15.728
27	16.89 (34.90)	12.52	21.79 (18.55)	18.38	21.817 (17.92)	18.5	19.181 (18.87)	16.135	19.919	16.383
Mean	13.26	10.51	18.13	14.91	17.80	14.83	15.36	12	16.136	13.062

Values between brackets represent rates of increment (%).
P, Proteinaceous food ; C ,Control (non- proteinaceous food).

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