

**MORPHOMETRICAL, BIOLOGICAL AND BEHAVIORAL
STUDIES ON SOME HONEY BEE RACES AT EL-BEHEIRA
GOVERNORATE**

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V. SUMMARY

The present study is a step in understanding characters of honey bees at El-Beheira Governorate. *Apis mellifera lamarckii* is the native honey bee of Egypt, and have traits beneficial for beekeepers like adaptation to local condition and resistance to diseases, but shows high levels of defensive behavior and swarming. So, *A. m. carnica* was imported over 30 years period and maintained in Egypt. Also *A. m. ligustica*, *A. m. caucasica* and *A. m. mellifera* were imported to Egypt to improve the native honey bee.

The current study included the following five points: 1) development of a technique for measuring morphological characters of honey bees, 2) characterization of morphological characters of El-Beheira honey bees, 3) studying the effects of requeening under natural mating conditions on morphological characters of the first generation, 4) comparison the morphological characters of Carniolan, Italian, Dark hybrids with Local bees under El-Beheira Governorate conditions, and 5) comparison between Local and Carniolan hybrid colonies on the basis of biological and behavioral activities.

1- Development of a technique for measuring morphological characters.

Measuring of morphological characters was done by using a simple technique depends on the combination between Scanner and Photoshop program. This technique was called (Scan Photo method).The main idea is to dissect the body parts of honey bee worker, and then the separated parts were scanned as images. The images were opened at Photoshop program, and then the ruler of the program was used to measure the characters. To prove the accuracy of

this technique, a ruler was scanned beside a separated wing to measure its length which also was measured by the Photoshop ruler. The Photoshop program gave the same value as the ruler showed.

Comparison between Scan Photo technique and using Binocular with unocular micrometer was done. Measurements were 8.80 , 3.05 , 6.22, 185 , 6 , 2.85 , 2.20 , 1.05 and 2 mm using Scan Photo technique , and 8.85 , 3.15 , 6.32 , 1.90, 6.07 , 2.90 , 2.35 , 1.12 and 2.12 mm using binocular technique for Tongue length; fore wing length and width; hind wing length and width; tibia length; femur length; and basitarsus length and width, respectively. The obtained results showed that all nine morphometric characters measured with Binocular method were higher than the same characters measured with Scan Photo method. The differences ranged from 0.05 to 0.15 mm. Statistical analysis showed that there was no significant difference between the two methods in measuring the chosen morphometric characters.

2- Morphological characters of El-Beheira honey bees.

Samples of 15 honey bee workers were collected from each of 8 colonies from each of six districts at El-Beheira Governorate (Kafer El-Dawar, Etay El-Baroud, Hosh Esa, El-Dalangat, El-Mahmoudia and Damanhour).

2.1- Morphological characters during 2006.

The obtained data indicated that there were differences, among all of the six studied districts of El-Beheira Governorate, in measurements of 15 studied morphological characters of honey bee

workers during 2006. Tongue length means varied from 5.24 mm (El-Mahmoudia) to 5.79 mm (Kafer El-Dawar). Fore wing length means varied from 8.62 mm (El-Dalangat) to 8.86 mm (Damanhour), while fore wing width means varied from 2.92 mm (El-Dalangat) to 3.03 mm (El-Mahmoudia). Hind wing length means varied from 6.05 mm (El-Dalangat) to 6.18 mm (Damanhour), while hind wing width means varied from 1.71 mm (El-Dalangat) to 1.85 mm (Hosh Esa). Cubital A length means varied from 0.50 mm (Damanhour and Hosh Esa) to 0.53 mm (Etay El-Baroud), while Cubital B length means varied from 0.15 mm (El-Dalangat) to 0.20 mm (Etay El-Baroud). Cubital index means varied from 2.54 (Etay El-Baroud) to 3.79 (El-Dalangat). Distance C length means varied from 0.79 mm (El-Mahmoudia) to 0.83 mm (El-Dalangat and Kafer El-Dawar), while Distance D length means varied from 1.85 mm (Damanhour) to 1.91 mm (Etay El-Baroud). Number of hooks means varied from 19.41 (El-Dalangat) to 20.85 (Damanhour). Femur length means varied from 2.22 mm (El-Dalangat and Kafer El-Dawar) to 2.29 mm (El-Mahmoudia), while tibia length means varied from 2.78 mm (El-Dalangat) to 2.91 mm (El-Mahmoudia). Basitarsus length means varied from 2.07 mm (El-Dalangat and Kafer El-Dawar) to 2.18 mm (El-Mahmoudia), while Basitarsus width means varied from 1.09 mm (Damanhour) to 1.12 mm (El-Dalangat and Kafer El-Dawar). Statistical analysis showed that, except for basitarsus width, there were significant differences among locations ($P < 0.05$) in all studied morphological characters.

2.2- Morphological characters during 2007.

There were differences, in measurements of all studied morphological characters of honey bee workers, among studied districts during 2007. Tongue length means varied from 5.92 mm (Hosh Esa) to 6.05 mm (Damanhour). Fore wing length means varied from 8.71 mm (Damanhour) to 8.82 mm (Etay El-Baroud), while fore wing width means varied from 2.88 mm (El-Mahmoudia) to 3.03 mm (Kafer

El-Dawar). Hind wing length means varied from 6.04 mm (Kafer El-Dawar) to 6.16 mm (Etay El-Baroud), while hind wing width means varied from 1.67 mm (Etay El-Baroud) to 1.80 mm (Kafer El-Dawar). Cubital A length means varied from 0.47 mm (Damanhour) to 0.53 mm (Etay El-Baroud and El-Mahmoudia), while Cubital B length means varied from 0.15 mm (Damanhour) to 0.21 mm (El-Dalangat). Cubital index means varied from 2.45 (El-Dalangat) to 3.19 (Damanhour). Distance C length means varied from 0.80 mm (Etay El-Baroud) to 0.83 mm (El-Mahmoudia), while Distance D length means varied from 1.82 mm (Hosh Esa) to 1.91 mm (El-Mahmoudia). Number of hooks means varied from 20.12 (Etay El-Baroud) to 21.15 (Damanhour). Femur length means varied from 2.21 mm (El-Dalangat) to 2.28 mm (Kafer El-Dawar), while tibia length means varied from 2.79 mm (Damanhour and Etay El-Baroud) to 2.85 mm (Hosh Esa). Basitarsus length means varied from 2.07 mm (Damanhour) to 2.14 mm (El-Mahmoudia and Etay El-Baroud), while Basitarsus width means varied from 1.07 mm (Damanhour) to 1.12 mm (El-Mahmoudia). Statistical analysis revealed that there were significant differences among locations ($P < 0.05$) in all studied morphological characters except in five characters: fore wing length, hind wing length, distance D, femur length and basitarsus length which found to be insignificant.

The overall means of the studied morphological characters of honey bee workers showed variations between the two years of the study. Some characters increased in 2007 while the others decreased. Also, the variations between locations in 2006 were greater than those of 2007. One insignificant difference (basitarsus width) in 2006 vs. five insignificant differences (fore wing length, hind wing length, distance D, femur length and basitarsus length) in 2007.

2.3- The overall mean values of 2006 and 2007.

There were differences in the overall mean values (of 2006 and 2007) of all studied morphological characters of honey bee workers, among studied districts. Statistical analysis showed that all studied morphological characters were found to show significant differences among locations ($P < 0.05$) except four characters: fore wing width, cubital B, cubital index and distance C.

The obtained results of El-Beheira honey bees showed that the overall mean of tongue length was found to be 5.75 mm. The longest tongue during the two years of study was found to be 5.98 mm, while the shortest one was 5.25 mm. The overall mean of fore wing length was found to be 8.74 mm. The longest fore wing was found to be 8.86 mm, while the shortest one was 8.83 mm. The overall mean of fore wing width was found to be 2.96 mm. The widest fore wing was found to be 3.04 mm, while the narrowest one was 2.92 mm. The overall mean of hind wing length was found to be 6.11 mm. The longest hind wing was found to be 6.19 mm, while the shortest one was 6.04 mm. The overall mean of hind wing width was found to be 1.76 mm. The widest hind wing was found to be 1.85 mm, while the narrowest one was 1.67 mm. The overall mean value of cubital index was found to be 2.94. The highest value of cubital index during the two years of study was found to be 3.79, while the smallest one was 2.54. The overall mean of distance C length was found to be 0.81 mm. The longest distance C was found to be 0.83 mm, while the shortest one was 0.79 mm. The overall mean of distance D was found to be 1.87. The longest distance D was found to be 1.91 mm, while the shortest one was 1.82 mm. The overall mean value of number of hooks was found to be 20.34. The highest value of number of hooks during the two years of study was found to be 21.15, while the smallest one was 19.42. The overall mean of femur length was found to be 2.24 mm. The longest femur was found to be 2.29 mm, while the shortest one was 2.21 mm. The overall mean of tibia length was found to be 2.82 mm. The longest tibia was found to be 2.78 mm, while the shortest one was 2.91 mm. The overall mean of basitarsus length was found to be 2.13 mm. The

longest basitarsus was found to be 2.31 mm, while the shortest one was 2.07 mm. The overall mean of basitarsus width was found to be 1.10 mm. The widest basitarsus was found to be 1.13 mm, while the narrowest one was 1.13 mm.

Honey bee workers sampled from Kafer El-Dawar district recorded the highest mean values of 4 characters: tongue length (5.88 mm), fore wing width (2.99 mm), hind wing width (1.82 mm), and distance C length (0.82 mm). Also, honey bee workers sampled from El-Mahmoudia district recorded the highest mean values of 4 characters: distance D length (1.9 mm), tibia length (2.87mm), basitarsus length (2.16 mm), and basitarsus width (1.12 mm). Honey bee workers sampled from Damanhour district had the highest mean values of 3 characters: fore wing width (2.99 mm), number of hooks (21), and femur length (2.26 mm). Also, honey bee workers sampled from El-Dalangat had the highest mean values of 3 characters: cubital index (3.12), distance C length (0.82 mm), and basitarsus width (1.12 mm). Honey bee workers sampled from Etay El-Baroud district had the highest mean values of 2 characters: fore wing length (8.82 mm) and hind wing length (6.15 mm). On contrary, honey bee workers obtained from Hosh Esa did not record any highest mean values among all of the studied characters.

2.4- Comparison between El-Beheira honey bee population and some honey bee races.

The obtained results of El-Beheira honey bee population were compared with those of the Egyptian honey bees (*A.m.lamrackii*) and some honey bee races. The overall mean of tongue length of El-Beheira honey bees was higher than that of *A.m.lamrackii* and Sudanese honey bees, and less than that of Carniolan, Italian, Caucasian and Syrian honey bees. The overall mean of fore wing length of El-Beheira honey

bees was higher than that of *A.m.lamrackii*, Sudanese and Syrian honey bees, and less than that of Carniolan, Italian and Caucasian honey bees. The overall mean of fore wing width of El-Beheira honey bees was higher than that of *A.m.lamrackii* and Syrian honey bees, and less than that of Carniolan, Italian, Caucasian and Sudanese honey bees. On the other hand, the overall means of hind wing length and hind wing width of El-Beheira honey bees were less than Carniolan and Syrian honey bees. In regard to Cubital index of El-Beheira honey bees, it was higher than that of *A.m.lamrackii*, Sudanese, Carniolan, Italian, Caucasian and Syrian honey bees. Concerning, number of hooks of El-Beheira honey bees, it was more than that of Italian honey bees, and less than that of Carniolan, Sudanese and Syrian honey bees. In regard to leg characters of our honey bees, it was found that femur and tibia were shorter than those of Caucasian honey bees, while basitarsus length and width were smaller than those of Carniolan and Syrian honey bees. Also, basitarsus of El-Beheira honey bees was longer than that of *A.m.lamrackii*, Sudanese, Italian and Caucasian honey bees, while it was wider than that of Sudanese honey bees.

3- Morphological characters of Local honey bee workers from Parent colonies (P) and their First generation (F₁).

The measurements of 11 morphological characters of honey bee workers from Local colonies (Parents) were compared with those of their F₁ colonies, in which queens have been mated under natural mating conditions of Damanhour city. The overall means of Parents (P) and their F₁ were 5.95 mm and 6.05 mm for tongue length; and 8.91 mm and 8.64 mm; 3.05 mm and 3.22 mm; 6.28 mm and 6.05 mm; 1.81 mm and 1.71 mm for fore wing length; fore wing width; hind wing length and hind wing width, respectively. Also, the overall mean values of P and F₁ were 2.89 and 3.25 for cubital index; and 20.8 and 20.6 for number of hooks, in respect. On the other hand, the overall means were 2.25 mm and 2.22 mm; 2.83 mm and 2.80 mm; 2.10 mm and 2.04

mm; 1.08 mm and 1.06 mm for femur length; tibia length; basitarsus length and basitarsus width of P and F₁, in respect. Statistical analysis illustrated that significant differences were found only between workers of parent and F₁ mean in tongue length, hind wing length and basitarsus length, while insignificant differences were found between them in the other characters.

4. Morphological characters of Local honey bee workers compared with those from the Italian, Carniolan, Dark hybrids.

4.1- Body characters.

Differences among studied races were as the following:

(1): Head characters:

The highest hybrid in head capsule width was Italian with (3.86 mm), while the lowest one was Local with (3.68 mm). Tongue length differed among hybrids by (0.4 mm), and Carniolan hybrid workers had the longest tongue with mean of (6.11 mm), while the Local workers had the shortest tongues with (5.71 mm). The studied hybrids were arranged according to the two studied head characters, in descending order, as the following: Italian, Carniolan, Dark and Local. Statistical analysis showed that there were significant differences among hybrids in head capsule width and tongue length. The Local workers were significantly lower than those of other hybrids, in head capsule width. Also, the Local workers were significantly lower than the studied hybrids, except the Dark, in tongue length.

(2): Thorax characters:

Fore wing length differed among hybrids by (0.25 mm), where the highest hybrid was Carniolan with mean of (9.08 mm), while the lowest hybrid was Dark with (8.83 mm). Fore wing width differed among hybrids by (0.09 mm), and the highest hybrid was Carniolan with mean of (3.17 mm), while the lowest one was Italian with (3.08 mm). Hind wing length ranged from (6.36 – 6.29 mm) with variation of (0.07 mm), the highest hybrid was Carniolan and the lowest one was the Local. Hind wing width differed among hybrids by (0.1 mm), and the highest hybrid was Carniolan with mean of (1.96 mm), while the lowest hybrid was both (Italian and Dark) with mean of (1.86 mm). Number of hooks differed among hybrids with value (2.60), and the highest hybrid was Dark with mean of 23.6, while the lowest one was Italian with 21. Among studied wing characters, Carniolan hybrid workers had the highest values of four characters, while the Dark hybrid bees had the highest value in number of hooks.

Femur length differed among studied hybrids by (0.16 mm), and the Carniolan was the highest hybrid with mean of (2.44 mm), while the lowest one was Italian with (2.28 mm). Tibia length varied among hybrids by (0.11 mm), and the highest hybrid was Carniolan with mean of (2.92 mm), while the lowest one was Local with (2.81mm). Basitarsus length differed among hybrids with (1.11 mm), and the highest hybrid was Carniolan with mean of (2.22 mm), while the lowest one was Italian with (1.11 mm). Basitarsus width differed among hybrids with (0.11 mm), and the highest hybrid was Carniolan with mean of (1.16 mm), while the lowest one was Italian with (1.05 mm). Carniolan hybrid workers occupied the first place, among studied hybrids, in all studied leg characters, while Italian hybrid workers occupied the last place in three leg characters. Statistical analysis showed that significant differences were detected among hybrids for FWW, HWW, TL, BL and BW. On the other hand, the Local workers did not differ significantly from those of other hybrids, in all studied thorax characters, except in tibia length; where they were significantly lower than Carniolan hybrid workers.

(3): Abdomen characters:

Sting shaft length differed among hybrids by (0.11 mm), and the Dark hybrid workers had the longest sting shaft with mean of (2.09 ± 0.11), while the Local workers had the shortest sting shaft with (1.92 ± 0.18 mm). Tergit 3 length (T3) varied among hybrids by (0.13 mm), and the highest mean was found in Dark hybrid workers (2.22 ± 0.04 mm), while the lowest one was found in Local workers (2.09 ± 0.02 mm). Tergit 4 length (T4) varied among studied hybrids by (0.12 mm), and the highest mean was found in Dark hybrid workers (2.18 ± 0.04 mm), while the lowest one was found in Local workers (2.06 ± 0.04 mm). Also, body size (T3+T4) varied among studied hybrids by (0.25 mm), and the highest value was found in Dark hybrid workers with mean of (4.40 ± 0.03 mm), while the lowest value was in Local bees with (4.15 ± 0.03 mm). Dark hybrid workers occupied the first place, among studied hybrids, in all studied abdomen characters, while Local workers occupied the last place in abdomen characters. Statistical analysis showed that significant differences were found among hybrids in studied abdominal characters, except for sting shaft length. On the other hand, the local workers were significantly lower than those of Dark hybrid, in Tergit 3 length (T3), and those of Italian and Dark hybrids, in Tergit 4 length (T4) and Body size (T3+T4).

4.2- Fore wing venation characters.

The obtained results showed that Cubital A differed among studied hybrids by (0.07 mm), and the highest hybrid was Carniolan with mean of (0.54 mm), while the lowest one was the Local with (0.47 mm). Cubital B differed among hybrids by (0.07 mm), and the highest mean was found for Dark hybrid (0.21mm), while the lowest mean was for Carniolan hybrid (0.14 mm). The variation among studied hybrids in

Cubital index was found to be (1.68), and the highest mean value was found for Carniolan hybrid (4.1), while the lowest mean value was for Dark hybrid (2.42). Distance C length differed among hybrids by (0.04 mm), and the Carniolan hybrid workers were the highest (0.82 mm), while Italian hybrid workers were the lowest (0.78 mm). Distance D length differed among hybrids by (0.03 mm), and workers of Local bees and the Italian hybrid were the highest (1.89 mm), while Carniolan hybrid workers were the lowest (1.86 mm). Inner wing length differed among studied hybrids by (0.16 mm), and the highest hybrid was Carniolan with mean of (4.35 mm), while the lowest hybrid was Dark with (4.19 mm). Inner wing width differed among hybrids by (0.1 mm), and the highest hybrid was Carniolan with mean of (1.87 mm), while the lowest hybrid was Dark with (1.86 mm). Radial field differed among hybrids by (0.08 mm), and the highest hybrid was Carniolan with (3.24 mm), while the lowest one was Local with (3.16 mm). Mean values of Dumb bell index differed among studied hybrids by (0.11), and the highest mean value was found for Carniolan (1.02), while the lowest mean value was found for Local bees (0.91).

Statistical analysis illustrated that no significant differences among hybrids in only two characters (Distance A length and Distance D length). Also, there were insignificant differences among studied hybrids in the other seven wing venation characters, except in some cases. The Cubital B lengths mean of Dark hybrid workers was significantly higher than that of Carniolan hybrid workers. The Cubital index and Dumb bell index (Hantel index) means of Carniolan hybrid workers were significantly higher than those of both Local and Dark hybrid workers. Distance C lengths mean of Italian hybrid workers were significantly less than that of other the studied hybrid workers. The Dark hybrid workers were significantly less than both Italian and Carniolan hybrid workers in Inner wing lengths. On the other hand, Carniolan hybrid workers were significantly higher than Local workers in Inner wing length. The Inner wings of Carniolan hybrid workers were significantly wider than those of Dark hybrid workers. Finally, Radial

fields of Carniolan hybrid workers were longer than those of Local workers.

5- Comparison between Local and Carniolan hybrid honey bee colonies.

5.1- Biological studies:

5.1.1. Worker brood rearing activity.

The mean amounts of worker sealed brood (in square inches and calculated as numbers of worker sealed brood cells) produced by Carniolan hybrid colonies were higher than those produced by Local colonies, after the first date (26/4/2008) until the end of experiment (16/11/2008). The total amount of worker sealed brood produced, during the all period of experiment, by Local colonies was 3025.33 square inches (with overall mean of 168.07 ± 56.17 square inches/colony) compared with 3531.05 square inches (with overall mean of 196.17 ± 61.86 square inches/colony) produced by Carniolan hybrid colonies. On the other hand, the mean amounts of worker sealed brood produced by Local and Carniolan hybrid colonies decreased sharply from May until the beginning of July. After that, they increased sharply with peaks in August, and then decreased gradually until the end of experiment.

Statistical analysis revealed that mean amounts of worker sealed brood reared by Carniolan hybrid colonies were significantly higher than those reared by Local colonies in all measuring dates, except on 26/4, 13/6 and 7/7/2008 with insignificant differences. When the amounts of workers sealed brood through all measuring dates were summed, the total amount produced by Carniolan hybrid colonies was significantly higher than that produced by Local colonies.

5.1.2. Food storage activity

The mean areas of pollen (in square inches) stored by Carniolan hybrid colonies were higher than those stored by Local colonies, during the period from 1/6/2008 until 16/11/2008. The total area of pollen stored, and measured during all measuring dates, by Local colonies was 331.08 square inches/colony (with overall mean of 22.07 ± 8.71 square inches/colony) compared with 379.13 square inches/colony (with overall mean of 25.27 ± 10.91 square inches/colony) stored by Carniolan hybrid colonies. On the other hand, the mean amounts of pollen stored by Local and Carniolan hybrid colonies decreased gradually from the beginning of experiment until the end of July. After that, they slightly increased until the beginning of Sept., and then decreased gradually until the end of experiment.

Statistical analysis revealed that mean amounts of pollen stored by Carniolan hybrid colonies were significantly higher than those stored by Local colonies in all measuring date, except on 19/7, 31/7, 29/9, 11/10, 23/10 and 4/11/2008 with insignificant differences. When the mean areas of stored pollen through all measuring dates were summed, the total amount stored by Carniolan hybrid colonies was higher than that collected by Local colonies, but with no significant difference.

On the other hand, the mean amounts of sealed honey (in square inches) stored, through most measuring dates during the period from 1/6/2008 until 19/11/2008, in Local colonies were higher than those in Carniolan hybrid colonies. The total amount of honey stored, and measured during all measuring dates, by Local colonies was 434.33 square inches/colony (with overall mean of 28.95 ± 15.37 square inches/colony) compared with 414.49 square inches (with overall mean

of 27.63 ± 19.96 square inches/colony) stored by Carniolan hybrid colonies. On the other hand, the mean amounts of honey stored by Local and Carniolan hybrid colonies decreased gradually from the beginning of experiment until the end of July. After that, they slightly increased until the beginning of Sept., and then decreased gradually until the end of experiment. The pattern of fluctuation of stored honey through the season was similar to that of stored pollen. Also, it is obvious that there was a shortage in nectar sources as well as in pollen sources in the surrounding area.

Statistical analysis revealed that amounts of honey stored by Carniolan hybrid colonies were significantly higher than those stored by Local colonies on 1/6, 13/6, 19/7, 12/8 and 5/9/2008. On contrary, amounts of honey stored by Local colonies were significantly higher than those stored by Carniolan hybrid colonies on 7/7, 31/7, 24/8, 17/9, 11/10, 23/10, 4/11 and 16/11/2008. On the other hand, the differences were not significant on 25/6 and 29/9/2008. When the mean areas of stored honey through all measuring dates were summed, the total amount stored by Local colonies was higher than that stored by Carniolan hybrid colonies, but with no significant difference.

5.2-Hygienic behavior:

Means of hygienic behavior (expressed as %) of Local and Carniolan hybrid colonies in different times (6, 24, 30 and 48 hours) after the perforation of the brood cell were determined. Mean of cleaned cells was 32.2% for Local colonies compared with 15.5 % for Carniolan hybrid colonies after 6 hours, while after 24 hours they were 70.6 % and 38.4 % for the previous colonies, in respect. Also, mean of cleaned cells was 83.8 % for Local colonies compared with 46.7 % for Carniolan hybrid colonies after 30 hours, while after 48 hours they were 93.4 %

and 64.4 % for the previous colonies, in respect. Statistical analysis indicated that percentages of cells cleaned by Local colonies were significantly higher than those cleaned by Carniolan hybrid colonies in the all times of observation after the perforation (6, 24, 30 and 48 hours).