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## SUMMARY

The present investigation was designed to study and evaluate certain biometrical, morphometrical, behavioural and physiological characters of three  $F_1$  hybrids and two races, i.e. Carniolan hybrid, Italian hybrid, Caucasian hybrid, Egyptian race and Carniolan race, during the period of 2000-2003, in Assiut region. Obtained results could be summarized as follows:

### **Part I: Biometrics of honeybee colonies:**

The descending order of the tested colonies according to the mean workers sealed brood area (in sq. inch./colony) measured all over the different seasons is as follows: Italian hybrid (274.4 sq. inch.), Carniolan race (241.0 sq. inch.), Caucasian hybrid (226.3 sq. inch.), Carniolan hybrid (213.6 sq. inch.) and Egyptian race (104.6 sq. inch.).

The descending order of the tested colonies according to the mean drones sealed brood area (in sq. inch./colony) measured all over the different seasons is as follows: Carniolan race (10.36), Carniolan hybrid (9.223), Egyptian race (8.323), Caucasian hybrid (6.977) and Italian hybrid (6.432).

The descending order of the test colonies based on the mean colony population determined all over the different seasons is as follows: Italian hybrid (23831.62 adult), Carniolan race (21943.99 adult), Caucasian hybrid (19795.76 adult), Carniolan hybrid (19154.24 adult) and Egyptian race (9058.12 adult).

The descending order of the tested colonies according to the mean number of unsealed queen cells counted all over the different seasons is as

follows: Egyptian race (8.917 queen cell), Carniolan race (2.655 queen cell), Carniolan hybrid (2.56 queen cell), Caucasian hybrid (1.173 queen cell) and Italian hybrid (0.8067 queen cell).

The descending order of the tested colonies according to the mean number of constructed queen cells counted all over the different seasons is as follows: Egyptian race (8.197), Carniolan race (2.235), Carniolan hybrid (1.623), Caucasian hybrid (0.8467) and Italian hybrid (0.5083).

The descending order of the tested colonies according to the mean surplus honey (in sq. inch./colony) measured all over the different seasons is as follows: Carniolan hybrid (174.2 sq. inch.), Caucasian hybrid (161.3 sq. inch.), Carniolan race (138.6 sq. inch.), Italian hybrid (135.8 sq. inch.) and Egyptian race (97.95 sq. inch.).

The descending order of the tested colonies according to the mean pollen stored (in sq. inch./colony) measured all over the different seasons is as follows: Italian hybrid (81.37), Carniolan hybrid (78.07), Caucasian hybrid (68.12), Carniolan race (54.93) and Egyptian race (35.0).

The descending order of the tested colonies according to the mean honey production (kg/colony) produced all over the different seasons is as follows: Carniolan hybrid (6.503), Caucasian hybrid (5.895), Carniolan race (5.123), Italian hybrid (5.094) and Egyptian race (3.333).

The descending order of the tested colonies according to the mean drawing out wax foundation (in sq. inch./colony), measured all over the different seasons is as follows: Egyptian race (219.4 sq. inch.), Carniolan race (192.6 sq. inch.), Carniolan hybrid (184.4 sq. inch.), Italian hybrid (178.4 sq. inch.) and Caucasian hybrid (153.4 sq. inch.).

The descending order of the tested colonies according to the mean honey-sac weight (mg/bee) weighted all over the different seasons is as follows: Carniolan race (30.15 mg), Italian hybrid (29.58 mg), Carniolan hybrid (27.3 mg), Caucasian hybrid (25.92 mg) and Egyptian race (20.33 mg).

The descending order of the tested colonies according to the mean T.S.S. (%) of honey-sac contents measured all over the different seasons is as follows: Egyptian race (38.8), Italian hybrid (38.74), Caucasian hybrid (38.57), Carniolan hybrid (38.53) and Carniolan race (38.46).

The descending order of the tested colonies according to the mean pollen loads weight (mg/bee) weighted all over the different seasons is as follows: Caucasian hybrid (10.34 mg), Carniolan hybrid (8.324 mg), Carniolan race (7.895 mg), Italian hybrid (7.751 mg) and Egyptian race (6.018 mg).

Brood rearing of workers and bee population was 2.63 times more, and stored pollen was 2.33 times more in Italian hybrid, as compared with Egyptian race. It is obvious that pollen stores, bee population and workers brood rearing are highly correlated. The reverse is true, in case of building of queen cells, which was about 14 times more in Egyptian race as compared with Italian hybrid.

Weight of honey-sac was 1.49 times more, surplus stored honey was 1.78 times more, and extracted honey was 1.96 times more in Carniolan race and its hybrid, as compared with Egyptian race. It is clear that, all these three characters are highly correlated.

Weight of pollen loads in Caucasian hybrid was 1.72 times more than this of Egyptian race. The reverse was observed in case of wax

building, and it was 1.43 times more in the Egyptian race, as compared with Caucasian hybrid.

Scoring method was used for comparison of different biometrical characters, or activities of tested five races and hybrids. Lowest number of scores (1), reflects the first place or maximum, and highest number of scores (5), reflects the last, fifth place or minimum. Depending on the obtained total scores, the descending order for tested races and hybrids was: Carniolan race, with 30 score; Carniolan hybrid, with 32 scores; Italian hybrid = Caucasian hybrid, with 38 scores; and finally, Egyptian race, with 42 scores. Twelve biometrical characters were used for evaluation of tested races and hybrids, in Assiut region.

Carniolan honeybee colonies and tested hybrids were more active than the Egyptian bees, except in case of, queen cells and wax building and in this respect, Egyptian race was more active.

## **Part II: Morphometrical results:**

### **A- Workers:**

The Carniolan race characteristics were more better. The Carniolan workers had significant the longest organs in all morphometrical characters measurements except for in case of dry body weight (mg) where, Italian hybrid was the highest weight, (30.45 mg); body water content (%) where, Carniolan hybrid was the highest value, (70.74%); proboscis length (mm) where, Caucasian hybrid was the longest, (6.569 mm); The distance between the two first wax mirrors (mm) where, Egyptian race with the highest value, (0.2537 mm) and sting shaft length (mm) where, Italian hybrid was the longest, (2.168 mm). On the other hand, the Egyptian workers had significantly the shortest measurements, in general.

**B- Queens:**

The Egyptian queens had significantly the shortest morphometrical characters measurements, except in case of: cubital index, and number of hamuli. Insignificant differences were noticed between the other tested hybrids and races. The Carniolan hybrid queens, the Carniolan race, the Caucasian hybrid and the Italian hybrid followed descendingly in the measurements of most organs.

**D- Drones:**

The Egyptian drones had significantly the shortest organs in all morphometrical characters measurements except for in case of number of hamuli where, insignificant differences was noticed between the tested hybrids and races. The Carniolan race drones, the Carniolan hybrid, the Italian hybrid and the Caucasian hybrid followed descendingly in the measurements of most organs.

**D- Egg size:**

For egg length (mm), the Carniolan race was the longest, (1.56). On the other hand, Egyptian race was the shortest, (1.526). While in case of egg width (mm), the Egyptian and the Carniolan races were the highest values, (0.3537 and 0.3533), respectively. In contrast, Italian hybrid was the lowest value, (0.3507).

Fifty four morphological characters were used for evaluation, or scoring method for tested hybrids and races. Total scores and (ranking order) of morphometrical characters were: 86 (1), 140 (2), 151 (3), 180 (4) and 247 (5), in Carniolan race, Carniolan hybrid, Caucasian hybrid, Italian hybrid and Egyptian race, respectively. The same situation was noticed with biometrical characters.

**Part III: Behavioural results:****A- Rate of varroa mite infestation:**

Carniolan race was highly infested by varroa mite in case of workers brood and adult workers, followed in a descending order by Carniolan hybrid. Meanwhile, workers brood and adult workers was the lowest infested by varroa mites in case of Egyptian race, followed in descending order by Italian hybrid.

Regarding to the infestation level during the months, it varied considerably from one month to another. For the workers brood infestation, the average rate being lowest in March and the highest was during October. In case of adult workers infestation, the lowest rate was during April and the highest during September.

**B- Grooming behaviour:**

Italian hybrid and Egyptian race were with the highest grooming behaviour. In contrast, Carniolan race had the lowest grooming behaviour. Meanwhile, the grooming behaviour was medium in case of Carniolan hybrid and Caucasian hybrid.

**C- Hygienic behaviour:**

The highest hygienic behaviour, (99.5) was found in the Egyptian race followed by Italian and Carniolan hybrids. While the lowest values (89.0 and 89.25) were observed in Caucasian hybrid and Carniolan race, respectively.

**D- Aggressive (Defensive) behaviour:**

Egyptian race revealed the highest defensive behaviour, while Carniolan race was more gentle, easily handled and showing a mild defensive responses. Smoking was significantly reduced the aggressive

behaviour of bees. Opening the hive or exposure the balls to workers on the comb tops after the lid and remove it markedly increased the aggressiveness. Geraniol was active in inducing aggressive response and severe stings.

Highly significant and negative correlation ( $r = -0.94$ ) was detected between cubital index (X), and aggressiveness (Y), in studied races and hybrids.

Six behavioural characters were used for evaluation, or scoring method for tested hybrids and races. Total scores and (ranking order) of behavioural characters were: 114 (1), 167 (2), 211 (3), 250 (4) and 288 (5), in Italian hybrid, Egyptian race, Caucasian hybrid, Carniolan hybrid and Carniolan race. The reverse ranking order was found in case of biometrical and morphometrical characters.

#### **Part IV: Physiological results:**

The newly emerged workers for Carniolan hybrid, Caucasian hybrid and Carniolan race were with the highest thorax fresh weights (mg/bee), (32.2, 32.09 and 32.27 mg), respectively. Meanwhile, Egyptian race had the lowest weight, (27.97 mg). In case of thorax dry weight (mg/bee), Carniolan hybrid and Carniolan race were with the highest weight, (8.309 and 8.421 mg), respectively. Meanwhile, Egyptian race had the lowest weight, (7.245 mg). The highest nitrogen content, (10.395%) was found in Carniolan race, whereas, the lowest nitrogen content, (7.637%, was noticed in Egyptian race. The same trend was obtained for total protein content (%).

The newly emerged workers for Carniolan hybrid, Caucasian-hybrid and Carniolan race had the highest head fresh weights (mg/bee), (9.989,

9.992 and 9.941 mg), respectively. Whereas, Egyptian race had the lowest weight, (8.582 mg). For head dry weight (mg/bee), Carniolan hybrid was the highest, (2.582 mg). Meanwhile, Egyptian race was the lowest, (2.207 mg).

Carniolan hybrid, Caucasian hybrid and Carniolan race were with the highest K content (ppm), (62.82, 60.87 and 62.44 ppm), respectively. Whereas, Egyptian race had the lowest value, (41.23 ppm). The highest Ca content (ppm), (37.39 ppm) was detected in Carniolan race. Meanwhile, Egyptian race was the lowest, (24.08 ppm).

Maximum Na content (ppm), (94.78 ppm), was found in Carniolan race. Meanwhile, Carniolan hybrid, Italian hybrid and Caucasian hybrid were with the lowest values, (70.74, 71.99 and 68.93 ppm), respectively. Maximum Mg content (ppm), (62.41 ppm) was found in Carniolan hybrid. Meanwhile, Egyptian race was the lowest, (38.12 ppm). Carniolan hybrid and Caucasian hybrid were with the highest (K/Na) ratio, (0.952 and 0.9485), respectively. Meanwhile, Egyptian race was the lowest, (0.579).

The highest (Mg/Ca) ratio, (2.334) was noticed in Carniolan hybrid. Whereas, Carniolan-race was the lowest (1.401). The newly emerged workers for Carniolan race had the highest total fat content (mg/bee), (2.213 mg). Meanwhile, there were insignificant differences between Carniolan hybrid, Italian hybrid, Caucasian hybrid and Egyptian race.

Workers with 12 days old were with the highest degree of hypopharyngeal gland (HG) development in all tested hybrids and races. On the other side, workers, with 3 days old were with the lowest degree of (HG) developmental in all tested hybrids and races of honeybees.

Nine-days old workers were with the highest means acinal surface area in case of all tested hybrids and race. Meanwhile, fifteen and eighteen-old workers were with the lowest acinal surface area in all tested hybrids and races. Maximum degree of (HG) development and maximum acinal surface area, were noticed in Carniolan hybrid.

Italian hybrid was the maximum ovarioles number of virgin queens, (128.8). On the other side, the lowest ovarioles number was observed in the Egyptian race, (98.42). The same previous trend was noticed for the length of tergites (3+4) in virgin queens.

Total scores and (ranking order) of physiological characters were: 56 (1), 65 (2), 85 (3), 94 (4) and 108 (5), in Carniolan race, Carniolan hybrid, Caucasian hybrids, Italian hybrid and Egyptian race, respectively. Reverse situation was observed in case of behavioural studies, while the same situation was found with biometrical and morphometrical studies. This reflects a close relationship between biometrical, morphometrical and physiological characters of studied races and hybrids of honeybee colonies, and the reverse is true in behavioural studies.

Twelve biometrical characters, fifty four morphological characters six behavioural characters, and twenty two physiological characters, with a total of ninety four characters were used in evaluation of tested honeybee races and hybrids. Final ranking order was: Carniolan race (1), Carniolan hybrid (2), Italian hybrid (3), Caucasian hybrid (4), and Egyptian race (5).