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BODY CHARACTERISTIC OF DRONES OF DIFFERENT ORIGIN

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ABSTRACT

Computer-based methods help beekeepers and scientists in apidology and bee research. Using software Optika Vision Pro in this study, three body morphological characteristics has been applied to honeybees' drones (*Apis mellifera carnica*) of different origin in identification of difference among them. All three measured body morphological characteristics (body length, forewing length, and head length) were statistically different between drones originated from colonies with mated queens and drones originated from colonies with unfertilised queen and/or with unfertilised worker bee(s), respectively, thus making them potentially more successful in queen fertilization and secondary colony development and productivity.

Key words: body morphological characteristics; computer-based methods; drones; honeybees

INTRODUCTION

The Carniolan honeybee is globally widespread with a wide diversity of subspecies, which can be classified with morphometric tools [13].

Three major groups of body morphological characteristics are commonly used: Length measurements, colour measurements, and wing venation characteristics, while wing venation characteristics have been studied more intensely than other body morphological characteristics. The measurement of body morphological characteristics can be done for different reasons, but a major reason is to characterize bee races [7, 14] and/or to determine the degree of hybridization with foreign races [12]. Moreover, body morphological characteristics are measured to investigate the impacts of imported queens on honeybee populations, or to check population purity [4, 8].

Commonly, body characteristics are standardly measured according to Ruttner et al. [13], and Ruttner [14], which can be divided according to body parts into: head, thorax, and abdomen characteristics. Head characteristics include: head length (HCL), and capsule width (HCW), antenna length (AL), and number of segments (ANS), compound eyes length (CEL), and width (CEW), and tongue length (TonL). Some methods also include: the mandible length (ML), beside some other characteristics. The thorax characteristics are: forewing width (FWW), and length (FWL), hindwing length (HWL), and width (HWW), number of hooks (NH), thorax width (thW), tibia length (TL), femur length (FL), basetarsus length (BL), and width (BW), brush hair rows number (HN), and pollen basket size (PBS). The abdomen characteristics are: lengths of tergit 3 (T3), and 4 (T4), body size (T3+T4), length of hairs on tergit 5 (HLT5), pigmentation of tergit

2-4, length of sternite 3 (LS3), wax mirror length (WML), and transversal (WMT), and sting shat length (StL).

Honeybees are classified into three basic castes: queens, drones, and workers, while only drones (male honeybees), are developed from unfertilised female eggs. The origin of unfertilised female eggs is different; (i) from mated queen which is physiologically laying them during the season, mainly at the beginning; (ii) from unfertilised queen which was not mated from different reasons, and from (iii) unfertilised worker bee(s), when queen is lost from different reasons. The eggs laid by fertilised queen, are developed in cells with larger diameter, compared to eggs originated from unfertilised queen, and/or unfertilised worker bee(s), which are laid into worker bee´s cells [3].

The body characteristics may be used for indirect prediction of colony productivity, or for selection of productivity, where honeybees with longer legs, and wings, have higher power light, and could gather more pollen and nectar for brood rearing, and consequently colony population [10].

To this time, there is no study aimed at the measurement of body morphological characteristics of drones of different origin. Based on the facts presented above, we focused on the body characteristics of drones of different origin. The use of these characteristics may help classify them according to their origin.

MATERIALS AND METHODS

The study was performed during summer 2021. According to some studies, at least 15 honeybee workers should be collected from each colony during the morphological analysis [4, 7]. In this study, we analysed 256 individuals of drones from six different geographical areas of Slovakia (Fig. 1). The sampled drones were of different origin, all three groups were covered equally; 86 drones originated from colonies with laying queens, 80 individuals from colonies with unmated queens, and 90 drones from colonies with unfertilised worker bee(s). Drones were collected directly from brood comb(s), according to Padilla et al. [11]. The collected drones were preserved in a deep-freezer (-18 °C) and later dissected and analysed in a laboratory.

Table 1. Sample origin details

Drone origin	Sample ID	Site	Number of drones
Mated queen	1	Košice	30
	2	Rozhanovce	30
	3	Kozelník	26
Unmated queen	4	Rozhanovce	30
	5	Rozhanovce	20
	6	Prešov	30
Unfertilised worker bee	7	Zvolen	30
	8	Rozhanovce	30
	9	Kurima	30

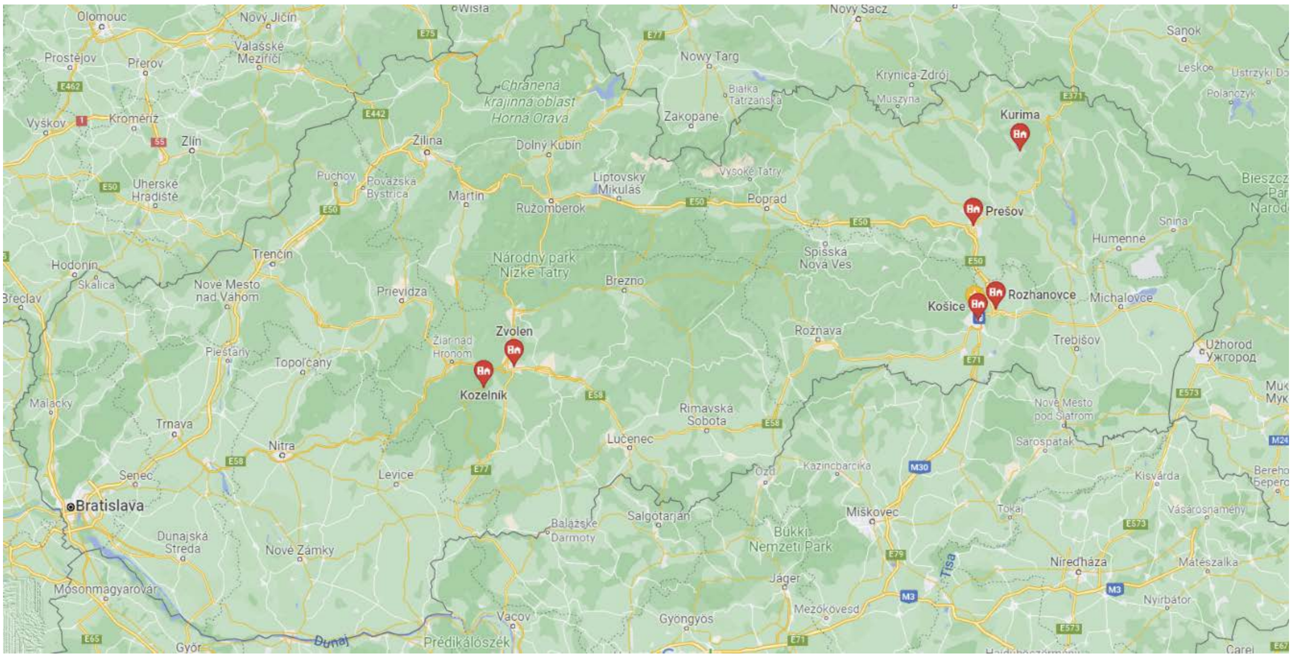

Fig. 1. Sampling sites
https://www.google.com/maps/@48.6635723,19.9533694,8.3z/data=!4m3!11m2!2sQCZwaYWaRt2IHLictE5gHw!3e3?hl=sk-SK)

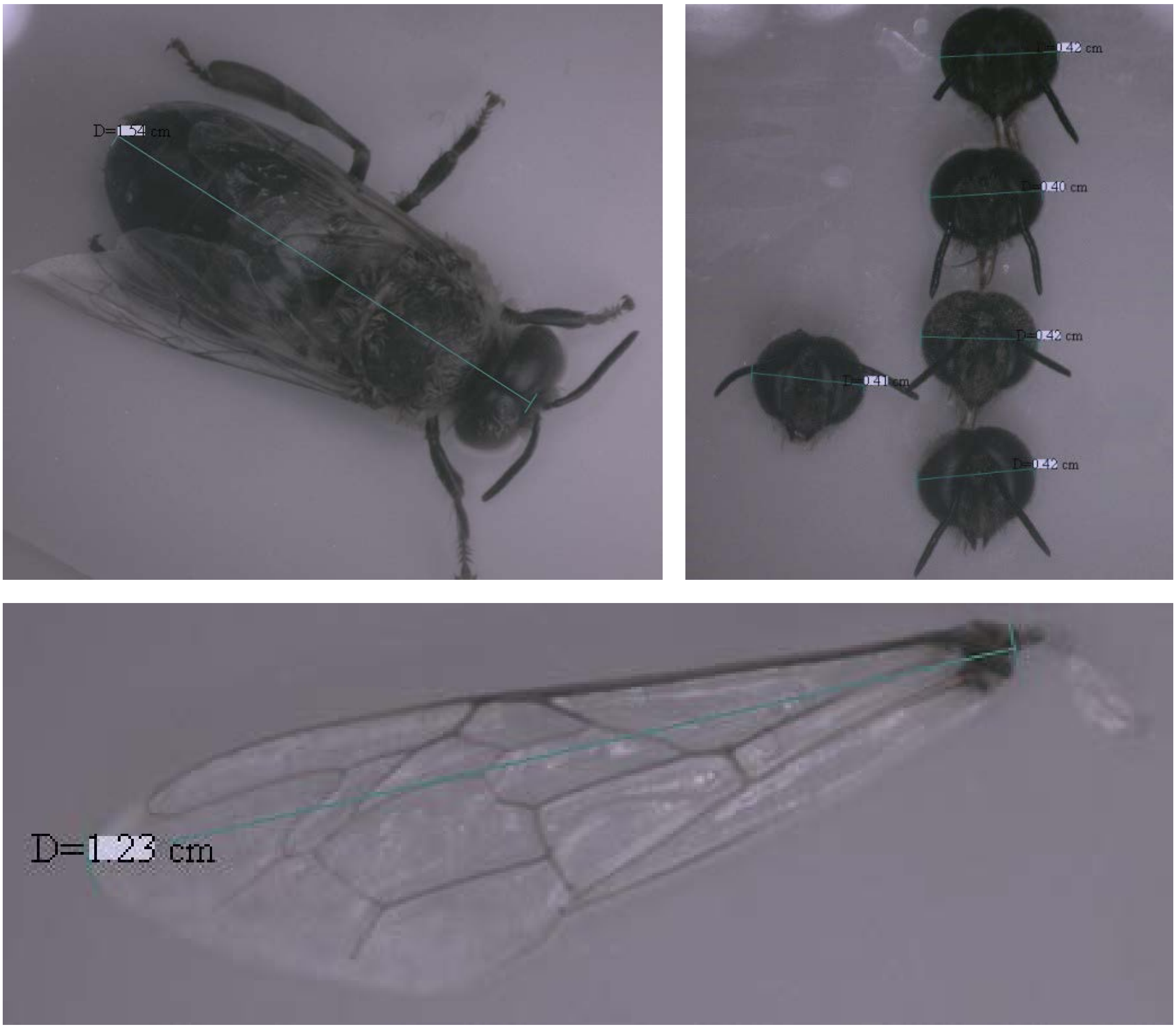

Fig. 2. Examples of body morphological characteristics measurement

The body measurements were obtained using a stereomicroscope (MOTIC, Hong Kong) with an ocular micrometer [3, 6, 14].

The body length, forewing length (FWL) and head length (HCL) were measured using software Optika Vision Pro (OPTIKA SOFTWARE, Italy) (Figure 2).

The measured values of the individual parameters were statistically evaluated using GraphPad Prism 3.0 for analysis of variance (ANOVA), and Tukey's test at a significance level of P = 0.001.

RESULTS AND DISCUSSION

The measurement of body morphological characteristics is done for different reasons, but a major use, is to characterize honeybee races [7, 14], but also to determine the degree of hybridization with foreign races [1, 12]. Moreover, morphological characteristics are measured to investigate the impacts of imported queens on honeybee populations and/or to check populations purity [4, 8]. The obtained results are summarised in Table 2.

Table 2. Body morphological characteristics of drones of different origin

Drone origin	Mean ± SD (cm)		
	Body length	Forewing length	Head length
Unfertilised worker bee	1.44 ± 0.08	1.16 ± 0.05	0.42 ± 0.01
Unmated queen	1.40 ± 0.09	1.16 ± 0.05	0.42 ± 0.01
Mated queen	1.53 ± 0.08	1.24 ± 0.04	0.44 ± 0.02
ANOVA	P < 0.0001	P < 0.0001	P < 0.0001
Tukey test	P value	P value	P value
Unfertilised worker bee vs. unmated queen	P < 0.001	P > 0.05	P > 0.05
Unfertilised worker bee vs. mated queen	P < 0.001	P < 0.001	P < 0.001
Unmated queen vs. mated queen	P < 0.001	P < 0.001	P < 0.001

Mean body length of 1.53 ± 0.08 cm was observed in drones originated from colonies with mated queen, followed by mean body length of 1.44 ± 0.08 cm in drones originated from colonies with unfertilised worker bees. Drones originated from colonies with unmated queen have the mean body length of 1.40 ± 0.09 cm. Using Tukey test, all three groups were statistically significant ($P < 0.001$) (Table 2). The next two morphological characteristics of drones of different origin (forewing length and head length) showed the same picture; drones originated from colonies with unfertilised worker bee, vs unmated queen have the same length of forewing and head, with no statistical significance ($P = 0.001$). But comparing these two groups with drones obtained from colonies with mated queen, we may see differences in length of forewing and head with statistical significance ($P < 0.001$).

Multiple body characteristics, including tongue length, wing length, and width, were used to differentiate between honeybee subspecies [2, 16]. Interestingly, some studies concluded that tongue length was found to be an indicator of geographical variation [6, 15]. Proboscis length was also found to be the most differentiated characteristics between *A. m. carnica*, *A. m. mellifera*, and *A. m. caucasica* [16].

K o l m e s and S a m [5] found that honey production was highly correlated to overall size, wing measurements, and corbicular area in Carniolan honeybees. Moreover, newer study showed that honey production was related to tongue length, forewing length and width, hindwing length, leg length, femur length, tibia length and metatarsus width [9]. The body characteristics may thus, be used for indirect selection of productivity where honeybees: with bigger legs, and wings, have higher power light, and could gather more pollen, and nectar, for brood rearing, and consequently colony population [10].

CONCLUSIONS

Nowadays, various computer-based methods are used in morphological measurements used in apidology and bee research. Ongoing evaluation of morphological characteristics may help in understanding the racial fluctuations due to hybridization, beekeeping practices, and environmental factors. Moreover, there is evidence, that body morphological characteristics are very important, and correlated with colony productive characteristics.

This study revealed body morphological differences among drones originated from different origin. The longest mean body length, forewing length, and head length, was observed in drones originated from colonies with mated queen, thus making them potentially more successful in queen fertilization. But it is apparent that still more work is required to provide insights into the impacts on body morphological differences in the future.

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