

## MORPHOMETRIC TRAITS OF BUCKFAST AND CAUCASIAN BEES

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### S u m m a r y

The aim of the study was to assess and compare morphometric traits in Buckfast bees. The traits were compared with the traits of the Caucasian, which is the foreign bee that has been bred in Poland for the longest time.

The study involved pure-bred Buckfast and Caucasian worker bees. The following traits were measured: the length of the proboscis, venation for determination of the cubital index of the right wing, and the width of tergite III and IV. Additionally, the right hindwing hooks as well as the rows of pollen brush hairs on the right leg of the 3<sup>rd</sup> pair of legs were counted, and the bees were weighed.

The morphometric traits of the Buckfast bee were similar to those of the Italian race described by Ruttner. The Buckfast bee was developed from the Italian breed. The biggest discrepancies in the Caucasian breed standard were observed in the length of the proboscis, whereas the other morphometric traits did not differ from the standard. Maintenance of the purity of the Caucasian breed for approximately 50 years was impossible. It is likely to have crossed with the Carniolan bee, which is indicated *inter alia* by the proboscis length.

**Keywords:** morphometric, honey bees, Buckfast bees, Caucasian bees.

### INTRODUCTION

Most bee subspecies are characterised by specific morphometric traits. There is a considerable range of the trait values within particular subspecies. The trait values may also apply to several subspecies (Gromisz, 1967) and overlap (Ruttner, 1988). The origin of distant subspecies may be determined on the basis of two morphometric traits (Ruttner, 1992). If bee breeds have the same ancestors, a bigger number of morphometric traits are necessary to distinguish them than in the case of more genetically remote subspecies (Ruttner, 1988). Gromisz (1984) claims that morphometric traits may be employed for species, genus and family recognition. Ruttner (1992) postulates that the bee wing hooks are the best indicators for distinguishing between the subspecies.

Not all bee breeds are characterised by definite morphometric traits, since not all breeders aimed at breeding bees with morphometric traits which correspond to the standard (Brother Adam, 1983). Brother Adam focused on breeding bees and assessing them based on their usability and behavioural traits, and on the colour of the abdominal segments (Brother Adam, 1983), rather than on measurable morphometric traits. Ruttner (1988) determined 36 parameters including the shape of the wing, and the size and colour of bee body parts. Assessment of the many morphometric traits is time and labour consuming. For this reason researchers more frequently focus on assessment of the traits of the wings only (Tofilski, 2004; Tofilski and Frączek, 2007; Gerula et al., 2009). A wing can be easily prepared and measured with the use of computer

programmes (Rostecki et al., 2006; Rostecki et al., 2009; Tofilski, 2008). Measurements performed with the use of computer techniques are more reliable than these made in the ocular microscope (Dedej and Nazzi, 1994).

The aim of the study was to assess and compare morphometric traits in Buckfast bees by comparing them with the traits of the Caucasian. The Caucasian is the foreign bee that has been bred in Poland for the longest time.

## MATERIALS AND METHODS

The study involved pure-bred workers of two bee breeds: Buckfast (Bcf), line 133 imported from northern Germany and Caucasian (Cau) provided by the Regional Bee Breeders' Association, Lublin.

The study bees were from pure-bred instrumentally inseminated queens. The study bees were kept in 10 colonies (5 colonies of each breed). From each colony 10 bees were selected, anesthetized with CO<sub>2</sub> and frozen. The proboscis, the right forewing and hindwing, tergite III and IV and the third pair of legs were prepared. The body parts were placed on a double-sided white adhesive tape attached to the basic microscopic slide. The photographs were taken using a digital camera connected to the OLYMPUS SZX 12 microscope. The photographs were analyzed using MultiScanBase software for image analysis. For more accurate measurements, the photographs had to be scaled as they may have been taken at various magnifications. Millimetre paper was attached next to each part of the insect body, which facilitated calibration of the MultiScanBase software. The length of the proboscis and venation determining the cubital index of the right wing, and the width of tergite III and IV were measured. The cubital index was calculated and featured according to Alpatov (1929) and Goetze (1940) notation. Additionally, the right hindwing hooks as well as the rows of pollen brush hairs on the right leg of the 3<sup>rd</sup> pair of legs were counted, all of the bees were weighed.

The results obtained were statistically analysed in the SAS programme (Institute, SAS User's Guide Version 6.11., 1996) with the use of the one-way Anova variance analysis and the RSD (reasonable significant difference) test.

## RESULTS AND DISCUSSION

The cubital index calculated according to Alpatov and Goetze differed between the Buckfast and Caucasian bees with statistical significance (Tab. 1). According to Goetze, the cubital index in Buckfast bees has similar values (2.43 mm) to the Italian bees (2.55 mm) measured by Ruttner (1992). This indicates a relatedness between Buckfast bees and Italian bees, which is confirmed by the fact that the Buckfast bee was created from the Italian races (Brother Adam, 1983). The cubital index of Caucasian bees (2.037 mm, 50%) is similar to that reported by Ruttner (2.16 mm) (1992) and Gromisz (54%) (1978b).

The cubital index value is affected by the length of the wing and its better venation; this may exert an influence on the bees' flight range.

There was a statistically significant difference (at  $p \leq 0.01$ ) in the length of the proboscis between the Buckfast and Caucasian bees. The proboscis length (Tab. 1) in Buckfast bees (6.35 mm) has a similar value to that in Italian bees (6.36 mm) described by Ruttner (1992). The length of the proboscis in the Caucasian bees (6.602 mm) was different from that reported by Ruttner (7.05) (1992) and Gromisz (6.996 mm) (1978b). This may imply that the Caucasian bees may have been crossed with the Carniolan bees breed, in which the proboscis length is 6.4 mm, according to Ruttner (1992). Similar results were obtained by Borsuk et al. (2009), who confirmed the genetic similarity between Caucasian and Carniolan bees using the RAPD-PCR method of genetic differentiation of honeybees bred in Poland.

The bee body size may be defined as the sum of the width of tergite III and IV

Table 1

The cubital index and the length of the proboscis of Buckfast and Caucasian bees

Traits	Breed	$\bar{x}$	SE	Min.	Max.
Cubital Index acc. to Alpatov [%]	<b>Bcf</b>	44.15 <sup>Aa</sup>	0.93	32.98	58.10
	<b>Cau</b>	50.92 <sup>Bb</sup>	0.99	32.60	63.46
Cubital Index acc. to Goetze [mm]	<b>Bcf</b>	2.43 <sup>Bb</sup>	0.04	1.71	2.83
	<b>Cau</b>	2.04 <sup>Aa</sup>	0.05	1.38	3.07
Length of proboscis [mm]	<b>Bcf</b>	6.36 <sup>B</sup>	0.02	5.95	6.77
	<b>Cau</b>	6.60 <sup>A</sup>	0.04	6.04	7.16

$\bar{x}$  - mean, SE – standard error, Min. - minimal value of the trait, Max. - maximal value of the trait, Bcf - Buckfast bees, Cau - Caucasian bees  
A, B - the differences between the study traits are statistically significant at  $p \leq 0.01$   
a, b - the differences between the study traits are statistically significant at  $p \leq 0.05$

Table 2

The width of the III and IV tergites of Buckfast and Caucasian bees

Traits	Breed	Tergite	$\bar{x}$	SE	Min.	Max.
Width of tergite III and IV [mm]	<b>Bcf</b>	III	2.49 <sup>c</sup>	0.02	2.21	2.89
	<b>Bcf</b>	IV	2.29 <sup>b</sup>	0.02	2.05	2.65
	<b>Cau</b>	III	2.31 <sup>b</sup>	0.01	2.04	2.53
	<b>Cau</b>	IV	2.17 <sup>a</sup>	0.01	2.02	2.31
Sum of tergite III and IV [mm]	<b>Bcf</b>	III+IV	4.79 <sup>b</sup>	0.02	4.26	5.45
	<b>Cau</b>	III+IV	4.49 <sup>a</sup>	0.01	4.23	4.76

$\bar{x}$  - mean, SE – standard error, Min. - minimal value of the trait, Max. - maximal value of the trait, Bcf - Buckfast bees, Cau - Caucasian bees  
a, b, c - the differences between the study traits are statistically significant at  $p \leq 0.05$

(Gromisz, 1971, 1979; Ruttner, 1992).

This indicates that the Buckfast bee is big, as the sum of its tergites equals 4.78 mm (Tab. 2). The abdomen size affects: the volume of the honey sac, the bee's ability to carry bigger amounts of nectar and the possibility of a better usage of the load, which is corroborated by the higher honey efficiency of the Buckfast bees (Olszewski et al., 2002; Gerula and Jagiełło, 1998). Buckfast bees are bigger than European dark bees. With the tergite sum reaching 4.59 mm, the European dark bees had been considered to be the biggest honeybees up to date (Ruttner, 1992). This trait in the Caucasian bee has undergone a slight change: Ruttner measured it to be 4.51 mm, whereas now it is 4.49 mm (Tab. 2).

Gromisz measured the width of IV tergite (1979) to be 2.24 mm, whereas now it is 2.31 mm (Tab. 2). This implies that the Caucasian bees may have been crossed with the Carniolan bee (Gromisz, 1978a, 1978c; Borsuk et al., 2009).

The bee body size may be reflected in their body weight, which was similar in both the study bee breeds. Interestingly, the Caucasian bees, regarded as the smallest, and the big Buckfast bees, whose size is confirmed by the sum of tergites (Tab. 2), had similar body weights (Tab. 3). Therefore, bee body weight is evidently not a reliable size measure. The various degrees to which the honey sac is filled with nectar or the hindgut with faeces may falsify bee body weight results significantly.

The bee body size is related to where they

Table 3

Additional morphometric traits of Buckfast and Caucasian bees

Trait	Breed	$\bar{x}$	SE	Min.	Max.
Number of wing hooks [pcs.]	Bcf	20.78	0.22	15.00	24.00
	Cau	20.86	0.15	19.00	23.00
Number of hair rows in the brush on the on the right leg of the 3 <sup>rd</sup> pair of legs [pcs.]	Bcf	10.82 <sup>b</sup>	0.06	9.00	11.00
	Cau	10.06 <sup>a</sup>	0.04	9.00	11.00
Body weight of a single bee [mg]	Bcf	122	0.01	0.11	0.13
	Cau	121	0.01	0.11	0.13

$\bar{x}$  - mean, SE - standard error, Min. - minimal value of the trait,

Max. - maximal value of the trait, Bcf - Buckfast bees, Cau - Caucasian bees

a, b - the differences between the study traits are statistically significant at  $p \leq 0.05$

originated and where they were bred. The severe climate of south-western England probably had an effect on the body size of the Buckfast bees (Brother Adam, 1983). The Buckfast and Caucasian bees did not differ in the number of wing hooks, but there was a statistically significant difference (at  $p \leq 0.05$ ) in the number of the hair rows on the brush on the right leg of the 3<sup>rd</sup> pair of legs (Tab. 3).

The morphometric traits in the Buckfast bee were similar to the traits of the Italian bee described by Ruttner, from which it originated. The most remarkable discrepancies from the breed standard were observed in the length of the proboscis and width of IV tergite in the Caucasian bees. Other morphometric traits did not diverge from the breed standard. Since it was hardly possible to maintain the purity of the Caucasian breed for approximately 50 years, it may have been crossed with the Carniolan bee (Borsuk et al., 2009), which is evidenced by the length of the proboscis.

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## CECHY MORFOMETRYCZNE PSZCZÓŁ BUCKFAST I KAUKASKICH

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### S t r e s z c z e n i e

Celem pracy była ocena cech morfometrycznych rasy pszczoł Buckfast i porównanie ich z cechami pszczoł kaukaskich, obcej rasy najdłużej użytkowanej w Polsce.

Badania przeprowadzono na czystorasowych pszczołach robotnicach Buckfast i kaukaskich. Pszczoły do badań pochodziły od matek sztucznie unasienianych, utrzymywanych w 10 rodzinach (po 5 rodzin dla każdej z ras). Z każdej rodziny pobrano po 10 pszczoł, uśpiono CO<sub>2</sub>, a następnie zamrożono. Z pszczoł preparowano języczek, duże prawe skrzydło, III i IV tergity oraz odnóża trzeciej pary. Fotografie wykonano aparatem cyfrowym sprzężonym z mikroskopem OLYMPUS SZX 12. Zdjęcia przeniesiono do pamięci komputera, który posiadał program do cyfrowej analizy obrazu MultiScanBase. Za jego pomocą zmierzono: długość języczka, żyłki oceniające indeks kubitalny skrzydła prawego, szerokość III i IV tergity. Dodatkowo policzono haczyki na prawym małym skrzydle oraz rzędy włosków w szczoteczce III pary odnóży. Obliczono indeks kubitalny wg Alpatowa i Goetzego oraz zważono pszczoły.

Cechy morfometryczne rasy pszczoł Buckfast zbliżone były do cech pszczoły włoskiej opisanej przez Ruttnera, która stanowiła podstawę do wyhodowania pszczoł Buckfast. Największe rozbieżności, co do wzorca rasy pszczoł kaukaskich stwierdzono w długości języczka i szerokości IV tergity, a pozostałe cechy morfometryczne nie odbiegały od wzorca rasowego. Prawdopodobnie pszczoły kaukaskie zostały skrzyżowane z pszczołą kraińską, wskazuje na to długość języczka.

**Słowa kluczowe:** morfometria, pszczoły miodne, pszczoły Buckfast, pszczoły kaukaskie.