Dataset of wing venation measurements for *Apis mellifera caucasica*, *A. mellifera carnica* and *A. mellifera mellifera* (Hymenoptera: Apidae), their hybrids and backcrosses

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Abstract

Background

Wing venation is used as a tool in honeybee (*Apis mellifera* L., 1758) subspecies identification. The presented dataset concerns nineteen landmarks located at honeybee worker's forewing vein junctions. Landmarks of *Apis mellifera caucasica* Pollmann, 1889, *A. mellifera carnica* Pollmann, 1879 and *A. mellifera mellifera* Linnaeus, 1758, their hybrids and backcrosses were measured. In total, data from 9590 wings were collected. The dataset could be used in geometric morphometric analysis, studies of degree of inheritance of morphological features and, after further development and supplementation with other local subspecies and hybrids, can contribute to in-depth evolutionary research on honeybees.

New information

Baseline dataset for wing venation of hybrids and backcrosses of *A. mellifera carnica, A. mellifera caucasica* and *A. mellifera mellifera*.

Keywords

morphometric analysis, geometric morphometry, honeybee, subspecies

Introduction

Wing venation is commonly analysed as an important characteristic of insect species (e.g. Owen 2012, Perrard et al. 2014, Rossa et al. 2016, Breitkreuz et al. 2017, Loh et al. 2017, Jacquelin et al. 2018). In honeybees (*Apis mellifera*), the measurement of wing venation is used for subspecies determination (Tofilski 2008, Gerula et al. 2009, Tofilski 2010, Francoy et al. 2012, Santana et al. 2014, da Silva et al. 2015, Węgrzynowicz et al. 2019Gerula et al. 2009, Santana et al. 2014, Tofilski 2008, Węgrzynowicz et al. 2019). Due to a significant correlation between morphometric and molecular methods, the measurements and analysis of wing veins are a cost-effective and reliable identification measure (Miguel et al. 2011, Oleksa and Tofilski 2015, Henriques et al. 2020Oleksa and Tofilski 2015). Geometric morphometrics, based upon nineteen landmarks located at honeybee worker's forewing vein junctions, has been used in Poland since 2008 as a tool for assessing subspecies identity (Tofilski 2008, Gerula et al. 2009). Creating databases that not only include representatives of various subspecies, but also data from hybrids and backcrosses, seems to be particularly valuable. This Data Paper provides raw metadata freely available for further exploration, which can be correlated, for example, with the reference samples for the subspecies from the Morphometric Bee Data Bank in Oberursel, Germany. It may also be used to assess inheritance of morphological features.

Sampling methods

Sampling description: The original colonies of subspecies came from long-term breeding. *Apis mellifera carnica* and *A. mellifera caucasica* come from colonies maintained within a selection carried out by the Research Institute of Horticulture. *A. mellifera mellifera* was supplied from a conservation breeding programme supervised by the National Animal Husbandry Center (https://www.kchz.agro.pl/wykaz-ksiegi-1_03_2019_1/). These subspecies are commonly maintained in Poland. Methodology described by Węgrzynowicz et al. (2019) was used in order to obtain the parental generation of bees from *A. mellifera carnica, A. mellifera caucasica* and *A. mellifera mellifera* subspecies, their hybrids and backcrosses. Two hundred queens with 24 different genotypes have been obtained, representing all possible hybrid and backcrosses combinations of *Apis mellifera carnica*, *A. mellifera caucasica* and *A. mellifera mellifera* subspecies. To conduct morphometric analyses, worker bee samples were taken shortly after emergence directly from incubated combs. Bees were stored in plastic containers filled with 96% ethyl alcohol at room temperature for 4 to 5 months. After this period, each worker bee had its right wing removed. The wings were mounted in a glass photographic frame and scanned with a Nicon Coolscan 500 ED scanner (image resolution 2400 dpi, greyscale). Wing images were analysed with DrawWing software (freely available at: http://drawwing.org/node/2) to determine the coordinates of nineteen landmark features (Suppl. material 1). The dataset (Suppl. material 2, Suppl. material 3) contains parameter measurements for individually analysed honeybee wings.

Geographic coverage

Description: The Institute of Horticulture, Apiculture Division in Puławy, Poland. Altitude above sea level: 137 m.

Coordinates: 51.246 Latitude; 21.581 Longitude.

Taxonomic coverage

Description: Wing venation is a suite of characteristics that allows the identification of subspecies. Locally-sustained bees of *A. m. caucasica*, *A. m. carnica* and *A. m. mellifera* with stabilised wing parameters were used to create hybrid and backcrossed workers and all were included in our baseline dataset.

Temporal coverage

Data range: 2013-5-20 - 2015-9-15.

Notes: Beekeeping seasons in Poland.

Usage licence

Usage licence: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: Dataset of wing venation measurements

Number of data sets: 2

Data set name: Wing_venation_dataset

Column label	Column description
No.	serial number
Queen/Colony ID	Queen/Colony ID
Maternal origin ID	Maternal origin ID
Fatherly origin ID	Paternalorigin ID

GENOTYPE	GENOTYPE - short name which is described in the "Genotype_description" set
WINGS ID	WINGS ID - individual ID given to each sample from a combination of: "No.", "Queen/Colony ID", "Maternal origin ID", "Fatherly origin ID", "GENOTYPE"
x0, y0 - x18, y18	Parameter coordinates (in separate columns)

Data set name: Genotype_description

Column label	Column description
GENOTYPE	GENOTYPE
Number of measured wings	Number of measured wings
Colonies amount	Colonies amount
Abbreviation description	Abbreviation description [P0, P1 - parental generations, F1 - hybrid generation, BC - backcrosses generation; lowercase letters represent the subspecies: first letter: parental-queen, second letter: paternal-drone (m - *A. m. mellifera*, k - *A. m. carnica*, c - *A. m. caucasica*)]

Acknowledgements

Author contributions

PW designed and implemented a research project that enabled data collection, conducted measurements, prepared the dataset and supervised writing of the manuscript. AŁ conceived the research, prepared the dataset for publication and helped write the manuscript. Both authors agree with the final version of the manuscript and declare no conflict of interest.

References

• Breitkreuz LV, Winterton S, Engel M (2017) Wing tracheation in Chrysopidae and other Neuropterida (Insecta): A resolution of the confusion about vein fusion. American Museum Novitates 3890 (3890): 1-44. https://doi.org/10.1206/3890.1

- da Silva FL, Grassi Sella ML, Francoy TM, Costa AHR (2015) Evaluating classification and feature selection techniques for honeybee subspecies identification using wing images. Computers and Electronics in Agriculture 114: 68-77. https://doi.org/10.1016/j.compag.2015.03.012
- Francoy TM, Gonçalves LS, De Jong D (2012) Rapid morphological changes in populations of hybrids between Africanized and European honey bees. Genetics and Molecular Research 11 (3): 3349-3356. https://doi.org/10.4238/2012.september.17.5
- Gerula D, Tofilski A, Węgrzynowicz P, Skowronek W (2009) Computer-assisted discrimination of honeybee subspecies used for breeding in Poland. Journal of Apicultural Science 52 (2): 105-114.
- Henriques D, Chávez-Galarza J, Teixeira JSG, Ferreira H, Neves CJ, Francoy T, Pinto MA (2020) Wing geometric morphometrics of workers and drones and ingle nucleotide polymorphisms provide similar genetic structure in the Iberian honey bee (*Apis mellifera iberiensis*). Insects 11 (2). https://doi.org/10.3390/insects11020089
- Jacquelin L, Desutter-Grandcolas L, Chintauan-Marquier I, Boistel R, Zheng D, Prokop J, Nel A (2018) New insights on basivenal sclerites using 3D tools and homology of wing veins in Odonatoptera (Insecta). Scientific Reports 8 (1). https://doi.org/10.1038/s41598-017-18615-0
- Loh SYM, Ogawa Y, Kawana S, Tamura K, Lee HK (2017) Semi-automated quantitative *Drosophila* wings measurements. BMC Bioinformatics 18 (1). https://doi.org/10.1186/s12859-017-1720-y
- Miguel I, Baylac M, Iriondo M, Manzano C, Garnery L, Estonba A (2011) Both geometric morphometric and microsatellite data consistently support the differentiation of the *Apis mellifera* M evolutionary branch. Apidologie 42 (2): 150-161. https://doi.org/10.1051/apido/2010048
- Oleksa A, Tofilski A (2015) Wing geometric morphometrics and microsatellite analysis provide similar discrimination of honey bee subspecies. Apidiologie 46 (1): 49-60. https://doi.org/10.1007/s13592-014-0300-7
- Owen ER (2012) Applications of morphometrics to the Hymenoptera, particularly bumble bees (Bombus, Apidae). Morphometrics https://doi.org/10.5772/34745
- Perrard A, Baylac M, Carpenter JM, Villemant C (2014) Evolution of wing shape in hornets: why is the wing venation efficient for species identification? Journal of Evolutionary Biology 27 (12): 2665-2675. https://doi.org/10.1111/jeb.12523
- Rossa R, Goczał J, Tofilski A (2016) Within- and between-species variation of wing venation in genus *Monochamus* (Coleoptera: Cerambycidae). Journal of Insect Science 16 (1). https://doi.org/10.1093/jisesa/iev153
- Santana F, Costa AR, Truzzi F, Silva F, Santos S, Francoy T, Saraiva A (2014) A reference process for automating bee species identification based on wing images and digital image processing. Ecological Informatics 24: 248-260. https://doi.org/10.1016/j.ecoinf.2013.12.001
- Tofilski A (2008) Using geometric morphometrics and standard morphometry to discriminate three honeybee subspecies. Apidologie 39 (5): 558-563. https://doi.org/10.1051/apido:2008037
- Tofilski A (2010) Automatic measurement of honeybee wings. Systematics Association Special Volumes277-288. https://doi.org/10.1201/9781420008074.ch17

- Węgrzynowicz P, Gerula D, Tofilski A, Panasiuk B, Bieńkowska M (2019) Maternal inheritance in hybrids of three honey bee subspecies. Journal of Apicultural Science 63 (1): 131-138. https://doi.org/10.2478/jas-2019-0010

Supplementary materials

Suppl. material 1: Image of the x and y coordinates obtained with the DrawWing sofware for 19 vein connections on the right wing of worker honey bee

Authors: Paweł Węgrzynowicz
Data type: Image
Download file (2.32 MB)

Suppl. material 2: Dataset of wing venation measurements - abbreviations descriptions

Authors: Paweł Węgrzynowicz
Data type: txt
Brief description: Descriptions of the abbreviated names of the genotypes used in the dataset of wing venation measurements.
Download file (3.07 kb)

Suppl. material 3: Dataset of wing venation measurements

Authors: Paweł Węgrzynowicz
Data type: txt
Brief description: The database contains the x and y coordinates obtained with DrawWing sofware for 19 vein junctions on the right wing of worker honeybees (38 coordinates for each wing). The analysed wings originate from offspring of 200 queens with 24 different genotypes representing all possible hybrid and backcrosses combinations of *Apis mellifera carnica*, *A. mellifera caucasica* and *A. mellifera mellifera* subspecies. Results from a total of 9590 wings are presented in the dataset.
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