

## METHODS OF CLASSIFICATION OF HONEYBEE RACES USING WING CHARACTERS - A REVIEW

Dorothea Kauhausen, Roland Keller

Erdmannstr. 14, D-16540 Hohen Neuendorf, Germany.

Morphometric analysis for classification of races and breeding lines of the honey bee, *Apis mellifera*, is still in use today, as has been for the past 40 years. Even with the advent of genetic analysis on a molecular level, an inexpensive and easy-to-use

method is needed to supply wide spread information for the bee breeders. Most importantly, it must be a method that a beekeeper can use without special training or expensive equipment.

Over 40 years ago, the imported carnica race needed to be differentiated from the predominant mellifera race in Germany. For this purpose the cubital index (Fig. 1) was good for discrimination, and is still in use today. For other races like ligustica, caucasica and the breeding line Buckfast this method failed.

Kruber (1994) suggested to expand this method of the cubital index, to allow a more precise selection of pure breed carnica from hybrids. Further wing characters, formerly established by Goetze (1964), were added - the "Hantelindex" and the "Discoidal-

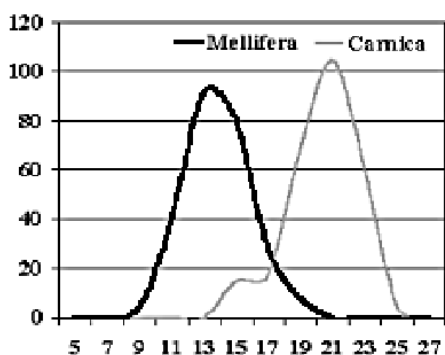


Fig. 1 Frequency distribution of cubital index for *A. m. carnica* and *A. m. mellifera*

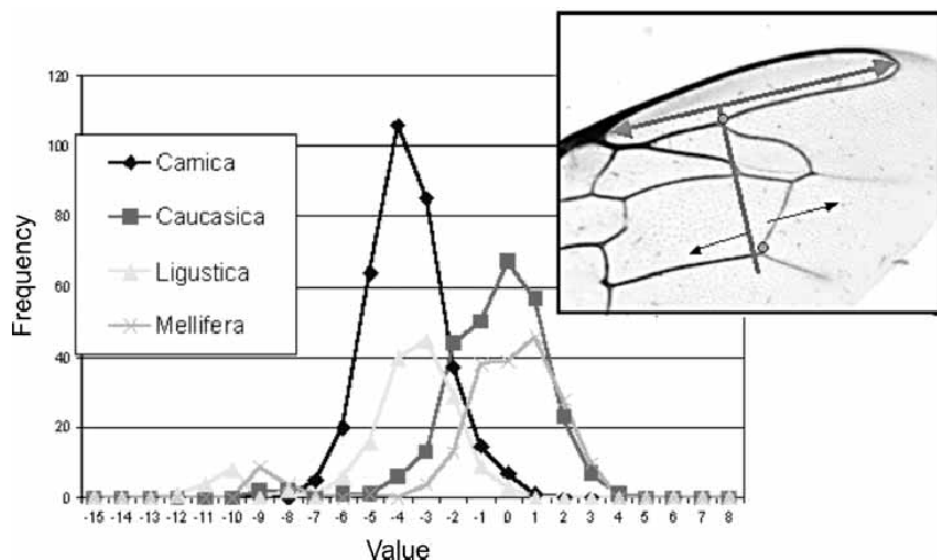


Fig. 2 Distribution of Discoidal displacement for different races

Korrelation Hantelindex: Discoidalverschiebung

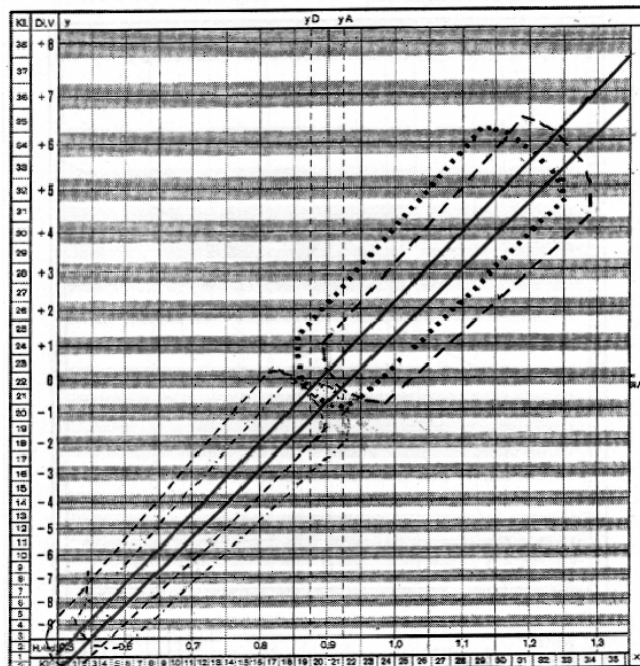


Abb. 17. Referenzlinien und Vertrauensbereiche (Rassenabgrenzungen)

Fig. 3 Reference lines and confidence intervals for discrimination of races (Kruher 1994)

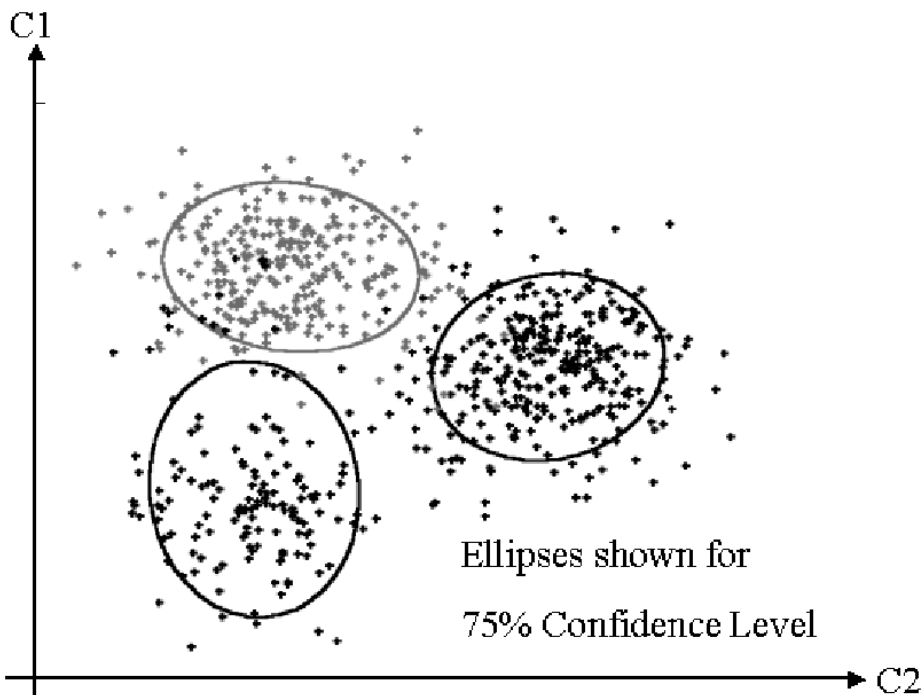


Fig. 4 Discriminant analysis showing C1 and C2 as canonical coordinates and 3 sample groups

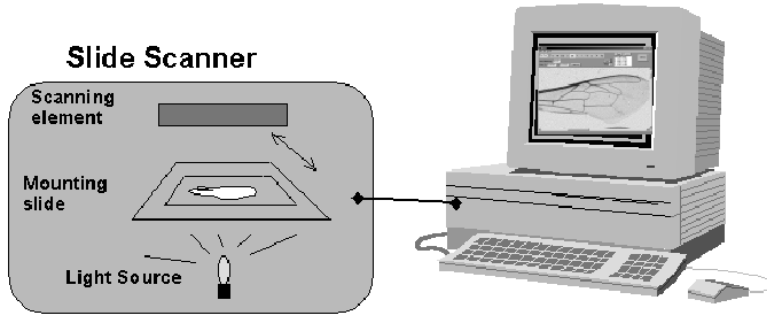


Fig. 5 Slide scanner with PC

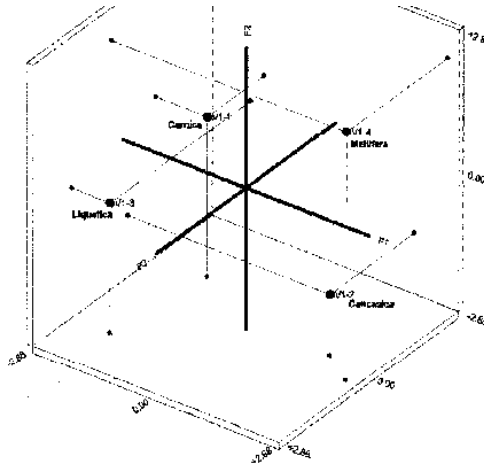


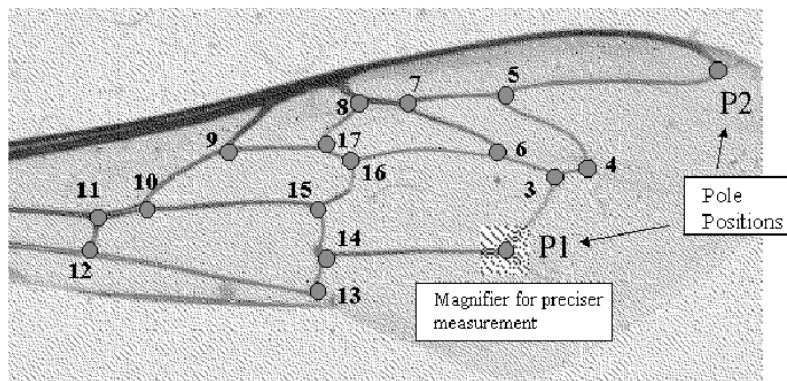
Fig. 6 Position of group centroids using only wing characters (introduced by DuPraw 1964)

verschiebung" (Fig. 2). The results of these two characters represented in a diagram, would allow better differentiation between carnica and mellifera, and their hybrids (Fig. 3). With other races, like *A. m. ligustica* or *A. m. caucasica*, however, a differentiation is still not better than with the cubital index.

A major step forward was undertaken by Prof. F. Ruttner (1988), who used 15 wing characters, 13 size characters, length of cover hair and 2 characters of the tomentum as well as 5 characters of pigmentation. These 36 different characters were used in a statistical method called "discriminant analysis" which reduces the many characters to a few "best canonical factors" from which two or three dimensional distribution plots could be made. A priori predictions were made by choosing

certain confidence levels expressed in distance from the group centroid (Fig. 4). Using this method, it was possible for Ruttner to classify among twenty four different subspecies of *Apis mellifera*. The preparation and measurement of samples was quite tedious - nearly a whole week was required for one single sample of twenty working bees from a colony.

In the following years, various development in using digitizers linked with a computer for faster data taking went under way. Video cameras soon took the place of digitizing tablets, and finally slide scanners (Fig. 5), which did not need optical lenses. Since measurements of wing characters were the most precise, with a high repeatability, focus was set on these, and the other body characters were neglected.



**Fig. 7** Location of geographic coordinates on the forewing

Using only the wing characters, introduced by DuPraw (1964), gives a fairly good discrimination between *mellifera*, *carnica*, *ligustica* and *caucasica*, to take a few of the common Central European subspecies (Fig. 6). DuPraw took the position of 18 vein intersections on the forewing, drew a standard wing diagram and measured 13 angles and two size characters.

An attempt was made by Kauhausen-Keller and Keller (1994) to improve this discrimination by adding characters of the associated hind wing - with success. However, the hind wing is quite difficult to handle, and to mount on a slide.

A latest and simplest method of using wing characters was to discard the measuring and calculating of wing characters like DuPraw, and using pure geographic coordinates of the centres of the vein intersections on the forewing (Fig. 6). Also the scanning and digitizing techniques were improved to such a degree that easy handling and precise

measurements were possible. The small hind wing can be neglected. Sufficient discrimination can be achieved among the mentioned subspecies (Fig. 7). Using this method, the determination of racial purity is as simple to handle as when determining the cubital index.

## CONCLUSIONS

Wing characters have proven to be the most reliable in measurement, and easiest to handle. During mounting, the wing does not change in size or structure, as it is with other body parts. Also, the geographic coordinates seem to exhibit a wide variability, correlated with different races. Hence, for the determination of race or racial purity (or degree of hybridization), this method proves to be a quick and reliable technique which can also be used by bee breeders.

**Keywords:** morphological characters, wing, discriminant analysis, honeybee races.

## REFERENCES

- DuPraw E.J. (1964) - Non Linnean taxonomy. *Nature* 202 (4935):849-852.
- Goetze G. (1964) - Die Honigbiene in natürlicher und künstlicher Zuchtauslese. *Paul Parey*, Hamburg.
- Kauhausen-Keller D., Keller R. (1994) - Morphometrical control of pure race breeding in the honey bee (*Apis mellifera* L.). *Apidologie*, 25, 133-143.
- Kruber W. (1994) - Hantelindex und Diskoidalverschiebung. *Die biene*, 1:8-18, 2:62-77, 3:125-135.

Ruttner F. (1988) - Biogeography and Taxonomy of Honeybees. *Springer*, Berlin.

## METODY OCENY PRZYNALEŻNOŚCI RASOWEJ PSZCZÓŁ ZA POMOCĄ CECH MORFOLOGICZNYCH SKRZYDEŁ - PRZEGLĄD

**Kauhausen D., Keller R.**

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

Pomiar cech morfologicznych pszczoł do oceny ich przynależności rasowej prowadzony jest od ponad 40 lat. Rasą dominującą w Niemczech jest pszczoła kraińska. Od pszczoły środkowoeuropejskiej łatwo ją odróżnić wartością indeksu kubitalnego (rys. 1), trudniej od innych ras (włoska, kaukaska). Do przeprowadzenia pełnej analizy morfologicznej wykonywano dotychczas pomiar 36 różnych cech, jest to jednak bardzo pracochłonne. Okazało się, że do dobrego odróżnienia wystarczy pomiar 18 cech na skrzydle pszczoły. Wykonanie tych pomiarów na ekranie komputera i poddanie ich analizie dyskryminacji przy użyciu specjalnego programu komputerowego pozwala na stosunkowo szybkie i łatwe odróżnienie ras i linii pszczoł.

**Słowa kluczowe:** cechy morfologiczne, skrzydło, analiza dyskryminacji, rasy pszczoł.