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GENETIC VARIABILITY IN GREEK HONEY BEE (*A. mellifera* L.) POPULATIONS USING GEOMETRIC MORPHOMETRICS ANALYSIS

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ABSTRACT. The genetic variability of 37 honey bee populations of Greece was studied, using geometric morphometrics analysis, on a sample of 798 honey bees collected from 105 different apiaries. The geometric morphometrics analysis was based on coordinates of 19 landmarks located at vein intersections of the left wing.
Statistical analysis of measurements, using MS Excel and Matlab packages, showed high hybridization between the Greek honey bee populations, probably due to beekeeping manipulations (migratory beekeeping and commercial breeding), represented with the standarized wings' shapes and revealed from the centroid size of the wings' shapes appearance. This estimation is confirmed in the UPGMC dendrogram, where all populations are mixed with the exception of Ikaria and Antikythira populations. Minor inter-population variability was detected only in Karpathos, Kos, Ikaria, Antikythira and Astypalaia islands populations. Samples from Crete island appear to be of a mixed origin, a result that it is in coincidence with a previous study based on mtDNA analysis (Harizanis and Bouga, 2003). Our results are in disagreement with Ruttner's (1988) morphometrics analysis and partly in disagreement with a preliminary study of ours (Hatjina *et al*., 2002), where we found that the populations from Rodos, Astypalaia and Ikaria were clearly differentiated from the rest ones and formed a distant group.
Geometric morphometrics analysis can be very powerful in exploring intra-specific variation at the population level and it is largely employed in evolutionary studies concerning honey bees in Greece, combined with other approaches such as classical morphometrics and molecular markers.

KEY WORDS. Greece, honey bee, geometric morphometrics, wing, landmarks

INTRODUCTION

The genetic variability of 37 honey bee populations from Greece was studied, using geometric morphometrics analysis.

The geometric morphometrics analysis is a collection of approaches for the multivariate statistical analysis of Cartesian coordinate data, usually limited to landmark point locations (Bookstein, 1991), being, a powerful tool in evolutionary studies to explore intraspecific variation at the population level. According to Ruttner (1988) morphometrics analysis, four distinct honey bee races should exist in Greece: *A.m.macedonica* in Macedonia and Thrace regions, *A.m.cecropia* in Thessalia, Peloponnese and Kyklades islands, and *A.m.adami* in Crete. Bees of Ionian islands were assigned to *A.m.carnica* race.

The aim of our study was to investigate the existence of variability in honey bee populations from Greece using geometric morphometrics analysis.

METHODOLOGY

A sample of 798 honey bees was collected from different apiaries of 37 large areas of Greece. A geometric morphometrics analysis was contacted, based on coordinates of 19 landmarks located at vein intersections of the left wing (Fig. 1). Data was processed, using MS Excel and Matlab program packages.

RESULTS

- Statistical analysis of measurements has shown high hybridization between the Greek honey bee populations, as it is revealed from the centroid size of the wings' shapes appearance represented (Fig. 2) and represented with the standarized wings' shapes (Fig. 3).
- Minor inter-population variability was detected only in Karpathos, Kos, Ikaria, Antikythira and Astypalaia populations.
- The topology of the dendrogram confirms the above mentioned results (Fig. 4).

CONCLUSIONS

- The present study clearly shows that extended hybridization has taken place in honey bee populations from Greece, probably due to beekeeping manipulations (migratory beekeeping and commercial breeding).
- These results are confirmed in the UPGMC dendrogram where all populations are mixed with the exception of Ikaria and Antikythira islands.
- Our current study results are partly in disagreement with a preliminary study of ours concerning populations of the mainland and Aegean islands (Hatjina *et al.*, 2002) where we detected a 'Macedonia like group' in the mainland and part of

Crete while the populations from Rodos, Astypalaia and Ikaria (Aegean islands) were clearly differentiated from the rest ones and formed a distant group.

- Samples from Crete island (*A.m.adami*) appear to be of a mixed origin, a result that it is in coincidence with a previous study based on mtDNA analysis (Harizanis and Bouga, 2003).
- It is interesting to note that an 'average' pattern is, at first, revealed for the honey bee populations from Greece.

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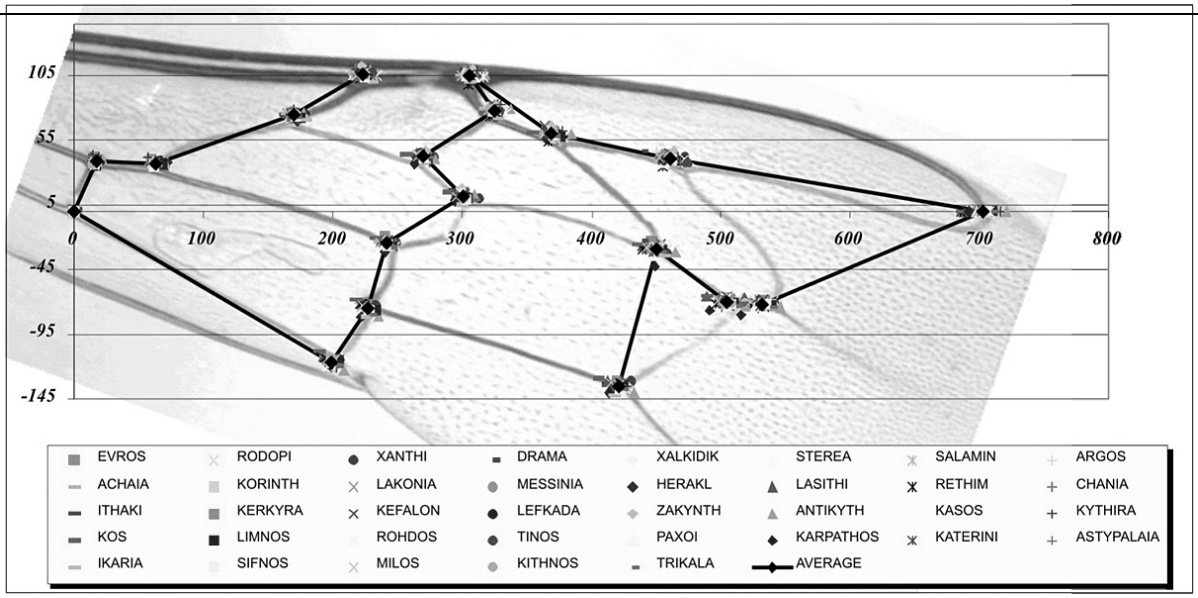

Fig. 1. *Picture of the wing with the average measurements of the 19 landmarks of honey bee populations after Least Square Procrustes Superimposition method.*

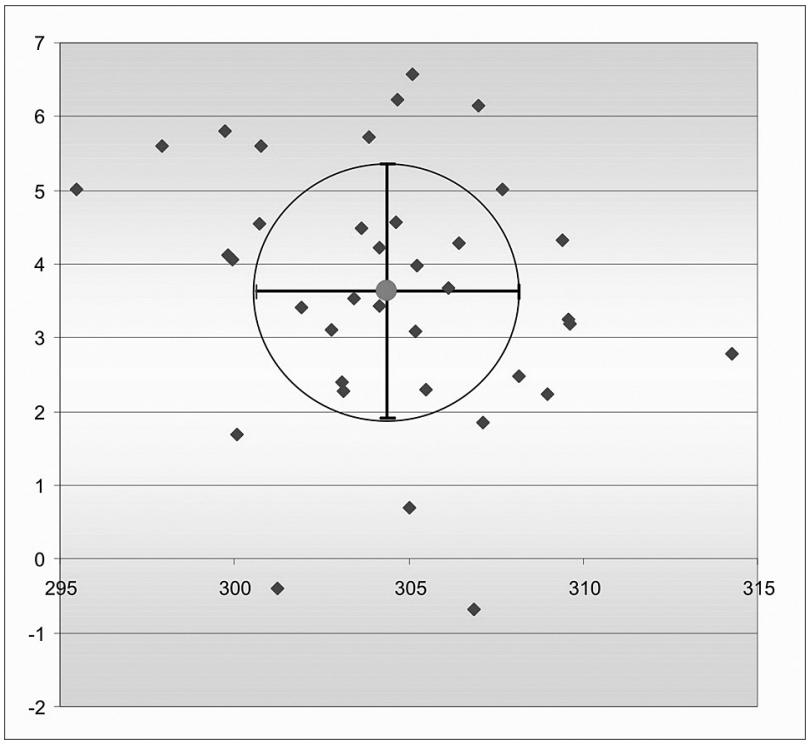

Fig. 2. *X-Y scatter of the 37 populations' centroid size*

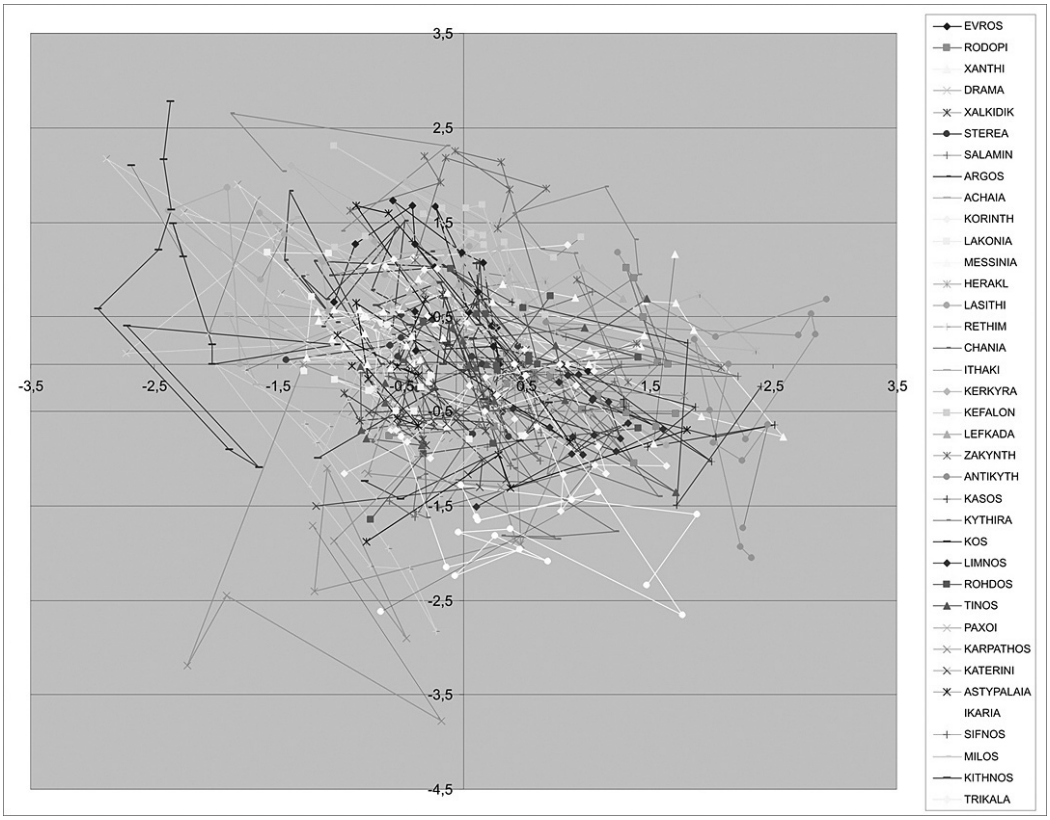

Fig. 3. *Representation of standarized wings' shapes*

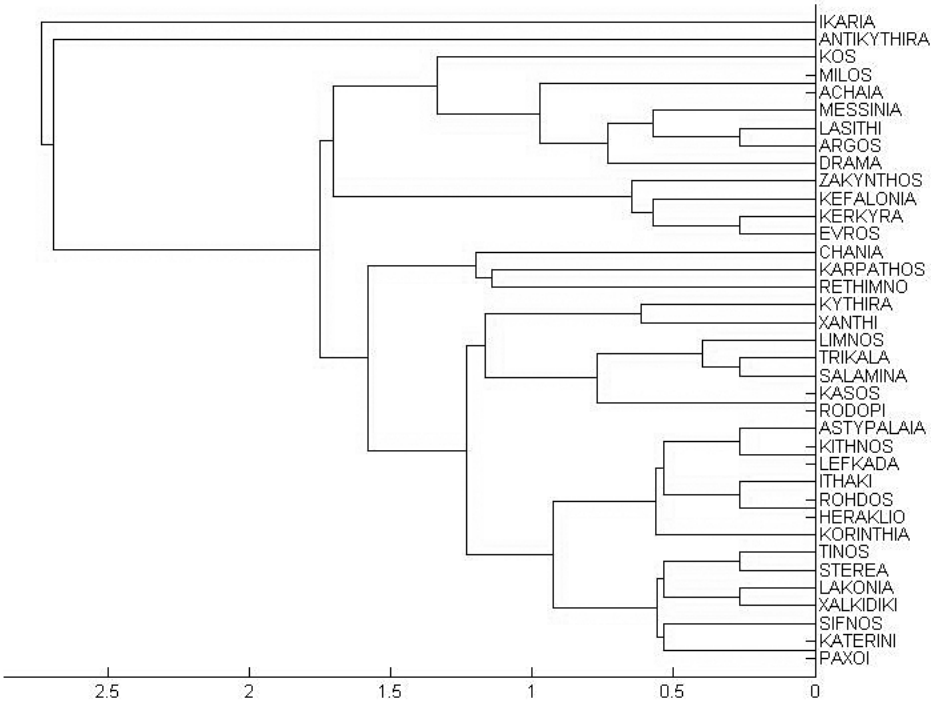

Fig. 4. *Phylogenetic tree according UPGMC (Un-weighed Pair Group Method Centroid) method based on standarized Eucledean distance*