

Rearing of *Hippodamia variegata* in laboratory changed its shape and size: a geometric morphometric study

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Introduction

Hippodamia variegata (Goeze, 1777) (Col.: Coccinellidae) is a dominant species in Iran with a highly distribution in all around of the country so that it exists in all provinces. *H. variegata* is so sensitive to changes of the environment that different geographical regions could affect its shape and size. Changing shape and size of *H. variegata*, as one of the most important biocontrol species which is reared in laboratories of many countries, could affect its biology and subsequently results of scientific studies and also biological control.

Material and Methods

A geometric morphometric study was carried out based on 9 landmarks and 14 morphometric variables in hind right wing (Figure 1 & Figure 2) among four Iranian populations, males and females: LFH: laboratory females of Hamadan, FFH: farm females of Hamadan, LMH: laboratory males of Hamadan, FMH: farm males of Hamadan, LFK: laboratory females of Karaj, FFK: farm females of Karaj, LMK: laboratory males of Karaj, FMK: farm males of Karaj. For gaining landmarks and morphometric data we used softwares Dinolite 2, Digimizer 4.1.1.0, tpsDig2 v2.16, tpsUtil 1.52, tpsRelw v1.49, tpsRegr v1.381. Also all of statistical analysis were executed by softwares SPSS 19 and PAST v2.17c

Results and Discussion

PCO and three-way MANOVA based on shape variables demonstrated sexual dimorphism and shape difference between farm and laboratory populations (Figure 3). PCA detached all populations to four groups including FMK-LMH, FFK-LMK-LFH-LFK, FMH and FFH (Figure 4). Three-way MANOVA based on morphometric variables showed existence of significant difference in geographical populations, between laboratory and field populations, and combined effect of lab-geographical populations. Three-way ANOVA based on all morphometric variables and centroid size of landmarks and Tukey test indicated FFH and FMK were larger than the others (Figure 5). Our results indicated that rearing in laboratory affected shape of *Hippodamia* wing and made it smaller. This must be considered in biological control and scientific studies

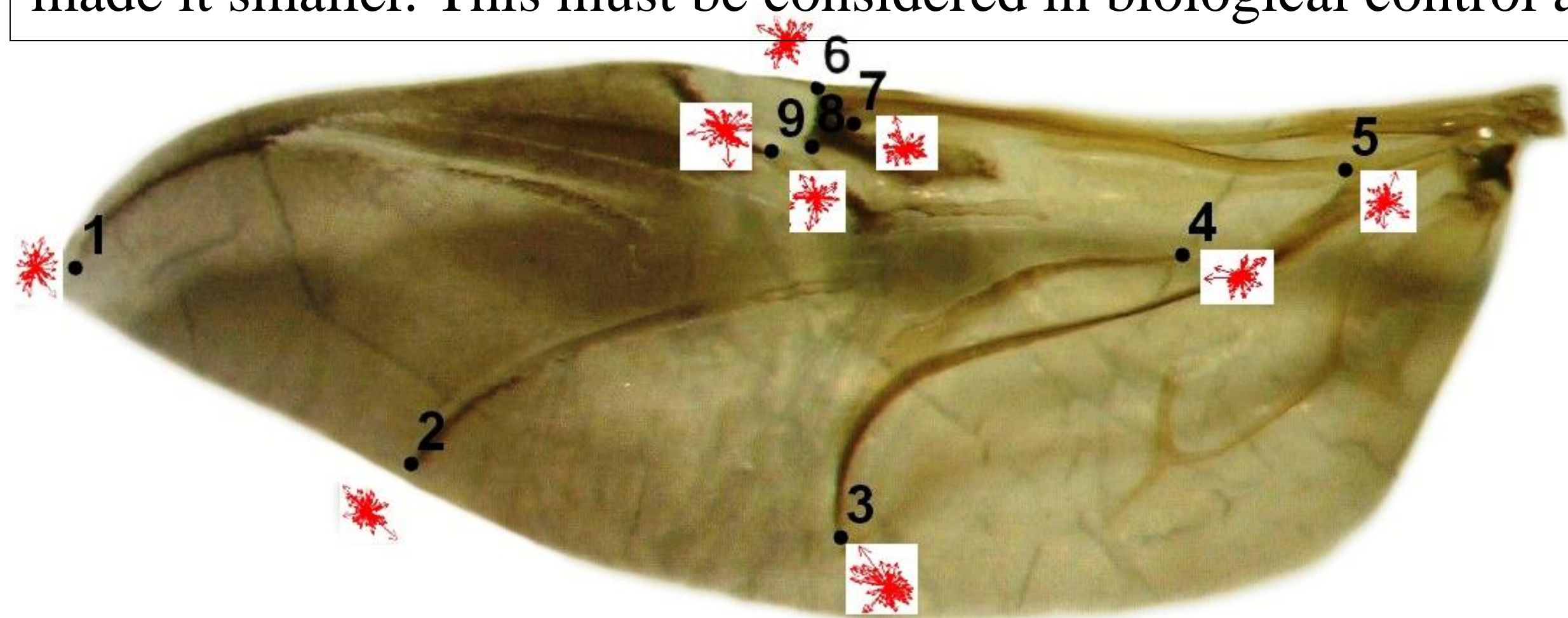


Figure 1. Distribution of 9 landmarks in hind wing of *H. variegata*

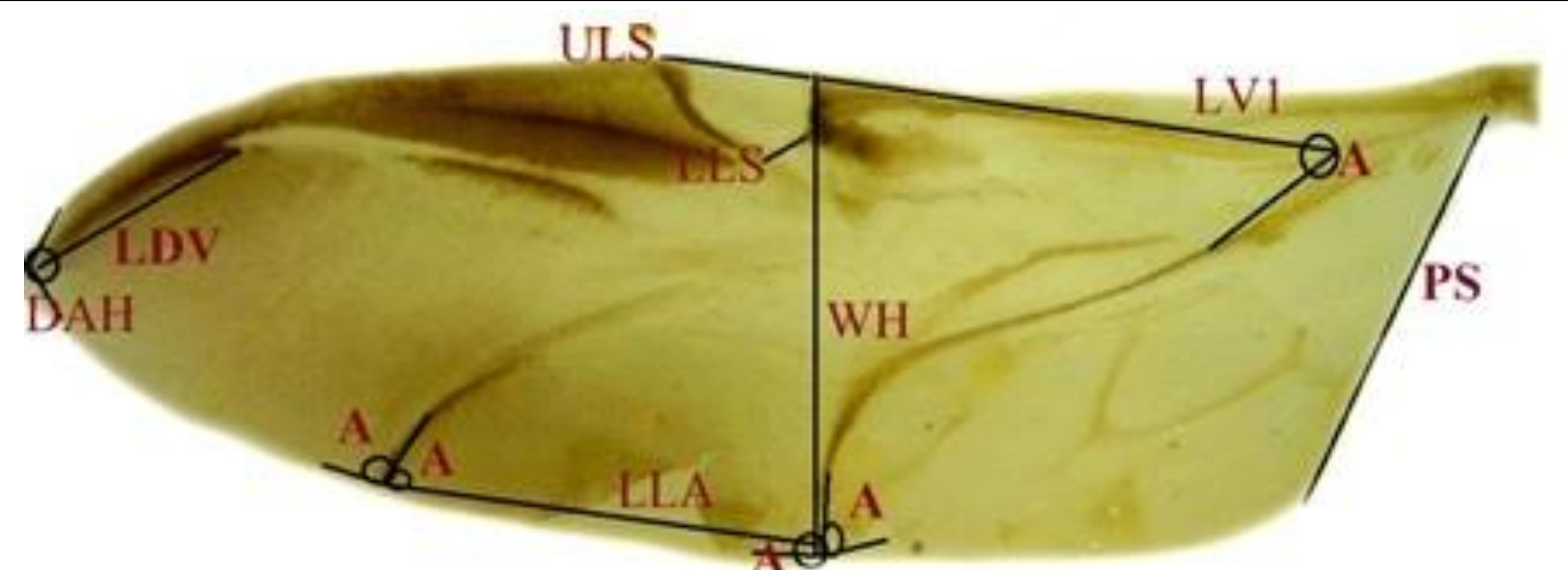


Figure 2. morphometric traits in hind wing of *H. variegata*; A: angle; LVI: length of the first vein; ULS: upper length of spot; LLS: lower length of spot; WH: width of hind wing; LDV: length of distal vein; DAH: distal angle of hind wing; PS: posterior slope of wing; LLA: lower length of arc

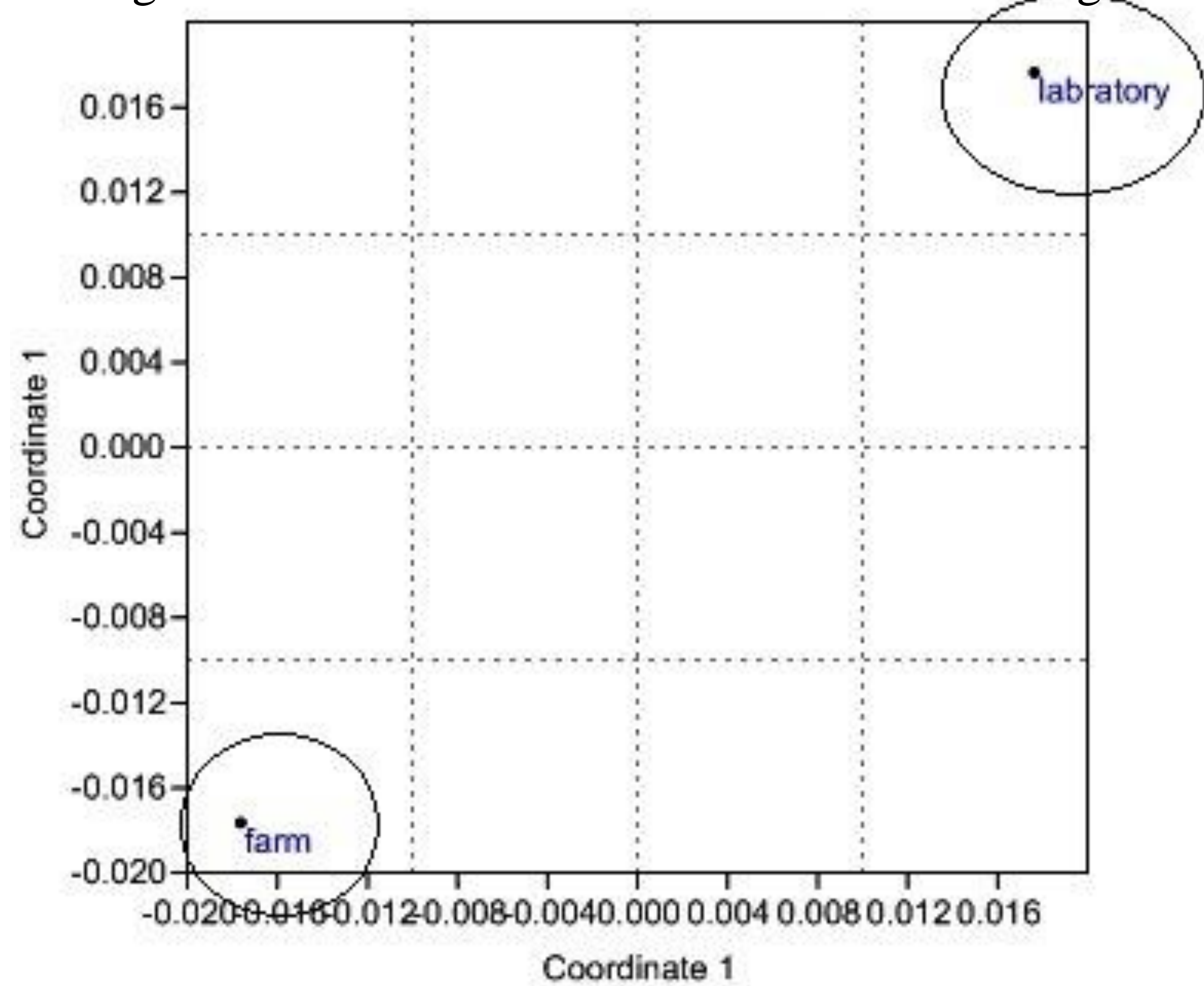


Figure 3. PCO based on weight matrices of Partial warps between laboratory and farm populations of *H. variegata*

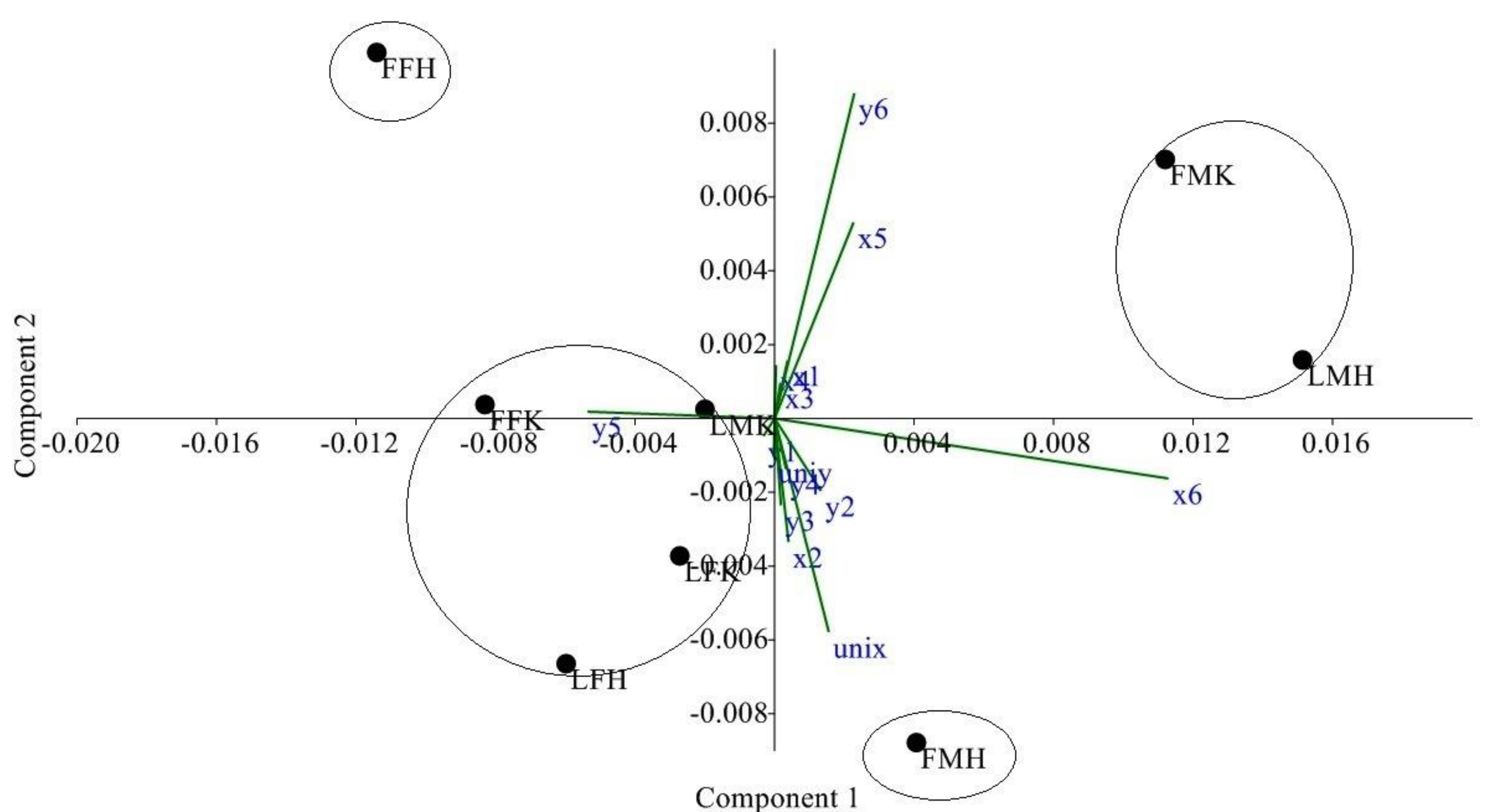


Figure 4. Distribution of the populations of *H. variegata* on PC1 and PC2 axes and the most important variables in creating shape variations, x: uniform variable; unix and uniy: non-uniform variable

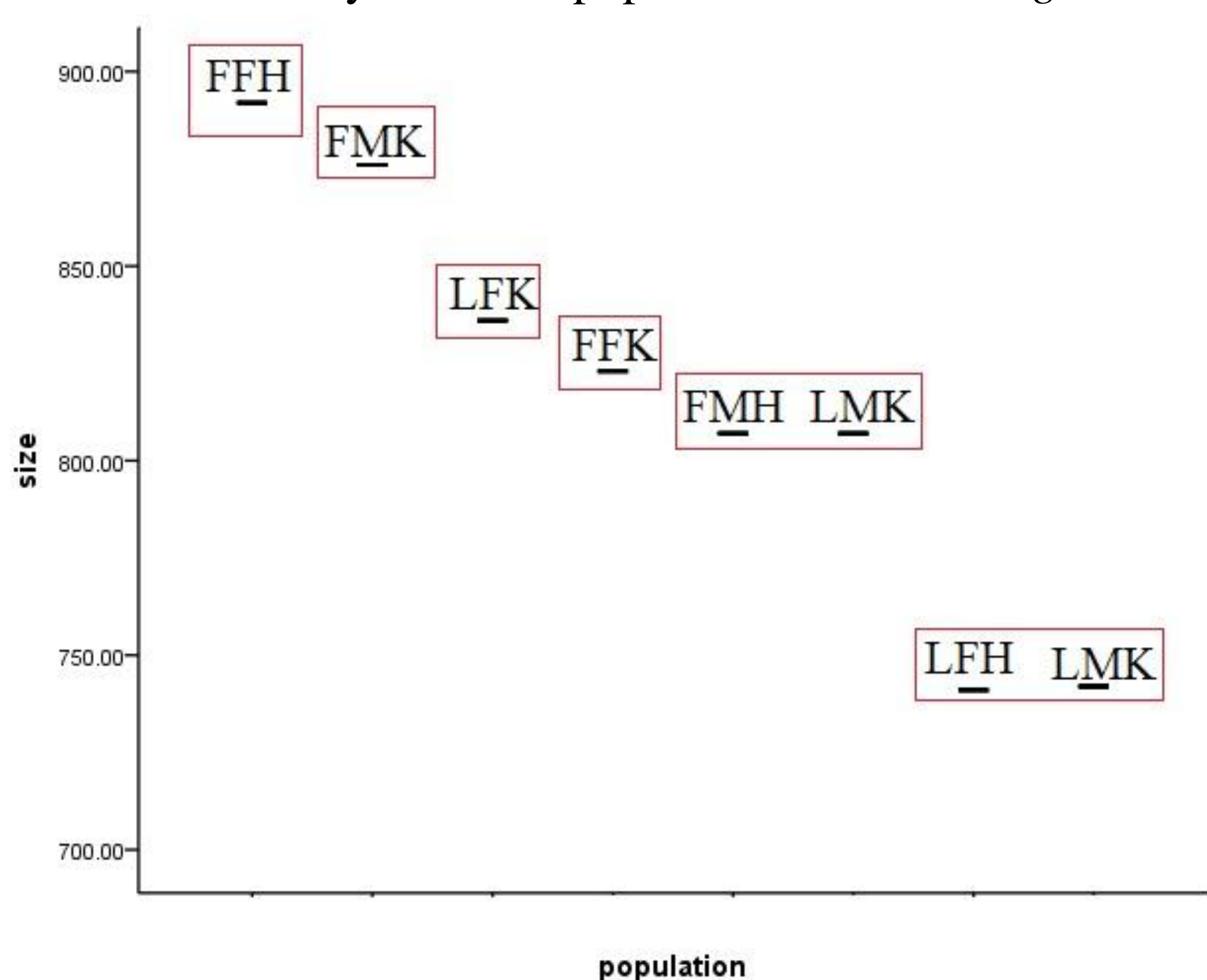


Figure 5. Size comparison based on all morphometric traits and centroid size among the populations of *H. variegata* in both sexes