SHORT COMMUNICATIONS

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DOES THE COEFFICIENT OF VARIATION REFLECT DEVELOPMENTAL INSTABILITY IN PLANTS? **Miroslava V. Veličković.** *Siniša Stanković Institute for Biological Research,* 11060 Beograd, Serbia and Montenegro

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Developmental stability or homeostasis refers to the ability of an individual to produce a consistent phenotype in a given environment (Graham *et al.* 1993). Reduced developmental stability can result from a wide variety of environmentally (or genetically) induced perturbations (Valentine and Soulé, 1973; Valentine *et al.* 1973; Siegel and Doyle, 1975; Siegel *et al.* 1992; Yablokov, 1986; Clarke, 1992, 1993).

Typically, the most commonly used index of developmental stability is the level of fluctuating asymmetry (Møller and Swaddle, 1997). Fluctuating asymmetry is the random deviation from perfect bilateral symmetry and is characterized by normally distributed R-L differences about a mean of zero (Van Valen, 1962; Palmer and Strobeck, 1986; Leary and Allendorf, 1989; Parsons, 1990), where R and L represent measurement of the right and left sides of bilaterally symmetrical traits, respectively. Besides FA, there are other indicators of developmental instability, such as the frequency of asymmetric traits, the frequency of phenodeviants, namely individual variance and the coefficient of variation or the relative variation in value of a trait. Concerning CV as an index of developmental perturbations, in animals and plants, there are opposite opinions.

The main aim of the present study was to evaluate the potential use of CV as an indicator of developmental perturbations of leaf traits in common plantain *Plantago major* L. (Plantaginaceae). Inasmuch as Rasmunson (1960) found a positive relationship between fluctuating asymmetry and the coefficient of variation in *Drosophila*, in the present study FA and CV values for each trait at both sites were calculated and then compared.

Two bilateral linear dimensions on each leaf: (1) leaf width (LW, which is the distance from the midrib to the right and left margins at a leaf's widest point) and (2) vein distances within a leaf (VD, which is the distance between veins in the left and right side of a leaf, measured at the leaf's widest point) were analyzed. These morphometric traits were measured with a digital caliper (0.01 mm accuracy). Thirty-two leaves per site (one leaf per plant) were sampled during July of 2004. Each measurement of the left and right sides for each leaf, was performed twice during two independent sessions, and all measurements were performed by the same person (V. M.).

Leaves were sampled from two sites in Northern Serbia. The Karaburma site is located near Pančevo, a town in Serbia which has a large petrochemical complex and fuel storage facilities. At the petrochemical plant, chlorinated solvents, e.g., trichloromethane, tetrachloromethane, trichloroethane, dichloroethene, trichloroethene, and others that are often associated with PVC (polyvinyl chloride) production as unwanted by-products were found in both soil and groundwater samples (Gopal and Deller, 2002). The Zemun (Gornji Grad) site is a forested area, far from any known contamination.

In keeping with Palmer (1994), the level of FA for each trait separately by site was calculated as σ_i^2 by partitioning the measurement error out of the side x individual mean squares of the ANOVA results (Palmer and Strobeck, 1986), while CV values were calculated using the formula:

$$CV = S.D. \times 100/\mu,$$

where S.D. = standard deviation and μ = mean value of the trait

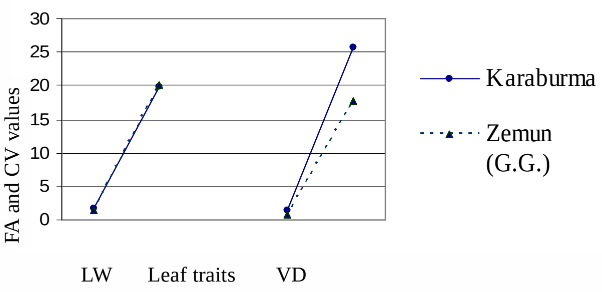

Fig. 1. Comparison of fluctuating asymmetry (FA) and coefficient of variation (CV) in two leaf traits, leaf width (LW) and vein distances within a leaf (VD), in two populations of common plantain: Karaburma = polluted area and Zemun (Gornji Grad) = reference site.

Before proceeding with the asymmetry analysis, the Pearson coefficient of correlation (r^2) between original and repeated measurements for each side of each trait was calculated. The following values were obtained: for leaf width, 0.999 (left side) and 0.999 (right side); and for distances within the leaf, 0.999 (left side) and 0.998 (right side). We therefore considered our measurements reliable. Deviation from normality of the R-L distributions was assessed using the Kolmogorov-Smirnov test of normality. All R-L distributions were normal ($0.14<d<0.19$, $p>0.05$).

Because the σ_i^2 values are variances, differences between samples were detected by comparing heterogeneous of variances using the F-test. The obtained results showed significantly higher values on the environmentally stressed sample than on the reference one ($p>0.01$).

Reporting significantly higher values of FA for both leaf traits on the environmentally stressed sample and a positive relationship between FA and CV values (Fig.1), the study corroborates the potential of CV as an indicator of developmental perturbations.

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