EFFECTS OF GENOTYPE AND ENVIRONMENT ON THE PLANT IONOME

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The ionome is defined as the elemental composition of a subcellular compartment, cell, tissue or organism. The ionome includes all mineral elements, whether they are essential or nonessential for life, in whatever chemical form they occur. Many studies report that the concentrations of mineral elements in shoot tissues differ between plant species growing in the same environment. Such comparative studies can be combined using residual maximum likelihood (REML) procedures and used to reveal phylogenetic effects on the concentrations of mineral elements in the shoot and provide insights to the evolution of the contrasting shoot ionomes of different plant taxa. Elements for which considerable variation in shoot concentrations has been attributed to phylogenetic divisions above the family level include silicon (Si), aluminium (Al), calcium (Ca), strontium (Sr) and magnesium (Mg). Elements with least variation in shoot concentrations attributed to phylogenetic divisions above the family level include nitrogen (N), phosphorus (P), sulphur (S) and selenium (Se). It is noteworthy that, among angiosperms, (1) commelinoid monocots have high shoot Si concentrations and low shoot Ca, Sr and Mg concentrations and (2) Caryophyllales have low Ca:Mg ratios in shoot tissues and an ability to accumulate sodium (Na) in shoots, even when grown in nonsaline solutions.

The availability of mineral elements in the soil can also affect the concentrations of mineral elements in shoots. However, environmental effects on phylogenetic variation in shoot ionomes have rarely been quantified. Recently, the hypothesis that phylogenetic variation in shoot ionomes is robust to environmental perturbation was tested using the Rothamsted Park Grass Continuous Hay Experiment. Herbage was sampled from six subplots that had received contrasting fertilizer treatments since 1856. Herbage was separated into its constituent species and concentrations of eleven mineral elements were determined in dried shoot material. Twenty one species were surveyed: *Agrostis capillaris*, *Alopecurus pratensis*, *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca rubra*, *Holcus lanatus*, *Poa pratensis* and *Poa trivialis* (Poaceae), *Ranunculus acris* (Ranunculaceae), *Lathyrus pratensis*, *Lotus corniculatus* and *Trifolium pretense* (Fabaceae), *Rumex acetosa* (Polygonaceae), *Plantago lanceolata* (Plantaginaceae), *Achillea millefolium*, *Centaurea nigra*, *Leontodon hispidus*, *Taraxacum officinale* and *Tragopogon pratensis* (Asteraceae), and *Anthriscus sylvestris* and *Heracleum sphondylium* (Apiaceae). Shoot concentrations of Ca, Mg, zinc (Zn), manganese (Mn) and Na showed significant variation associated with plant species, and responded similarly to fertilizer treatments in diverse plant species. Species x treatment interactions were indicated for P, potassium (K), nickel (Ni), copper (Cu) and iron (Fe). Different plant families could be distinguished by their shoot ionomes. The most informative elements for discriminant analysis were Ca > Mg > Ni > S > Na > Zn > K > Cu > Fe > Mn > P. Although shoot ionomes were sensitive to fertilizer treatment, phylogenetic variation in a subset of the shoot ionome (Ca, Mg, Zn, Mn) was robust to this environmental perturbation.

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