Variation in leaf mineral concentrations of terrestrial plants in Japan

Mitsuru Osaki[1,5], Toshihiro Watanabe[1], Sehat Jaya Tuah[1], Jitsuya Takada[2] Kenichi Satake[3] and Steven Jansen[4]

[1]Graduate School of Agriculture, Hokkaido University, Kita-9, Nishi-9, Kita-ku, Sapporo, 0608989 Japan
[2]Research Reactor Institute, Kyoto University, Kumatori-cho Sennan-gun, Osaka, 590-0494 Japan
[3]Faculty of Geo-Environmental Science, Rissho University, 1700 MegachiKumagaya-Shi, Saitama, 3600194 Japan
[4]Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3DS, U.K.
[5]Corresponding author

This study was based on the hypothesis that variation in the accumulation of mineral elements is closely related to the evolution of plant species with different nutrient requirements. We determined the concentrations of 40 elements in leaves of 387 plant species including 102 families in Japan, and also examined phylogenetic variation in element accumulation. It was revealed that elemental abundance in plants and also in the earth's crust decreases linearly with increasing atomic mass. Considering the occurrence and significance of the elements, both in plants and earth's crust, the pivotal role of the earth's crust as a natural reservoir for all of chemical elements in the biosphere is obvious. Considerable variation in element accumulation in different taxonomic groups of plants was observed, particularly in micro or trace elements. On the contrary, accumulation of essential macro-elements such as K, Ca and Mg, did not show much variation, indicating that macro-elements are acquired and maintained by plants in a relatively constant ratio in their organs regardless of plant species. As reported in previous works, Al accumulators were often found in the orders of Myrtales and Ericales, including Melastomataceae, Theaceae, Ternstroemiaceae, Symplocaceae, and Diapensiaceae. Both Zn and Cd accumulators were distributed in same families, Flacourtiaceae and Clethraceae. It was reported in a previous study that Zn and Cd share a common transport system at the root cell plasma membrane. Interestingly, Pteridophytes, the primitive plants, exhibited a wide spectrum of accumulative behavior for various metals, such as Al, Sc, Cr, Fe, Ni, Cu, As, Se, Cd, Sb, Ba, Lu, Au, Hg and all lanthanide elements. Since many metals induce excess toxicities in plant tissues, hyper-accumulating plants should have internal mechanisms to tolerate them. Results of this study have emphasized some necessary information on evolutional aspects of mineral accumulation in terrestrial plants.