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#### 14. Biogeography, Ecology, and Evolution~~Geology and Soils~~

### The availability of nickel in ultramafic soils~~Hyperaccumulation of Ni in serpentines of Albania and Continental Greece: what are the trade-off between accumulated elements?~~

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Over the past ~~sixty years only a few soil scientists have devoted time and energy to understand the typical and unusual features of ultramafic soils, mostly as a key factor to understand the specificity of the ecosystems they host. In all cases, it appears that ultramafic soils undergo a particular pedogenesis, mostly as a consequence of the unusual chemical composition of the substrate (high Mg and Fe, low Al, Ca and K)~~decades, reports concerning the hyperaccumulating flora of the Balkans have been published either from herbarium specimens or from field-collected specimens. Most of the reports focused on the single accumulation of Ni. Progressively, other elements have been taken into account when reporting for field-sampled hyperaccumulator plants. Only very recently, it was discovered that Alyssum murale and other Brassicaceae had an extreme accumulation potential for K, although this element is deficient in serpentine soils. After a few surveys in Albania and Continental Greece, we now have a good vision of the hyperaccumulator diversity. We even report a new taxon that had never been mentioned before as a Ni-hyperaccumulator. Two families are present in the ultramafic areas of the two countries (Brassicaceae and Asteraceae) and several genus for the Brassicaceae family (i.e. Alyssum, Bornmuellera, Leptoplax and Noccaea). Two species of the Centaurea genus represent the Asteraceae hyperaccumulators. Continental Greece makes a transition between Turkey and the rest of the Balkan peninsula. We have reported the main characteristics of the fertility of the soils on which they were collected and have analysed full composition of cations in the plant parts (stem, leaves, reproductive parts). Several locations for each taxon are reported whenever possible.

Results clearly indicate different behaviours. Some species (e.g. Bornmuellera tymphaea and Leptoplax emarginata) are able to accumulate more Ni than others and this seems to be related to a lower Ca uptake. Calcium and potassium are taken up in similar concentrations than Ni and the three elements are always higher than Mg. Under A reasonable hypothesis to explain the higher levels of Ni accumulation is probably a lower uptake of the other cations (i.e. Ca and K) and probably relies on either genetic or phenotypic differences. The identification of the potential of hyperaccumulator taxa for phytoextraction has to be interpreted in a more complete way by analysing the cation absorption balance in whole plants. Soil analysis and level of available Ni, Ca and K has also to be taken into account to fully characterise the environment conditions in which the plant has performed cation

~~accumulation. moderate weathering conditions, Mg is the first element to be leached out and Cambisols are formed with significant amounts of Ni-enriched amorphous metal oxides and secondary clays which hold large pools of available Ni. High-exchange clays (e.g. smectites) may form and are another source of available Ni.~~

~~Further weathering may follow two main pathways according to soil water drainage: (1) a more intense weathering will lead to leaching (temperate) and lateritisation (tropical conditions). Clay minerals are being hydrolysed and Si is then lost. Fe-oxides concentrate in soils with a higher degree of crystallinity and contain unavailable forms of Ni included in their crystal lattice. Nickel is lost at each dehydration step. Further dehydration of goethite into hematite in ferricrete decreases Ni content with strictly unavailable forms. (2) In poor draining conditions (lowlands) in warm-temperate to tropical climates, Mg-rich clays may accumulate in soils and become the main bearing phases for available Ni.~~

~~These general features may also vary according to the bedrock composition (e.g. degree of serpentinisation) which will temper or accelerate these phenomena.~~

~~**In terms of biogeochemical cycling, it seems that the initial lack of Ca and K is being compensated by an extreme and active recycling of these elements through both physico-chemical and biological mechanisms. The Cation Exchange Capacity in the surface organo-mineral  $A_1$  horizons is also enriched with Ni compared to lower horizons. Plants seem to be strongly involved in the recycling of major (Ca and K) and trace (Ni) elements in the surface of soils.**~~

~~Key words: Serpentine, pedogenesis, hyperaccumulation, mineral weathering, calcium, biogeochemical, potassium cycling, bearing phases, *Centaurea charrellii*, bioavailability, *Centaurea thracica*, cation budget~~