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Seasonal Variations in Cadmium Concentrations of Plant Leaves

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Several factors influence the metal concentrations of vascular plants. Soil and soil water properties (including pH and ionic composition) affect the root uptake and atmospheric deposition contributes to total leaf concentrations. Many environmental factors (including solar radiation, temperature and age of the plant) control general functions and growth of the plant. The toxic effects of cadmium on tree roots may be related to an altered nutrient uptake (Gussarsson 1994). As we found increasing cadmium concentrations from Bank voles *(Clethrionomys glareolus)* in southern Finland during a 1.5 months sampling period (Lodenius et al. 2002), we wanted to check the possible influence of food items on the variations in these animals. *Vaccinium myrtillus* is an important food item for voles in Finland but they may also consume shrubs like *Salix*.

MATERIALS AND METHODS

Leaves of *Salix caprea* and *Vaccinium myrtillus* were collected eleven times during the growth period (21.5 - 7.11) in summer 2000 (*V. myrtillus* has dropped its leaves at the last sampling occasion). The samples were collected from a suburb of Helsinki with no significant pollution sources. The leaves of *Salix* were collected from the same specimen and the same side (shade) of the plant and those of *Vaccinium* from a limited area (approximately 5x5 m). Duplicate samples were analysed. The leaves were dried, homogenized, dissolved in concentrated HNO_3 and analysed by AAS (Varian SpectrAA 400 equipped with GTA-96).

RESULTS AND DISCUSSION

No trend was found for cadmium concentrations in leaves of *Vaccinium myrtillus* while the concentrations steadily increased in *Salix caprea* (Figure 1). The starting point for *S. caprea* is clearly higher than that of *V. myrtillus* (0.31 vs 0.05 μg/g dw). In *S. caprea* the concentrations increased during the growth period being more than twice as high at the end compared to the situation in May.

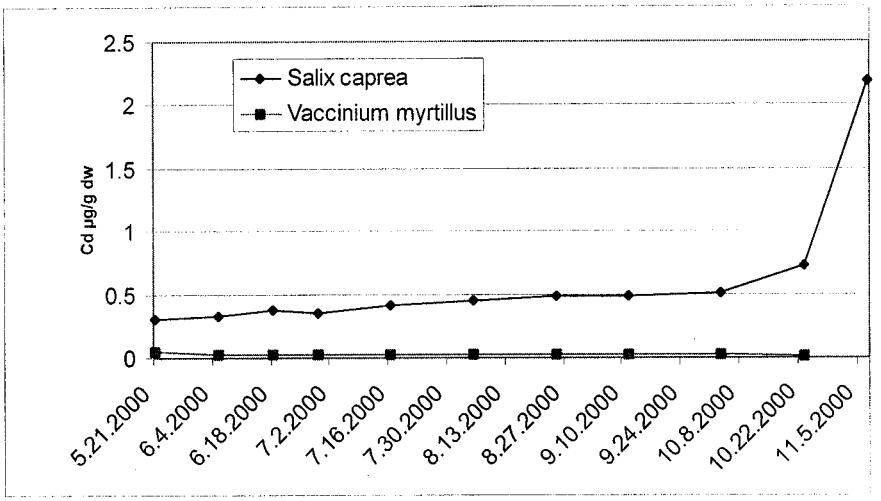

Figure 1. Cadmium concentrations (µg g^{-1} dry wt) in leaves of *Vaccinium myrtillus* and *Salix caprea* during the growth season.

Seasonal variations in metal concentrations have been observed in many different organisms, eg. in vascular plants (Glavac et al. 1990, Hagemeyer et al.1992, Nikolaidis et al. 1996), in mosses (Markert & Weckert 1989), in evertebrates (Janssen et al. 1990, Braunschweiler 1995) and in mammals (Crete et al. 1989). The variations are not consistent: maximum concentrations occur at different seasons for different organisms. In *Phragmites australis* the concentrations have been found to increase until August-September where after a decline can be seen (Nikolaidis et al. 1996). In *Fagus sylvatica* Glavac et al. (1990) recorded peak values in spring and minimum concentrations in the autumn while Hagemeyer et al. (1992) found marked variations with lowest concentrations in April, highest in June and intermediate in September and the following January.

Species belonging to the genus *Salix* are known for their ability to accumulate cadmium which fact is a disadvantage when using *Salix* for biomass energy. On the other hand, cadmium has been reported to be toxic to tree fine roots already at low concentrations in the soil water (Godbold & Hüttermann 1985). *S. caprea* removes nutrients and chlorophyll from the leaves before dropping them in the autumn. This may explain the sharp increase in Cd concentrations in late autumn. In *V. myrtillus* most of the nutrients and chlorophyll remains in the leaves, which may explain the absence of a late autumn increase of cadmium.

Obviously, *S. caprea* has both a greater capability than *V. myrtillus* for cadmium uptake (higher initial concentrations) and a slower removal (increasing concentrations during the growth period). The observed seasonal variation may at least partly explain the increase of cadmium in voles. This variation should be taken into account when analysing environmental cadmium concentrations.

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